THE CENTER FOR RESEARCH ON LEARNING AND TEACHING IN ENGINEERING

2011-2012
Report for the College of Engineering

UNIVERSITY OF MICHIGAN

Authored by: Cynthia Finelli
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HIGHLIGHTS

The Center for Research on Learning and Teaching in Engineering (CRLT-Engin), together with the main CRLT, provides a variety of services for the College of Engineering. Some highlights of 2011-2012 follow.

NEW INITIATIVES

CRLT-Engin designed and implemented the large course pilot initiative for Chemical Engineering and the successful Teaching Circle for Large Engineering Courses program. Participants’ approaches to teaching changed significantly during the program.

CRLT-Engin staff merged their faculty development work with their research interests for the NSF project on motivating faculty to adopt research-based effective teaching practices. Data from focus groups with faculty, students, and advisors, and from a student survey have elucidated ways to enhance the culture of teaching and learning in engineering.

COLLEGE-WIDE PROGRAMS

CRLT-Engin offered eleven college-wide seminars and seven programs for new instructors. Overall, these had an attendance of 213 (164 unique individuals) and 607 (379 unique individuals), respectively. These programs included a new required program for first time undergraduate Instructional Aides.

Three engineering faculty were among five, university-wide recipients of the esteemed Teaching Innovation Prize offered by the main CRLT.

CONSULTATIONS AND CLASSROOM INTERVENTIONS

CRLT-Engin reached out to department chairs to better inform them about CRLT-Engin, connected with new faculty, and conducted over 360 midterm student feedback sessions and one-on-one consultations on teaching and learning.

NATIONAL LEADERSHIP

CRLT-Engin staff consulted with 30 individuals at 26 organizations outside U-M and reviewed several proposals for NSF, journal manuscripts, and conference papers.

RESEARCH IN ENGINEERING EDUCATION

CRLT-Engin provided a variety of opportunities to strengthen the engineering education research community. These included: (1) almost 80 consultations on proposal preparation or education research, and (2) eight other sessions that engaged 166 participants (117 unique individuals).

Engineering faculty were awarded twelve grants totaling $58,550 (through programs administered by the main CRLT and including $6,000 of funding matched by CoE).

Staff from CRLT-Engin engaged in eleven research projects, submitted five NSF grant proposals, and published 30 refereed journal or conference publications (including six manuscripts in the prestigious Journal of Engineering Education).
GSIs enjoying a performance by the CRLT Players.
ABOUT CRLT IN ENGINEERING

The Center for Research on Learning and Teaching in Engineering (CRLT-Engin) represents a partnership between the College of Engineering (CoE) and the main CRLT office (www.crlt.umich.edu). Established in 2004, CRLT-Engin is located on North Campus and is staffed by experienced engineering educators who work in close collaboration with CoE faculty and administrators. The office, originally named CRLT North, was renamed in 2011 to more accurately portray the partnership between CRLT and CoE and the joint reporting structure of CRLT-Engin. Both CRLT-Engin and the main CRLT office provide services to engineering instructors. Goals for CRLT-Engin include:

- Delivering high-quality professional development programs for faculty and student instructors,
- Consulting with individuals and units wishing to promote a culture of outstanding teaching and learning,
- Supporting faculty engaged in research and scholarship in engineering education,
- Providing national leadership to enhance the visibility of U-M in engineering education, and
- Planning and conducting rigorous research in engineering education.

CRLT IN ENGINEERING ADVISORY BOARD

The CRLT-Engin Advisory Board provides guidance and insight about programs, and it advocates for CRLT-Engin within the engineering community. In 2011–2012, the board assisted in selecting the Richard and Eleanor Towner Prize for Outstanding GSIs and met twice. Members of the board include:

- Krzysztof Fidkowski – Aerospace Engineering,
- John Foster – Nuclear Engineering and Radiologic Sciences,
- Jessy Grizzle – Electrical Engineering and Computer Science,
- Jerome Lynch – Civil and Environmental Engineering,
- Joanna Millunchick – Materials Science and Engineering,
- Mark Moldwin – Atmospheric, Oceanic and Space Sciences, and
- Margaret Wooldridge – Mechanical Engineering.

2012 CRLT IN ENGINEERING FACULTY ASSOCIATE

Dr. Joanna Millunchick was selected as the 2012 CRLT-Engin Faculty Associate because of her ongoing commitment and dedication to programs at CRLT-Engin. In her role, she has collaborated on developing a Teaching Circle on Large Engineering Courses. Besides planning the program and co-facilitating its multiple sessions, she consulted with and provided advice for faculty participants, is assisting with disseminating results of the project through CoE and beyond, and will help to plan the next phase of the project. She also presents and facilitates programs for CRLT-Engin as needed.
CRLT IN ENGINEERING STAFF

During 2011–2012, Cynthia Finelli, Tershia Pinder-Grover, and Shanna Daly served as primary professional staff of CRLT-Engin. Their biographies are listed here. Additional programming and consultations were provided by staff from the main CRLT office including Constance Cook, Crisca Bierwert, Chad Hershock, Matthew Kaplan, Jeffrey Steiger, Mary Wright, and Erping Zhu. Program support was provided by Laurie Stoianowski, Kenyon Richardson, Pam Fisher, Amy Wester and Charmayne Wiley, as well as by Amy Hamermesh and Jeri Hollister.

