At Harvard and the Massachusetts Institute of Technology there is raging a "battle of the brains" . . .

WILL *Machines* REPLACE THE *Human Brain?*

SERGE FLIEGERS

The placid brown waters of the Charles River, rolling through Cambridge, Massachusetts, bathe what is undoubtedly the most intellectual shore line in this country — the few odd miles that stretch between the stately grey halls of the Massachusetts Institute of Technology and the bright, crenelated houses of Harvard. This winter, the waters of the Charles are being rippled not only by the harsh winds of the north but also by the echoes of a sizzling controversy between two intellectual giants of our times — Professor Howard Aiken of the Harvard Computation Laboratory and Professor Norbert Wiener of the Department of Mathematics at MIT.

This controversy, somewhat muffled by good-natured academic politeness, is nevertheless aptly named the "Battle of the Brains." This is because it involves not only the human, or perhaps slightly superhuman cerebral mechanisms of Aiken and Wiener; it is also because, pitched against each other, are two inhuman monsters of reason and logic: The "Mark IV" of Harvard versus the "Whirlwind" of MIT. These two giant electronic computing machines — known commonly as electronic brains — are competing in a race that has so far produced a new science named "Cybernetics" and the promise of another industrial revolution, a revolution that may affect our civilization more profoundly than the steam engine or the atomic bomb.

This correspondent recently completed a tour of the very front line of this unique battle. First stop was the modernistic, red-brick and glass building behind Harvard's Law School, which serves as headquarters

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to Professor Aiken, and which is guarded by a sign that says: "Visitors, Keep out." Unlike the sign, Professor Aiken is the soul of hospitality. Pushing aside a large stack of letters from businessmen who want the computing machine to solve their marketing and production problems, the Professor devoted considerable time explaining binary mathematics, differential equations, and showing us around his "baby." There are two "babies," in fact, both about ten feet high and running the entire length of a medium-sized room. One is Mark III built for the Naval Ordnance Bureau by Professor Aiken and the International Business Machines Corporation. The other, Mark IV, has just been completed and was starting to operate as we began our tour. Both machines look like enormous radio sets with their sides torn off. Their entrails show thousands of flickering electronic tubes, capacitators, resistors, switches and bright red and amber control lights. Mark IV receives instructions and gives answers on magnetic tape and has a control booth that looks like a setting for "Space Cadets." Mark III, more old-fashioned, is operated by a roll of perforated paper tape which looks exactly like the roll of a player piano. While we looked on, the tape was being sucked in by the machine and, at one end, an electric typewriter began clattering. Mark III, it seems, was in the process of writing a book of mathematical equations. It would complete the 300-page book in about three days. A skilled mathematician, working twelve hours a day, seven days a week, would take more than a year to accomplish a similar task.

"So this," we remarked innocently, "is the thinking machine."

Professor Aiken, a tall, distinguished-looking and relaxed gentleman, snapped out of his seeming lethargy. Pounding his right fist against his left palm, he explained emphatically: "This is not an electronic brain or a thinking machine. It is merely a computer — fast, accurate — but nothing more than a slavish automatic device designed to help us solve mathematical and mechanical problems."

This question — can machines think? — lies at the very heart of the "Battle of the Brains" controversy. Before approaching this ticklish point, we listened to Professor Aiken explaining what the machines can do, and what they have done.

"During the war, for example, Mark III flew a bomber from Chicago to Los Angeles. First with all four engines going, then with two and even three engines conked out, with different loads, at different altitudes. Today, with Mark IV, we can fire a guided missile and trace its path through the atmosphere under varying conditions." All this, naturally, is not meant in the literal sense. What Mark III and Mark IV actually do is to take a differential equation representing the physical properties of the plane or missile to be tested, and then subject this equation to various factors representing speed, altitude, and so forth. In practice, this method has saved our government millions of dollars. Previously, plane designers would take "engineering guesses," then construct expensive experimental models which often crashed, losing lives and money. Today, the machine's calculations have taken much of the guesswork out of engineering guesses.

