Research Evaluation, 19(3), September 2010, pages 000–000
DOI: ???; http://www.ingentaconnect.com/content/beech/rev

A bibliometric and historiographic analysis of the work of Tony van Raan: a tribute to a scientometrics pioneer and gatekeeper

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Using the HistCite™ software and downloading searches of the Web of Science database we have created a master collection of 1,518 papers that have cited his work and several subset collections showing his impact in the field of scientometrics and research evaluation. Using the percentile rank indexes of his publications we have demonstrated his high impact in that area and have included a table of 14 of his papers in the 95th percentile of papers published in those respective journals. Using HistCite we also created several additional historiographs of his work, which clearly shows the main papers and books which have influenced his work involving bibliometrics and fractal analysis.

IT IS A PLEASURE for me to congratulate Tony van Raan on his 65th birthday. Time, energy and resources do not allow me to provide a detailed review of his work but I thought it would be suitable to create a series of HistCite™ collections of Tony's published work (see <http://garfield.library.upenn.edu/histcomp/index-vanRaan.html>).

While there have been numerous publications about HistCite, I thought it would be of didactic value to explain how they were compiled, and to call out certain features which help us to understand those authors who most influenced Tony, and also to visualize the evolution of his work through the construction of several historiographs, that is a chronological display of publications and their references.

In the following paragraphs we explain how we proceeded to compile his bibliography and then how we retrieved the complete set of papers that have cited his work.

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HistCite methodology

A HistCite collection is usually created by a multipart process that results in a master file. The first step is to collect all relevant data. The second step is to confirm the data and remove any potential duplicates or false hits. Next is to edit variations in the cited references that may prevent the establishment of the appropriate links. Finally, from the edited list of cited references in the HistCite collection, missing articles can be identified and added to the collection at the user's discretion. Commonly, there are non- Web of Science (WoS) records that must be added to the collection manually. This process results in a HistCite master file which can be used to create additional HistCite collections as per the researcher's needs.

The HistCite collections of Tony's contributions to science were created initially from records downloaded from the WoS database; 104 papers were retrieved using the following WoS author query: (van raan a* or vanraan a*). The wildcard character allows a match for any characters that follow the first initial. Using a publication list supplied by Robert Tijssen of the Center for Science and Technology Studies, all the entries resulting from the above search were confirmed to be papers by Tony van Raan.

To acquire the records citing Tony, a cited reference search was completed on WoS, Cited

 0958-2029/10/03000-00 US$12.00

Author=(vanraan or vanraan a* or van raan a* or raan afj). A second search was conducted to acquire two more papers which cite 'VANRAAN' without initials. Since some papers by Van Raan may also cite a Van Raan paper, there is some overlap between the author and cited reference searches. However, since any given Van Raan paper does not necessarily cite another Van Raan paper, both searches are required. Thus 1,490 unique citing papers were found in WoS. All the records from these searches were combined in the HistCite software for a total of 1,518 records.

HistCite treats any variations in author names as distinct authors. The records that used 'vanraan' as author were changed to 'van Raan'. Upper and lower case letters do not affect the analysis results, but variations in the first and middle initials do; therefore the three articles that lacked the author's full initials of 'A F J' were changed. This resulted in 104 source records for the author 'AFJ van Raan'. Bibliometricians are well aware of the frequency of non-standard, idiosyncratic ways that authors cite; hence the necessity to standardize the data to facilitate algorithmic matching. If the citation is incomplete or otherwise in error, the software may not be able to make the appropriate linkage between the citing and cited record. The WoS software unifies many variants through the use of its Keysave™ system (Garfield, 1977). Although data in WoS is continually being standardized by various computer procedures, many variants, especially in the cited references, do find their way into the database. This is particularly true for cited books.

HistCite has many editing features that help the user find and correct these variations. The collection's 'Cited Reference' list is the pool of all references cited in all the papers contained within the collection. The default sort of this table is by citation frequency, and thus shows the publications that are cited most by the HistCite collection. References to publications which are contained in the HistCite collection are shown in blue.[1] The blue references are clickable and open the individual HistCite record for the cited publication. References that are listed in black are not linked to any record within the collection. This non-linkage means the object of the reference is not within the collection, or else, the reference is not sufficient to meet the program's requirements for linkage between a reference and its object. The reference's 'Rec' number is the number of papers in the collection which cite that reference. Clicking on the 'Rec' number shows those records in a table-formatted page.

The total pool of cited references for the collection can also be sorted according to the first cited author name, in this case, 'vanRaan'. This listing makes it easy to spot the variations in the references to Van Raan's work. Each variation is counted as a separate entry in the list of references. References to non-WoS publications, particularly books, may or may not be unified by the WoS procedures. By unifying the variants of references to Van Raan, it is easy to see which of his publications are most cited, and of those, which are absent from the collection. Eleven Van Raan publications were identified in this way and added to the collection via manual input, bringing the total of Van Raan publications to 115. For example, Tony's chapter 'Measuring science — capita selecta of current main issues', in the *Handbook of Quantitative Science and Technology Research: the Use of Publication and Patent Statistics in Studies of S&T Systems* (H Moed *et al* eds, 2004) was added to the collection because it is not a source entry in WoS. After the variant cited references to the chapter were unified, it was seen to be cited 60 times. However, for all non-WoS records added to the HistCite collection their cited reference lists were not included since we did not have access to the full text. These cited references could have been added manually but would not significantly affect the statistical results.

HistCite enables the user to make most corrections easily. Others are more difficult and time-consuming to implement. For example, for those references citing a non-WoS, Van Raan publication in which Van Raan is not the first author, no corrections were made. In order to do that, the user must identify the relevant co-authored Van Raan works and then conduct an individual cited reference search in WoS for each co-authored publication in question. Once that search is completed, the additional entries must be added to the collection.