CYNTHIA FINELLI, DIRECTOR OF CRLT-ENGIN AND RESEARCH ASSOCIATE PROFESSOR

Dr. Cynthia Finelli earned B.S.E.E., M.S.E.E., and Ph.D. degrees from U-M in 1988, 1989, and 1993, respectively. Prior to joining CRLT in April 2003, she was the Richard L. Terrell Professor of Excellence in Teaching, founding director of the Center for Excellence in Teaching and Learning, and associate professor of electrical engineering at Kettering University. Her current research interests include evaluating methods to improve teaching, studying faculty motivation to change classroom practices, and exploring ethical decision-making in engineering students. Dr. Finelli was co-editor for a special issue of the International Journal of Engineering Education on applications of engineering education research, is past Chair of the Educational Research and Methods Division of the American Society of Engineering Education, and holds an appointment as research associate professor in engineering education at U-M.

TERSHIA PINDER-GROVER, ASSISTANT DIRECTOR OF CRLT-ENGIN

Dr. Tershia Pinder-Grover earned a B.S. degree in Fire Protection Engineering from the University of Maryland in 1999 and M.S. and Ph.D. degrees in Mechanical Engineering from U-M in 2002 and 2006, respectively. She joined CRLT in August 2005, where she coordinates initiatives for engineering GSIs (especially programs for Preparing Future Faculty), develops workshops and seminars, and consults with faculty and graduate students on a variety of pedagogical topics. Her current research interests include examining the effect of instructional technology on student learning and performance and examining GSIs’ perceptions of active learning teaching methods.

SHANNA DALY, INSTRUCTIONAL CONSULTANT FOR CRLT-ENGIN AND ASSISTANT RESEARCH SCIENTIST

Dr. Shanna Daly earned a B.E. in Chemical Engineering from the University of Dayton in 2003, and an M.S. in Chemistry and a Ph.D. in Engineering Education from Purdue University, in 2006 and 2008, respectively. At CRLT-Engin, Dr. Daly consults with faculty and GSIs, and she coordinates the Engineering Teaching Consultant program. Dr. Daly holds an appointment as assistant research scientist in engineering education at U-M. Her research focuses on the investigation of design ideation, innovation practices, and creative processes as well as the translation of research to practice in the form of pedagogy, curriculum development, and faculty support. She received the Apprentice Faculty Grant Award from the Educational Research Methods Division of ASEE.
CRLT-Engin provides several college-wide programs to promote a culture of teaching and learning in engineering. These include two large course programs (a new strategic initiative this year), the CRLT-Engin Seminar Series, programs to support engineering education research, and activities for new engineering instructors. Several of these included theater performances by the CRLT Players. Altogether, these programs had an attendance of 1040 (612 unique individuals). Additionally, CRLT-Engin coordinates the Engineering Teaching Consultant Program and the Towner Prize for Outstanding GSIs, maintains a website (with nearly 25,000 hits annually), and provides several education-related grants and university-wide programs through the main CRLT. The chart here shows attendance data for several of the college-wide programs.

Large Course Initiatives

Chemical Engineering Large Course Program

In collaboration with the Associate Dean for Undergraduate Education in Engineering, CRLT-Engin planned and coordinated this program for three Chemical Engineering faculty in Fall 2011. The program involved a series of six meetings that featured research-based best practices and technology demonstrations. The faculty participants learned from each other and from their successful peers, and they were able to adopt effective teaching practices and instructional technology for their large-course teaching. In Winter 2012, the program expanded to two additional Chemical Engineering faculty.
Teaching Circle for Large Engineering Courses

- CRLT-Engin’s Director co-facilitated this program together with Faculty Associate Joanna Millunchick. Twenty-five faculty applied, and seven were invited to participate. The program consisted of four sessions which addressed the following topics:
  - Active learning,
  - Building rapport in large classes,
  - Student motivation and screencasts, and
  - Student preconceptions and clickers.

The sessions featured relevant research and practical implementation strategies, and they allowed faculty to interact extensively with the two program facilitators, each other, and other faculty who were invited guests. Participants had a midterm student feedback session, and they completed a survey and had classroom observations at the beginning and end of the term. Each was eligible for a $1,000 grant to support their large course teaching.

- Faculty participants’ approaches to teaching changed significantly during the program, and their self-reported enthusiasm and clarity increased statistically significantly more than it did for faculty in a control group.

It was a fantastic program that far exceeded my expectations! Not only did it provide me with great ideas and an opportunity to freely ask questions about how to improve my teaching, but I greatly valued the networking opportunities with other faculty of various levels of expertise facing similar challenges in engineering.

The possibility of changing my classroom from one of passive learning to one that incorporates some active learning is the big take-away possibility that this program provided. Plus, I now believe that I can undertake such a transition in an incremental fashion that allows me to avoid huge risky time investments and to take corrective action in timely manner.

The program definitely affected how I approach teaching. I am now aware of the resources and ways I can try to use in my teaching. This is empowering to me.

