Scientometrics, Vol. 13. Nos 3–4 (1988) 81–91

THE ROLE OF TRADE LITERATURE IN THE COMMUNICATION SYSTEM

F. VAN STEIJN,* A. RIP**

**Department of Science Dynamics, University of Amsterdam, Nieuwe Achtergracht 166, 1018 WV Amsterdam (The Netherlands)*
***Center for the Studies of Science and Society "De Boerderij", University of Twente, P.O. Box 217, 7500 AE Enschede (The Netherlands)*

(Received April 17, 1987)

Bibliometric methods in general undervalue technological research. This study examines the relation in literature between technological/industrial journals and scientific journals in the case of the plastics industry and polymer science. Trade-journals cannot be used in a straightforward bibliometric manner, but can be an aid in mapping the different groups and reveal the 'hidden' communication between technological and scientific communities.

Introduction

Existing bibliometric methods systematically undervalue technological research for several reasons, the most obvious of these being the lack of publications on industrial research when it is in its stage of application and development. Another reason is the fact that many technical publications are written in national languages and are therefore not represented in the international (English) literature and databases. In addition of the problem of language, also the *nature* of the journals that publish technological developments may result in diminished visibility for technological research-groups, both in industry and in (technological) universities. The reason for this lies in the circumstance that the majority of these journals do not address a purely scientific or technological audience, but to a large extent aim at managers of production and marketing. This affects the contents and style of these journals; e.g. citation – if it occurs at all – will be different from that found in the scientific literature.[1]

This paper is based on a preliminary study on the possibilities of investigating technical research and interactions between university and industry on a technological level through secondary journals that *do* report on technological development: trade journals.[2] In this study the polymer chemistry/plastics industry was chosen as a case to analyse in detail. This choice is based on several considerations. Firstly, trade

Elsevier, Amsterdam–Oxford–New York
Akadémiai Kiadó, Budapest

journals in the plastics industry, including the Dutch journal *Kunststof en Rubber,* are of high quality. Secondly, in this sector of industry an increase in interactions between research and applications can be observed of late, concerning especially research on new materials and the 'design' of polymers. The third reason is the expertise available on polymer chemistry within our research group.[3]

The design of the study is 'bottom-up' instead of 'top-down'. The study starts from the journal *Kunststof en Rubber,* which is edited and published by the Dutch institute of the same name, which is part of the Dutch Technical Research Organization TNO. The journal specializes in technological and industrial development. By starting from this journal the problem is investigated at the lowest level, namely that of applications in the Netherlands. Through this journal the issues that are important in technology and in its industrial applications will be visible at a national level; this might not be the case if international journals had been chosen as starting point. The second step will then be to establish the relation of the national issues to international developments in the field; and finally the relations governing the literature on this subject, the nature of the journals and their relation with the scientific literature will be examined.

The trade journal Kunststof en Rubber

Kunststof en Rubber was established in 1946 by TNO to inform the Dutch plastics industry about international developments. The journal addresses primarily management and marketing departments in industry and only secondary its R&D departments. Its circulation is 2500.

The subjects covered in this journal include: new applications of polymers, the availability and properties of materials, processing techniques, and transportation.[4] There are also references to the current international literature under the headings of (translated): 'Journal Service', 'Our Reading Table', and 'Books'. Furthermore, readers are informed by advertisements about industrial equipment and the availability of materials. An analysis of the contents of volume 1985 of *Kunststof en Rubber* resulted in the distribution of subjects shown in Table 1.

These contents illustrate the primary orientation of this journal towards marketing and production. This is consistent with the editorial policy; no subjects are reported that do not promise a marketvalue within five years.[5] Information about scientific developments will in general fail to meet this requirement, and is therefore not included. The interested reader, however, is helped and guided by *Kunststof en Rubber* in acquiring such information. The way of referring to international developments in research is considered in the following section.