But the machines can perform even more complicated and direct functions. Mark I, the first machine built by Aiken to help him with calculations for his Ph.D thesis, is now running a whole shop of calculating machines. "It does not take too much of a stretch of imagination," the Professor explains, "to see a machine shop run by an electronic computer. And then, you are looking in the direction of an automatic factory. And where we have automatic files stored on magnetic tape, we approach the problem of an automatic office."

No secretaries or typists in this office of tomorrow, just a machine that reads letters by means of a photocell scanning device, delves into its automatic files for the information requested, and then automatically types out a reply. There could be, for example, an automatic insurance company, calculating premiums, sending out due notices, and crediting payments, all without the help of a single human employee.

At present, Professor Aiken is considering a project whereby his machines would produce word-by-word translations from Russian into English. "Then, by increasing the sophistication of the machine," the Professor adds placidly, "we could get a more literary translation."

How are these seemingly human tasks performed by steel-and-glass machines which, according to Professor Aiken, cannot think and are merely slavish and mechanical instruments? For an answer to this we crossed over to headquarters of the opposite camp at MIT. These headquarters proved to be a small, dusty office at the end of a long, dusty corridor. There we found Professor Norbert Wiener, surrounded by books on philosophy, mathematics, biology, politics, physiology and a few twenty-five-cent mysteries. Professor Wiener is an ebullient, barrel-chested man ("my favorite sport in college was wrestling," he explains) with a handsome Vandyke beard and quick, humorous eyes. There was not enough room in the office for the Professor, his pretty secretary, the books and this interviewer, so we went to an unused classroom.

Interviewing Professor Wiener is

not easy. To begin with he is a real, honest-to-goodness genius. He entered Tufts College at the age of eleven, graduated at fourteen and shortly thereafter took his Ph.D. at Harvard. He speaks six languages fluently including Chinese and ancient Greek, and is apt to break into any one of them in the midst of a discussion of the quantum theory, Einstein's role in the modern world or the harmonics of Johann Sebastian Bach.

Nevertheless, with the use of a blackboard and a short course in binary mathematics, Professor Wiener was able to demonstrate some fundamentals of the electronic computing machine.

To explain the workings of this machine it might be easiest to use the methods recently employed by a young British father whose wife pressed him to tell their children the facts of life. Calling the kids into his study, he asked somewhat embarrassedly: "Do you know about the bees and the flowers?"

"No, daddy," they replied blankly. "Well, dash it, do you know how babies are born?" "Certainly," the kids chorused eagerly. "That's wonderful," the relieved father sighed, "it's the same with the bees and the flowers."

In other words, one can understand the working of a mechanical computer by studying the mechanism of the human brain.

Speaking roughly, and oversimplifying unmercifully, one might say that our thinking mechanism is composed of a vast system of nerve-fibres that might schematically look like a network of railroad tracks approaching a central station. Along these fibres, or tracks, run tiny pulses, like trains trying to get into the station. At each juncture of two tracks there is a switching point, called a synapse. When our imaginary train arrives at such a synapse, it can be switched right or left, to the next synapse, and so until this pulse — or train — arrives at its proper destination. The switches are controlled by our memory.

Suppose the simple thought of "I want to eat" originates at the beginning of the network. The "eat" pulse will go to the first switch, labeled, let's say, "breakfast." But you have already had breakfast, and your memory of that has closed the "breakfast" switch. So the pulse goes on to the next synapse, marked "lunch." You haven't had lunch yet, so the pulse passes through that open switch to the next juncture, which we can call "sandwich." But the "sandwich" switch is closed because you remember that you're on a diet, and must not eat sandwiches, so the pulse goes on to an open switch marked "salad." And that's what you finally have for lunch.

Multiply the speed of such a process several million times, increase the complexity of the system a few more billion times, and you'll have a rough inkling of what goes on in a human brain — and in a "thinking machine."

For the machine works on exactly the same system.

