

science researcher at Bell Labs. We were given unlimited access to the source code that drives Toyotas and to the technical experts who could explain its working in detail. I learned more about the software controls in cars than I could have imagined. We immersed ourselves in this problem

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for about five months in 2010, working full-time at Toyota facilities in Los Angeles, and I believe we were able to complete a really thorough analysis of the code. The puzzle was the usual one: Can we find out how something that is not supposed to be happening might happen anyway? We were able to rule out a number of potential causes for unintended acceleration, although much of our analysis has not been released publicly. The complexity of an analysis like this immediately leads back to my original fascination with software complexity: it should be possible to design software in such a way that we can rule out bad behavior conclusively. My colleagues and I are today even more determined than ever to develop such a method for use in safety critical systems.

ENGenious: What are the main research challenges in reliable systems design?

Holzmann: The main challenge in reliable systems design is to make sure that unacceptable events are actually rendered “impossible”—and not just “unlikely.” To do this, we first have to recognize that no single part of a complex system is ever perfect, and that includes the software. The key is to build reliable systems from potentially unreliable parts. Nothing is foolproof. So we often try to

find a compromise between cost and benefit, but extremely dangerous consequences should be firmly placed outside such a cost-benefit analysis. Many have not yet fully embraced this approach, partly because it is tempting to interpret events with a very small probability of occurrence as virtually impossible. We only have to look at how nuclear power plants sometimes fail to see that extremely low-probability events are still very much possible.

ENGenious: Are engineering students trained well to design reliable systems? What, if anything, should change?

Holzmann: I think there are two possible answers to this. In most areas of engineering, the answer is yes. Civil engineers, for instance, can design a building or bridge to successfully withstand an earthquake of a certain magnitude. In software engineering, though, the answer is often negative. The prevailing belief is that the hardware has known failure modes, but that software can be perfect. The fault protection software onboard a spacecraft is designed to recover the spacecraft when a hardware problem strikes, but it is often powerless when a software problem occurs. The fault protection software itself, furthermore, can also be faulty or subtly incomplete. We should design

safety critical applications in medical devices, cars, power plants, and spacecraft with knowledge of the failure modes, including software failure modes. This is something that we are not very good at today.

ENGenious: One way of improving the reliability of systems is to have them tested extensively. Should members of the community participate in testing? Can systems such as OnStar help?

Holzmann: Direct measurement of the true performance of a system in practice is invaluable. It is how we learn the hidden flaws and what gives us the opportunity to adapt our designs to improve them. In a sense, all spacecraft that are currently active across the solar system have the equivalent of an “OnStar” button. Every time a spacecraft presses that button, so to speak, we learn something new about how the spacecraft we built yesterday works today and how it could be designed even better tomorrow.   

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Visit lars-lab.jpl.nasa.gov.

ENGenious sat down with Eva Graham, the Director of the Caltech Center for Diversity (CCD), to learn more about the center and how it has been serving the Caltech community since its creation in 2008.

The Caltech Center for Diversity

Providing a Real Pathway to Membership for Underrepresented Students at Caltech

ENGenious: How was the CCD created?

Graham: It has been three years since the Office of Minority Student Education at Caltech was combined with the Women’s Center to form the Caltech Center for Diversity. In this area, Caltech was following a trend already established at several other educational institutes. It has not only been more cost-effective, but it also has given us the opportunity to reach communities that we may have missed before, because now we have overlap in expertise and programming areas. With the overlap, we are able to reach a woman who is African-American and Lesbian, Gay, Bisexual, Transgender, Questioning and Allies (LGBTQA). We are also down the hall from International Student Programs, which provides us with the opportunity to work with international students.

ENGenious: What has stayed the same?

Graham: We have maintained our programs for women and minority students. Their foci are the same. With women, we still focus on helping them access resources and become part of the community. Long before the CCD was created, the Women’s Center was doing a great job helping women understand their roles in science and engineering. I’m happy to say that now women are seeing themselves as part of an even larger community. There are larger numbers of women on campus, and we’re hearing less and less about inappropriate behavior toward women. Certain programs are as popular as ever, such as self defense, assertiveness, and programs related to being women in a laboratory environment (because they might still be the only woman in a lab). With minority students, the focus has always been on outreach, recruitment, and retention. We also focus on community building, because the numbers of minority students remain low.

ENGenious: What has changed?