Table 1
Frequency of subjects in *Kunststof en Rubber*, 1985

Subject:	Percentage	Number of articles
Polymer products	42%	(157)
Materials/Properties	21%	(80)
Machines/Equipment	18%	(65)
Economic analyses	11%	(43)
Informatics/Robotics	2%	(8)
Subjects like toxic properties, pollution, regulations	5%	(17)
Theoretical subjects	1%	(4)

Kunststof en Rubber and developments in research

Developments in research are reflected in *Kunststof en Rubber* in three ways: (1) through direct references to research in its articles, (2) through reviews of literature, and (3) through the journal service through which readers can order articles published in the international literature.

(ad 1) Direct information on scientific/technological developments are infrequent. References to university activities in 1985 totaled seven: one equipment exhibition, two on education, two on research on composites, and two on robot-techniques. These references have the function of illustration or announcement and do not elaborate the actual contents of university research.

(ad 2) Under the monthly heading 'Our reading table' two or three articles from the international literature are reviewed. These articles are often on properties and materials (about one third).

(ad 3) Through the 'Journal service' a larger set of articles is listed for the readers. The contents of these are not specified or abstracted, their relevance being apparent from the titles alone.

Studying the entries in 'Our reading table' and 'Journal service' in *Kunststof en Rubber* enables to construct a network of journals related to the plastics industry and – as will be seen – to polymer science as well.

The network of trade journals

The journal *Kunststof en Rubber* presents about 25 titles of articles each month. Selection is based on two criteria: (1) articles on the main processing techniques (extruding, pipemoulding) and (2) articles from well established journals in the field,

Table 2
Journals referred to in *Kunststof en Rubber,* 1985

Name of the journal	N of references	Included in *Science Citation Index*
Kunststoffe	39	+
Modern Plastics	30	+
Plastverarbeiter	23	+/−*
Kautschuk + Gummikunststoffe	20	+
Plastics Technology	20	+/−*
Gummi Fasern Kunststoffe	17	+
Adhesives Age	16	+
Adhaesion	14	−
Rubber World	8	−
Coating	6	−
Machine Design	6	+/−*
European Rubber Journal	5	−
Industrial & Production Engineering	5	−
Kunststoffe im Bau	5	−
Materials Engineering	5	−
European Plastics News	4	−
Fahrzeug + Karosserie	4	−
Japan Plastics Age	4	−
Kunststoffe Plastics	4	−
Plastics & Rubber Processing and Applications	4	−
Caoutchoucs & Plastics	3	−
Composites	3	+
MBProductietechniek	3	−

**Plastverarbeiter,* like *Plastics Technology* and *Machine Design* is not included in the *Science Citation Index* as a separate entry, but these journals do appear in other entries when being cited in them.

especially *Kunststoffe* and *Plastverarbeiter* (both German) and *Modern Plastics* (English). Language is an additional criterion for the editor; only Dutch, English, German and occasionally French articles are selected. Response from the readers is high: monthly some 50 readers of *Kunststof en Rubber* order about 100 reprints.

An overview of important journals, based on the articles listed in 1985 is presented in Table 2. They are ranked according to their recommendation by *Kunststof en Rubber,* in terms of the number of articles selected.

In addition to the journals listed in Table 2, 36 other journals were noted in 1985 one or two times, which brings the total to 59 journals. The full list contains the following groups of journals: (1) non-Dutch trade journals of the plastics industry; (2) journals for application sectors like construction or the automobile industry; and

(3) a small number of scientific journals. The contents and lay-out of the top listed journals (*Kunststoffe, Modern Plastics, Plastverarbeiter*) show a strong resemblance to those of *Kunststof en Rubber,* but they conform somewhat more to the characteristics of scientific journals in respect to subjects and citations.

Let us now examine the characteristics of those journals most often referred to ('cited' is not the proper word for the way they appear in *Kunststof en Rubber*).