INSTEAD of nerve-fibres it has electric wires or, in the case of the Mark IV, electric connections painted on with a ball-point pen to save space. Instead of synapses, the machine has relays and electronic switches called Eccles-Jordan circuits, and nicknamed Flip-Flops by simplicity-loving scientists. These flip-flops are open or shut, according to information stored in the machine at the beginning of each problem. They act as part of the machine's memory, retaining information, wiping it out after it becomes useless by "forgetting" it, and then acquiring new information as the problem progresses. Since these switches have only two positions — either flip or flop — they make only yes or no decisions, relaying a pulse to the next correct switch, or stopping it.

Numbers are stored in these switches by converting decimal figures into binary numbers. The binary system uses only 1 and 0 or, to convert this further into thinking machine lingo, it uses only flip or flop. To store a number, the machine plays a sort of game of twenty questions: Is it 1? No. Is it 2? No. Is it 3? Yes! Letters can be stored this way, too, with the same twenty-question game principle.

In addition to this, various machines have additional "memories" where information can be stored. "Mark IV" uses a huge magnetized drum. "Whirlwind" at MIT, fastest computer at the time of this writing, uses thirty-two electrostatic storage tubes, each of which holds 2048 sixteen-digit binary numbers, and MIT is installing an additional memory drum.

With simulated nerve-fibres, switches that make unerring decisions, and tapes, drums and tubes that store knowledge, why can't these machines think?

We asked Professor Wiener this question. He shrugged his heavy shoulders: "You could unquestionably duplicate, on a lower level, a large number of phenomena which we associate with thought and the working of the human brain. But when it comes to imitating the human brain . . ."

The professor stopped for a minute to make a quick calculation, then continued: "Look here, we have roughly a million fibres in the brain, each with the ability of making a yes or no decision. Therefore, you've got a storage capacity of 2 to the power of one million. To reproduce so many yes-or-no devices mechanically, you would have to have a machine capacity of about 100,000,000 cu. ft. With so many electronic tubes you would have the temperature of a fur-nace. . . ."

APPROACHING the subject from the opposite direction, Dr. W. Ross Ashby, Director of Research at Barnwood House, a British Psychiatric Hospital, has just issued an enormously important study entitled "Design for a Brain." Published here by Wiley, the book uses some Cybernetics to explain the brain's amazing ability to adapt itself to an unending stream of different situations. During his research, Ashby constructed a "Homeostat," a small machine designed specifically to imitate basic functions of the brain.

This desire to build a machine like a brain has long been imbedded in man's soul. As far back as 1617 John Napier, Laird of Merchiston, invented an "ingenious contrivance" called Napier's bones, designed "to help man with his logickal reckoning." French mathematician Blaise Pascal and German philosopher Gottfried Wilhelm Leibnitz also worked on the possibility of constructing a mathematical engine. In view of their concept of mathematics as a supreme form of logic it might well be supposed that such an "engine" might have been used to solve more than just problems of addition and subtraction.

The most ambitious project in this line was undertaken by British inventor Charles Babbage who, in 1833, began work on an "analytic engine" which was supposed to carry out complete computations according to specific instructions. Babbage's engine raised an intellectual furor in Victorian London and precipitated a metaphysical argument that foreshadowed closely the present controversy on "thinking machines versus brains." At that time Lady Lovelace wrote caustically: "The analytical engine has no pretension to originate anything. . . ." and today, that is the very argument put forward by the anti-Cybernetics faction.

Babbage was never able to prove whether his machine could originate anything. He died before he could even originate a working model of the machine. And the matter rested there until the early days of World War II, when German planes were taking a murderous toll of Allied Shipping. The U. S. Government approached Professor Wiener with a strange request: "We need a mechanism that can point a naval gun at an oncoming plane. It must be able to calculate the speed of the plane, predict its zigzags, take into account wind velocity, and the speed and rolling of the ship. To put it bluntly, the mechanism must do what an expert anti-aircraft gunner does — only better."

