DRAPER LABORATORY

TECHNICAL CHALLENGE COMPETITION

for

NSBE STUDENTS

In Conjunction With The

2016 NSBE Region 1 Regional Conference

The Charles Stark Draper Laboratory, Inc.

555 Technology Square

BACKGROUND

Draper Laboratory is a not-for-profit, engineering organization dedicated to applied research, development and technology transfer of advanced solutions to our nation's most challenging problems in security, space, healthcare, and energy.

Located in Cambridge, Massachusetts, Draper traces its roots to MIT. When it became independent in 1973, it retained a strong educational mission manifested in the robust education programs offered to graduate and undergraduate students. Some 50-60 masters and PhD students participate in the Draper Laboratory Fellows program, an opportunity to work on solutions to real-world problems that forms the basis of their thesis research. Undergraduate programs include internships and co-op programs.

As part of our educational outreach and in support of NSBE students, Draper is sponsoring a technical design challenge to showcase NSBE student members' innovative problem solving, technical writing, and presentation skills. The competition starts in September 2016 and will culminate at the Region 1 Fall Regional Conference in November 2016. Four finalist(s) will be selected to present their solutions at the conference and one winner will be selected from them. Three finalists will receive scholarship awards.

COMPETITION OVERVIEW

Draper staff will administer the competition from defining the problems to selecting the winners by a review committee comprised of engineers.

Contestants will answer one of the six challenge questions in the form of a short technical paper, which will be submitted to Draper via its website. The review committee will evaluate all submissions received by the deadline and identify the finalists prior to the conference. Finalists will present their solutions at the conference in the form of a PowerPoint presentation. A winner will be chosen following the presentations and scholarships awarded.

The challenge questions will be aligned with various technology areas being pursued at Draper and available for students on the competition website by September 23rd.

PROCESS

Each competitor will propose a technical approach to reach a solution for one challenge question of his/her choice. The proposal may include experimental procedures and intended analysis, preliminary design and testing, or a systems level design that solves the problem. In the first stage, the student competitor will submit a written solution to the challenge question, no more than 750 words, to a panel of judges. The written solution will generally include the following elements: a description of the problem, an approach, and a proposed method to reach a solution.

In the second stage, the student-competitor will deliver a technical presentation to a panel of judges. The presentation will aim to persuade that the student's approach is the technically feasible and thorough with respect to solving the challenge selected.

Eligibility and Criteria:
- Graduate and undergraduate students who are enrolled in an engineering, math, or science degree program in the 2016-2017 academic calendar year.
- Only individual contestants can enter.

- Individual contestants can submit only one entry.

- All contestants must register on the Draper website and submit a personal information sheet listing name, address, phone number, e-mail address, NSBE Membership Number, college attending, major and degrees received or expected (B.S., M.S., etc.).

- Student-competitors under the age of 18 may need parental permission to participate; please contact Draper Lab at nsbe@draper.com to make arrangements.

- Must be a member of NSBE.

- Employees of Draper (and their immediate family members and/or those living in the same household, whether or not related) are not eligible to win.

Paper Submission and Presentation

- All solutions submitted must be no more than 750 words, excluding title page and citations, double spaced, and should follow a standard style for technical papers per standard preparation guidelines (see example in the Appendix: Paper Organization). The paper must be typed and in English. Any elements appearing in an Entry must be the competitor's own original work, created solely by the competitor. Use of anything that is not the competitor's own original work, may result in disqualification. Draper reserves the right to reject any Entry that it deems, in its sole discretion, to violate any of these content related requirements.

- DEADLINE: November 7th . All papers must be submitted in pdf format to http://nsbe.draper.com no later than November 7th, 2016.

- In the final round at the conference, each finalist will be assigned a 20-minute time for his or her presentation to a panel of three judges.

- The presentation material should be in format of Microsoft PowerPoint slides and include both a soft copy (memory stick) and 10 print copies of the presentation.