Kunststoffe is the 75 year old journal of the Deutscher Kunststof Fachverbande; it addresses industry, but is connected with the Technical University of Aachen (RWTH Aachen). Volume 1985 contains 62 technological/scientific contributions ('Originalbeiträge'), mostly by authors from the RWTH Aachen. Furthermore it contains 12 editorial essays ('Leitartikel'), 23 articles on special events and fairs and 13 economic reviews. The remainder consists of many short announcements under regular headings, similar to those in *Kunststof en Rubber.* Because of the contributions of the Technical University, *Kunststoffe* contains articles with citations and these articles are definitely 'citable' themselves. *Kunststoffe* is reported in the *Journal Reports* of the *SCI* and has an impact factor of 0.36.[6]

Plastverarbeiter published 11 articles with literature references in 1985, all originating from technical universities. The remainder consists of regular headings presenting applications, techniques and economic news. The articles in *Plastverarbeiter* are taken into account in the *Journal Reports* of the *SCI*, but the journal is not itself an entry. Consequently no impact factor is calculated for *Plastverarbeiter.*

A remarkable characteristic of **Modern Plastics** – besides its great similarity to the other trade journals described here – is that articles often do not cite in the ordinary manner, but instead include a list of the names of companies 'for more information'. The impact factor of *Modern Plastics* is calculated at 0.15.

These descriptions show that such trade journals operate in the border area between R&D and production/marketing. Journals that incline to the latter, like *Kunststof en Rubber* and many others in Table 2, contain virtually no citations or citable articles and are not included in the *SCI.* Journals that are intended more for an R&D-audience contain more citations, but their number does not come close to that of citations in scientific journals. These journals are recorded in the *SCI*, but have obviously small impact factors.

The next step in this study was to look at the patterns of citation and of being cited in the journals that do appear in the *SCI* and are thus connected with the international literature. This was done using the method developed by *Leydesdorff,* which allowed us to construct two networks of journals, one connected with citing behaviour and the other with the way journals are cited by other journals.[7]

Figure 1 was constructed by starting with the five journals that were found to be most important in *Kunststof en Rubber* and were recorded in the *Cited Journal*

Listing of the *SCI.* These were: 1. *Kunststoffe,* 2. *Kautschuk und Gummi Kunststoffe,* 3. *Gummi Fasern Kunststoffe,* 4. *Modern Plastics* and 5. *Adhesives Age.* Using the metaphor of 'information flow', we can draw arrows designating the flow of information between two journals.[8] The figure is constructed by taking the top three

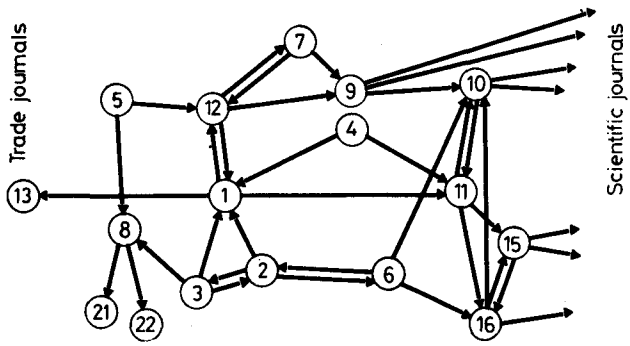

Fig. 1. Network of journals based on the cited journal listing.

Journal	Impact factor		
1 Kunststoffe	0.36	14 J. Polymer Science, Polymer Chemistry	1.24
2 Kautschuk Gummi Kunststoffe	0.27	15 Macromolecules	2.73
3 Gummi Fasern Kunststoffe	0.11	16 Polymer	1.82
4 Modern Plastics International	0.15	17 J. Polymer Science, Polymer Physics	1.88
5 Adhesives Age	0.08	18 J. American Chemical Society	4.43
6 Rubber Chemical Technology	0.92	19 J. Chemical Physics	2.99
7 Acta Polymerica	0.45	20 J. Material Science	0.98
8 Chemiker Zeitung	0.84	21 J. Organometalic Chemistry	1.91
9 Angewandte Macromolekulare Chemie	0.50	22 Zeitschrift für Naturforschung B	1.30
10 J. Applied Polymer Science	1.03	23 Analytical Chemistry	3.02
11 Polymer Engineering and Science	0.99	24 Forest Products	0.28
12 Plaste Kautschuk	0.23	25 Wood Science	0.67
13 Plastverarbeiter	–	26 Holz Roh. Werkst.	0.34

