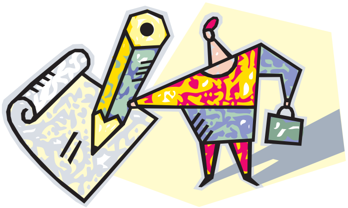

第 67 回全国大会招待講演

# JOHN ATANASOFF
## THE ELECTRONIC PROMETHEUS


**Blagovest Hristov Sendov**
（ブルガリア大使／元 IFIP 会長）



Konichiwa! I'm sorry, I'm not able to continue in Japanese for the time being and I'll speak in English. First of all I would like to thank the organizers for inviting me to speak for John Vincent Atanasoff. I would like to present his work and try to prove that he made one of the major steps toward the development of computers.

One of the biggest achievements in the last century is the use of the electronics for digital information processing. The electronic computers became universal instruments for transformation of information. They change quickly the way people use information and communicate between themselves. It is a question of great cultural interest how it happened and who made the first step. Everybody writing historical notes in a text book for computers has to say something about the first digital electronic computer and who built it. It is safe to copy the story written in other books. So, it becomes widely known that the first digital electronic computer is ENIAC, built by John P. Eckert and John W. Mauchly. The purpose of my lecture is to underline the difference between the introduction of a new technology, namely the electronic digital computing, and the building of an electronic digital computer based on this technology. We all know that the real breakthrough is the new technology and that its inventor deserves appropriate recognition. It is undisputable that the inventor of the electronic digital computing is John Vincent Atanasoff.


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## *The inventor*

John Vincent Atanasoff (1903-1995) was born on 4th of October 1903 a few miles west of Hamilton, New York. His father, Ivan Atanasov, an electrical engineer, was a Bulgarian immigrant. His mother, Iva Purdy, was a mathematics school teacher. John Atanasoff used to say that his mother was a typical American mixture of four different nations, but his father was only Bulgarian. John Vincent Atanasoff was a mathematician and physicist. By 1935 he was been teaching graduate students and supervised the research of doctoral students in Iowa State University, United States. Together with his students, he worked in various areas such as quantum mechanics, electricity and physics of the elasticity of crystals. In almost every case, he came across the problem of solving linear differential equations, which are not to be solved directly. He wrote the approximation method for solving these problems and reached to large systems of linear algebraic equations, a fact which everybody today knows very well.

From this time, John Atanasoff started to think over a machine for solving systems of linear algebraic equations, as a specialized machine not a universal one. In a letter to me, dated September 2nd 1970, John Atanasoff wrote:

"This problem becomes my obsession in a certain degree. Firstly, I tried analog methods of calculation, soon I found that they lacked accuracy, then I used tabulator of the Hollerith type and began to think using a mechanically connected calculating system. In the spring of 1937 I ventured in constructing new calculating elements. That was in a very cold evening in the fall of 1937, I came back to my study at the university in order to work on that problem. I tried to concentrate on the problems thinking about specific details, but nothing came out. Despaired, I got in my car and drove almost 300 kilometers at over 100 kilometers per hour. I got off in the chilly night and entered in a bar of an inn. In the course of several minutes, I felt my mind very calm and clear and I was if I saw in front of me, without any references or notes, all my knowledge and experience. When I started towards home early next morning, I had reached to a considerable new approach to the process of calculation."

There is something missed in this story here, in this letter. As a matter of fact, in Iowa, there was a dry regime, there was no alcohol and John Atanasoff drove far away to go in a bar in an other state, where he had his mind very clear after the first cup of whiskey.

John Atanasoff continues,

"In the first place, I worked alone but in the fall of 1939 I collected some finances and hired Clifford Berry. Late in the fall of the same year, our first prototype, which carried out addition and subtraction operations, came out. Chronologically, we demonstrated the following:

1. The first application of the binary number system in computing;
2. The first regenerative memory;
3. The first logic diagrams similar to the schemes used today;
4. The first actual application of consecutive calculations; and
5. The first electronic computer and other details of lesser importance of modern computers."

This is the list of the claims of John Atanasoff. And this is the original drawing of the machine of John Atanasoff (**Fig. 1**). You see it's very simple; it's very small, nothing to compare with ENIAC. This is a replica which was produced about 15 years ago (**Fig. 2**), and it is interesting that the all cost of the machine of Atanasoff was about $17,000, but the replica consumed more than $200,000. This is the original drum memory of John Atanasoff which was used in his machine (**Fig. 3**).

