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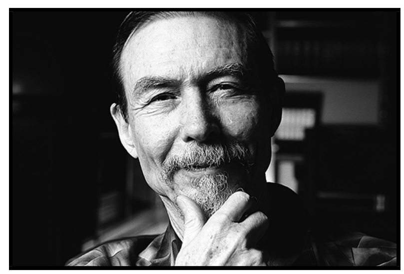
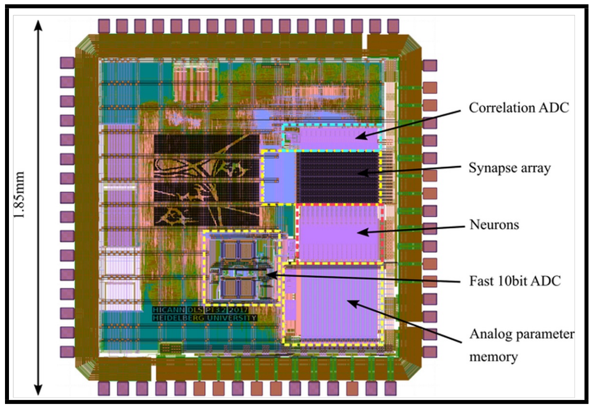
The year is 1988. Two scientists are studying a small chip of silicon. By 1988, the silicon itself is nothing of note; of greater importance, however, is the goal of the two scientists: creating a single chip that mimics retinae. Their paper, "A Silicon Model of Early Visual Processing," is to be the birth of a new field of study. One of the earliest endeavors into Very-Large-Scale Integration (VLSI), the paper of Carver A. Mead and Misha Mahowald will pave the way for Neuromorphic Engineering - the development of VLSI chips mimicking life itself.



The creation of Neuromorphic Engineering is credited mostly to Carver Mead, pictured right. Mead, a Caltech graduate, received his Ph.D. in 1960 with his paper "Transistor Switching Analysis." Mead's paper with Mahowald represents the first scientific exploration of neural VLSI circuits. The field was then further cemented by Mead's 1989 book, "Analog VLSI and Neural Systems," detailing many of the principles that founded Neuromorphic Engineering. In 2013, in an interview with MIT Technology Review, Mead described his inspiration for first starting the field. Having explored creating very large computer systems, he had run up against problems with power dissipation - losing power as electrical systems got larger. His solution was to look to animal systems for inspiration, such as in the retinal experiment described earlier, which led him to begin making VLSI circuits.

A recently developed field - and more importantly, a highly technical one, Neuromorphic Engineering has had little time to make a big splash. As Mead stated in the 2013 interview with MIT Technology Review, when asked about this peripheral nature, "It always starts that way. The transistor was a tiny little wart off a big industry, and people said, 'Oh, well, you can make hearing aids out of them.' You never know when something's going to click." Despite this novelty, however, the Neuromorphic industry is growing rapidly, with some stunning achievements recently.

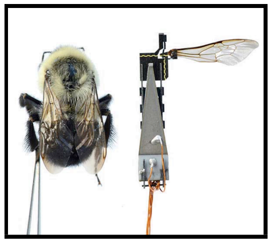
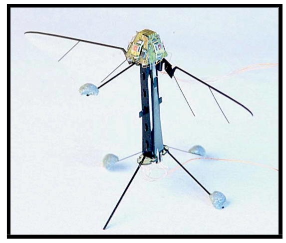
One such development in the field is the introduction of Neuromorphic Conventions such as the Telluride and CapoCaccia conventions. These two conventions provide a place and time for Neuromorphic Engineers to meet and put their heads together for the sake of breakthroughs. For example, in 2012, participants in the Telluride convention developed a robot that learned to mimic facial expressions and even draw the attention of a human. The robot's speech patterns were programmed, but it should be stressed that Neuromorphic techniques were applied such that positive and negative feedback from the user would train the robot to speak the right sentences of its own volition. The video of this robot is available at https://youtu.be/KD6cpn_V-wY.



Another major impact of Neuromorphic Engineering is the Human Brain Project (HBP): https://www.humanbrainproject.eu/en. The HBP is an ambitious international undertaking, much like the Human Genome Project, that requires extensive knowledge from many fields including Neuromorphic Engineering. The goal of the HBP is "mapping and better understanding the structure and organisation of the human brain," a goal comprising fields such as neuroscience, medicine, and robotics. A result of this research is the BrainScaleS 2, the chip diagrammed at right. The chip contains nearly two hundred thousand electronic neurons and fifty million synapses, neural connections, and the chip is touted to evolve as it runs and has new experiences, demonstrating the technical capability and potential of Neuromorphic Engineering.

But perhaps the best demonstration of the potential applications of Neuromorphic Engineering is in the context of a larger project: engineering robotic bees, for example. This 5-year, $10-million project, dubbed the "RoboBee Collective," was a step forward in a variety of engineering disciplines - after all, the goal was to design a system the size of a bee capable of flight. However, the project's initial inspiration came from an electrical engineer, Gu-Yeon Wei, and required significant electrical and computational advancements.

Indeed, making the collection of wires fly was a significant challenge, so the engineers took the lazy approach: Let it teach itself! And with significant improvements in the design of Deep Neural Networks (DNNs), electrical emulation of the brain, that's just what they did. And this is no small achievement; their engineering shrunk DNNs from needing " 'massive' computing capacity" to the needing size shown in the images below. This change is a major step in the inevitable evolution of hi-tech gear from large to small and is likely to be Neuromorphic Engineering's big breakthrough into everyday households. With learning simulations this easily accessible, integration is unavoidable.

However, as a student looking ahead to a future career, the quintessential question is one of four words: Why choose this field? Neuromorphic Engineering entices me because it sits at the bleeding edge of realizing my Sci-Fi fantasy. Having a few years of programming experience, I have developed a strong interest in technical computations such as that of artificial intelligence. Helping design a machine that can think and process information at a similar level to humans sounds like a dream come true for me.

But as a profession, what is Neuromorphic Engineering and what is necessary to become involved in the field? Unfortunately for the prospective engineer, Neuromorphic Engineering is not a standalone field but instead is the cumulative goal of many different fields working in tandem. This is demonstrated by the fact that one does not simply walk into a college and ask to become a Neuromorphic Engineer: There is no discrete major for this field at Harvard, MIT, Caltech, or Rutgers. Instead, the most likely path for an engineer seeking to tackle this field is through Electrical or Computer engineering, a major available at all of the schools mentioned above.

Some of the best schools for electrical engineering are MIT, Caltech, Stanford University, and Georgia Tech. MIT, Caltech, and Stanford University all have tuition costs of around $50,000, and Georgia Tech costs around $33,000 in tuition. At these schools, a variety of degrees are offered, ranging from a Bachelor’s to a Master’s Degree to a Ph.D. in electrical engineering. According to Glassdoor, electrical engineers here in New Jersey make just around the national average of $83,000 per year.

A young field with what appears to be a prospective future, Neuromorphic Engineering seems to be a great place for those with interest in computation and artificial intelligence; few interests better describe my professional self. And if worst comes to worst, the necessary experience in electrical engineering will certainly be a good fallback. With any luck, I’ll be able to find a well-paying job engineering circuits to mimic my brain. If this pans out, I’ll be sure to have my robotic assistant contact you - assuming we aren’t wiped out by sentient robots first.

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