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Eugene Garfield: innovator of the bibliographic control and entrepreneur with a cause*

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* Laudation delivered by Cristóbal Urbano, lecturer at the Faculty of Library and Information Science, during the ceremony in which Eugene Garfield was awarded the University of Barcelona's honorary degree the *Doctor honoris causa*, on 14 June 2016 in the Paranymph Hall of this university's Historic Building.

Introduction

In summing up the merits that justify inviting Eugene Garfield to become a member of our University's Council of Doctors, I would like to start by asking you to think back to the literature searches you have carried out in recent months to write your research projects or guide your students' work. Think, too, about your actions in relation to the ever complex, delicate operation of gathering evidence for assessing your own research activity, about evaluating competitive research projects or sitting on selection committees for new teaching and research staff.

Well, many of the information resources and assessment processes that might have sprung to mind are the link between this Council and Eugene Garfield: every day, lecturers, students and researchers use tools for organizing scientific literature that have been developed with Garfield's ideas, projects or products. For a university institution such as ours, which aspires to be a leader in research, the merits that are the reason for this *laudatio* can be considered in terms of disciplines particularly information sciences and documentation, sociology and the history of science and instruments, including a wide range of operations to support and manage research, which affect all members of the university community, regardless of their field.

Our guest today is important because of his achievements in these two areas. For that reason and in its first honorary degree nomination, the Faculty of Library and Information Science did not hesitate to propose an individual whose work affects the scientific activity of all other schools and faculties at the University of Barcelona, whether directly or indirectly, as well as the management of science policy in the Rector's Office.

A new paradigm of specialized bibliographical control

In fact, the tasks of searching for and retrieving scientific information that we carry out on a regular basis are often supported by products developed through the geniality of Garfield, known as *Gene* to his friends and colleagues, so seemingly predestined by his name to his career. Garfield was the forerunner of indexing systems for scientific literature based on citations, so also based on the functional, intellectual and symbolic networks that authors establish between each other when they write their papers and cite the studies that they have drawn on in their research. He created *Current Contents*, the *Citation Index*

(*Science, Social Science and Arts & Humanities*) and the *Journal Citation Reports*, which assign impact factors to scientific journals. However, the importance of his work lies in his conviction that citation is key to representing the content of publications, determining the relationships between studies, and assessing scientific output.

Garfield's ideas and, above all, his perseverance, are what led to the consolidation of citation indexes, which have influenced the search engines that we use every day. Search engines rank web pages by relevance on the basis of links; a tool that bears certain similarities to citations. We can also see Garfield's intellectual ties to the internet if we look back in time. In his early works, which discussed the need to mechanize bibliographic control and indicated that citation networks could provide opportunities to filter information, Garfield frequently referred to H. G. Wells' *World Brain* (1938), and Vanevar Bush's concept of *Memex* (1945) in other words, to two authors who we often consider as the intellectual forerunners of the World Wide Web. In 1964, just after publishing the first edition of the *Science Citation Index (SCI)*, Garfield wrote a short paper entitled "Towards the World Brain", in which he described his appearance before a US congressional committee dedicated to studying the creation of a national centre for processing research data. Clearly, Garfield did not consider the *SCI* to be just another indexing and abstracting service, but rather part of a radically new approach to information management, which we have experienced in our time with the internet. In his own words, this is what he had to say:

The idea of a World Brain is a general concept towards which we seem to be moving. As things stand at present, the situation in scientific information is quite chaotic. To dramatize this point, there follows below a passage from my testimony before a Congressional committee which has been investigating the need for an American-based World Brain. This testimony may provide a little more insight into the rationale of the Science Citation Index and how it will be a giant step in the direction of the World Brain which, I believe, far from being authoritarian, is a step in the direction of freedom because of the improved communication and access to world knowledge. (Garfield, 1964: 8-9)

Beyond his contribution to the creation of tools for searching the scientific literature, Eugene Garfield is an essential figure for understanding the development of scientometrics, which analyses science through the metric study of research inputs and outputs, and focuses in particular on the analysis of scientific publications.

