HONORS AND AWARDS:

MARVIN MINSKY

United States – 1969

CITATION

For his central role in creating, shaping, promoting, and advancing the field of Artificial Intelligence.

Marvin Minsky is Toshiba Professor of Media Arts and Sciences, Emeritus, and Professor of Electrical Engineering and Computer Science, Emeritus, at the Massachusetts Institute of Technology. His research includes important contributions to cognitive psychology, neural networks, automata theory, symbolic mathematics, and especially artificial intelligence, including work on learning, knowledge representation, common sense reasoning, computer vision, and robot manipulation. He has also made important contributions to graphics and microscope technology.

Minsky was born in New York City. He attended the Fieldston School and the Bronx High School of Science, in New York City, followed by Phillips Academy, in Andover, Massachusetts. After spending time in the United States Navy toward the end of World War II, he continued his education, earning a BA in Mathematics from Harvard College, followed by a PhD in Mathematics from Princeton University.

During his undergraduate years at Harvard, he interacted with the distinguished mathematician Andrew Gleason and the eminent psychologist George Miller. Minsky impressed Gleason with some fixed point theorems in topology, which first established his depth in mathematics and hinted at his eventual elevation to the National Academy of Science.

While at Princeton he built a learning machine, with tubes and motors, which established his passion for building and forecasted his elevation to the National Academy of Engineering. At Princeton, John Tukey and John von Neumann were on his thesis committee.

When he finished his PhD work, John von Neumann, Norbert Wiener, and Claude Shannon supported his admission to the select group of Junior Fellows at Harvard. As a Junior Fellow, Minsky invented the confocal scanning microscope for thick, light-scattering specimens. Light travels from the light source, through a beam splitter, comes to a point inside the specimen, bounces back to the beam splitter, and from there into the viewing optics. Because only one point is viewed at a time, the specimen has to be moved to form a complete image.

Minsky's invention disappeared from view for many years because the lasers and computer power needed to make it really useful had not yet become available. About ten years after the original patent expired, it started to become a standard tool in biology and materials science.

Minsky's work on Artificial Intelligence using symbol manipulation dates from the field's earliest days in the 1950s and 1960s. Many consider his 1960 paper, "Steps toward Artificial Intelligence," to be the call-to-arms for a generation of researchers. That paper established symbol manipulation—divided into heuristic search, pattern recognition, learning, planning, and induction—to be at the center of any attempt at understanding intelligence.
In the early 1960s, Minsky, along with John McCarthy, founded the MIT Artificial Intelligence Laboratory. Students and staff flocked to this new laboratory to meet the challenge of understanding intelligence and endowing machines with it. Work in the new laboratory included not only attempts to model human perception and intelligence but also efforts to build practical robots. Minsky himself designed and built mechanical hands with tactile sensors and an arm with fourteen-degree-of-freedom. He exploited the fact that the force and torque vector associated with any single point of contact along an arm can be determined by a sophisticated force-sensing wrist.

From the 1960s, Minsky has argued that space exploration, undersea mining, and nuclear safety would be vastly simpler with manipulators driven locally by intelligent computers or remotely by human operators. Early on, he foresaw that microsurgery could be done by surgeons who work at one end of a telepresence system at a comfortably large scale while the other end machines do the chore required at the small scale where tiny nerve bundles are knitted together or clogged blood vessels are reamed out.

In the late 1960s, Minsky began to work on perceptrons, which are simple computational devices that capture some of the characteristics of neural behavior. Minsky and Seymour Papert showed what perceptrons could and could not do, thus raising the sophistication of research on neurally-inspired mechanisms to a new level. Renewed interest in neurally-inspired mechanisms, twenty years later, led to a reprinting of their classic book, *Perceptrons*[3], with a new chapter treating contemporary developments.

Taken together, Minsky's steps toward Artificial Intelligence, his early work on symbol manipulation and perceptrons, the founding of the MIT Artificial Intelligence Laboratory, and the work of his earliest students firmly establish Minsky as one of the founders of Artificial Intelligence.

Minsky and Papert continued their collaboration into the 1970s and early 1980s, synergistically bringing together Minsky's computational ideas with Papert's understanding of developmental psychology. They worked both together and individually to develop theories of intelligence and radical new approaches to childhood education using Logo, the educational programming language developed by Papert and his colleagues.

Minsky's best known work from the mid-1970s centers on a family of ideas that he called the Theory of Frames. He emphasized two key concepts in his famous, often reprinted paper, "A Framework for Representing Knowledge." Minsky's frames can be summarized by noting two things:

1. objects and situations can be represented as sets of slots and slot-filling values;
2. many slots ordinarily can be filled by inheritance from the default descriptions embedded in a class hierarchy.

A frame describing a birthday party, for example, would have a slot for the person celebrated, the person's age, the location, and a list of the gifts presented. When published, the Theory of Frames offered not only a fresh way to consider human thinking, but also had high impact on Artificial Intelligence as an emerging engineering discipline: the popular expert-system shells developed during the following decade all offered tools for developing, manipulating, and displaying frames.

A few years later, in "K-lines: A Theory of Memory" (1979), Minsky addressed four key questions:

1. How is information represented?
2. How is it stored?
3. How is it retrieved?
4. How is it used.

His answer was that knowledge lines help us solve a problem by actuating those parts of our brains that put us back in a mental state much like one we were in when we thought about a similar problem before. An elementary physics problem, for example, might take a student into a mental state partially populated with previous applications of Newton's laws, the conservation of energy, force diagrams, and the role of friction.

In 1985, frames, k-lines and many other ideas came together in Minsky's book, *The Society of Mind* [4]. As its name suggests, the book is not about a single idea. Instead it is a statement that intelligence emerges from the cooperative behavior of myriad little agents, no one of which is intelligent by itself. Throughout the book, Minsky presents example after example of these little agents at work, some supporting natural language understanding, some solving problems, others accumulating new ideas, and still others acting as critics.
In 2006, Minsky published a second seminal book, *The Emotion Machine* [6], which is full of ideas about consciousness, emotions, levels of thinking, and common sense. Multiplicity is a dominant theme. Minsky wrote that our resourceful intelligence arises from many ways of thinking, such as search, analogy, divide and conquer, elevation, reformulation, contradiction, simulation, logical reasoning, and impersonation. These ways of thinking are spread across many levels of mental activity, such as instinctive reactions, learned reactions, deliberative thinking, reflective thinking, self-reflective thinking, and self-conscious emotions. The upper levels of mental activity enable many ways of modeling self, such as physical, emotional, intellectual, professional, spiritual, social, political, economic, and familial. Concepts such as awareness and consciousness seem complex largely because such words do not label single, tightly bounded processes, but rather many different ways of thinking, spread across many levels of mental activity, involving many ways of modeling self; awareness and consciousness are suitcase words so big you can stuff anything into them.

Minsky and his wife, Gloria Rudisch Minsky, have three children, Margaret, Julie, and Henry.

Author: Patrick Henry Winston