



## Dynamite, Electricity, and Nobel's World

It has become a tradition to expect the announcement of the Nobel Prizes in the last quarter of the year. This past October, we were pleased to witness the rarity of two women scientists, Donna Strickland from Canada and Frances Arnold from the United States, be accorded the Nobel Prizes in Physics and Chemistry, respectively. Strickland is only the third woman to receive the Nobel Prize in Physics (the last time this happened was more than 50 years ago in 1963). What a fitting answer these announcements were to the statement that “physics was invented and built by men,” which was proclaimed by an Italian physicist at the European Center for Nuclear Research (CERN) in September. He was attending a workshop, the goal of which was to highlight gender issues in physics, and it did!

This does not mean that the Nobel Prize institution has not been remiss in its duty to acknowledge the contributions of outstanding women scientists. In fact, the Nobel Prizes provide one vivid example of the problematic gender gap that plagues the sciences, as highlighted by the statistics in Table 1 [1]. Only 5.7% of all Nobel laureates are women—and Marie Currie is counted twice! To compound the issue, only a single woman has received the Nobel Prize in Economic Sciences. These dismal numbers are

not for lack of excellent candidates. For example, in 1944, the Austrian-Swedish physicist Lise Meitner (1878–1968) was denied sharing the Nobel Prize in Chemistry, which went to her male collaborator, in a decision that many considered unjust. Other similar incidents have occurred [2].

The Nobel Prize was a stroke of genius by the Swedish chemist Alfred Nobel (1833–1896), who was the inventor of dynamite and profited immensely from the sales of arms, gunpowder, and explosives. Many believe that to ensure that his legacy was not associated with these instruments of death, he bequeathed his wealth to the establishment of five Nobel Prizes in Physics, Chemistry, Physiology or Medicine, Literature, and Peace. The first prizes were given in 1901, while the Economics prize was added later in 1969.

Given their long history and unwavering quality, the Nobel Prizes have

risen to become the most eminent prize in science and are watched across the globe with intense media coverage. Their prestige is undisputed and their laureates' achievements are among the finest. At the same time, the Nobel Foundation is held accountable to higher standards and its decisions are subject to scrutiny.

For example, there was a controversy this past year when the 2018 Nobel Prize in Literature was not awarded due to sexual assault allegations by 18 women against the husband of one of the Swedish Academy members. In earlier years, the award did not recognize several deserving scientists or pacifists. One glaring omission is Mahatma Gandhi, who was apparently nominated five times but was never awarded the Nobel Peace Prize! Other examples are Thomas Edison and Nikola Tesla who were bypassed despite the incredible revolution that electricity has brought to our world, certainly

**Table 1. Gender statistics for the Nobel Prizes.**

Nobel Prize	Number of Prizes	Number of Laureates	Female Laureates	Women (%)
Physics	112	210	3	1.4
Chemistry	110	181	5	2.8
Medicine	109	216	12	5.6
Literature	110	114	14	12.3
Peace	99	107	17	15.9
Economy	50	81	1	1.2
Total	590	909	52	5.7

Digital Object Identifier 10.1109/MSP.2018.2880688  
Date of publication: 24 December 2018

more than Nobel's dynamite and gunpowder. If you were to choose between turning off all electricity in the world or destroying all piles of dynamite and gunpowder, which choice would you make? In other instances, the prizes have been controversially awarded to some scientists while ignoring legitimate contributions by others. This even happened as recently as 2017 when the Nobel Prize in Physics was awarded to three deserving scientists for the discovery of gravitational waves. This discovery involved the efforts of literally hundreds of other individuals from more than 20 countries. The three scientists were awarded the prize for "their decisive contributions to the LIGO detector and the observation of gravitational waves." Notice the use of the word "decisive." It has a purpose. It was perhaps meant to ensure that only three individuals share the award, which is the limit that the Nobel Foundation follows. This rule is likely spreading scientific injustices, regardless of intention. The scientific community has always been strict about the practice of proper citation to the work of others and we, as scientists, are expected to properly acknowledge prior contributions. Why should the Nobel Foundation be allowed to apply a different standard?