Wiener set to work and soon perfected a theory whose full importance has not yet been realized. It is the theory of feedback, or of continuous control mechanism. Wiener used the concept that our muscular actions are not stiff mechanical movements. Instead, they are flexible and constantly controlled. For example, when we extend a hand to grasp a pencil, our arm does not move rigidly like a mechanical piston or a crane. Our action is flexible, taking into account the speed, force and direction of our moving arm, the pull of gravity, the distance of the pencil, and numerous other factors. If our hand shoots out too far, it is pulled back by this feedback mechanism. If it goes too much to the right or the left, its direction is controlled and it is put back on the right path. When the object we want to grasp is stationary, there is no great problem. But when the object moves, our feedback mechanism goes into high gear, compensating both for our actions and for the movement and timing of the object we are aiming for. That is how a hunter downs a flying duck, and how an anti-aircraft gunner shoots at an enemy plane. Somehow, Wiener managed to incorporate the concept of feedback into the mechanism of a naval artillery piece, and his work is credited with having saved thousands of Allied lives and hundreds of thousands of shipping tons.

At the same time, Wiener's invention went one large step beyond the technique of existing mechanical computing machines.

If these existing machines already showed frighteningly human qualities, Wiener's concept of feedback started an epidemic of "mechanical brains."

One scientist constructed a machine that could find its way through a maze, another one built a mobile machine with two photoelectric cells on its face, capable of locating a light and going towards it with the sure instinct of a moth approaching a flame. Dr. Claude Shannon, top researcher of the Bell Telephone Laboratories, envisages a computer that can play chess, and he knows of at least one machine in England that does quite well at a game of checkers.

"But," detractors of the "thinking machine" theory argued, "all these machines act only on orders of the scientists handling their controls. They can't act independently."

So a brilliant young mathematician named Anthony Oettinger designed a small computer named Edsac, which he taught to recognize figures independently. He would feed numbers to the machine at random. When Edsac would pick the wrong number, Oettinger would "punish" it by pressing a button marked "punish." When Edsac chose the right number, Oettinger pressed a button marked "reward." Soon little Edsac was blithely picking the right numbers from a long string of jumbled mathematical symbols without help or prompting from its master.

Oettinger explains his work very matter-of-factly: "Edsac picked up habits very fast. It reacted just like an intelligent animal or a child — except that it made no mistakes. So, just to pursue the analogy, I rigged it up to make occasional mistakes. I even gave it a failing memory."

"But," Oettinger adds deprecatingly, "nothing in this stuff is a miracle. Or, if it is, it's definitely a man-made miracle."

NEVERTHELESS, the miraculous possibilities of these electronic gadgets have inflamed the imagination of the world. Professor Wiener, as the originator and apostle of the theory that machines might approach some form of thought, is the central figure of the new cult of "Cybernetics" — a term derived by Wiener from the Greek word for helmsman, and used earlier, without Wiener's knowledge, by French writer Louis Aragon to describe a system of political control.

Publications on Cybernetics are today being issued in England, France, and Italy. When Wiener once went to Geneva to rest from overwork, his Swiss doctor approached him diffidently: "You are the great Professor Wiener, yes?" Wiener, too tired to speak, only nodded.

The doctor smiled: "Would you be so kind and possibly write us a paper about Cybernetics?"

In Paris, Father Dubarle of the Dominican order, is president of a *Cercle Cybernétique*. We asked Professor Wiener whether there was any conflict, in his mind, between religion and the new theory of Cybernetics. Wiener mused: "When Pythagoras discovered his theorem of the triangle, he sacrificed a hecatomb, lest the gods be displeased. Now, every time a scientist discovers something new, all the oxen tremble."

"But," he continued "what is valid in religion will not suffer from Cybernetics or any other scientific probing. After all, there is still the central mystery of creation."