## The recognition

Now, I will turn to the process of recognition of John Atanasoff, because I'm sure that nothing is reported by experts that will side John Atanasoff in the first place as an inventor of the electronic computer. The famous American journalist, Clark Mollenhoff, bearer of the most prestigious Pulitzer Prize, describes in his book "*Atanasoff, Forgotten Father of the Computer*" [1)], published it in 1988, the saga of the recognition of John Atanasoff's priority as the inventor of the electronic digital computer in a court trial. In this remarkable and easy to read book he follows with journalistic skill the life and the brilliant invention of John Atanasoff, without technical and mathematical details.

A very important step of the recognition of John Atanasoff is made from a technical point of view. The first competent defense of the contribution of John Atansoff was made by Arthur and Alice Burks in their extensive historical article, "*The ENIAC, First General-Purpose Electronic Computer*" [2)] published in 1981. The article is very competent and convincing since Arthur Burks had worked with Eckert and Mauchly and kept the richest documentation about ENIAC and original parts from that remarkable machine.

It is natural to ask the question: why these competent publications written by very famous authors didn't lead to the categorical and complete recognition of John Atanasoff even until now. The answer to this question is not an easy or unambiguous one. I will try to formulate several factors, which taken together, offer some explanation for this situation.

First, this is the court recognition. The proof for John Atanasoff's priority is provided in an indisputable way by the court. He himself is impressed by the strength, the competence

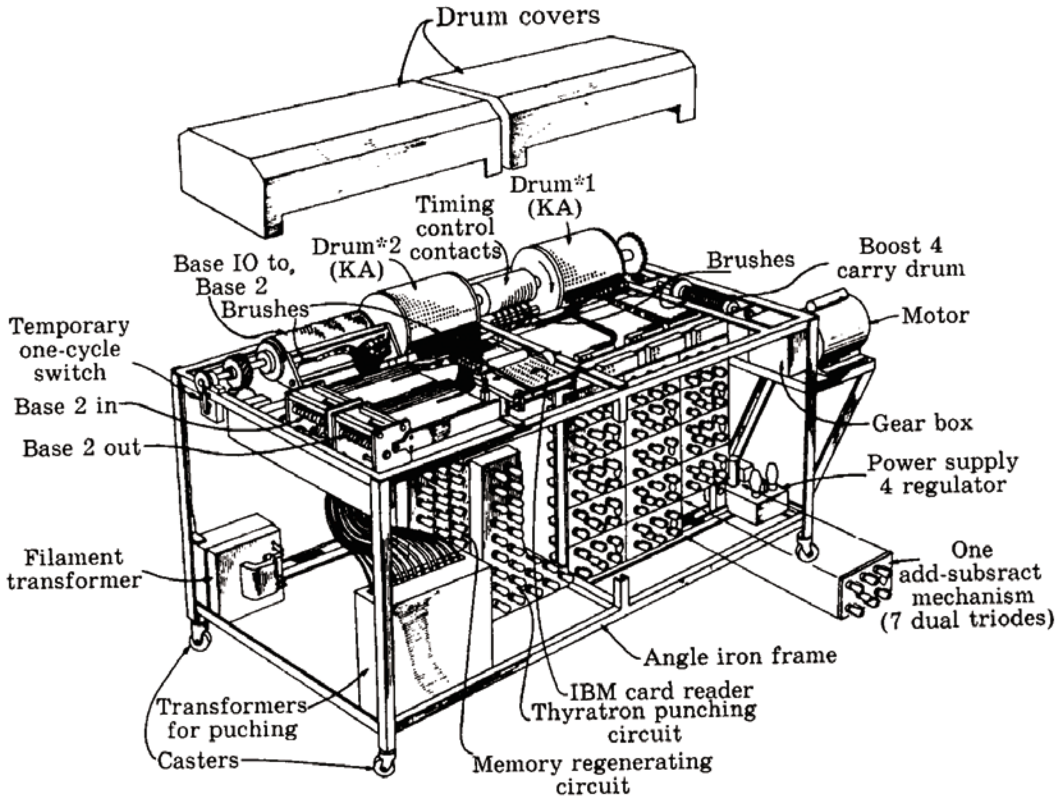



Figure 1. ABC Computer. (Thomas J. Hayes, South Bend, Indiana)