- PRESENTATION TIME LIMIT –20 minutes-, broken down as follows:
  - 10 minutes for the presentation
  - 10 minutes for Q&A and answer/scoring period

Judging Criteria

The following criteria will be use to evaluate the written solution to the problem and the technical presentation:

- Innovation and Creativity (15%)
- Technical Content (15%)
- Quality of material (15%)
- Originality of solution (15%)
- Feasibility of solution (15%)
- Demonstrated understanding of problem and of proposed solution (15%)
- Presentation skills (10%)

In the event of a tie, the judges will determine the winner based on the overall creativity, originality, and feasibility of the tied entries. Judges' decisions are final, binding, and conclusive on all matters related to the competition.

Awards

All finalists participating in final round of the challenge competition at the Fall Regional Conference will receive participation recognition from Draper. The judges based on the competition guidelines will choose the three top finalists, and their submissions will be posted online.

First Place: $2,000
Second Place: $1,000
Third Place: $500

Winners will be selected and notified at the conference. Any finalist who is unable to present his or her paper at the conference will be disqualified.

Competition Schedule

The competition will begin in September 2016 and conclude in November 2016. The schedule follows:

- **September 23, 2016**

  Competition timeline and rules posted on Draper website. http://nsbe.draper.com

- **September 23, 2016**

  Competition opens on Draper Website with challenge questions and criteria.

- **September 26, 2016**

  Registration opens for the competition on the Draper website:

  http://nsbe.draper.com/registration.html

- **November 7, 2016**

  DEADLINE to submit written entries to challenge questions to the Draper website:

  http://nsbe.draper.com/submit.html

- **November 9, 2016**

  Finalists notified via e-mail.

- **November 19, 2016**

  Conference presentations by finalists and selection of winners.

Contact Information

E-mail: nsbe@draper.com

Website: http://nsbe.draper.com

DRAPER TECHNICAL CHALLENGE

2016

Select one of the following problem statements and propose a technical approach to developing a solution. Your proposal may include experimental procedures and intended analysis, preliminary design and testing, or a systems level design that solves the problem.

QUESTION 1

Password Replacement: Passwords have become the primary means of securing much of our digital lives, but they have fundamental weaknesses. Strong passwords tend to be difficult to remember, leading to the need for password reset capabilities. Weak passwords are easily recalled, but also easily defeated by automated password-cracking software. Numerous identity verification schemes have been proposed as alternatives to passwords. Survey these methods and project which scheme is most likely to succeed based on technical merits, societal trends/values, etc. If possible, propose a novel identity verification method and contrast it with other proposed methods.

QUESTION 2

Testing Water Potability: One of the biggest challenges in developing nations is access to potable water. There are varieties of reasons that water might be unsafe to drink: high salinity, presence of biological waste, presence of industrial contaminants, etc. While hardware and testing regimens to detect the presence of harmful contaminants exist, these tests are often time consuming (many hours or several days) and expensive by the standards of a developing nation. Identify a common water contaminant (biological or chemical), describe the current state-of-the-art testing protocol for that contaminant, and then propose a device or method that would represent a significant improvement in the speed and/or cost associated with testing for that contaminant.

QUESTION 3

Large Scale Energy Storage: Large scale energy storage can have a tremendous impact on the overall efficiency and distribution of power. The ability store MW-hr to GW-hr levels of energy in an efficient and low cost manner will enable the large scale integration of renewable resources while compensating for continuously changing loads on the electric grid. Likewise, such systems will also allow the lowest cost and most efficient energy sources to be leveraged by leveling the load and reducing peak demand. Conventional approaches (batteries, hydro, etc.) are either too expensive or have logistical limits which prevent their widespread adoption. What new approaches can be applied to efficiently store large quantities of energy at very low cost?