Teaching Circle participants
CRLT IN ENGINEERING SEMINARS

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<td><strong>113</strong></td>
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*Individuals who attended multiple events are counted multiple times

In 2011–2012, there were 213 attendees (representing 164 unique individuals) at the following 11 programs in the CRLT-Engin Seminar Series:

1. **Are they getting it? Low stakes ways to assess student learning** (for graduate students and postdocs)
2. **Research based principles for making learning work**
3. **Education research in the College of Engineering: Who’s doing what?** A panel featuring Lorelle Meadows, Joanna Millunchick, and Cindy Finelli
4. **Using concept questions to engage students and check their progress** (for faculty)
5. **Your advisor: The collaborator, the senior scientist, or the hands-off supervisor?** (for GSIs), featuring the CRLT Players
6. **Best teaching practices: Perspectives from experienced GSIs** (for GSIs)
7. **Seven strategies to improve your teaching** (for GSIs)
8. **Instructional technology in engineering courses,** with faculty panel featuring Lola Eniola-Adefeso, Joanna Millunchick, and Jeff Ringenberg
9. **Inspiring the entrepreneurial mindset in the classroom**
10. **The key to an impressive academic job application: Your teaching philosophy statement** (for GSIs)
11. **Ethical development in engineering undergraduates: Research findings**

I am writing to let you know that I believe that attending your workshops played a big role my achieving tenure... The reward for attendance at the programs and subsequent implementation was consistently high teaching scores.

Unsolicited comment from newly tenured Associate Professor
CRLT-Engin created multiple opportunities for faculty who are pursuing engineering education research to network and share data, refine research ideas, participate in a poster fair, and mentor graduate students. These programs for engineering education research engaged 166 participants (117 unique individuals) and included:

- **Research and Scholarship in Engineering Education Poster Fair** with 17 posters on display,
- Seven networking and data-sharing sessions to discuss ongoing engineering education research. In all, there were 74 present, representing 34 unique individuals,
- Six consultations with 4 faculty teams regarding Investigating Student Learning projects,
- Email group for members of the U-M engineering education research community, with more than 60 messages sent to the group,
- Meeting of faculty board for the Rackham Certificate in Engineering Education Research, subsequent updates to certificate requirements, and first recipient of the certificate, and
- Support and guidance for student chapter of ASEE and their panel on engineering education research following CRLT-Engin poster fair.

### Programs for Engineering Education Research

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*Individuals who attended multiple events are counted multiple times*
### Programs for New Instructors

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*Individuals who attended multiple events are counted multiple times

#### New Faculty Programs

- **There were 58 new engineering faculty (representing 38 unique individuals) in attendance at four workshops:**
  - **College of Engineering New Faculty Orientation**, featuring a panel of experienced faculty discussing teaching at U-M and a session for new faculty to deliver a practice lesson and receive feedback on their teaching,
  - **Strategies for New Faculty Success**, a program which spurred the new faculty present – the new faculty in attendance to organize a series of networking lunches,
  - **Networking for New Engineering Faculty**, and
  - **Preparing an NSF Career Proposal**, 25 present (including 15 engineering assistant professors and several postdoctoral fellows) plus seven presenters.

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I benefitted a lot from the practice teaching session [at new faculty orientation], very good session indeed.

Great job by the organizers. **Very useful information.**

*Participants in College of Engineering New Faculty Orientation*
**ENGINEERING GSI & IA TEACHING ORIENTATIONS**

- CRLT-Engin coordinates the mandatory teaching orientation program for new GSIs and IAs. Altogether, **607 GSIs/IAs** (representing **341 unique students**) attended the three separate programs:
  - **GSI Teaching Orientation**, a day-long program featuring two separate concurrent sessions on teaching, a performance by the CRLT Players, and a practice teaching session,
  - **IA Teaching Orientation**, an evening teaching program for undergraduate IAs with two concurrent sessions and a practice teaching session, and
  - **Advanced Practice Teaching** sessions focusing on active learning.

- Ratings of the program continue to be high, as shown below.

**Would you recommend the program?**

- Yes: 95%
- No: 5%

**Do you feel well prepared to teach?**

- Yes: 96%
- No: 4%

> The orientation cleared up a lot of the questions I’ve had about grading, office hours, and other topics I never considered.

> GSI who participated in teacher training in Fall 2011

**ENGINEERING TEACHING CONSULTANTS**

- CRLT-Engin hires, trains, and manages the Engineering Teaching Consultant (ETCs). The ETCs are a group of experienced GSIs who work in teams to serve the entire engineering GSI/IA population by mentoring 70-90 GSIs/IAs per team. In the fall and winter, respectively, ETCs served **311** and **288 GSIs/IAs**. Consultations and midterm student feedback services provided by the ETCs are documented elsewhere in this report.

> Thank you ... for making the ETC program so great...it really is one of the best experiences I have had at the university.

> Graduating ETC, Winter 2012
GROUP CONSULTATIONS

- ETCs arranged 16 group activities (which were attended by 110 GSIs/IAs) for the following departments:
  - Aerospace Engineering,
  - Atmospheric, Oceanic, and Space Sciences
  - Biomedical Engineering,
  - Civil and Environmental Engineering,
  - Chemical Engineering,
  - Electrical Engineering and Computer Science,
  - Industrial and Operations Engineering,
  - Mechanical Engineering,
  - Materials Science and Engineering,
  - Naval Architecture and Marine Engineering,
  - Nuclear Engineering and Radiologic Engineering,
  - Undergraduate Engineering.

