

# 'Citation Indexes for Science' – A 50 year citation history

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FIFTY years have now passed since the publication of Garfield's paper in *Science*: 'Citation indexes for science: A new dimension in documentation through association of ideas'<sup>1</sup>. Here Garfield presents his idea of a citation index, its potentialities as well as its construction. Ten years before, Vannevar Bush<sup>2</sup> presented his vision of an associative linking machine, called Memex, in the famous paper 'As we may think'<sup>2</sup>. Bush is generally seen as an internet pioneer who inspired the development of the World Wide Web. Compared to Bush, Garfield was not only a visionary; he actually designed and constructed his associative machine.

In *Web of Science (WoS)* Garfield's paper was cited by 121 papers between 1988 and 2004, while the Bush paper got 493 citations (Figure 1). Although based on small numbers, it seems that Garfield is catching up during the last years. The two papers are associated, or co-cited, six times, which indicates that at least some authors have discovered their interrelatedness. Interestingly enough, Garfield himself made the first co-citation of the two papers in 1964, when he again in *Science* wrote about the *Science Citation Index*<sup>3</sup>.

The citation history of Garfield's paper shows a steady accumulation up to 226 citations in the midst of the year 2005 (Figure 2). In the year 2000 a festschrift for Garfield was published, which yielded about 20 citations that year. In Figure 2 this peak is reduced to 12 citations since *WoS* appears to have duplicate entries for the papers of the festschrift. Still, from 2001 and onwards the 1955 paper got 52 citations. We can also see that about half of the citations come from journals outside Library and Information Science (LIS). This indicates a renewed and broad recognition of the Garfield paper.

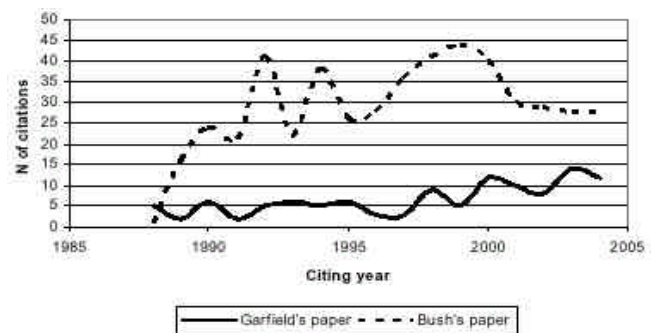
The associative trails related to a given paper can be visualized in several ways. One way is to study how the papers citing Garfield's paper from 1955 are interrelated by citations. In Figure 3 circles represent papers and links citations among them. There is a time sequence in the map when we go from the upper right part with papers on citation indexing, over to the upper left with papers on mapping, citation networks and web links, and downwards to recent papers dealing with the journal impact factor.

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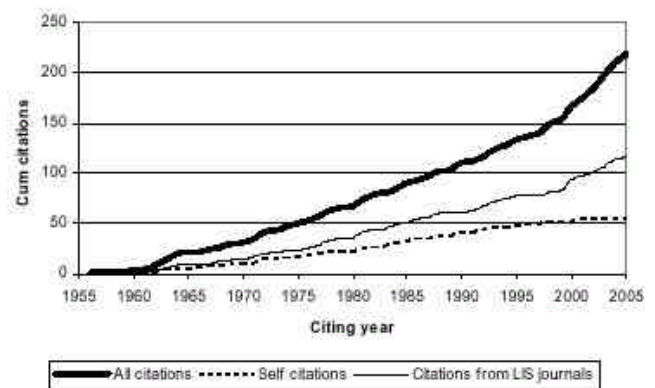
Maps like the one presented here, are an example of the association idea in Garfield's 1955 article:

'By referring to the listings for his article, an author could readily determine which other scientists were making reference to his work, thus increasing communication possibilities between scientists. It is also possible that the individual scientist thus might become aware of implications of his studies that he was not aware of before.'