Even the Nobel Peace Prize has generated controversies. It is reported that Alfred Nobel once stated, "I intend to leave after my death a large fund for the promotion of the peace idea, but I am skeptical of its results" [3]. Indeed, the Nobel Peace Prize has been awarded 99 times since its launch. Is our world more peaceful today? There have always been conflicts brewing in different parts of the world with innocent people and children falling victim to violence. Who was not touched by the image of three-year-old Alan Kurdi lying lifeless on a beach in September 2015 after drowning in the Mediterranean Sea, or the painful sight of seven-year-old Amal Hussain who starved to death this past October 2018 in the midst of a tragic war? Despite modern advances in our world, children do still starve to death. Yasser Arafat, Shimon Peres, and Yitzhak Rabin shared the 1994 Nobel Peace Prize for "their efforts to create peace in the Middle East." Is

the Middle East a more peaceful place today? Many others are calling for the 1991 Nobel Peace Prize to be revoked citing the apparent indifference of Aung San Suu Kyi to the calamity befalling the Rohingya people in her country. I have always wondered, since my younger years, how could the origins of a Peace Prize of this magnitude be associated with dynamite and gunpowder!

### **Is the Nobel Prize doing enough to stimulate diversity in the STEM fields?**

I recently watched a documentary about the life of King Edward VII who ascended to the throne of England in January 1901, following the death of his mother Queen Victoria. This is the same year in which the Nobel Prize was launched. What I found interesting about the two-part documentary was not his adventures as a prince, but rather the video footage showing how life was at that era when Nobel penned his will. Alfred Nobel (1833–1896) lived in a different time with its own technological limitations. Imagine if we were to switch off electricity today, ground our planes, park our cars, disconnect our communications infrastructure, and disable all phones, radios, TVs, and the Internet. In the minds of many, we would be returning to the Stone Age. But that was, to a good extent, how the world looked like during Nobel's lifetime. Nobel did not witness any of the wonders we take for granted today. His interests and thinking were framed by the experiences of his time. While the STEM fields (science, technology, engineering, and mathematics) are recognized today as indispensable and strategic drivers for the economic growth of nations, Nobel himself ignored the "TEM" fields altogether and focused mainly on "S" alone. At a time when we need to popularize STEM fields among younger students, and especially among female students, it is fair to question whether the Nobel Prizes of today are helping or hindering this effort. I am of the opinion that these prizes could and should do more to support STEM outreach for several reasons.

First, the Nobel Foundation is hardly awarding sufficient prizes to female scientists. This in itself sends a distorted

message to the younger generation of female STEM students who are eager for role models.

Second, there was no place for technology, engineering, and mathematics in Nobel's plan following his "mature deliberation," as he refers to it in the opening line of his will. Many have criticized him for leaving out mathematics. Does not much of the work by laureates in the economic sciences, for example, rely heavily on sophisticated mathematical and statistical models?

Third, although he was an engineer, one can perhaps forgive Nobel's oversight of technology and engineering since; at his time, these disciplines did not have the significant influence they have on our lives today. There are today other prestigious prizes in these domains, including the Turing Award, the Kyoto Prize, and Queen Elizabeth's Prize for Engineering. Despite their prominence, these prizes do not attract the same level of global and media attention as the Nobel Prize. Back in 1986, a proposal was made to the Nobel Foundation by the American Association of Engineering Societies to create a Nobel Prize in Engineering. The proposal was rejected [4]. But that was more than 30 years ago and our world has changed dramatically since then. A step like this would immediately raise awareness of the critical role that technology and engineering play in modern times in the public's mind, as well as in the minds of the younger generation of students whom we wish to attract to the STEM fields.