DEPARTMENT GSI ORIENTATIONS

- ETCs were present at eight department orientations. Approximately 150 students attended programs held by the following departments:
  - Chemical Engineering (three sessions),
  - Electrical Engineering and Computer Science,
  - Industrial and Operations Engineering (two sessions), and
  - Mechanical Engineering (two sessions).

PROFESSIONAL DEVELOPMENT FOR ETCS

- ETCs attended biweekly professional development programs on topics that included:
  - Active learning,
  - Bloom’s taxonomy,
  - Consulting with GSIs,
  - Midterm student feedbacks,
  - Multicultural teaching,
  - Peer-to-peer teaching,
  - Teaching philosophies, and
  - Team building.
Richard and Eleanor Towner Prize for Outstanding GSIs

CRLT-Engin coordinated the Towner Prize to recognize outstanding graduate student teaching. Members of the CRLT-Engin Advisory Board, as well as others, reviewed the 26 nominations. $1,500 awards were made to the following four GSIs this year (and winners were announced in the Michigan Daily and the College of Engineering Facebook and Twitter pages):

- Shaurjo Biswas
  Materials Science and Engineering,
- Andrew DeOrio
  Electrical Engineering and Computer Science,
- Marcial Lapp
  Industrial and Operations Engineering, and
- Shani Ross
  Biomedical Engineering.

CRLT in Engineering Website

The website had 8,860 visits (by 3,225 unique visitors) and 24,172 pageviews/hits. The pages most frequently visited include:

- Services for GSIs & IAs (8,949 hits),
- Workshops & seminars (2,765 hits),
- Towner Prize for GSIs (1,618 hits),
- Engineering education research resources (1,105 hits), and
- Certificate in engineering education research (700 hits).

CRLT Players Theater Performances for Engineering

The CRLT Players Theater Troupe performs sketches that engage faculty and graduate students in discussions of diversity, effective pedagogy, and institutional climate. In 2011-2012, the CRLT Players had four performances that included 228 engineers (representing 211 unique individuals) in the audience:

- Climate in the Classroom, addressing diverse student perspectives and international experiences in the engineering classroom (two performances),
- Graduate Student Vignettes, focusing on developing good relationships between graduate students and their faculty research advisors, and
- The Faculty Meeting, depicting a faculty discussion about a faculty search and demonstrating how gender dynamics and faculty rank influence the conversation.
GRANTS ADMINISTERED THROUGH THE MAIN CRLT

- In 2011–2012, the main CRLT office administered several grants for faculty to improve teaching and learning, and engineering faculty were very competitive for them. Twelve engineering proposals were funded for a total of $52,550 (with additional matching funds totaling $6,000 provided by CoE).

INVESTIGATING STUDENT LEARNING (ISL) COMPETITION

- Through the ISL competition, awardees attend an all-day symposium on scholarship of teaching and learning, work with staff from CRLT-Engin to conduct education research on student learning, and present their work at the year-end ISL poster session. This year, the following engineering awards were made (and CoE provided $6,000 in matching funds)
  - Robin Fowler – Technical Communication
    The effect of electronic platform on student engineering design team success, $3,000 (matched by CoE).
  - Steve Yalisove – Materials Science and Engineering
    Improving student learning with an inverted classroom model: An action-based immersive learning experience proposal, $3,000 (matched by CoE).

TEACHING INNOVATION PRIZE

- Through the Teaching Innovation Prize competition, five faculty from across the university were recognized for developing student learning innovations. This year, three engineering faculty received the award, the largest number of recipients from a single college to date. Each recipient was awarded $5,000 and will disseminate their teaching innovations at a future campus-wide event.
  - Lola Eniolo-Adefeso – Chemical Engineering
    Using K-12 outreach to motivate self-directed learning in the engineering classroom.
  - Joanna Millunchick – Materials Science Engineering
    The use of screencasts in large lecture courses.
  - Kathleen Sienko – Mechanical Engineering
    Design for global health.

OTHER GRANT COMPETITIONS

- Engineering faculty were awarded the following seven grants:
  - David Chesney – Electrical Engineering and Computer Science
    Microsoft Kinect platform for game and app development for patients with autism - Gilbert Whitaker Fund: Stage 1, $10,000.
  - Amy Cohn – Industrial and Operations Engineering & Michelle Macy – Medical School
    Developing a framework for hands-on collaborations between engineering and medical students on open-ended projects - Gilbert Whitaker Fund: Stage 1, $9,700.
  - Allen Liu – Mechanical Engineering
    Teaching ME 211 using a tablet computer - Instructional Development Fund, $500.
  - Wei Lu – Mechanical Engineering
    A virtual lab for nanotechnology education - Teaching with Technology Institute, $2,500.
  - Stephanie Sheffield – Technical Communication
    Improving oral presentation, design, delivery, and feedback in large lecture courses through interactive online in-class activities - Teaching with Technology Institute, $2,500.
  - Jan Stegemann – Biomedical Engineering
    Integrating case studies into the Biomedical Engineering design - Faculty Development Fund, $5,850.
  - Dawn Tilbury – Mechanical Engineering
    Take-home control experiment - Instructional Development Fund, $500.
CRLT UNIVERSITY-WIDE PROGRAMS

CRLT offers a variety of seminars and workshops for participants across the university. There were 214 engineering participants (representing 138 unique individuals) at activities offered by the main CRLT office.