journals cited by the entry journals, resulting in one arrow each, and repeating this step with the new journals to a maximum of two beyond the original entries.
In Figure 1 the typical trade journals (1 trough 5, 12 and 13) appear as important sources of information for each other. Scientific journals also appear: *Journal of Applied Polymer Science* (10), *Polymer Engineering and Science* (11), *Macromolecules* (15) and *Polymer* (16). The latter two are leading journals in polymer chemistry.[9] The weight of their impact factors (2.73 and 1.82 respectively) also shows that these journals are much more 'visible' in the scientific world.

The journals *Rubber Chemical Technology* (6) and *Angewandte Macromolekulare Chemie* (9) seem to take a position between the trade journals and the scientific

journals; an examination of their contents shows that they do not offer information typical of trade journals but contain primarily articles on applications of polymer chemistry.

Further examination of the Fig. 1 suggests that the direction of information is primarily from the trade journals towards the scientific literature. To assess this rather unexpected phenomenon it is necessary to construct a second figure with the

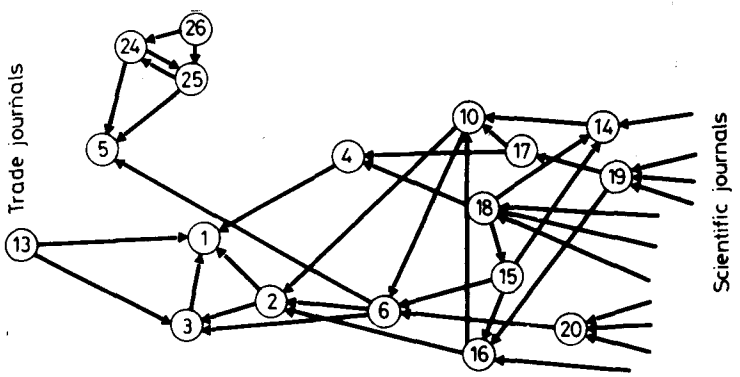

Fig. 2. Network of journals based on the citing journal listing. The meaning of numbers as in Fig. 1

same method, now based on the *Citing Journal Listing* of the *SCI.* This results in Fig. 2.

In Figure 2, the 'flow of information' seems to go from the right to the left, i.e., from the scientific journals to the trade journals. A closer analysis of the method of construction of both figures reveals that the direction of the arrows in Fig. 1 is an artefact caused by the fact that trade journals contain far fewer citations than scientific journals. One example: *Kunststoffe* is not cited very often (537 times in 1984 of which 242 were self-citations) but when it *is* cited, this is done in scientific journals that contain many citations, e.g. *Polymer Engineering and Science* which cited *Kunststoffe* as much as 23 times in 1984, making it the third ranking journal that cites *Kunststoffe. Polymer Engineering and Science,* however, contained altogether 4213 citations in 1984, of which *only* 23 referred to articles in *Kunststoffe.*

If scientific journals had been taken as entries for the construction of the figures, the trade journals would not have been visible at all (as is indeed shown by *Zeldenrust*).[10]

Further analysis of the group of journals

The construction of Figs 1 and 2 resulted in a list of journals of which some appear in both and others only in one. It is now possible to make a statistical analysis of the numbers of citations between all these journals. Factor analysis[11] reveals seven factors some of which can be interpreted as sectoral or national groups of trade journals (e.g. adhesives and wood processing, nrs. 5, 24, 25, 26 or the German