Specifications: The proposed system should be competitive with pumped-hydro. Desired specifications for the solution are shown below:

Capacity: > 1 GW-hr

Power: > 500MW

Efficiency > 80%

Cost < $425/kW-hr

Lifetime: > 13,000 cycles

QUESTION 4

Human Centric Design: In the modern society, determining which individuals present a threat to public safety is a difficult task; people with ill-intent come in all shapes and sizes. Airport security in particular has been a focus of improving security screening. Potential targets for bad actors include the top 5 largest airports in the USA, collectively averaging nearly 100,000 passengers daily:

a. Hartsfield–Jackson Atlanta International Airport (ATL - Atlanta, GA)

b. Los Angeles International Airport (LAX - Los Angeles, CA)

c. O'Hare International Airport (ORD – Chicago, IL)

d. Dallas/Fort Worth International Airport (DFW – Dallas, TX)

e. Denver International Airport (DEN – Denver, CO)

Design a system that will detect malicious intent from individuals as they enter a designated checkpoint area that has a commonality in all above airports. What method(s) would you use to evaluate the individual? What sensor and hardware would you use to accomplish this? How would you account for unreliability in these sensors/hardware?

QUESTION 5

Cyber Threats: The age of individuals driving their own vehicles is soon coming to an end, at least that is the hope of many autonomous car designers, such as Google. However, with your life and safety no longer in fully under your control behind that wheel, what is the chance that someone else could gain control remotely? Car hacking is old trick that will likely have new victims as autonomous vehicles enter the market over the next several years. Nevertheless, in order to solve the problem, you must first get to the root of the issue. If you were the hacker, how would you hack into a self-driving car? How would you prevent other hackers from entering the system in the same manner? If another hacker manages to bypass your defense, how do you detect when they have access?

QUESTION 6

Allergen Detection: The release of harmful gases into the environment, intentional or otherwise, remains a constant threat to one's personal safety. Airborne allergens, food allergens, and other contagions can be harmful and some cases deadly. Peanut allergies and its adverse reaction is a growing concern and highlight the need for better personal awareness of these contagions. In recent years, we have seen the proliferation of warning labels on food packaging in cafeterias and in restaurants. The wide use of cell phones can offer a level of safety to better deal with these threats. Discuss how cell phone technology coupled with smart-phone applications and mobile sensing can be applied to provide a level of personal safety from these threats.

PAPER ORGANIZATION

The technical paper shall be organized as follows:

- Paper Title
- Challenge Question
- Introduction
- Main Body of Paper
- Conclusion

All major sections in the paper should be numbered consecutively, starting with the Introduction as Section 1 and continuing with sections 2, through the Conclusion.

Title Page and Challenge

This is the first page of the paper, and it contains the conference header, Draper header, author's name; name of institution to which the author is affiliated; the location of the institution (city and state), and the "challenge question". See "sample title page" for wording, format, and font size. The "challenge question" paragraph should be taken from one of four challenge questions presented. The challenge question paragraph should fit completely on the title page.

Introduction, Body of Paper, and Conclusion

The Introduction should start at the top of the second page. Continue with the Body of the Paper through the Conclusion, numbering each section and subsection. All solutions submitted must be no more than 750 words, excluding title page and citations, double-spaced.

References

References cited in the text should be listed on a separate and last page. The formatted references cited in the text should be based on IEEE standards. For additional information, you can visit the following website: http://www.ieee.org/documents/ieeecitationref.pdf

DRAPER LABORATORY

TECHNICAL CHALLENGE COMPETITION

for

NSBE STUDENTS

I.M. Student
State University of Boston
Boston, Massachusetts

CHALLENGE

Implantable Device Biocompatibility: Biocompatibility and the option of implantable is an important factor in the design of new medical devices. While much of the device is often of an electrical nature, concerns governing the biocompatibility are generally of a mechanical and/or chemical nature. Technologies that enable the advancement and miniaturization of implantable medical devices (e.g., neural recording and stimulation) are in need in order to complement advances in sensing, stimulation, and repair technologies. Design an implantable device that addresses a major health issue (e.g. Bloods clots, returned cancer cells, etc.). Potential topics include in-vivo degradation and accelerated lifetime testing, hermetic electronics micro-packaging, biocompatibility enhancements, energy efficient bio-telemetry circuits, neural stimulator circuits, and optical fiber sensors. Your approach can focus on a specific discipline (e.g. electrical, mechanical, biological, chemical).