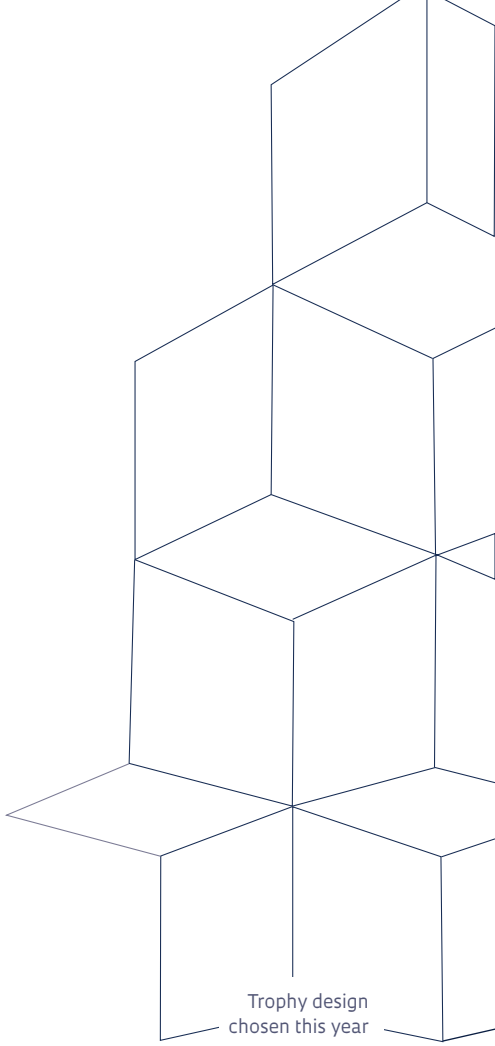
Celebrating Engineering

British award recognizes the most innovative accomplishments in the applied sciences and honors creators of digital imaging



Trophy design chosen this year

Engineers responsible for groundbreaking innovations may compete for an award which is seen as a type of Nobel for the most important innovations in the applied sciences because of the rigor in selecting the winners and the monetary prize offered. This award is known as the Queen Elizabeth Prize for Engineering (QEPrize). It has been granted three times since 2013 by a British foundation sponsored by large corporations, including Siemens, BP, Toshiba, and Sony, and in partnership with the Royal Academy of Engineering in the United Kingdom. The award, which is in its third prize cycle and which is offered every two years, was most recently on February 1. It acknowledged the contributions of four researchers from the United Kingdom, the United States, and Japan for the spread and popularization of digital imaging. Their innovations have produced technology that has enabled the use of cameras within portable devices and the sharing of more than three billion photos per day.

American researchers Eric Fossum and George Smith, Japanese professor Nobukazu Teranishi, and English engineer Michael Tompsett are going to share the one-million-pound prize, to be awarded in June in a ceremony at Buckingham Palace, the official residence of Queen Elizabeth II and the headquarters of the British monarchy. The amount of the QEPrize is greater than the eight million Swedish kronor (equivalent to 728,000 British pounds) awarded for the Nobel Prize and is also greater than the six million Norwegian kroner (equivalent to 550,000 British pounds) awarded for the Abel Prize, one of the most important in mathematics. The winners also receive a trophy, the design of which changes every prize cycle. The trophy is produced as part of a competition: students from many countries participate in the contest and propose computer models of three-dimensional structures.

The engineers are chosen based on suggestions or recommendations submitted to the Queen Elizabeth Prize for Engineering Foundation, the institution responsible for the award. To guarantee that good candidates will be considered, a search committee comprised of sixteen researchers and coordinated by Stephen Williamson from the University of Surrey considers the names of scientists with the right profile for the prize from all over the world and requests nominations. These nominations can be made on the foundation's website during a specific period and must be supported by two recommendation letters from specialists in the candidate's field of research. The candidates are analyzed by an international panel of 15 judges.

Led by Christopher Snowden, vice chancellor of the University of Southampton, the panel brings together engineers and researchers from both universities and the private sector. These judges include computer scientist John Hennessy from Stanford University, physicist Brian Cox from Manchester University and host on scientific shows on the BBC, Choon Fong Shih, dean of the National University of Singapore from 2000 to 2008, Bioengineer Viola

PHOTOS 1 PROLINESERVER 2010 / WIKIMEDIA COMMONS 2, 3 AND 4 QEPRIZE

INNOVATIONS RECOGNIZED IN THE 3RD QEPRIZE CYCLE


1

1969

With Willard Boyle, American physicist **George Smith** developed technology capable of transferring charge on the surface of a semiconductor. It soon became clear that the sensor, which came to be known as a charge-couple device (CCD), could convert light into electricity


2

1972

English researcher **Michael Tompsett** leveraged the potential of CCDs and invented digital cameras. He created the first colored image using the technology – a photo of his wife, Margaret – with a camera the size of a shoebox


3

1980

Japanese engineer **Nobukazu Teranishi** of the Nec Corporation invented the pinned photodiode (PPD), a device which improved the efficacy of digital cameras by increasing image resolution


4

1993

American researcher **Eric Fossum** from the NASA Jet Propulsion Laboratory created a new type of image sensor known as the complementary metal oxide semiconductor, or the CMOS image sensor, which made cameras significantly smaller and cheaper

Vogel, head of the Department of Health Sciences and Technology at ETH Zurich, and physicist Carlos Henrique de Brito Cruz, professor at the State University of Campinas (UNICAMP) in Brazil and scientific director of the São Paulo Research Foundation (FAPESP). The judges evaluate the nominees by considering three questions: What is it that this person has done (or up to five people have done) that is a groundbreaking innovation in engineering? In what way has this innovation been of global benefit to humanity? Is there anyone else who might claim to have had a pivotal role in this development? The result of this analysis is a list of nominees for the foundation's administrative council, which decides on the winners.