SEMINARS

- 73 faculty and GSIs (representing 48 unique individuals) at 18 CRLT Seminar Series events.
- 30 participants (18 unique individuals) at seven Enriching Scholarship programs in Spring 2012.

PROVOST’S CAMPUS LEADERSHIP PROGRAM

- The main CRLT office worked with the Provost’s Office to organize the Provost’s Campus Leadership Program, an orientation for new chairs and associate deans and monthly sessions for both new and experienced ones. During the year, there were 30 engineering attendees (11 unique deans or chairs) at six separate sessions.

POSTDOCTORAL SHORT COURSE

- Seven of 34 participants in the seven week Rackham/CRLT Postdoctoral Short Course on College Teaching in Science and Engineering were engineering postdocs.

PREPARING FUTURE FACULTY (PFF) PROGRAMS

- In May, CRLT-Engin staff co-directed the Rackham/CRLT Seminar on Preparing Future Faculty, and eight engineering students participated (out of 55 total).
- The main CRLT office offered a one-day conference, Getting Ready for an Academic Career. 60 engineering graduate students and postdocs participated (out of 321 total).
- The Rackham/CRLT Graduate Student and Postdoc Mentorship Program brings together U-M graduate students and faculty from nearby colleges and universities to explore faculty work-life and the academic job search. Three mentor / mentee pairs (out of 24 total) involved engineering graduate students.

GRADUATE TEACHER CERTIFICATE PROGRAM

- With the Rackham School of Graduate Studies, the main CRLT office coordinates a program for graduate students across the university to earn a U-M Graduate Teacher Certificate. One of the 47 students who completed certificates in 2011–2012 was an engineering student.

OTHER PROGRAMS

- 14 engineering faculty at the Thurnau Professor Dinner and 18 at the International Faculty Dinner.
- 41 engineering participants at the CRLT 50th Anniversary Panel and Plenary.
- 15 new engineering faculty at the university-wide New Faculty Orientation.
- Two new engineering GSIs at the university-wide GSI Teaching Orientation.
- Two engineering faculty at the Provost’s Seminar on Teaching titled Teaching with Collections: Engaging Students in the Archives, Museums, and Gardens of the University of Michigan.
- Four engineering faculty participants in the Google Faculty Learning Community.
SERVICES FOR INDIVIDUAL FACULTY, GSIs, AND POST-Docs

CRLT-Engin provides a comprehensive range of services for individual instructors that includes classroom interventions (such as midterm student feedback sessions), teaching-related consultations, consultations on proposal preparation and education research, and long-term collaborations.

MIDTERM STUDENT FEEDBACK SESSIONS AND OBSERVATIONS

- Staff from CRLT-Engin (including the Engineering Teaching Consultants) conducted:
  - 35 Midterm Student Feedback sessions for engineering faculty and 55 for engineering GSIs, allowing 2,949 students to provide feedback on faculty teaching.
  - 24 classroom observations and follow-up consultations with engineering faculty, and 28 for GSIs.

Your comments and suggestions were very constructive, and easy to implement. I used the [MSF] service for a course that I was teaching for the sixth time. Even though I was comfortable with the way I had taught the course, the program encouraged me to make simple but important changes that I know had a big impact on the students. I have recommended this service to all of my colleagues, whether they are junior or senior.

Assistant Professor, Fall 2011

Thanks again for the midterm student feedback help! It really changed the way that I both structured my class and interacted with my students. I truly appreciate it!

Assistant Professor, Winter 2012

I had a midterm feedback session for the first time in my long career at U-M. It was really valuable.

Full Professor, Winter 2012
INDIVIDUAL CONSULTATIONS

TEACHING-RELATED CONSULTATIONS

- Staff from CRLT-Engin (including the Engineering Teaching Consultants) and the main CRLT conducted the following consultations about issues related to teaching and learning:
  - 45 consultations for 33 unique faculty, staff, or administrators, and
  - 97 consultations for 78 unique graduate students (including GSIs).

CONSULTATIONS ON PROPOSAL PREPARATION

- Staff conducted 22 consultations with 15 U-M engineering assistant professors submitting NSF CAREER proposals.
- Staff conducted 25 consultations with 15 unique faculty preparing NSF proposals other than the CAREER and internal proposals (other than the CAREER) for the following programs:
  - NSF Research Initiation Grants in Engineering Education (RIGEE) Program,
  - NSF Broadening Participation Research Initiation Grants in Engineering (BRIGE) Program,
  - NSF Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) Centers,
  - NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) Program,
  - NSF Transforming Undergraduate Education in STEM (TUES) Program, and
  - Mellon Foundation.

CONSULTATIONS ON EDUCATION RESEARCH

- Staff from CRLT-Engin conducted the following consultations about issues related to engineering education research:
  - 11 consultations for 10 unique faculty, staff, or administrators, and
  - 20 consultations for 15 unique graduate students (including GSIs).

