STATISTICAL INVESTIGATIONS ON PIONEERS OF ROCKETRY AND SPACE TRAVEL

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Part I: The Method

Some years ago I have published a method for the measurement of the importance of scientists. At the core of this method is the analysis of citation frequencies of persons in the index of monographs [1].

Per definition, a monograph is a single treatise on a subject to be regarded as a comparatively integrated whole. It thus gives an objective survey of its subject matter taking into account all the relevant literature and imaginary problems will be eliminated. Obviously, the relative frequency of citations of or references to various scientists must be regarded as a quantitative statement on the importance of these scientists for the production of the knowledge represented in the monograph. Starting from this basic idea, I have examined the distribution of citation frequencies in the name indexes in many astronomical monographs of the 19th and 20th century. It was found that the distribution of the total number of citations over the total number of names is extremely unsymmetrical. But in all monographs examined – independent of their size, absolute frequency of names, citations and subject – the functions of the citation frequency are characterized by a surprising similarity.

The characteristics of the distributions are as follows:

Sudden decrease in the proportion of names in the case of 0.73 % of quotations (mean value)

Sudden increase in the proportion of names in the case of the last 6.1 % of the names (mean value)

Now I introduce an eminence figure E

$$E = \frac{Q \cdot T_a}{100}$$

E = eminence value
Q = relative frequency of quotations in per cent
T_a = total number of persons included in the register

and obtain three eminence classes with the following statistical attributes:

TAB 1

Class	Total number of authors	Total number of quotations	Eminence value
I	80,8±5,08	44,6±12,2	0,53±0,12
II	12,8± 5,1	23,7±7,2	1,84±0,36
III	6,1±1,6	32,2±9,9	5,35±1,31

The individual names are assigned to the eminence classes to the following E values:

Class I $0{,}01 < E \leq 0{,}77$
Class II $0{,}78 < E \leq 2{,}99$
Class III $3{,}00 \leq E \leq ?$

It is very interesting that a comparison of the individual names with the eminence figures reveals that class III contains the pioneers, and only the pioneers, of the field concerned.

The names included in class I are characterized by smaller contributions to the development of the field. In class II we find the names of scientists who deservedly

contributed, within the framework of methods elaborated by the pioneers, but without own innovative ideas.
In view of the small range of variation of the mean eminence figures, their significance in the individual classes was examined by means of the student-t-test, assuming that the valuation of the individual names in the different monographs may be regarded as „experimental values“ or „measurement values“ independent of each other. These are, in accordance with a normal distribution, dispersed around a “true” value. The E values in the three classes differ from each other to a statistically significant extent, with an error probability of 0.1%. The basic material analysed comprises 17 monographs with approximately 6000 names and 17 000 quotations. Samples showed that, in all probability, the results obtained apply to all exact natural sciences, without regard to the special subject (figure 1).

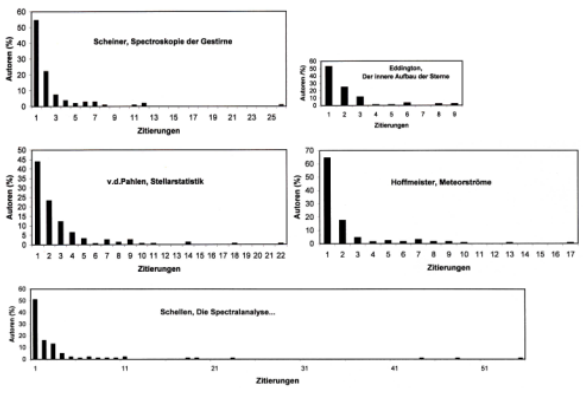

Figure 1

Part II: Some results relating to the history of rocketry and space travel

I have examined especially problems related to the history of astrophysics using the method of eminence measurement. But also in the field of rocketry and space travel we can find very interesting results. We can see that the distribution of citations in the literature on rocketry and space travel is fundamentally different to special sciences like physics, astronomy, biology, etc. The most evident differences are: (1) In different monographs from different countries written in different times we can find different pioneers. I have studied the following 13 monographs published between 1925 and 1979 to find out the pioneers:

List of used monographs in alphabetical order:

Baker, D. The Rockets, New York 1978

Braun, W.v. and F.I. Ordway III, History of Rocketry and Space Travel, Nelson 1966