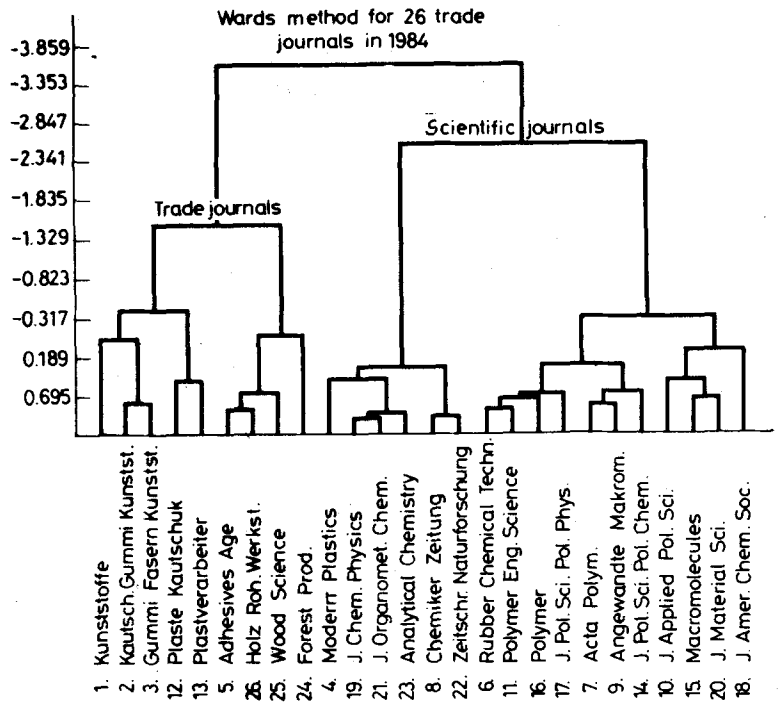

Fig. 3. Cluster analysis on 26 journals

trade journals nrs. 1, 2, 3) and others as groups of scientific journals in chemistry. Factor analysis, however, can not disclose the relations or 'distance' between these groups of journals. This can be done with cluster analysis, represented in the dendogram of Fig. 3.[12]

Figure 3 shows two main groups which can easily be interpreted as trade journals on the one hand (with the exception of *Modern Plastics*[13]) and as journals in chemistry and polymer chemistry on the other. The existence of two groups with strong internal

coherence and with exchanges (through citations) between them, can be discussed further in terms of the relation between industrial/technological and scientific fields.

The result of this exercise, namely that the relation between technology and science is one of two rather separated communities, is confirmed by *Zeldenrust*'s analysis of publication behaviour in the field of polymer chemistry in the Netherlands.[14] Out of a total of 390 articles by Dutch polymer chemists published between 1978 and 1984, 114 were published in one of the scientific journals from Fig. 3, and 50 of those were published in *Macromolecules* and *Polymer*. None of these articles were published in any of the 59 trade journals from the total collection in *Kunststof en Rubber*.

Also in recent sociological studies the existence of separate communities is indicated, as e.g. by *Van den Belt* and *Rip*:

> Both science and technology can be characterized as heuristic search processes, but different institutionalizations have emerged that now constitute separate systems, between which exchange can occur.[15]

The role of literature is very different in each of these two communities. In the polymer technology/plastics industry the trade literature informs its audience about possible solutions to existing problems, about profitable possibilities, and about the availability of basic materials, machines, and instruments. The scientific literature on the other hand is important for the reporting of results, the presentation of claims, and the establishment mutual recognition. In present day R&D practices a sharp split has become institutionalized between science and technology/development, but at the same time attempts must be made – and they *are* being made also through the literature – to bridge this gap. Figure 3 shows both this gap and the attempts to bridge it.

The relation between scientific and technological literatures

This study has confirmed the difficulties in establishing and evaluating technological work using existing bibliometric methods, and furthermore it has thrown some light on the relations between industrial/technological and scientific literatures. Conclusions can be drawn in both respects.

Bibliometric methods indeed cannot be used with trade-journals in a straightforward manner, as was evident in the case of *Kunststof en Rubber*. For the same reason, *Turner* and *Callon* constructed their own specialized database on the journal *Plastiques et Elastomères*.[16] The absence of bibliometric links is related to the function of these journals. For an industrial audience there is apparently no need to transfer scientific results, although the journal does open and maintain a 'window on science'. The actual transfer is established through other channels, probably informal

ones. This result means that further analysis of the contents of *Kunststof en Rubber* would not have been very useful for generating indicators of technological progress because the resulting set of subjects could not have been interpreted without some knowledge of the coherence of the field. In particular the relation with achievements in science would remain invisible.