I wanted to let you know that the CAREER proposal I submitted this summer was awarded and I think the assistance I received from you in formulating a broader impacts plan was very helpful.

CAREER recipient

I will be resubmitting my CAREER proposal this year, but I don’t think I will be changing up my broader impact and educational section much, because it got great reviews thanks to your help last year.

CAREER recipient
### Consultations* (Including MSFs) Related to

<table>
<thead>
<tr>
<th>Department</th>
<th>MSFs and Observations</th>
<th>Teaching</th>
<th>Proposal Preparation</th>
<th>Education Research</th>
<th>Total</th>
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<td>NERS</td>
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<tr>
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<td></td>
<td>9</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>142</strong></td>
<td><strong>142</strong></td>
<td><strong>47</strong></td>
<td><strong>31</strong></td>
<td><strong>362</strong></td>
</tr>
</tbody>
</table>

This table includes services provided by the Engineering Teaching consultants

*Individuals who had multiple services are counted multiple times.
SUSTAINED CONSULTATIONS AND COLLABORATIVE PROJECTS

• CRLT-Engin staff engaged in sustained consultations with faculty and staff on the following projects:
  ▪ Improving teaching style,
  ▪ Learning qualitative research skills in survey design, interview protocol design, and qualitative data analysis, and
  ▪ Refining a course-based innovation for a research journal.

• CRLT-Engin staff engaged in long-term collaborations with faculty and staff on the following projects:
  ▪ Designing a TA training program for the Summer School for Integrated Computational Education,
  ▪ Designing and leading sessions for the Center for Entrepreneurship Young Entrepreneurs Workshop,
  ▪ Designing and leading two sessions for the Design Immersion Program,
  ▪ Discussing the new teaching orientation policy for undergraduate instructional aides,
  ▪ Investigating interdisciplinary interactions in large-scale research and development projects,
  ▪ Planning NextProf: Diversifying the Academy, a future faculty summit for engineers, and
  ▪ Synthesizing a survey instrument from engineering education literature to assess the Multidisciplinary Design Minor’s Design Immersion Program for 100 entering students.
To support administrators, staff, and the broader community, CRLT-Engin staff consults with administrators and staff and have regular meetings with administrators to ensure that programming meets the needs of the community, assume a variety of teaching responsibilities (for full courses and as a guest lecturer), and serve on numerous committees.

CONSULTATIONS FOR ADMINISTRATORS AND STAFF

- Staff had one-on-one meetings with chairs of the following departments to discuss CRLT-Engin:
  - Aerospace Engineering,
  - Atmospheric, Oceanic, and Space Sciences,
  - Civil and Environmental Engineering,
  - Chemical Engineering,
  - Computer Science Engineering,
  - Materials Science & Engineering, and
  - Naval Architecture and Marine Engineering

- Staff made presentations about CRLT-Engin at faculty meetings for the following departments:
  - Computer Science Engineering,
  - Materials Science & Engineering,
  - Civil and Environmental Engineering.

- Staff from CRLT-Engin and the main CRLT conducted 26 consultations for 20 staff and administrators on topics that included:
  - A town hall meeting for the Honor Council,
  - Developing an honors program,
  - Difficult faculty members,
  - Information about NSF CAREER awards,
  - Learning styles and the Myers-Briggs Type Inventory,
  - Lecturer reappointment,
  - Programs to highlight entrepreneurship,
  - Research on creativity and art making,
  - Sustainability courses and programs,
  - Teaching large classes,
  - Theater performances for engineering, and
  - Using reflective writing in the multidisciplinary design program.

- CRLT-Engin met as needed to consult about faculty development, teaching-related issues, and GSI training with the following administrators:
  - Associate Dean for Undergraduate Education,
  - Associate Dean for Academic Affairs, and
  - Managing Director of the Office of Academic Affairs.
TEACHING AND GUEST LECTURER ACTIVITIES

▪ Staff from CRLT-Engin had the following teaching responsibilities:
  ▪ ENGR 490-08: Intro to design process (Winter 2012), and
  ▪ ENGR 200: Product design (Spring 2012) – Tecnun University, Spain

  This is one of the best new classes in the College of Engineering. It is so unique, and it covers material that every engineer should learn. I would (and already have) encourage all my friends to take this class. For the first time, I feel like I have an idea about how to go about designing a system.

  Student enrolled in ENGR 490-08, Winter 2012

▪ Staff from CRLT-Engin made 13 guest lecture presentations in the following seven classes:
  ▪ ENGR 580: Teaching Engineering (two times),
  ▪ ENGR 590: Engineering in the K-12 Classroom,
  ▪ ME 250: Design and Manufacturing I (two sections),
  ▪ ARTDES 300/ ME 450/ DESCI 501: Analytical Product Design,
  ▪ CHE 405: Problem Solving and Trouble Shooting in the workplace,
  ▪ ENGR 100: Introduction to Engineering (five sections), and
  ▪ University of Dayton, Multidisciplinary Design.