These reasons, which we will look at in greater depth, explain why Garfield is one of the most widely recognized professionals and academics in the field of information and scientific documentation. I would now like to describe his career in greater detail.

From Chemistry to Information Science

Eugene Garfield was born in New York on 16 September 1925. He graduated in Chemistry from Columbia University in 1949 and became interested in the management of scientific information right at the start of his professional career, when he came into contact with *Chemical Abstracts*, the well-known international index of chemistry literature that has been published since 1907. This interest led him to work on various projects using computer science to solve problems caused by the growth in scientific information, a phenomenon that was already beginning to limit researchers' ability to keep abreast of the developments in their fields.

In 1951, his interest in creating tools to facilitate the search for and retrieval of scientific information led Garfield to work on the Welch Medical Library Indexing Project, undertaken at the Johns Hopkins University and funded by the Army Medical Library, which would later become the National Library of Medicine. The aim of the project was to automate the tasks of indexing medical literature, using punched cards and the "IBM 101 electronic statistical machine". The experience he gained in this project helped Garfield develop two of his key ideas for improving access to scientific information: indexes of contents to help researchers keep up with journals in their field of knowledge, and citation indexes as a way to organize, access and assess scientific literature.

In 1952, Garfield began to use photocopies of the contents of library and information science journals to develop *Contents in Advance*. This tool enabled professionals to consult references to papers even before they reached the shelves, and would eventually become the well-known *Current Contents* service.

In 1954 and as a result of his interest in the management of scientific information, Garfield obtained a master's degree in library science from the School of Library Service at Columbia University. Just one year later, he published a seminal paper in *Science* entitled "Citation indexes for science: a new dimension in documentation through association of ideas" (Garfield, 1955). This work was based on a term paper in which he explained the bases of citation indexing, from a perspective that can be linked in part to studies on academic social networks in today's collaborative web.

From innovation to entrepreneurship

Garfield has always combined an entrepreneurial spirit with an innovative vision of information retrieval tools. His entrepreneurship led him to market his contents service, *Current Contents*, and to found the Eugene Garfield Associates-Information Engineers consultancy, whose name was changed shortly afterwards to the Institute for Scientific Information. The consultancy carried out documentation projects for various chemical and pharmaceutical companies and this professional contact with chemical information and documentation inspired him to explore the common ground between automatic indexing, automatic translation and the automated processing of chemical formulas.

This explains why he went on to gain a doctoral degree in 1961 from the Department of Structural Linguistics at the University of Pennsylvania, with a thesis on an algorithm for translating chemical names

to molecular formulae. He had already begun to explore this area in 1960, when he indexed chemical compounds in the *Index Chemicus*, which is still used on the *Web of Science* portal. It is surprising to us that Garfield's small company generated the doctoral research that he carried out, in contrast to the usual path of spin-offs and start-ups originating from the work of young researchers at a university.

From citation indexes to the bibliometric study of science

In addition to the commercial development of *Current Contents* and the *Index Chemicus*, from 1955 Garfield continued to work on his major contribution to science: citation indexes. The inspiration for this system for indexing scientific literature came from *Shepard's Citations*, an index created at the end of the nineteenth century that continues to be used by law professionals to search for US federal and state rulings through case citations. Garfield immediately saw the methodological potential of *Shepard's Citations* to index the increasing volume of scientific literature. Encouraged by Joshua Lederberg, winner of the Nobel Prize in Medicine in 1958, he put his ideas into practice with the creation of a citation index for the field of genetics, an initiative that resulted in the publication, in 1963, of the *Science Citation Index*, covering 613 journals and 1.4 million citations. Interestingly, the pilot test project funded by the National Science Foundation and the National Institutes of Health that led to this first edition was focused on an index of genetics. However, it was immediately clear that the best service the index could offer geneticists was multidisciplinary, covering all areas of knowledge in the experimental and biomedical sciences.

