



September 28, 2018

## The Honda Prize 2018

### **Awarded to Dr. Fujio Masuoka, Professor Emeritus, Tohoku University -Inventor of the “flash memory” non-volatile semiconductor memory-**

Honda Foundation, the public interest incorporated foundation (established by Soichiro Honda and his younger brother Benjiro, and currently led by President Hiroto Ishida) is pleased to announce that the Honda Prize 2018 will be awarded to Dr. Fujio Masuoka, Professor Emeritus, Tohoku University in recognition of his invention of the world’s first “flash memory” technology, enabling large-capacity non-volatile semiconductor memories, and his major contributions to technical progress in that domain and to the numbers of persons entering it.

The Honda Prize, established in 1980 and awarded once each year, is an international award that recognizes the work of individuals or groups generating new knowledge to drive the next generation, from the standpoint of eco-technology<sup>\*1</sup>. Dr. Masuoka, foreseeing a future era of large capacity data handling, announced in 1984 the technology behind the “flash memory,” non-volatile semiconductor memory that can electrically delete 256K bits of data instantly in one batch. Back then, the DRAM<sup>\*2</sup> was the most commonly used data storage semiconductor memory device. Invented in the 1970s, the DRAM was a volatile memory whose recorded data were automatically erased when power was cut off. The flash memory, by contrast, was a non-volatile memory that could retain data in that circumstance, as magnetic memory does. Its other strength was that it required less than one-quarter the bitwise occupied area of existing devices, allowing a drastic reduction in product size and cost. Today, flash memory diffusion contributes to smaller sizes in IT equipment and to far less electricity consumption. In recognition of his achievement, the Foundation deems it appropriate to award this year’s Honda Prize to Dr. Masuoka.

This year marks the 39th award of the prize. The presentation ceremony will be held on November 19, 2018 at the Imperial Hotel Tokyo, at which Dr. Masuoka will be presented the medal, the certificate and an honorarium of 10 million yen.

#### <Dr. Masuoka’s flash memory>

Non-volatility is required when computer data are recorded on an external medium. Ongoing recording is necessary even in the absence of a power source. In early days, paper tape and punch cards were used, supplanted in the 1950s by magnetic tapes as the recording medium and thereafter by floppy disks and hard disks. This trend has now led to the diffusion of CDs and DVDs, whose information recording is performed via reflected light. These magnetic and optical media, however, had structural issues concerning data recording such that reading and writing data required a substantial amount of time, and equipment miniaturization was difficult.

Semiconductor non-volatile memory retains electrons at what is called a floating gate covered by an insulation film, and by controlling the method by which electrical current electrons are accumulated and removed, enabling data recording and elimination. When research began in the first half of 1970s, the quality of the insulation film was poor, and electrons could be retained for only several microseconds.

The late 1970s were a technical watershed for insulation film manufacturing methods, when the research theme shifted to electrical data overwriting methods. In 1980, an American semiconductor company brought out the “EEPROM<sup>\*3</sup>,” which enabled overwriting of electrical data. But because electron entry and exit required 2 transistors per bit, the degree of integration could not be increased and recording of large data quantities was difficult.

In 1983, the majority opinion about recording devices took the view that non-volatile semiconductor memory was not a substitute for hard disk-led magnetic memory. At that time, however, Dr. Masuoka had already been creating prototypes using his own favored concepts. Within a semiconductor memory chip there are innumerable rooms called cells. The world’s research of that era centered on control of data elimination in each cell, but Dr. Masuoka’s approach opted for elimination of data in multiple cells in one batch. As a result, the number of transistors used was drastically reduced and the degree of integration was successfully increased. Batch elimination of data can be compared to a camera’s flash function, so “flash memory” products appeared in 1985 and embarked on worldwide diffusion.

Presently, flash memory is essential to the IT infrastructure supporting society. It is used in autos, household appliances, computers and smart phones, memory cards and others. The arrival of the IoT era predicts that the 2020 worldwide digital data volume will be 44 zettabytes (ZB)<sup>\*4</sup>, so integration of recording devices is of utmost importance. Dr. Masuoka is pursuing research into practical use of 3-dimensional flash memory that will accumulate electrons in a memory chip with a cylindrical configuration instead of the usual flat shape, and enable cell multi-layering.