COMMITTEE SERVICE

▪ Staff from CRLT-Engin regularly participated on the following committees:
  ▪ All-Hands group of the Associate Dean for Undergraduate Education,
  ▪ College of Engineering’s Undergraduate Education Team,
  ▪ Dissertation committee for Design Science Ph.D. student, and
  ▪ Faculty Advisory Council of the Center for Engineering Outreach and Diversity.
NATIONAL LEADERSHIP

CRLT-Engin is dedicated to providing national leadership to enhance the visibility of U-M in engineering education. As such, CRLT-Engin consults with individuals outside the U-M community, serves on national committees and review boards, and participates in national workshops and conferences.

CONSULTATIONS OUTSIDE OF U-M

- 34 consultations for 30 individuals at the following 26 organizations outside of U-M:
  - American Society of Engineering Education,
  - ASEE Prism,
  - Duke University,
  - Georgia Institute of Technology,
  - Kettering University,
  - Lonestar College,
  - Makarere University, Uganda,
  - Mathworks,
  - National Science Foundation,
  - Oakland University,
  - Olin College,
  - Purdue University,
  - Ritsumeikan University, Japan,
  - Shanghai Jiao Tong University, China,
  - University of California – Irvine,
  - University of Chicago,
  - University of Cincinnati,
  - University of Louisville,
  - University of Maryland,
  - University of Pittsburgh,
  - University of San Diego,
  - University of South Carolina,
  - University of South Florida,
  - University of Texas – Austin,
  - Virginia Tech, and
  - Western Michigan University.

NATIONAL SERVICE

- During 2011–2012, staff at CRLT-Engin served in the following national leadership roles:
  - Member of Kettering University’s Center for Excellence in Teaching & Learning Advisory Board.
  - Member of Frontiers in Education Conference Steering Committee.
  - Reviewer for conference papers submitted to:
    - 2012 ASEE Conference, Educational Research and Methods Division, and
    - 2011 Research in Engineering Education Symposium.
  - Reviewer for manuscripts submitted to:
    - Design Studies,
    - Journal of Mechanical Design, and
    - Journal of Science and Technology Education.
  - Reviewer for proposals submitted to:
    - National Science Foundation Graduate Research Fellowship Program, and
    - National Science Foundation International Research Experience for Students Program.
- Co-leader of Engineering Education Centers and Programs group.
PARTICIPATION IN WORKSHOPS AND CONFERENCES

- CRLT-Engin staff attended the following conferences to share research results, participate in professional development, and increase U-M national visibility:
  - *NSF Engineering Education Centers Division – Awardees Conference*, Arlington, VA, where CRLT-Engin’s Director co-facilitated two panels on “Building Value Propositions” and presented poster on ethics research,
  - Engineering Education Research Peer-mentoring Workshop, Athens, GA,
  - *2011 Annual ASEE Conference & Exposition*, Vancouver, Canada, and
CRLT-Engin recognizes the importance of its role in reforming engineering education and furthering the mission of the college to promote excellence in engineering education. In addition to supporting others who pursue scholarship in engineering education, CRLT-Engin conducts its own research. In particular, staff:

- Actively pursued eleven major research initiatives, and
- Submitted five grant proposals, and
- Had 15 refereed journal manuscripts and 15 refereed conference proceedings accepted or published, including six manuscripts in the prestigious *Journal of Engineering Education*.

### Research Activities by CRLT in Engineering Staff

<table>
<thead>
<tr>
<th>Title and Project Team</th>
<th>Project Description and Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Faculty Teaching Practices to Support Student Success</strong></td>
<td>This project, supported through an <em>NSF Course, Curriculum, and Laboratory Improvement</em> award, is intended to promote substantive and sustained changes in teaching practices to improve student success and support a diverse student body in engineering. Applying the Expectancy-Value Theory to faculty motivation to adopt research based effective teaching practices, the project aims to integrate local evidence about institutional context and faculty/student perspectives with research about successful teaching practices to develop an institutional change model.</td>
</tr>
<tr>
<td>Project team: Cynthia Finelli, Shanna Daly, James Holloway, one research assistant, and two U-M students in the Undergraduate Research Opportunity Program (UROP)*</td>
<td>Several aspects of the project were completed this year:</td>
</tr>
<tr>
<td></td>
<td>▪ Ten years of demographic and academic data were compiled for engineering students, and success metrics were compared by gender and minority status. An internal report describing the findings was used at the College of Engineering Diversity Retreat.</td>
</tr>
<tr>
<td></td>
<td>▪ Focus groups for academic advisors were conducted to identify faculty practices they believe support student success.</td>
</tr>
<tr>
<td></td>
<td>▪ A survey about teaching practices that positively impact student success was completed by 386 engineering undergraduates. Focus groups were subsequently conducted to explore interesting survey responses.</td>
</tr>
<tr>
<td></td>
<td>▪ Focus groups of engineering faculty were conducted to examine factors that influence faculty’s motivation to adopt research-based, effective practices.</td>
</tr>
<tr>
<td></td>
<td>▪ Dissemination included two conference papers and three internal presentations.</td>
</tr>
</tbody>
</table>

*Drs. Finelli and Daly received the UROP Faculty Recognition Award for Outstanding Mentorship as a result of their work with these two students.*
## Activities that Promote Ethical Development of Engineering Undergraduates

