

John von Neumann to Dr. Frank Aydelotte (extract)

Letter dated 11 October 1945

I have been connected as a consultant with the *Ballistic Research Laboratory* of the United States Army Ordnance Department at the Aberdeen Proving Ground, Maryland, since 1937. In 1940 the Scientific Advisory Committee to the Ballistic Research Laboratory was organized by the War Department. It consists of about a dozen members including physicists like H. Urey, I. I. Rabi, J. W. Beams and W. Hull, and its function is to review, three or four times each year, the functioning of the Laboratory and make suggestions to the War Department. I have served on it since its organization, and it is expected to continue functioning after the war. In my capacity as consultant to the Laboratory I have also spent a considerable amount of time — from 1943 up to early 1944 as much as up to 25 per cent. of my time — in advising the Laboratory on its work on aerodynamics. Since early 1945 I have been taking part in advising the laboratory on its development program on various high-speed computing devices, and quite particularly in planning a new electronic machine.

Col. Leslie Simon to John von Neumann

Letter dated 17 January 1945

17 January 1945

Professor J. von Neumann
The Institute for Advanced Study
Princeton, New Jersey

Dear Professor von Neumann:

It appears from the replies received in answer to my teletype of 2 January 1945 in regard to the next meeting of the Scientific Advisory Committee that at least ten of the Committee find it possible to attend the meeting if held on the proposed dates of 5 and 6 February. I have discussed this matter with senior staff members of the Laboratory and they agree with me that the meeting should be definitely set for that date. I hope that you will find it possible to meet with the Committee on the dates selected.

In addition to the various Laboratory problems to be considered in the group meetings, there are four major items which I desire to present to the Committee. They are as follows, (1) the research program of the Ballistic Research Laboratory for the Fiscal Year 1946; (2) the Laboratory's budget for the Fiscal Year 1946; (3) the growing seriousness of the computing problem that confronts the Laboratory; (4) an inspection of the Supersonic Wind Tunnels plant and review of its operation.

My office is preparing the agenda for the coming meeting and a copy will be forwarded to you in the near future.

The Laboratory staff and I look forward with enthusiasm to the opportunity of again meeting with the members of the Scientific Advisory Committee. Their unselfish cooperation in

making these meetings an invaluable source of suggestions and constructive criticism is deeply appreciated.

Sincerely yours
(signed) Leslie E. Simon
Colonel, Ord. Dept.
Director
Ballistic Research Laboratory Div.

John von Neumann to Col. Leslie Simon

Letter dated 30 January 1945

January 30, 1945

Dear Leslie:

I am enclosing the memorandum on Mechanical Computing Devices, which I promised you on January 17. I hope that it covers the points which you judge essential. If you wish to have it amplified in any respect, please let me know.

I hope that there will be an opportunity to discuss the subject of Mechanical Computing Devices at the Scientific Advisory Committee meeting.

Simultaneously with writing this letter, I am also wiring your office that I will arrive at Aberdeen at 9:18 p.m. on Sunday, February 4.

Looking forward to seeing you again, I am

Sincerely yours,
John von Neumann

Colonel Leslie E. Simon
Ballistic Research Laboratory
Aberdeen Proving Ground
Aberdeen, Maryland
JvN:GB

John von Neumann memorandum

January 30, 1945

To: Col. L. E. Simon
From: John von Neumann

MEMORANDUM ON MECHANICAL COMPUTING DEVICES

1. The Ballistic Research Laboratory has been using mechanical computing devices for many years and on a very large scale: Differential Analyzers at Aberdeen and Philadelphia, Standard IBM equipment as well as special IBM multipliers at Aberdeen, and steps have been taken to secure more and more efficient automatic computing equipment: The Bell Telephone Co. Relay Computer, the ENIAC, and the projected EDVC, – the last two being fully electronic, the ENIAC in particular an absolutely pioneer venture, the first complete, automatic, all-purpose digital electronic computer.