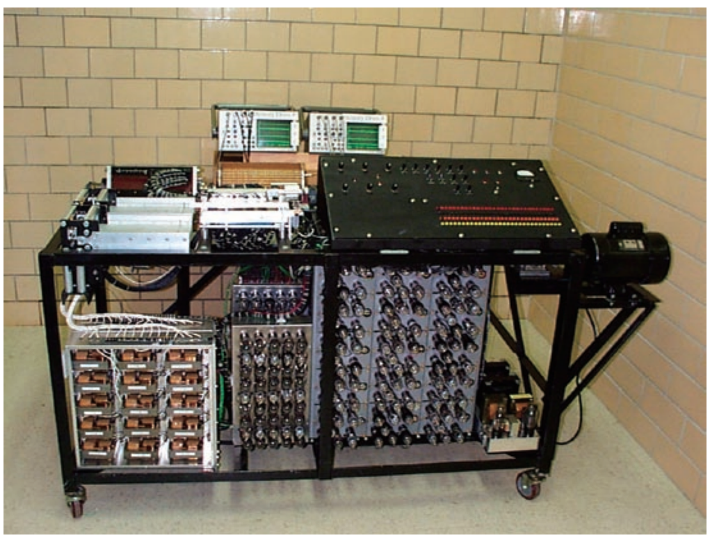


Figure 2. Replica of ABC.


Figure 3. Original drum memory of ABC.


and persuasiveness of the judges and patent attorneys in proving the scientific and technical facts and their origin. But the aim of the court case was to decide a dispute between *Sperry Rand Corporation and Control Data Corporation*, arguing about lots of money connected with the patents, while Atanasoff and Mauchly were only witnesses at the trial. As a side effect of this trial, it is proved that Mauchly has borrowed the basic principles of the ENIAC from Atanasoff. This is the ground for invalidating the patent for ENIAC and John Atanasoff was declared the inventor of the first electronic digital computer in the decision of the

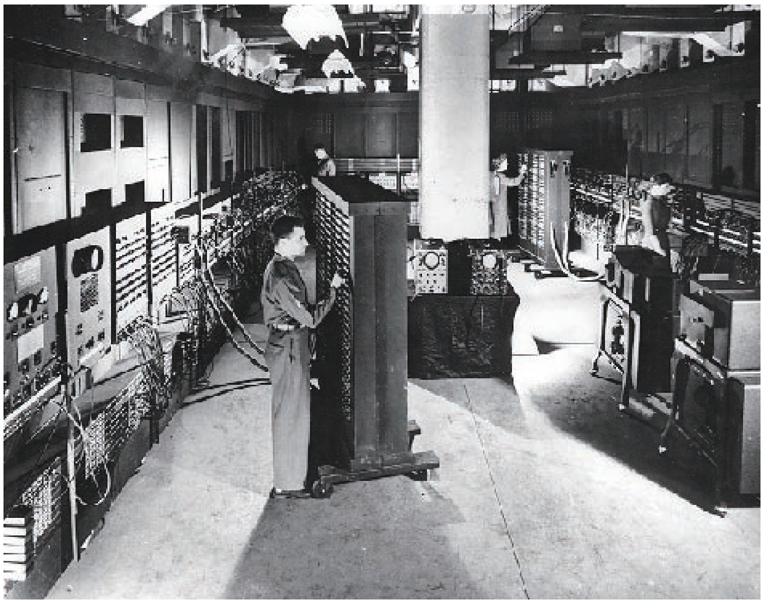


Figure 4. ENIAC.
Source: U.S. Army Photo

court.

The court decision, no matter how convincing, is somehow strange for scientists and for historians of science. The court's decision sentences the one and acquits the other, while the scientific and historical decision determines the place of both according to their contributions. Notice that Arthur and Alice Burks call the ENIAC, not *the first electronic computer*, but *the first general-purpose electronic computer*; first not among all electronic computers but among the general-purpose ones. The journalistic skill of Clark Mollenhoff which his book "Atanasoff, Forgotten Father of the Computer" turned to be very influential for the general-public. But, generally speaking, computers have existed ages before Atanasoff. In order to determine his place in the overall human intellect that credited the modern computer, it is necessary to define more precisely his contribution. And his contribution is really great and besides, he gave to the people electronic digital computing, which opens the door to the information age.