In the first prize cycle in 2013, the QEPrize recognized five engineers for their contributions to the development of the Internet: Robert Kahn, Vint Cerf, and Louis Pouzin were awarded for the creation of the protocols that have made up the fundamental architecture of the Internet; Tim Berners-Lee was awarded for the creation of the World Wide Web; and Marc Andreessen was awarded for his early '90s development of Mosaic, the first web browser used on the Windows operating system. In 2015, the second prize was given to only one researcher: chemist Robert Langer, professor at the Massachusetts Institute of Technology (MIT) and creator of polymers engineered to control drug delivery in the human body. This technology is used in medications for cancer and mental illness, and it has benefitted more than two billion people.

In the third prize cycle, the choice of digital image sensor technology was justified by the huge impact this technology has had on human behavior in society. "A picture is a universal form of communication," said Christopher Snowden when he announced the winners. It can be shared instantly with anyone around the world, no matter what language they speak. We chose this engineering innovation because it epitomizes what the prize stands for. This engineering innovation is inspirational, it is truly something that everyone can understand, and it has had a remarkable social impact worldwide."

QEPRIZE

Tompsett, Teranishi, and Fossum, at the award ceremony to recognize the popularization of digital imaging

It was not by chance that the group of researchers chosen have worked together and produced a chain of innovations over the last thirty years. "In this cycle, the award also came to highlight the importance of collaborating in research for excellence in engineering," said Carlos Henrique de Brito Cruz to *Agência FAPESP*. "By celebrating the most innovative accomplishments in engineering, the prize focuses on those which have had an enormous intellectual impact, as well as social and economic impacts."

One of the winners also won the Nobel Prize in Physics in 2009. American researcher George Elwood Smith, 86, was recognized for designing a type of electronic memory at Bell Laboratories in the United States in the 1960s. His work, which was completed in partnership with Willard Boyle (1926-2011), with whom he shared the Nobel Prize, resulted in the creation of a semiconductor sensor for image capture known as the charge-couple device (CCD). Today, this technology is used in digital photography, satellite image production, hospital equipment, and the field of astronomy. The technology, which was originally invented for computer memory, was advanced by English physicist Michal Francis Tompsett in the 1980s, a resident of the United States and director of the software company TheraManager. He designed and built the first video camera with a CCD sensor. Nobukazu Teranishi, a researcher from the Nec Corporation in Japan, created the pinned photodiode (PPD) in the 1990s. This device decreased pixel size (the pixel is the smallest unit that forms a digital image) and improved image quality. The complementary metal oxide semiconductor, or the CMOS image sensor, was invented by Eric Fossum in 1992 during his time as a researcher at NASA and resulted in the creation of smaller, cheaper, and more energy-efficient cameras.

The establishment of the award in 2011 was part of a broader strategy on the part of the QEPrize Foundation to highlight the work of researchers in engineering and to inspire young people to become engineers. "It's important that we recognize the engineers who have changed our world," said Lord Edmund Browne in *The Manufacturer* magazine. Browne is the former executive director of BP and Chairman of the Board of the foundation. Part of this strategy is the creation of a network of ambassadors for the prize. This network is formed by young engineers responsible for supporting the objectives of the prize to professors, students, politicians, and journalists by reporting on the work they do and the importance of engineering as a profession. The foundation also produces reports on the status of engineering education and of engineering research both in the United Kingdom and abroad. One of these documents, published in 2015, showed that interest in engineering among teens from sixteen to seventeen years of age is greater in developing countries such as India (80% of those who participated in the survey), Turkey (78%), South Africa (69%), China (68%), and Brazil (57%) than it is in developed countries such as Germany (50%), Japan (39%), the United States (30%), and the United Kingdom (20%). The young people involved in the survey completed a questionnaire online. In contrast, those interviewed in developing countries reported greater difficulty both in getting started in the career and in guaranteeing funding for education than young people from developed countries.

Interest in engineering among British youth is considered low, and the prize seeks to inspire new career choices

The lack of qualified engineers is of considerable concern for the large corporations sponsoring the prize. "The lack of professionals is already noticeable in certain fields, such as electronics engineering and software engineering, and is going to become a big problem in the next ten years," said Jurgen Maier, chief executive of the UK branch of Siemens, in an interview on the QEPrize website. Another survey organized by the foundation revealed a gender gap affecting engineering in the UK. Though the country needs one million new engineers to graduate by 2020, the survey found that parents of girls between five and eighteen years of age still tend to encourage their daughters to follow career paths other than engineering. A total of 73% of parents reported believing that other fields would offer better career opportunities to women. ■ **Fabrício Marques**