The results of the 'bottom-up' design that was followed in this study allow two important conclusions to be drawn. The first is that the technological/industrial community has its own means of communication; the set of trade journals is internally coherent, just like the scientific journals in polymer chemistry. Bibliometric methods are designed to establish structures only in the latter community and not in the first. Therefore, the differences between both communities become apparent in a particular way: the absolute number of citations within, from and to the group of trade journals is much smaller than comparable numbers in the group of scientific journals.

The second conclusion deals with the exchange of information between the separate systems. There exists a bilateral linkage between both groups of journals: not only do technologists cite from the scientific literature, but scientists also cite from the technological literature, and in this respect the numbers are comparable. Both communities, though self-contained, are important to each other with no predominance on either side.

These conclusions confirm that technological achievements *and* information flows are undervalued in bibliometric methods. Our study establishes that it is possible to reveal the 'hidden' extent of the trade literature and to map a part of this literature in connection with the scientific literature. This would not have been possible using only the *Science Citation Index* as a starting point. The result implies that no routinized way of tracing technological information flows is possible, unless specialized data-bases are set up. Such data bases must handle much more heterogeneous data than does the *SCI*/ISI.

Notes and references

1. The same holds for the way patents cite scientific literature, cf. *Evaluation of National Performance in Basic Research*, ABRC Science Policy Studies No. 1, Department of Education and Science, (1986) 237.
2. This study was conducted with a research grant from the Stichting voor de Technische Wetenschappen (STW), the Dutch Foundation for Technical Sciences. We wish to thank its director, Dr. C. LE PAIR, for his useful comments.
3. We are grateful for having been offered access to unpublished data from the study on 'Trends in Polymer Science' by S. ZELDENRUST.
4. Transportation concerns the application of plastics and rubber in the automobile industry (tires, etc.).
5. Interview with the editor, April 1986.

6. The impact factor of a journal is calculated on an annual basis by comparing the mean number of citations in a given year to the number of articles published in the journal in the two preceding years.
7. L. LEYDESDORFF, The development of frames of references, *Scientometrics*, 9 (1986) 103.
8. This metaphor is used in the sense that when journal A cites articles from journal B, A receives information from B. Citations, however, have more than a communicative function only. A too literal interpretation of this metaphor is therefore dangerous, but it does help to understand the arrows in the figures.
9. S. ZELDENRUST, *Trends in Polymer Science*, forthcoming.
10. S. ZELDENRUST, op. cit. note 9.
11. L. LEYDESDORFF, op. cit. note 7.
12. L. LEYDESDORFF, op. cit. note 7.
13. One possible explanation for the appearance of *Modern Plastics* among the chemical journals might well lie in the difference in language compared with the 'general' trade journals (nrs. 1, 2, 3, 12, 13), which are all in German. Note however, that the German *scientific* journals (nrs. 9, 18, 22, 23) are regularly included in the groups of English scientific journals.
14. S. ZELDENRUST, op. cit. note 9.
15. Translated from Dutch; H. VAN DEN BELT and A. RIP, *Technologie-ontwikkeling: het Nelson-Winter/Dosi-Model*, LISBON/R-84/21, Leiden, (1984). See also: H. VAN DEN BELT, and A. RIP, 'The Nelson-Winter/Dosi model and Synthetic Dye Chemistry', in W. E. BIJKER, T. P. HUGHESAND, T. J. PINCH (Eds), *The Social Construction of Technological Systems. New Directions in the Sociology and History of Technology*, Cambridge, MA:MIT Press, 1987.
16. W. TURNER, M. CALLON, State intervention in academic and industrial research: The case of macromolecular chemistry in France, in: M. CALLON, J. LAW, A. RIP (Eds), *Mapping the Dynamics of Science and Technology*, London, Macmillan, 1986, p. 144.