**Project team:** Cynthia Finelli, Donald Carpenter (Lawrence Technological University), Trevor Harding (California Polytechnic State University), Janel Sutkus (Carnegie Mellon University), and five U-M graduate students

- The project, funded by an NSF Engineering Education Centers award and involving 19 partner institutions, is designed to answer the question: What activities (in the formal and/or informal engineering curriculum) have the most positive impact on the ethical development of engineering undergraduates? Qualitative data were collected during focus groups and interviews with 123 students and 146 faculty or administrators, and quantitative data comprised survey responses from 3,914 undergraduate engineering students.
- Dissemination included one national and three regional workshops, three refereed journal articles, five conference presentations, and several internal presentations.
- NSF funded the next stages of this research in which a practical instrument for assessing students’ ethical development will be designed for use by engineering educators nationally.

## Design Heuristics: Cards to Prompt Creative Designs

**Project team:** Shanna Daly, Seda Yilmaz (Iowa State University), Colleen Seifert (Psychology), Richard Gonzalez (Psychology), and two U-M undergraduate students

- The Design Heuristics comprise 77 cards developed after extensive analysis of innovative products and expert designers. Each card describes one successful design strategy and includes an abstract image depicting the application of the strategy and two examples showing evidence of the strategy in existing consumer products. The current goals of this work, funded through a newly-awarded NSF Transforming Undergraduate Education in STEM grant, include validating the advantages of the 77 cards and studying how they can influence students’ idea generation processes and design outcomes.
- Through guest lectures, the 77 cards were shared with over 500 students in 15 classes. Other dissemination includes one manuscript and two conference presentations. Commercialization of the cards is underway.
<table>
<thead>
<tr>
<th>Research Activities by CRLT-Engin Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title and Project Team</strong></td>
</tr>
<tr>
<td><strong>Creative Process Pedagogy</strong></td>
</tr>
<tr>
<td>Project team: Shanna Daly, Colleen Seifert (Psychology), five U-M undergraduate students, and one U-M graduate student</td>
</tr>
<tr>
<td><strong>Effects of Ethnographic Investigations on Student Design Decisions</strong></td>
</tr>
<tr>
<td>Project team: Shanna Daly, Kathleen Sienko (Mechanical Engineering), and one U-M graduate student</td>
</tr>
<tr>
<td><strong>Screencasts to Increase Student Learning</strong></td>
</tr>
<tr>
<td>Project team: Tershia Pinder-Grover, Joanna Millunchick (Materials Science and Engineering), and one Michigan State University graduate student</td>
</tr>
<tr>
<td><strong>The Challenge of Transitioning from an Engineering Career to Graduate School</strong></td>
</tr>
<tr>
<td>Project team: Shanna Daly, Steve Skerlos (Mechanical Engineering), Diane Peters (U-M alum), and two U-M graduate students</td>
</tr>
</tbody>
</table>
OTHER RESEARCH PROJECTS

NSF WORKSHOP ON ENGINEERING EDUCATION RESEARCH TAXONOMY

- At the invitation of NSF and following conversations with NSF program officers and the executive Director of ASEE, the Director of CRLT-Engin submitted a workshop proposal to NSF. The purposes of the workshops are: (1) to engage the broad, national community in creating a taxonomy for the field of engineering education research, and (2) to prioritize areas of research within the framework of the taxonomy.

OPPORTUNITIES FOR CREATIVE DESIGN IN ENGR 100

- This research focuses on engineering students’ conceptions of creativity and their perceptions of creative opportunities in their ENGR 100 design projects as they progress through the semester. Four student surveys were developed, administered, and analyzed, and findings were presented internally.

EPORTFOLIOS FOR THE ACADEMIC JOB MARKET

- CRLT-Engin assisted faculty from Virginia Tech in implementing a pilot program for engineering GSIs. Through the program, ten participants created professional ePortfolios for the academic job market.

APPROACHES TO DESIGN

- This project focuses on ways people approach design tasks from different disciplinary perspectives. Two manuscripts about the work were published.

PROPOSALS, PUBLICATIONS, AND PRESENTATIONS

ONGOING, AWARDED, OR PENDING RESEARCH GRANTS

1. Daly, S. R., & Skerlos, S. Characterizing engineers who return from industry to earn a Ph.D. and their impact on innovation. National Science Foundation–Research in Engineering Education (REE) Program. Proposal #1159345, $425,999. 04/01/12- 3/31/14. [awarded]

2. Daly, S. R., Gonzalez, R., & Seifert, C. M. Integrating design heuristics into engineering education as a pedagogy for ideation. National Science Foundation–Transforming Undergraduate Education in STEM (TUES) Program. Proposal #1140256, $425,999. 04/15/12–03/31/14. [awarded]


Refereed Journal Publications (Or Equivalent) In Print Or Accepted


REFEREED CONFERENCE PROCEEDINGS


**OTHER PRESENTATIONS**


9. Tolbert, D. & Daly, S. R. (2012, Feb.). *Student perceptions of creative opportunities in engineering design: Preliminary findings.* Poster presented at the CRLT-Engin Research and Scholarship in Engineering Education Poster Fair, Ann Arbor, MI.