In short, the competitive advantage of citation indexes over other indexing and abstracts services was demonstrated by their capacity to surpass disciplinary barriers and to facilitate the identification of valuable information in places this would not generally have been sought. Later on, this principle was extended with the *Social Science Citation Index* and the *Arts & Humanities Citation Index*, which can be consulted on the *Web of Science* along with the *SCI*, an even more integrated, multidisciplinary search solution.

The idea of indexing scientific literature through the references it contains was not new. It had been used many years before in small-scale *ad hoc* projects. Looking back, the idea is very simple, but Garfield had to demonstrate his proposal's viability and efficacy with a real, working product: he had to create a mechanical, flexible, multidisciplinary solution for describing the content of scientific literature. Citation indexing meant that it was the researchers themselves who organized scientific literature, through the papers referenced in their studies and uncovering their consumption of information. As we have said, Garfield brought to fruition an idea that was not new but was initially greeted with skepticism by librarians and researchers because of its major technical challenges and the lack of financially solvent demand.

Garfield's contribution is singular because it systematically articulated a concept that already existed in some form (citation indexing) in a new context (of exponential growth in scientific literature) in a large-scale pilot study made possible by the new technology: the beginnings of computer science at the end of the 1950s and start of the 1960s. In this way, he overcame the problem of how to index documents on highly dynamic research areas rapidly and accurately. Because these were novel, rapidly changing areas, they were not fully incorporated into the scientific terminology, and even less into the classifications, thesauruses and other tools used in classic indexing and abstracting services.

After the creation of the *Science Citation Index*, Garfield saw connections between this tool for retrieving bibliographic information and the history and sociology of science, which he became interested in after reading John Desmond Bernal's book *The Social Function of Science*. Citations are the tracks that researchers leave in the course of their scientific activity, which enable them to acknowledge their predecessors, settle intellectual debts and guide readers towards new works in which they can gain greater knowledge. The study of these tracks helps the sociologist and historian of science to observe how disciplines evolve and follow the exchanges between researchers from different schools and traditions.

Garfield and his team kept in close contact with Bernal, Robert K. Merton and Derek de Solla Price, who confirmed how effectively the *SCI* could map relationships from citations, co-citation and the overlap in the literature. This technique can be used to represent the historical development of knowledge and research fronts. As well as providing a tool for searching the literature, citation indexes offered sociologists and historians a new way of exploring the structure of science. So perhaps the most important legacy of Eugene Garfield was to sow the seed of scientometrics as a discipline that has evolved over the last four decades and is now fully consolidated.

Citation analysis and research evaluation

Finally, we should consider Garfield's influence on science management. Clearly, citation analysis is now a standard approach to the tasks of assessing science but Eugene Garfield was also the first to criticize the often unfair, erroneous use of this approach. In many cases this is due to the inappropriate application of the Impact Factor (Garfield, 2006), a bibliometric indicator for evaluating journals that was developed by Garfield and is provided in the well-known selective lists of the *Journal Citation Reports (JCR)*. The "impactolatry" (Camí, 1997) that currently taints assessment processes here has been criticized by Garfield himself. Indeed, Garfield's reflections about uncritical use of metrics connects with the present movement that recently led to the Leiden Manifesto (Hicks et al, 2015), in which leading bibliometrics experts call for research assessment based on a philosophy that we could call "slow" and that should steer clear of simplifications and mechanical applications, particularly when it is people and projects that are being assessed.

However, the excesses of indiscriminate, automated use of bibliometric indicators are not due to the existence of bibliographic databases containing citation data, but to a culture of rankings. This culture, combined with insufficient financial resources to assess people and projects effectively, has led to the prevalence of assessment based on the impact of the journals in which the research results are published, rather than on the intrinsic value of each study or its metric indicators.

