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WARREN WEAVER AND THE LAUNCHING OF MT
BRIEF BIOGRAPHICAL NOTE

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The memorandum written by Warren Weaver in 1949 is perhaps the single most influential publication in the earliest days of machine translation. Written before most people had any idea of what computers might be capable of, it was the direct stimulus for the beginnings of research in the United States.

1 *The background*

Warren Weaver was born on the 17th July 1894 in the small Wisconsin town of Reedsburg, into a family descended from German 18th century immigrants. Fascinated by all things mechanical and electric – a lifetime hobby was the construction of radio sets – he seemed destined for an engineering career, and he entered the University of Wisconsin in 1912 to study civil engineering. However, he became fascinated by differential calculus and probability, and after graduating from Wisconsin (B.S, 1916) he was appointed to teach mathematics at the newly established Throop College, Pasadena, California (later California Institute of Technology.) After wartime work for the Bureau of Standards in Washington, and returning briefly to Caltech, he was invited in 1920 back to the University of Wisconsin, where he became an enthusiastic teacher and eventually chairman of the department.

In late 1931 he was invited to apply for the directorship of the Natural Sciences Division of the Rockefeller Foundation, the post he was to fill with great distinction for the next 27 years. Among his first actions was the inauguration of a programme to support quantitative experimental biology and molecular biology, not just in the United States but in Europe and elsewhere, with crucial and far-reaching consequences (Weaver 1970).

During the War, at the invitation of Vannevar Bush – the pioneer of the mechanical and electronic analogue calculator – Weaver joined the Office of Scientific Research and Development, first to head the "fire control" section and then a new agency, the Applied Mathematics Panel (AMP), directing the work of several hundred mathematicians on operations research. In this position, he had close contacts with many of the American computing pioneers, such as Howard Aiken, George Stibitz and John von Neumann. Indeed, it was at Weaver's invitation that von Neumann wrote for AMP a report that

represented an important step towards the formulation of the 'blueprint' for all future computers (Aspray 1990:240).

After returning to the Rockefeller Foundation in 1945, he inaugurated and carried through a globally important program of agricultural research in Central and South America, India and the Philippines. At the same time, he had a major impact on the development of US science through membership (often chairman) of bodies such as the Naval Research Advisory Committee, various boards of the War Department, the National Science Foundation and the American Association for the Advancement of Science (the latter as president in 1952). He collaborated with Richard Courant in plans for strengthening advanced mathematics research in the United States, and the establishment of the Courant Institute of New York University (its main building is named Warren Weaver Hall.) A report he wrote at the end of the war ("Comments on the general theory of air warfare") was a significant factor in the foundation of the RAND Corporation.

Throughout his career, Weaver was very active in the dissemination of science, both to students and the general public. At Wisconsin, he collaborated with his teacher and later colleague, Charles Sumner Slichter, in the third edition of a mathematics textbook (Slichter 1925), and with Max Mason on a textbook of electromagnetism (Mason and Weaver 1929). After the war, his now best-known collaboration was with Claude Shannon on the first book on 'information theory' – he wrote the non-technical introduction which contributed much to the success of the book (Shannon and Weaver 1949), and he also wrote an article for *Scientific American* (Weaver 1949b). Later he had even greater success with his popular book *Lady Luck* on his own speciality, the mathematics of probability (Weaver 1963). He was the author of many articles of popular science (collected as Weaver 1967b) and editor of a collection of introductory articles by eminent scientists (Weaver 1947). Finally, in his retirement, he was sponsored by the American Academy of Arts and Sciences to prepare a book on United States philanthropic foundations (Weaver 1967a), and at the same time he wrote his own autobiography (Weaver 1970).

Weaver had a particular fascination with Lewis Carroll's *Alice's Adventures in Wonderland*, and over the years built up a collection of translations of this classic of children's literature. He wrote a number of articles on the book and its author, including, as might be expected, one on Charles Dodgson (Lewis Carroll) as a mathematician, and finally a book on the problems of translating *Alice*, with a bibliography of translations based on his own collection (Weaver 1964).

2 *The memorandum*

Weaver had first mentioned the possibility of using the computer to translate in March 1947 in a letter to the cyberneticist Norbert Wiener and in a

conversation with Andrew Booth, a British x-ray crystallographer who was visiting various locations in the United States where computers were being built. On his return to England, Booth worked on ideas for a mechanical dictionary and collaborated with Richard H. Richens in a punched card experiment for producing word-for-word translations of scientific abstracts (Richens and Booth 1955). By 1949, the idea of MT was occurring to others, and so, having been urged by colleagues at the Rockefeller Foundation, Weaver elaborated his ideas in a memorandum (Weaver 1949) sent to some 20 or 30 acquaintances (Weaver 1970: 106). His aim was to suggest more fruitful methods than obviously limited word-for-word approaches, and he put forward four proposals, based mainly on the new theories of cybernetics and information theory. (For more details see Hutchins 1997).

The first proposal was that the problem of multiple meanings might be tackled by the examination of immediate context, i.e. the words to left and right of an otherwise ambiguous word (e.g. *fast* meaning "rapid" or "motionless"). Weaver expected the amount of context required to vary from one subject to another, but he did think that "relatively few nouns, verbs and adjectives" were actually ambiguous, so he believed the problem was not large.

His second proposal was founded on the logical bases of language. He drew attention to the work of McCulloch and Pitts (1943) on the analogies between the neural structure of the human brain and 'logical machines', which suggested that "insofar as written language is an expression of logical character," the problem of translation is formally solvable.

The third proposal concerned the possible applicability of cryptographic methods. Weaver had been impressed at the success of wartime cryptanalysis based, as he put it, on "frequencies of letters, letter combinations, intervals between letters and letter combinations, letter patterns, etc. *which are to some significant degree independent of the language used.*" His suggestion was linked to the statistical 'information theory', recently advanced by Claude Shannon, which embraced "the whole field of cryptography".[1]

His fourth proposal was based on the belief that underlying the statistical regularities of languages were logical and linguistic universals[2] constituting "the real but as yet undiscovered universal language", and which suggested an easier route than translation directly from one language to another. His memorable analogy was that of people attempting to communicate by shouting from tower to tower rather than going down to their common basements. He admitted that this approach would involve a "tremendous amount of work."

[1] Shannon had been the author of one of the most influential papers on cryptography, a wartime classified report (1 September 1945), not published until October 1949 (Shannon 1949), but seen by Weaver before its declassification, as he stated in the memorandum.

[2] Weaver cited remarks by Hans Reichenbach on common logical structures of grammars and by Erwn Reifler on semantic convergences between unrelated languages. (Hutchins 1997).

The memorandum met with scepticism among some recipients, and enthusiasm among others, including Erwin Reifler (University of Washington) and Abraham Kaplan (Rand), who both began investigations. It was a major stimulus to research activity, thanks in large part to Weaver's personal standing and influence. It led to the appointment at MIT of Bar-Hillel and the convening of the first MT conference (Hutchins 1997). The outcome of the conference was the first book-length treatment of MT, to which Weaver contributed the foreword (Weaver 1955). In this, his last contribution to the new field of MT, he states his optimism for the "new Tower of Anti-Babel" under construction "not to charm or delight, not to contribute to elegance or beauty; but to be of wide service in the work-a-day task of making available the essential content of documents in languages which are foreign to the reader." And so it has proved.

3 Selected writings by Warren Weaver (in date order)

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Weaver, W. 1970. *Scene of change: a lifetime in American science*. New York: Scribner. [Includes many photographs of Weaver.]

4 *Other references*

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