A fact for the belated recognition of John Atanasoff's contributions is that it started as a conflict between ABC, the machine of John Atanasoff and Berry, and ENIAC in a court case. My thesis is that the fact that this was defended in the court was not good for the scientists and historians. This is just a resolution between two companies and did not become very popular. What are borrowed are fundamental principles like the electronic medium of computing. We cannot say that everything in the ENIAC is borrowed from ABC. If you say, ENIAC is nothing and ABC is the first, nobody will agree because ENIAC was also a very big step forward, and not everything in ENIAC was borrowed from ABC. You know that ENIAC is a colossal computer finally completed in February 1946; it contains 18,000 electronic bulbs in a construction of 25 meters long, 2.5 meters high and weighting more than 27,000 kilograms (**Fig. 4**). There are fundamental differences of the motivation and the financing of ABC and ENIAC and I would like to stress about this. The first, ABC, was built for scientific purposes, with poor financial support and not patented. The second was built for military use to aid the computing of artillery shooting tables, very well financed as a top secret project and duly patented.

Next, I'd like to emphasize the importance of technological idea. Most of the admirers of John Atanasoff are trying to establish his name as the father of the modern computer. They have all the ground for that, but there are also other fathers of the modern computers like Charles Babbage who lived more than 100 years before John Atanasoff; and John Atanasoff doesn't know anything about him until many years after he builds his machine. Also we have John von Neumann and many others who are fathers of today's computer. The name of John Atanasoff cannot and is not opposed to the names of these two geniuses and names of other brilliant minds that have contributed to the present date of computer technology.

Without any doubt, John Atanasoff is the first man to achieve automatic computing with numbers represented through electronic medium. Until this moment, for thousands of years all instruments and devices for partial automatic calculation were exclusively with mechanical medium. Even if John Atanasoff have not built that entire ABC Computer, but only it's prototype, which worked successfully in November 1939, and added automatically 25 digit binary numbers, he would have been recognized sooner or later as the inventor of the electronic digital computing.

Today, we must assess the work of John Atanasoff not only as one of the fathers of modern computers. This is something which is already finding its place in the history of computers. It is much more important to look at his brilliant pioneer work as a forefather of the information society. As an inventor of electronic digital computing, he is also the inventor of electronic processing of information. That is why he deserves to be called the Electronic Prometheus.

The history of development of computing is an important part of human culture. One of the greatest discoveries in the computing which you owe to India and Arab culture is that the positional decimal system for writing down the numbers. Before the discovery and the distribution of this system which drastically simplifies computing, there were specially trained people called computers who were paid to make the necessary calculations in trading. Not every intelligent man at the time was able to deal with large numbers, especially to multiply or to divide. If you try to multiply two 3 digit numbers written in the Roman figures, I am sure, you will be not able to do it without transforming them in Arabic positional system. I'd like to emphasis that representation of the information, the medium that carries the information is extremely important for the technology of the information process.

It is much more important to find a new method of computing than to build a new computer which computes in the already known methods. John Atanasoff was the man who best realized this fact in defining his priority of the inventor of a new method of computing. With the help of Clifford Berry he built ABC and proved the practical realization and the potential of this new method of computing. The establishment of John Atanasoff's name as an inventor is usually connected with the answer to one question only-who build the first electronic digital computer in the world? Different circumstances lead to the long practice of stating in almost all books and articles, which are already mentioned, that the first such computer is ENIAC, built and patented by John Eckert and John Mauchly. I have done that too before I heard of the existence of John Atanasoff. I made this until the 1970. In 1970, I discovered the discoverer and invited him in Bulgaria.

This long tradition is also repeated in new publications even today. What is the reason? The work of John Atanasoff was well known to specialists. His computer practically started to function in 1941. It was demonstrated to the public. Its further improvement and practical implementation was forthcoming. The most important step is strength. There is proof for new method of computing which can be realized through various computers. John Mauchly, a professional friend of John Atanasoff, studied his principally new methods of computing in details. He was a personal guest of John Atanasoff for more than a week studying the computer. Every day of the week in the midst of 1941 he studied the principles on which ABC is based all day long. Later, Mauchly and talented electronic engineer John Eckert built ENIAC using the new method of computing discovered by Atanasoff. At that time, the United States entered the World War II, John Atanasoff stopped working on the improvement of his first computer project; he went to work in the military laboratory.