With a mischievous look, he pulled his beard: "It reminds me of the story of Frederick the Great and his court preacher. Every Sunday, King Frederick would send the preacher a slip of paper containing the subject upon which the King wanted his sermon preached. One Sunday, to amuse himself, Frederick sent up a blank piece of paper. The poor preacher looked at one side: 'There is nothing on this side' he said sadly. Turning over the paper he added: 'and there is nothing on this side . . .' Then, facing the King squarely he continued: 'And from nothing, God created this world . . . !'"

"And you know," Wiener chuckled, "he was quite right!"

Cybernetics may not solve the mystery of creation, but the work of Professors Wiener, Aiken and many others in the field of electronic computing machinery may well be adding a new problem to our life, the problem of an industrial and a clerical revolution.

Bertrand Russell, prognosticating what the next fifty years may bring, recently wrote: "Most things that are at present done by human beings can be done by robots. Mechanical brains are being rapidly perfected and it is hoped that before long, only experts will be able to distinguish them from live people. If we are to believe Dr. Norbert Wiener we must expect that, within the next fifty years at latest, a fully equipped factory will need only one man to press a button. All the rest will be done by ingenious mechanisms. . . . This will make the work of management much easier and, if the machines can be taught to vote, democracy will at last run smoothly."

It is still a far cry from machines that vote — although Remington Rand's "Univac" was used on election night by a television network to predict the result. But there is no question that electronic computers will move into industry in the very near future. Remington Rand already has seven "Univac" computers working in the field. One of them is being used by the Bureau of the Census. Others can maintain stock records, control inventory and production schedules, make out payrolls for a 10,000-man plant and handle mortgage loan accounts.

IBM is even further advanced in the industrial field, with more than 200 machines out, performing such tasks as locating skilled personnel for the Department of Defense and helping the FBI track down criminals. IBM's brain, by the way, makes a superior sleuth, with the ability to localize, sort and collate data on criminals at the rate of 650 suspects a minute.

WHAT EXACTLY will the total impact of all these "brains" be on our civilization? According to Professor Wiener, they will relieve man from the drudgery of tiring, mechanical work, just as the steam shovel relieved man from the drudgery of physical effort. According to Professor Aiken, computers will increase production, increase the standard of living and increase employment. "Look at the telephone," he says. "When the automatic exchange came in, everyone said that telephone girls would lose their jobs. Today there are more telephone operators than ever before."

Both men — temporarily abandoning their academic feud — agree that, if rightly handled, electronic "brains" may bring an economy of plenty and a life of increased leisure.

"But," asks Anthony Oettinger, "the question is whether people will use their new-found leisure to go to church or to go to war. . . ."

The Girl of My Dreams

Bernard Malamud

After Mitka burned the manuscript of his heartbroken novel at the blackened bottom of Mrs. Lutz's rusty trash can in her back yard, although the jolly landlady tried all sorts of bait and schemes to lure him forth, and he could tell as he lay abed, from the new sounds on the floor and the penetrating stench of her cologne that there was an unattached female loose on the premises (wondrous possibility of yore), he resisted all and with a twist of the key locked himself a prisoner in his room, only venturing out, unshaven, after midnight for crackers and tea and an occasional can of fruit, and this went on for too many weeks to count.

The novel had returned to stay in the late fall, after a long year and a half of voyaging among more than two dozen publishers, and he had hurled it into a barrel burning autumn leaves, stirring the mess at intervals with a long length of iron pipe, to get the inner sheets afire. Overhead a few dead apples hung like Christmas ornaments upon the tree stripped of leaves. The sparks, as he stirred, flew to the apples, to him representing not only creation gone for nothing (three long years), but all the dead hopes, ultimately even the proud ideas he had given the book; and Mitka, who was not a sentimentalist, felt as if he had burned (it took a thick two hours) an everlasting hollow in himself.

Into the fire also went a sheaf of odd-sized documents (why he had saved them he would never know): copies of letters to literary agents and their replies; mostly, however, printed rejection forms, with perhaps a half dozen typed notes from lady editors, saying they were returning the MS of his novel because — among other reasons, but this prevailed: because of the symbolism,

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