The flash memory developed out of his research has brought about the evolution of computer performance and significant effects on the development of science and technology. Further, mounting of non-volatile semiconductor memory can serve equipment miniaturization and electric power conservation, and contribute substantially to reduction in planetary power consumption. In view of these contributions to ecotechnology, the Foundation has certified Dr. Masuoka as the 2018 Honda Prize laureate.

\*1 Ecotechnology: a neologism combining imaging of the natural world (ecology), including civilization as a whole, and technology. Advocated by the Honda Foundation in 1979, it seeks new technological concepts required of human society in the sense of coexistence of people and technology.

\*2 DRAM: An abbreviation for Dynamic Random Access Memory. It is semiconductor memory that can read and write data. Data disappear when electric power is cut off, but the manufacturing cost per quantity is low, and it can be used as a computer main memory device.

\*3 EEPROM: Abbreviation of Electrically Erasable and Programmable ROM. It is semiconductor memory that can erase and rewrite electrically recorded content.

\*4 ZB (zettabyte): The 21st power of 10 bytes. It is equivalent to 1 hundred million people each creating 10 thousand GB data (i.e., 70 thousand video data pieces combined).

For more information, contact the Honda Foundation via:

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You may also contact Honda Motor’s Corporate PR Department via phone at +81-3-5412-1512.

# Dr. Fujio Masuoka

Professor Emeritus, Tohoku University



## **Date of Birth**

May 8, 1943

## **Biography**

1966: Graduated from Department of Electronic Engineering, School of Engineering, Tohoku University

1971: Obtained a doctorate in engineering from Department of Electronic Engineering, Graduate School of Engineering, Tohoku University

1971: Joined Tokyo Shibaura Electric Co., Ltd. (currently Toshiba Corporation)

1994: Resigned Toshiba Corporation and appointed as a professor of Graduate School of Information Sciences, Tohoku University

1996: Transitioned to a professor of Research Institute of Electrical Communication, Tohoku University

2004: Appointed as the director and chief technology officer of Unisantis Electronics (Japan) Ltd.

2007: Retired Tohoku University and appointed as a professor emeritus of the University

2012: Changed the corporate name from Unisantis Electronics (Japan) Ltd. to Semicon Consulting Ltd., continuing up to today

## **Major Patents, Papers, and Publications** (out of 189 patents, 79 papers, and 114 Int'l conference publications)

F. Masuoka, U.S. Patent, 4, 437, 174, Mar.13, 1984 (national patent application, 1981)

F. Masuoka, U.S. Patent, 5, 245, 566, Sept. 14, 1993 (national patent application, 1987)

F. Masuoka, et al., IEEE Tech. Digest, IEDM, 1984, p.464-467

F. Masuoka, et al., IEEE Tech. Digest, IEDM, 1987, p.552-555

B. Fulford : “Unsung Hero in Japan” , Forbes Global, June 24, p.24-26 (2002)

2010 Computer History Museum (CHM) (elected to the Hall of Fame)

2011 Consumer Electronics of America (CEA) (elected to the Hall of Fame)

Special Issue for Dr. Masuoka, IEEE Solid-state Circuits Vol.5, No.4 (2013)

“Transition of Semiconductor Memories and Their Future Prospects,” Journal of the Institute of Electrical Engineers of Japan, Vol. 136, Issue 1, p.34-37 (2016)

## **Major Awards Received** (out of 16 awards)

1980: Invention Award, National Commendation for Invention, Japan Institute for Promoting Invention and Innovation

1997: IEEE, The Morris N. Liebmann Memorial Award

2000: The Main Prize of Ichimura Industrial Award, the New Technology Development Foundation

2002: International Conference on Solid State Devices and Materials, SSDM Award

2005: The Economist Innovation Awards

2007: Medal of Honor with the Purple Ribbon

2012: The Photographic Society of America (PSA), Progress Medal

2013: USA Flash Memory Summit, Lifetime Achievement Award

2013: Person of Cultural Merit

2017: Orders of the Sacred Treasure, Gold and Silver Star