Eva Graham

Graham: For the LGBTQA community, we’ve focused on providing a safe space for coming out and gathering. We continued a working group made up of students and staff. The students are representatives of PRISM, which is Caltech’s campus social group for lesbian, gay, bisexual, and transgender students with support from staff, faculty, and their straight allies. In addition, we have created a Safe Zone program on campus led by one of the CCD Assistant Directors, Linda Webb. The program is designed to help build community, increase awareness, and support a safe space for the LGBTQA community. Student members of the program have designed their own logo, which is displayed in the offices on campus that are safe spaces for LGBTQA students who are struggling or have questions. In addition, we hold monthly community lunches. By

student request, we don't have presenters. Everyone just comes out for the food and loud music, and to get to know each other. These programs assist in building community for LGBTQA students and allies on campus.

ENGenious: What are some of the challenges experienced by the students who seek your services?

Graham: All Caltech students are highly capable when they get here, no matter what hue, part of the country, or racial or ethnic background they come from. They're capable! The challenge is coming to a community that's so different from what they know and from what they've been used to. It's like they're in shock. We have to be very cautious and not too quick to label them with syndromes. We're not dealing with a homogenous group of students. Our students are from all over and they come with lots to offer. The only way to gain the benefit of having them here is to help them be the best they can be. Part of this is to have zero tolerance for intolerance of difference. Intolerance of difference truly undermines our educational mission, and it makes it impossible to make sure that everybody is getting the most out of their Caltech experience. No one person has the right to limit another person's development or to limit her access to resources.

ENGenious: How are the alumni involved with CCD?

Graham: We have been working on creating more interactions between current students and alumni. Recently, one of the CCD Assistant Directors, Portia Harris, arranged an LGBTQA mixer for the alumni and current students. The alumni were so grateful and commented on the great change they are seeing on campus. One alumna from the 1960s recalled how LGBTQA students used to hide. Today, students can meet and interact with successful alumni from various backgrounds and professions and see that it gets better, that they can have success in their own lives. For some students, the alumni are the students' only access to life after Caltech.

ENGenious: What are concrete ways that the campus and our approach to diversity are different since the CCD was created?

Graham: One of our main accomplishments is that now there is more awareness on campus. We have staff and faculty calling our offices and asking questions because they are now aware of the different student populations they'll be working with. The awareness has given people an opportunity to say, "I don't understand," or, "How can I help?" And that's what you want. You don't want there to be a lot of fear associated with saying you don't know the

answer to something. And in those moments, we're here to field those questions.

Let's imagine that you're a faculty member and you think you have a student who is struggling with an undetected disability because you witnessed inappropriate behavior in the classroom or the laboratory. You can go directly to the dean of students, or you can come visit us at CCD. Our resources are completely confidential, so we'll keep your questions and identity confidential. We take the information and work with the appropriate parties to figure out the best way to work with the student and the faculty. We may get the dean of students involved, or, depending on the situation, it might be our Americans with Disabilities Act representative, Dean Barbara Green, who takes the lead. We also draw on other resources as needed, such as the Counseling Center, to make sure that the student and faculty are supported. Our goal is to help everyone in our community be the best they can be. The prime example of this at Caltech is Stephen Hawking; once you make the accommodations, the sky is the limit for what you can accomplish. It really is about helping a person access his or her full capability.

Another aspect of our work is to promote diversity and to really champion it. We know that differences in perspectives and approaches help students. The University of Illinois conducted a two-year diversity study beginning in 2004 and found that its faculty of color and international faculty were more likely to try different techniques when teaching difficult subject matter than their majority colleagues. We are promoting innovation, and we're promoting a climate where everybody feels valued. If we're ascribing to pluralism across the board, then we need to value each member of this community. Part of that is accepting boundaries that other people have for you and for themselves, and making sure that you've got some standards for yourself. **EN**

Eva Graham is Director of the Caltech Center for Diversity.

Visit diversitycenter.caltech.edu.



Lobby



Lounge



The Jorgensen Laboratory, formerly the home of computer science in EAS, is being renovated to serve as the new home for two of Caltech's key energy and sustainability research efforts: the Resnick Institute and the Joint Center for Artificial Photosynthesis. Large concrete overhangs have been removed to introduce more natural light and ventilation. Ninety percent of the materials from the interior demolition of the building are being reused or recycled. The goal for this laboratory-intensive building is LEED Gold Certification. The architects, John Friedman and Alice Kimm, have incorporated many energy-efficient design features to embody the innovative research that will be conducted within.