Fourth, in some cases the Nobel Prize is taking recognition away from technology and engineering and marginalizing their role. This is because many engineering innovations such as the radio, the transistor, the LED, and fiber optics have been recognized under the Nobel Physics Prize and, moreover, many Nobel laureates have been well-accomplished engineering researchers. For example, Dr. Frances Arnold (this year's laureate in Chemistry) is a professor of chemical engineering and a member of the U.S. National Academy of Engineering. Her undergraduate degree was in mechanical and aerospace engineering, and her Ph.D. degree was in chemical engineering. Likewise, Dr. Shuji Nakamura (Physics laureate, 2014) is a

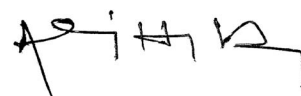
professor of materials science engineering at the University of California in Santa Barbara. His undergraduate degree was in electronic engineering in Japan. Also, Dr. Charles K. Kao (Physics laureate 2009) studied electrical engineering and received a Ph.D. degree in the same field in 1965. Closer to our discipline, Jack Kilby (1923–2005) was awarded the 2000 Nobel Prize in Physics for “basic work on information and communication technology.” That is squarely in the field of interest of our professional society. Kilby was an electrical engineer. He worked on the first integrated circuit at Texas Instruments. The technology was pivotal in launching the digital signal processor revolution, and in embedding signal processing intelligence into billions of electronic devices and gadgets including your cell phones.

Nobel’s intention has been to honor “inventions or discoveries” of the greatest practical benefit to mankind. It is difficult for anyone to argue that inventions like electricity; cellular communications, personal computing, and the Internet have not had such an impact. Besides, engineering today is a discipline where real discoveries and not just inventions happen, which is why the term “engineering sciences” is also common. It is not true anymore that scientific discovery alone drives engineering design. On the contrary, it is also true that engineering ideas help motivate and discover new science to enable them. And many Nobel Prize winning works would not have been possible without creative and amazing engineering and technological advances and discoveries. Einstein postulated the existence of gravitational

waves around 100 years ago. Why did it take until 2016 to detect them?

## References

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## FROM THE EDITOR *(continued from page 3)*

task of combining all of those observations to make meaningful decisions that account for different levels of uncertainty. Many research challenges remain in sensor fusion, with many specifically related to the combination of sensors under consideration and the level of preprocessing applied prior to fusion.

Communication is not required for automation, but it makes it more efficient. Most of the previous work at high levels of automation does not leverage the potential for low-latency and/or high data rate communication between vehicles. With communication, vehicles can share information over a much longer range than humans, making support for communication a departure from development over mirroring human drivers. Communication can be used to coordinate vehicles at lower levels of automation, as in platooning, for example, which leads to efficiency improvements. At higher levels of automation, communication facilitates exchange-sensor data. This allows, in essence, vehicles to

make use of the sensors on other vehicles or their infrastructure to expand the sensing range. New research is focused on the application of 5G communication systems to vehicles, especially high data rate millimeter-wave communications. For example, high data rates permit lower layers of sensor information to be shared and fused jointly. Signal processing research challenges include methods for making high data rate low-latency communication resilient in highly mobile channels, including tasks such as adaptive channel estimation and tracking in high-dimensional millimeter-wave communication systems.

While everything I have outlined targets ground vehicles, many of the research directions also apply to aerial vehicles. There are additional challenges due to the limited payloads in aerial vehicles, especially in small, unmanned vehicles. As a result, there are new tradeoffs related to the weight and energy consumption of sensors and signal processing hardware. For example, it may be possible to sup-

port only a limited number of sensors, and the data may be processed outboard at a ground-based processing center. An *SPM* special issue on signal processing for aerial vehicles will appear in the near future.

Vehicles are an exciting new application of signal processing. The types of signal processing associated with sensors and communication, however, have even broader applications. An example would be the similar challenges faced in robotics and factory automation. The recently launched Autonomous Systems Initiative (for more information, see <http://asi.politecnica.unige.it>) will become a focal point for signal processing research related to automation. In parallel, in *SPM*, we are working to include more content on these and other new advances of signal processing.



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