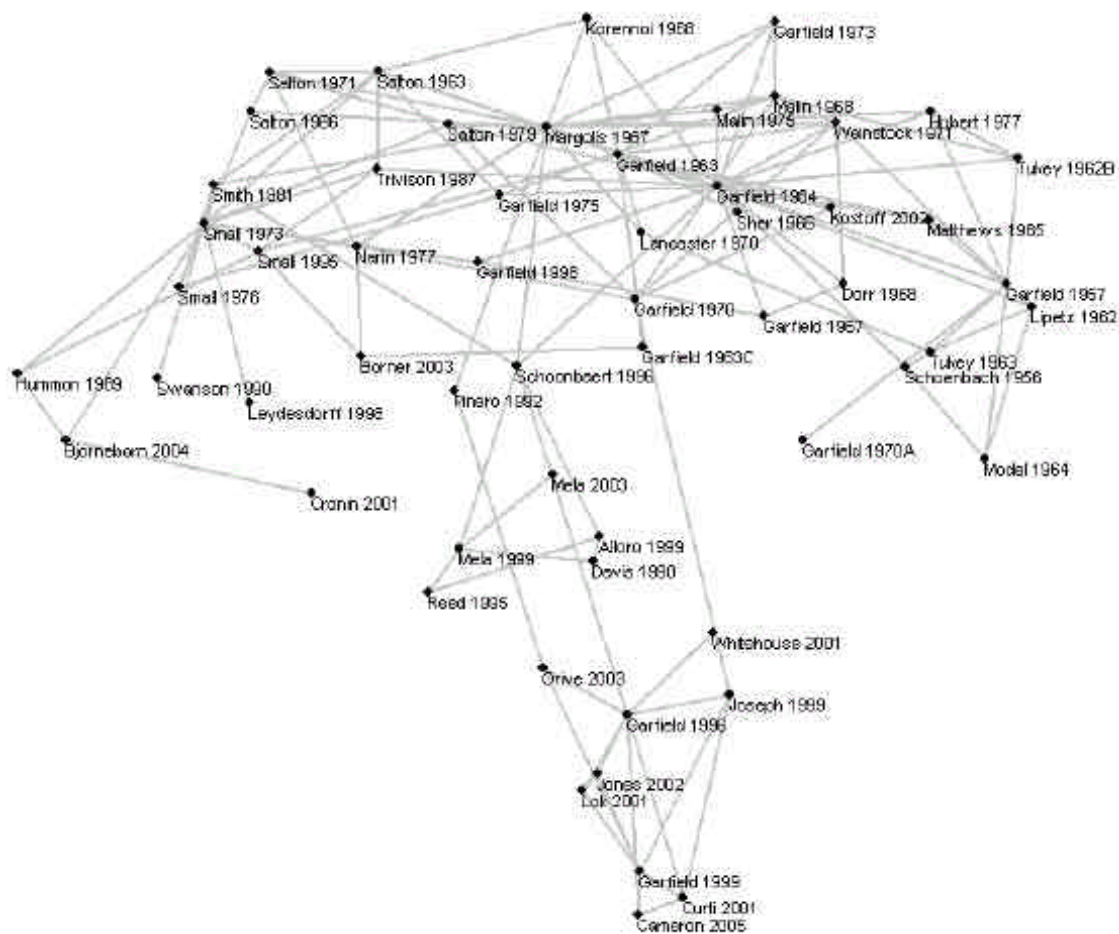
But there are developments that come much closer. Recently Garfield<sup>4</sup> has designed a historiograph with papers linked by citations and arranged by year. By using the dynamic element in visualizing citation networks, the historiograph marks another important step in utilizing the potentiality of citation indexes.



**Figure 1.** Citations to Garfield (1955): 'Citation indexes for science' and Bush (1945): 'As we may think'.



**Figure 2.** Citations to Garfield (1955): 'Citation indexes for Science'.



**Figure 3.** A citation map based on citations among papers that are citing Garfield (1955): ‘Citation indexes for science’.

1. Garfield, E., Citation indexes for science: A new dimension in documentation through association of ideas. *Science*, 1955, **123**, 108–111.
2. Bush, V., As we may think. *The Atlantic Monthly*, 1945, **176**, 101–108.
3. Garfield, E., *Science Citation Index: A new dimension in indexing*. *Science*, 1964, **144**, 649–654.
4. Garfield, E., Historiographic mapping of knowledge domains literature. *J. Inf. Sci.*, 2004, **30**, 119–145.