

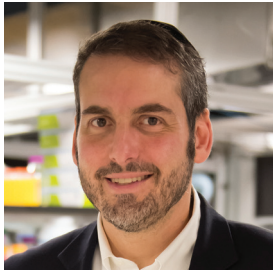
Electronics and Physics Industry



We don't often stop to think about how technology has changed our world for the better. The devices that we use day in and day out have made us faster, smarter, and even greener.

The 2016 National Inventors Hall of Fame Inductee class has made great strides in the fields of electronics, an industry that generated over \$1 trillion worldwide in 2014, according to the Consumers Electronics Association, and physics, a field comprised of individuals with STEM backgrounds in energy, engineering, healthcare, and technology, a segment that is growing at 1.7 times the rate of non-STEM jobs.

Three of our accomplished Inductees revolutionized the way we consume our media while another helped to reduce energy consumption and harmful emissions with just one tiny chip.



Joseph M. Jacobson a post-doctoral student at Stanford University, envisioned a book with content that could be changed and renewed at the push of a button. In the mid-1990s, Jacobson set out to create a changeable display, sketching out a system of black and white particles encapsulated in microspheres and embedded in a display medium. The microspheres, filled with a clear liquid that allowed the black and white particles to move around, would rise to the top of each capsule and become visible, depending on the electrical charge applied. This was the beginning

of electronic ink. A few years later, Jacobson enlisted students Barrett Comiskey, a math major, and JD Albert, a mechanical engineering major, to help advance the technology.

Jacobson earned his B.S. from Brown University and his Ph.D. from MIT, and is currently head of the MIT Media Lab's Molecular Machines research group, which focuses on synthetic biology.



Barrett Comiskey worked nights and weekends in the MIT Media Lab while earning his undergraduate degree in mathematics. Comiskey immersed himself in the chemistry, physics, and electronics needed to tackle the project. Experimenting with microencapsulation, Comiskey realized that electrophoretic displays, an otherwise forgotten technology, might be the answer. This approach overcame the practical problems faced by many previous attempts at building low-power displays with paper-like properties. Working together closely in the lab, Comiskey and fellow MIT student JD Albert built a working prototype.

Comiskey earned his B.S. from MIT and his MBA from Stanford University. He has been based in Asia since 2004 and has dedicated his efforts to bridging the digital divide for billions of people in developing countries.



Jonathan (JD) Albert studied mechanical engineering at MIT. With a keen interest in product design and new technology, he was recruited to work in Professor Joseph M. Jacobson's lab alongside fellow student Barrett Comiskey. Albert and Comiskey combined their skills from different disciplines, and in January 1997 they completed a working prototype of the technology. Albert continued to work alongside Comiskey upon graduating from MIT and went on to develop the manufacturing methods used to make electronic ink displays in high volume.

In 1997, with Harvard Business School graduate Russ Wilcox and LexisNexis founder Jerome Rubin, the inventors launched E Ink — and a reading revolution. The first commercial e-reader using electronic ink was produced by Sony and introduced in 2004; Amazon and Barnes & Noble soon followed with their versions, making the technology a cornerstone of the e-reader and e-book industry. To this day, over 70 million e-readers have been shipped worldwide.

Jacobson, Comiskey and Albert continued to improve electronic ink, including a color display patented in 2007, based on the same fundamental technology, which has since found applications in commercial signage as well as in the displays of some cell phones and smartwatches.

Albert teaches product design, engineering, and entrepreneurship to students in the Integrated Product Design program at the University of Pennsylvania and is the Director of Engineering for Bresslergroup, a product design and development firm.



Bantval Jayant Baliga

B. Jayant Baliga invented the insulated gate bipolar transistor (IGBT), a semiconductor power switch that has reduced gasoline consumption by 10 percent

and improved electrical energy efficiency by more than 40 percent, resulting in eliminating carbon dioxide emissions by over 100 trillion pounds worldwide during the past 25 years. The IGBT is a tiny chip that controls energy usage in electric-powered devices operating at high voltages. Used in household appliances, cars, solar panels, fluorescent lighting, medical equipment, and bullet trains, the IGBT has profoundly impacted the modern world by improving the quality of life for billions of people.

In 1974, when Baliga joined General Electric's R&D Center, two semiconductor transistors were being manufactured and used: the metal-oxide semiconductor field-effect transistor (MOSFET) for low-voltage applications, and bipolar transistors for high voltage applications. The technologies were deemed incompatible, but Baliga soon proposed and demonstrated a new high voltage transistor that utilized an MOS-gate region to control a bipolar current within a single device for the first time. Originally named the Gate Enhanced Rectifier to emphasize its diode-like on-state characteristics, the device is now manufactured worldwide as the IGBT. Since its invention, the IGBT has saved consumers \$24 trillion by reducing gasoline consumption by over 1.5 trillion gallons and electricity usage by over 75,000 TWhrs.

Baliga has been granted 120 U.S. patents, many of them commercialized via four successful start-up companies he founded in North Carolina. Among these, the GDMOSFET transistor is being manufactured worldwide for low voltage applications in computers, data-centers, and automotive electronics.

Baliga, a native of India, received his B.Tech. from the Indian Institute of Technology – Madras, and M.S. and Ph.D. degrees from Rensselaer Polytechnic Institute. He is currently a Distinguished University Professor of Electrical Engineering at North Carolina State University.