ENIAC was completed as a secret military project, patented and brilliantly demonstrated after the World War II. As a matter of fact, ENIAC never worked on the problems of shooting tables, because it started working after the war, but it worked on many more important things. The public is impressed by the machine, enormous in potential and size, which becomes a symbol of the new age of electronic machines and their alleged predecessor. ENIAC is much more complex than ABC; it implements the ideas of program control of Charles Babbage of more than a century ago. Practically, I guess, ABC, the machine of Atanasoff, doesn't have program control but it has a fixed program for solving systems of linear algebraic equations, which is a major problem for applications. John Atanasoff, as it often happens, wasn't aware of the work of Charles Babbage, but his first goal was to create a new method of computing and only after that to use it in a concrete computer.

## The new method of computing

What is the new method of computing? The new method of computing of John Atanasoff is connected with the following: First, I have to explain that the invention made by John Atanasoff didn't come so quickly and as easily as we may imagine today. What is difficult to go from mechanical to electronics? Nothing. But in these days, it was a very major step. Why? As a theoretical physicist and researcher, John Atanasoff wanted to find a way to solve numerically complex mathematical problems. It is enough to find even approximate solution but the accuracy needed can be achieved by solving the system of numerous linear algebraic equations. Finding such solutions, however, requires an enormous number of arithmetic operations.

By analyzing the current technology, John Atanasoff arrived at the conclusion that a new method of computing must be found; the existing methods were not satisfactory. As a true scholar, he first classified all existing methods of computing and for the first time divided them into two categories: digital and analog. He, by the way, coined the term analog computer. The first result of his analysis is that he is going to look for a new digital computing, since the analog one cannot provide the accuracy needed. The analysis of the digital means of computing brought him to the conclusion that the digits with which the numbers taking part in the computing are always memorized by means of the position of some mechanical part. An example is the wheel, which has ten different positions, corresponding to the ten decimal digits from 0 to 9. If you look the many machines of these days, starting with the abacus and going on many others, you will see that in all these machines the medium carrying digits are mechanical. There is not a single exception in the thousands of years of human practice of computing starting with the abacus. Until the middle of the last century mechanical medium was used for memorizing the digits, a disk with ten possible positions, like the counters of the mileage meters.

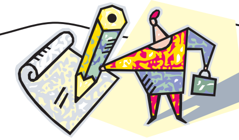
During the World War II, Konrad Zuse who was born in 1910 and died in the same year with John Atanasoff in 1995, built in Germany a computer too perfect for this time which used relay in it. The medium is again mechanical, the positions of the armature of the relay. All tabulators were based on relay. The main thing is who is carrying the digits, and until John Atanasoff, it was only mechanical medium. John Atanasoff was purposefully looking for a different method of memorizing the numbers and saw it in electronics, which at the time was still in the childhood. One possible electronic medium is, for example, the state of the electronic charge of a capacitor. After a detailed analysis of pros and cons of both mechanical and electronic medium, John Atanasoff realized why humanity has used for so many centuries only mechanical medium. Because you must provide absolute proof of the accuracy of computing. The mechanical medium has stable and easily controllable states which represent the different digits and they provide absolute memorization of numbers taking part in the computer. But the interaction of this states in the process of computing are very limited by the very nature of mechanical motion in space and time. On the other hand, the interaction of the electronic states is very flexible, fast and simple, but the electronic state themselves are not so stable to guarantee absolute security for computing.

Once John Atanasoff told me that, he wrote a letter to IBM Corporation during 1937-38 to ask for financial help, offering that he will build an electronic computer. And the answer from the top of IBM management was that IBM is not interested in his project because IBM is a very stable company and "they will never build electronic computers," because electronics in these days sounds not very serious, because electronics was not so stable and the corporation will not be sure.

Here in this state, John Atanasoff made a major step forward. John Atanasoff made the following, which is very simple but I think it's brilliant. What is this breakthrough? He concludes that the medium memorizing the numbers must be absolute stable only within defined limits and only for a defined time. The mechanical part stays in one fixed place. The electronics is not so stable, it changes; the charge may change. But it has to stay not for ever; it has to stay for a limited well-defined time in some limits and only for a defined time in these limits. It is not necessary that it has a strictly fixed state and this state is preserved for an indefinite time as with the mechanical medium. This is so simple and logical — that is why it is brilliant. The state of an electronic capacitor is not as stable as the position of a wheel, because with time and a contact with it, the capacitor loses its charge for its state to be read. But this state can be preserved within certain limits for a defined period of time and this is enough for it to remember a given number in a given digit. To have a stable state of the condenser within certain limits which correspond to a defined digit for a defined time, John Atanasoff creates the procedure of jogging. It periodically reads the charge and recharges it to a specific state. This is the procedure of the recharging which is standard for this digit; and this procedure is a basic procedure in the electronic information processing.