In any case (and as in all human activities, regardless of the existence of good and bad practices), Garfield's theoretical and practical studies in the area of information and documentation are essential to understand changes in the behavior of researchers and how their work is assessed. Without the information products developed by the ISI, or those that competitors have designed in recent years, we would not understand the assessment of science policies at an international, national or institutional level. Garfield's contribution to the management of science and technology can be considered key to understanding how science policy decisions are taken today, both when the decisions are balanced and when they are made without proper consideration.

Action from reflection: his writings, a witness of great value

The publishing products promoted and led by Garfield play a key role in his work. The marketing of these tools is a good example of the knowledge transfer that can take place between universities and companies; in this case the Institute of Scientific Information (ISI) of which Garfield has been honorary president since its acquisition by Thomson Reuters in 1992. However, as we have seen, his achievements go beyond providing a good example of knowledge transfer and a constant commitment to corporate research and development. Aside from his role for many years as CEO of the ISI, Garfield has produced a considerable body of literature on the research and reflection he carried out to support the creation of his scientific information products. His studies are described in hundreds of scientific papers in leading journals, both in the field of scientific information and documentation, and in highly prestigious multidisciplinary publications, such as *Science*. However, the nature of his work goes beyond the boundaries of typical research papers in scientific journals. His thoughts on our discipline are described in various works that actually constitute methodological studies, or commentaries on topical issues, such as the bibliometric bases of the Nobel Prize awards.

Particularly notable is the editorial column that Garfield and some of his collaborators published weekly between 1962 and 1993 in the print editions of *Current Contents*. These columns have been gathered in 15 volumes of his work, under the title *Essays of an Information Scientist*. Looking in perspective at this wealth of reflections on the evolution and assessment of science, accumulated week after week, we can state that Gene was a blogger "avant la lettre", as his weekly editorials anticipated this format of scientific communication, which is so important today in the context of academic social networks on the internet.

We have stated that bibliometric indicators on their own, out of context, cannot be the only reference used to establish the merit of a researcher. However, to conclude this *laudatio* on the singularity of Garfield's contributions, another way of recognizing his achievements is to consider the bibliometric data available in his ResearcherID profile,¹ which is fed by *Web of Science* citation indexes.

Constituting a kind of bibliometric "selfie", these data are exceptional for a man who defines himself firstly as an information and documentation professional; an "information engineer". And they are also surprising for someone whose career focuses more on business than academia, as we have seen. They are beyond the reach of most authors on information science, but also outstanding compared with many researchers in social sciences or information technology, at the intersection of which we can situate his 1,538 published papers, 1,534 of which are cited; the 9,077 citations of his works, and the list goes on. These figures can be summarized in an h-index of 155 (155 of his papers have received at least 155 citations each in the databases that he created).

A list of Garfield's complete works, with open access to the original documents in most cases, along with interviews and personal documents, is available on a website hosted on the server of the Library of the University of Pennsylvania,² a centre at which he has lectured in computer and information sciences since 1974. I recommend that the young people who are with us today read some of the older texts, for example, the early years of his *Current Contents* columns and his intense correspondence on the creation of *SCI*. In these texts, we can find the theoretical bases for citation indexing, considered in computer terms, even though the limited capacity of calculation and digitization of information at the time did not lend itself to this approach. To learn more about Eugene Garfield and his work, we could refer to the book dedicated to him in 2000: *The Web of Knowledge: a festschrift in honor of Eugene Garfield* (Cronin; Atkins, 2000).

Garfield, scientist and practitioner with a cause

Eugene Garfield is a leading "information scientist" who has mainly pursued this career outside of academia. He is a producer of databases which have revolutionized the retrieval of scientific information, and with which he has made considerable advances in the fields of the history and sociology of science. For these reasons, and for his example as an entrepreneur, the Board of the Faculty of Library and Information Science nominated Garfield for an honorary doctorate, an investiture that we have the pleasure and honour of celebrating today.

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Notes

¹ <http://www.researcherid.com/rid/A-1009-2008> (<http://www.researcherid.com/rid/A-1009-2008>) . Dades del 28 de març de 2016.

² <http://garfield.library.upenn.edu/> (<http://garfield.library.upenn.edu/>) .

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