2. All these devices were primarily needed for the solution of the ballistic differential equation, and some attendant problems, i.e. for the computing of firing tables. In connection with the Bell-Relay Computer and the ENIAC, however, the need of automatic mechanical computing devices in more general aerodynamical and shock wave work was already envisaged. Specifically, it was realized that the full and efficient use of the Supersonic Windtunnel really depended on the availability of this equipment. It is already clear in the general aerodynamical and shock wave work done with the facilities of the ballistic and shock wave ranges and with shadow photography, that the numerical reduction of the results is a task of dimensions comparable to those of the underlying physical experiments (range firing and photography). With the use of the Windtunnel and the Schlieren and Interferogram photographic methods, which produce much richer numerical material, the task of numerical exploitation of the observations will become one of quite overwhelming magnitude.

3. The importance of these general aerodynamical and shock-wave problems need not be emphasized here. Clearly, the shell, bomb and rocket work will be equally influenced by them, as well as the progress in the field of propellants and of high explosives.

4. It must be realized, on the other hand, that the mathematical and computational problems which arise in this connection are not as uniform as those which are familiar from the ordinary ballistic work. The differential equations are usually partial and 2 or 3 dimensional, and they are therefore in the simplest cases just on the margin of what the present equipment can handle, and in all other cases far outside its compass. The Bell Relay Computer and the ENIAC will together handle a not inconsiderable part of this work, but even they are not at their best in the more difficult problems of this type, and have definite limitations.

5. The EDVC is being designed with just this type of problem in view. If it is successful, and there is every reason to expect that it will be so, then it will be able to handle all problems which lead to partial differential equations of not more than 3 dimensions (3 spatial dimensions and stationary in time, or 2 spatial dimensions and transient [changing] in time), and do this simply and quickly. By “simply” is meant that the “setting up” and coding of such problems will be a process that can be carried out by trained mathematicians in a few hours, or at most a day in

extreme cases. The personnel requirements will be a small fraction of what is now considered reasonable. By "quickly" is meant that typical 2-dimensional problems which the Bell Relay Computer may solve in 30-60 hours will be done in less than one hour, and 3-dimensional problems, which may take on the Bell Relay Computer 300-600 hours or even completely defeat it, will be done in about 2 hours. The EDVC will be at its best in complicated problems, involving many multiplications and divisions and involved logical sequences. Its speed will be limited mainly by the need for occasional human intervention, in order to ascertain the progress of a solution, and the need for changing parameters, integration intervals, etc.

6. The speed thus obtained will affect the economy of computing procedures so radically as wholly to alter their scope. It will be possible to solve complicated problems for many values of variable parameters which they involve, judge questions of optimal procedures and arrangements by actual trials of numerous alternatives, etc.

Besides, truly 3-dimensional aerodynamical problems were in the past as good as beyond our horizon, and the effects of such possibilities of solving them (and easy ones at that) may be greater than anyone can now predict.

7. For the same reason statistical problems will be amenable to an entirely new kind of treatment. It will be possible to answer most questions of this type by performing the actual statistical experiment: by computing hundreds or thousands of special cases and registering their statistical distribution. Questions of statistical distribution, significance, fluctuations, the validity of sequential tests, the efficiency of fire-control devices and procedures, etc., will be approached in a new and effective way. In the past these problems had to be treated analytically and the success of the analytical attack was in all but the simplest cases fortuitous. "Statistical experimentation" too was restricted to the simplest cases. The new approach is one which will systematically and uniformly dispose of all problems up to a much higher level of complication.

8. The points enumerated above are those which can be predicted with reasonable certainty even now, when none of the envisaged devices are functioning, and the plans concerning the EDVC are actually still fairly fluid. Consequently these predictions are of a minimum character. It may be, indeed it is not improbable, that the most important possibilities created by these devices will only emerge after they have been in use for some time. They are likely to transform our thinking about problems of partial differential equations, statistics, and about the computational approach and its potentialities in general, quite radically.

9. From the point of view of the Ballistic Research Laboratory it ought to be re-emphasized that the computing devices of this type will multiply the efficiency of the other facilities. This applies quite particularly to the Supersonic Windtunnel, the Ballistic and Shock Wave Ranges, and to much further work which in the last analysis requires either partial differential equations or statistical procedures for its full exploitation. Considering the great economical and manpower effort embodied in the two first-mentioned items alone, and the great generality of the last-mentioned category, these considerations should contribute to placing in the proper perspective the importance of these high-speed automatic computing devices for the Ballistic Research Laboratory.