The daring of John Atanasoff to discard the stable and secure but very slow mechanics and to choose the flexible and fast electronics opens for people the door to the present information age. It is not accidental that when at the end of his research career, he was invited to be the Director of the Department of Space Research in a big corporation, after refusing it with the argument that he does not consider himself competent in this sphere, he offers the statement: "*Man can demonstrate greatest bravery not in open space but in thinking*." I think that his thinking was very brave. The brilliant invention of John Atanasoff is electronics as discrete information medium. He starts with the most standard and more accurately defined processing of information which is also in some sense the simplest computing. And like a real Prometheus he demonstrates electronics to humanity as a medium for automatic processing of information. Can you imagine the world today if humanity had continued using only mechanical means of processing information? The most sophisticated architecture of a computer — if it is mechanical it will have a very, very low limit of speed and flexibility.

We connect the name of John Atanasoff primarily with the first electronic digital computer and we call him father of the first electronic computer. This is perfectly deserved, but it is too narrow because it covers only part of the illustration of his



exceptional technological achievements; such achievements are the use of electronic carriers of information which allow unbelievably high speed in processing information. The first public recognition that John Atanasoff received was in Bulgaria. Many Bulgarians receive recognition outside Bulgaria first, but an American Citizen received his recognition first in Bulgaria on December 1970. He visited Bulgaria and he was awarded the highest Bulgarian order for science and culture, Order of Cyrille and Methodius, First Class. Cyrille and Methodius are the discoverers of the Cyrillic, the Bulgarian alphabet. Many people call it Russian alphabet, but it is Bulgarian, brought to Russian 100 years after it was used in Bulgaria. Exactly after 20 years on November 13, 1990, John Atanasoff was awarded the National Medal of Technology by President George Bush. And John Atanasoff was recognized also officially in United States. In the occasion of the 100 years jubilee of John Atanasoff, which was two years ago, a monument was erected in the center of Sofia, in the capital of Bulgaria, in his name; that's the Monument of John Atanasoff in the center of Sofia (**Fig. 5**).

As the first man who discovered electronic computing and I like to emphasize it because this is the point of my lecture, John Atanasoff discovered electronic computing and electronic processing of information; and because of this he has to be counted as one of the fathers of the modern computers. But he makes something more important, he makes this breakthrough from the mechanical to electronic and until now we have nothing else; we have brilliant steps forward. We have John von Neumann; we have this improvement of electronics that make them smaller and smaller and faster and faster. And in not more years ahead we'll come to the limit of the electronics, because electronics has also limits. But they are so far away that the people will explore this for many other purposes. But, it is also very important to look for what we have to expect. There are many breakthroughs in computing and information processing, but I think that the breakthrough of John Atanasoff was of the biggest.

What might be the next breakthrough? I think again, a new medium of information processing. Until now, we have only digital and analog and the major progress in a digital computing. We have to reach a limit to breakthrough; you can't breakthrough, if you have no limit. What are the limits now in information processing? One limit, I have some research as a mathematician, was image processing. I have been in Fujitsu recently and I saw face recognition; you have a picture of a girl and this girl is in front of an object and the computer have to recognize if the girl in the picture is the girl which stands in front of you. It's very, very difficult and the computer makes a lot of mistakes. You just have to stay in a very accurate position to be recognized. But a baby of one year recognizes the mother just looking in any way. I think that we are in great difficulties recognizing faces automatically, the computer recognize faces very, very difficult because I think that representation of the information for a face in the computer is like the Roman way of writing numbers. We don't have the proper representation of the information that I think one of the next very big breakthrough will be in new way of representing information. And my dream is to find out how the information is represented in the human brain. The human brain is not a digital computer, even the poets and writers and so on, they hate mathematics and they say that if you are a good poet, you have not to like mathematics and not to have calculations. And there is a lot of proof that the human brain is not a digital computer. The information in the human brain is not represented in the way it is represented by pixels, the human face is not represented in the human brain with pixels; it is represented in another way. Which is this way, I am not able to say because it is so complicated and I am not John Atanasoff. Thank you.

Figure 5. Monument of John Atanasoff in the center of Sofia, Bulgaria.

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2) Burks, A. and Burks, A.: The ENIAC, First General-Purpose Electric Computer, Annals of the History of Computing, Vol.3, No.4, pp.310-389 (1981).

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