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FOREWORD

by Baruch S. Blumberg

Late in his long and intensive life Baron Alexander von Humboldt embarked on an attempt to synthesize all that was known of the natural world. He called this work first published in 1847 *Kosmos*, that is, an orderly, harmonious, systematic, universe.

The goal of this massive compilation of zoology, botany, terrestrial magnetism, climatology, geology, geography, and more, was to create a grand summation and to see in this assembled mass a unity and an illuminating clarity on which all knowledge could be structured. Humboldt was said to have been the last scientist capable of comprehending all the scientific data of his day, for the sheer amount of information which accumulated afterwards could never be assimilated by a single person. Unfortunately, Humboldt's brave attempt was unsuccessful as others have been since they depend on the assumption that the world is finite; that all that is knowable will be known. But we now know that the very process of science may make this impossible. The more questions that are answered, the more are asked; and the experiments and observations the new questions generate continually multiply the store of knowledge which must now be fit into an explainable system.

Does that mean we are confronted with Chaos, the word whose meaning is the exact opposite of Humboldt's *Kosmos*? The answer to this weighty question is probably "no." Although we cannot encompass all of knowledge in a simple synthesis, the business of science is to find patterns which bind together a circumscribed body of data, and this can be accomplished.

Eugene Garfield has made an outstanding contribution to the construction of ordered patterns in the world of science. His medium has not been the original data itself, but the perceptions of the scientists who investigate nature's unknowns. Patterns are assembled at different levels. *Current Contents*® orders information according to its location in disciplinary and other journals. The *Science Citation Index*® (*SCI*®) orders knowledge in that it reveals who has referred to a particular article and thereby links the separate projects. Co-citation gives a quantitative measure of relatedness in that it indicates how often two or more papers are cited together. Another method measuring similarity is by bibliographic coupling based on the presumption that the number of cited references shared by two or more papers quantitates relatedness. From these co-citations, clusters of papers which

derive from similar interests can be identified and linked with each other and the papers in which they are frequently co-cited. This leads to a two dimensional diagram which includes a time element allowing the construction of a history of citation events. These can be linked in a complex network, modeling a pattern of scientific activities in a "research front" which is not only a history of events, but implies that future directions can be inferred or even recommended.

There is an additional very exciting potential use of the new CD-ROM edition of *SCI*. The total text can be searched and associations between research activities not obvious from their titles uncovered. If one defines a "new idea" as the recognition of an association of ideas not previously known, then these word searches could become a generator of innovation.

Garfield has cautioned that the patterns obtained from the literature data bases are derivative in nature. For example, the patterns obtained from the clusters can be termed "opinion polls" of those papers deemed important by scientists in the field. An early use of the co-citation methods was the construction of a two-dimensional time-related history of publications on the discovery of hepatitis B and the medical and scientific applications which derived from it. There was little doubt that this analysis gave an indication of how the published papers were related. But scientists who have participated in the discovery recognized that it bore only a partial relation to the actual history of events, much of which had not been published or been published late in the sequence of research in historical reviews. Hence, the history as related by the co-citation analysis is indeed a history, but not the only chronicle of interest to historians of science.

A special character of Gene's genius is that he has had, and continues to have, the ability to transform ideas into practical realities. Practical not only in the sense that they are useful to scientific workers, but that they are commercially valuable. It is a rare scientist, or any person for that matter, who can see the product of their intellect and imagination converted into an actuality that other people are prepared to pay for; this provides at least one test for validity.

The success of ISI® is no small achievement. It has made an important contribution to the high-tech business environment of Philadelphia, interacting extensively with the large bio-medical and academic activities of the city. It's a major Philadelphia industry.

A consistent feature of these volumes of *Essays of an Information Scientist* is the great diversity of interest that is expressed in their selection. I have inferred that this is an expression of the wide ranging intellect of the author who recognizes the enormous extent of knowledge that is knowable and the optimistic view that, using the bibliographic devices that he and his colleagues have devised, it can be integrated into the vast body of information already collected and indexed.

This volume of essays includes an analysis of the Nobel Prizes of the previous year. Sleep deprivation and hibernation are among the several articles on biological and medical topics. There is an interesting biography of Sir Henry Wellcome, an American who made a significant contribution to the British pharmaceutical

industry. The company he helped found is now very much in the public eye since they are the first producers of AZT for the treatment of AIDS.

The reflective guest essay by Joshua Lederberg is a fascinating personal account of scientific discovery, in fact, a classic of that genre. The discussion of science education in schools is particularly timely, if somewhat depressing. This is surely one of the most pressing problems facing scientists and one which has not been seriously regarded by the research community. I hope that Garfield's essays still to be written will focus additional attention on it.

A recurrent feature of the Forewords to the volumes of essays has been an account of how the author first encountered Gene Garfield. Well, I can't remember; it seems to me I've always known him, at least as long as I've been in Philadelphia. However, I can say why we have continued to be friends; but this requires a lengthy preamble.

In 1957 I did a season of field work in Nigeria. Although I traveled extensively, particularly in the north, most of my time was spent in the west, in Yorubaland. While there, I learned about the age clubs that were common in the culture of the Yoruba. People born in about the same year would band together in societies which would organize parties, excursions and other communal social events. This seemed to be an excellent idea; people born about the same time share a great deal and are likely to "understand" each other better than others might. When I returned to the United States, I formed a 1925 club for people born in the same year as I. Gene is a valued member of that club, and we often discuss the virtue of being born in that relatively benign time, a period before the great Depression, after the First and before the Second World War. The greatest disaster that year was the destruction of the airship "Shenandoah" and the only war of any significance the Grand Chaco War which has probably escaped the memory of most. It was an optimistic and promising period and, we would like to believe, has imparted its special character on those who were born then. Whether this has in fact happened is immaterial since many '25er's believe that it has.

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