Braun, W.v. and F.J.Ordway III, Raketen. Vom Feuerpfeil zum Raumtransporter, München 1979

Buedeler, W., Geschichte der Raumfahrt, Sigloch 1979

Emme, E.M. (Ed.), The History of Rocket Technology, Detroit 1964

Gluschko, W.P., Entwicklung des Raketenbaus und der Raumfahrt in der UdSSR, Moskau 1973

Obert, H., Wege zur Raumschiffahrt, 3. A., München und Berlin 1929

Petrie, W., Weltraumfahrt. Physik, Technik, Biologie, Hamburg-Stuttgart-München 1970

Sänger, E., Raumfahrt heute, morgen, übermorgen. Düsseldorf 1963

Scherschevsky, A.B., Die Rakete für Fahrt und Flug, 1929

Valier, M., Raketenfahrt, München 1930

Valier, M., Der Vorstoß in den Weltenraum, 2. Ed., München-Berlin 1925

Williams, B. and S. Epstein, The Rocket Pioneers and the Road to Space, New York 1955

The registers of the 13 monographs include 2716 names (double and multiple quotations of the same person included) quoted 5984 times in all. Using the method just described, 61 persons were found to qualify as pioneers of space travel and rocketry.

The six people most frequently quoted as pioneers are the following:

Ziolkowski	10
Oberth	9
Goddard	8
Dornberger	6
von Braun	5
J. Verne	4

Further, three persons are quoted as pioneers three times each, nine persons twice, and 43 persons just once. (2)

Not all the pioneers are scientists or technologists. There are also writers of utopian texts and popular books as well as politicians among them. The percentages are as follows:

Scientists/Technologists	87.1 per cent
Politicians	8.1 per cent
Writers	3.2 per cent
Utopian novelists	1,6 per cent

These figures are to be seen in relation not to all cited names but to all cited pioneers. In no other field of science and technology such a fascinating mixture of pioneers is found: there are scientists and technicians of the one hand, and philosophers, writers of science fiction literature and politicians on the other hand. They make up the international team of Space Travel creators.

Politicians and utopians become even more prominent if we consider the pioneers most frequently mentioned in the 13 monographs (i.e. quoted as pioneers three times or more).

In that case the percentages are:

Scientists/Technologists	55.5 %
Politicians	33.3 %
Writers/Utopians	11.2 %

Ziolkowski, Oberth and Goddard, who are internationally recognised today as the founding fathers of space travel, hardly ever quote one another, at least not in their early writings. Each of them worked out his basic studies independently and on his own, without knowing the work of the others. This was later reflected in the emergence of largely self-contained centres for the development of rocketry and space travel in the Soviet Union, The United States of America, and Germany.

A very interesting result are the eminence values for Ziolkowski in the several monographs. In all books published before 1929 the name Ziolkowski appears either not at all or with a small eminence value. Also, in the third edition of Oberth's very important book „Wege zur Raumschiffahrt" (1929) [2] the eminence value for Ziolkowski ist 1,4. But the first basic works of Ziolkowski were published already in the years 1903 to 1914 in Russia! In general: the low eminence values for some great scientists and technologists in the early years of the „crazy visions" of space travel are a logical consequence of the fact that the works was unknown. These findings show that the publications of Ziolkowsky were indeed considerably ineffective with respect to the development of rocketry and space travel in Western Europe [3].

I believe some questions of the history of rocketry and space travel can be solved using my statistical method of eminence values also in the future. But I think it is also important to know that statistical studies alone cannot

expound historical developments. Statistical investigations are useful as a complementation of other, more traditional and descriptive, methods for writing history.

References

[1] Herrmann, D. B., Eine Methode zur Messung der Bedeutung von Naturwissenschaftlern, Mitteilungen der Archenhold-Sternwarte 6(1976) Nr. 126 (with an Englisch summary)

[2] Oberth, H., Wege zur Raumschiffahrt, 3.Auflage, München und Berlin 1929

[3] Herrmann, D.B., K. E. Ziolkowski im Spiegel westeuropäischer Raumfahrtliteratur. Ein Beitrag zur Wirkungsgeschichte der Ideen von Ziolkowski. In: Dieter B. Herrmann, Astronomiegeschichte, Berlin 2004, pp. 228. See also Herrmann, D. B., Der Visionär von Kaluga, Astronomie und Raumfahrt im Unterricht 44(2007)2, pp. 30