The conclusion of this process resulted in the master file, an edited and reasonably complete collection of publications by Tony and the papers citing his work, a total of 1,529 papers. (See HistCite collection of publications by Van Raan and the papers citing Van Raan: <http://garfield.library.upenn.edu/histcomp/vanRaan_citing/>.) For other HistCite collections, such as the collection limited to Tony's scientometrics papers, see <http://garfield.library.upenn.edu/histcomp/vanRaan_scientometrics/>; for the collection centered on his 'Fractal dimension of co-citations' paper, see <http://garfield.library.upenn.edu/histcomp/van-raan_fractals-nature/>.
These were derived from the master file, but may also include additional records. (See Figures 1 and 2 for historiographs taken from the fractals collection.)

Another HistCite collection 'van Raan w/citing papers plus' began with the master file collection. Then added to it were several key records identified from the cited references list of the master collection. The cited references list (Table 1) orders the cited references by frequency, and therefore shows the publications that are most cited by all papers in the HistCite collection. References to publications that are contained in the collection are shown here in gray.[1] (See Figure 3 for a historiograph taken from this collection.)

There are several publications that were highly cited by the collection, but were not added to the collection from the initial WoS search. They do not

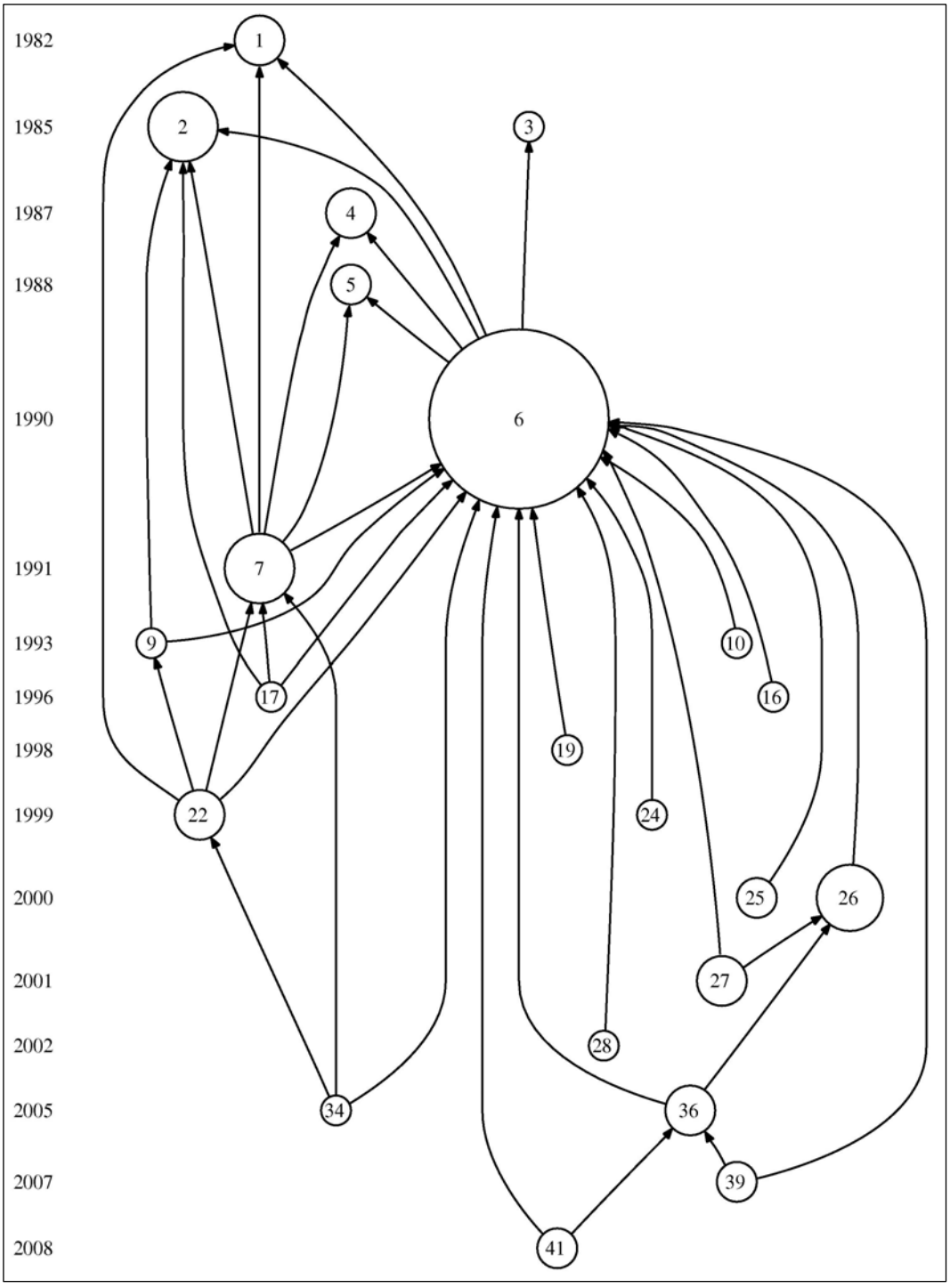

Figure 1. LCS historiograph derived from the Van Raan fractals HistCite
Source: <http://garfield.library.upenn.edu/histcomp/van-raan_fractals-nature/>

cite Van Raan and were not authored by him, or they were not available in the WoS database to begin with. Regardless, it is obvious from their high frequency in the collection that they are closely associated with the papers that were found in WoS. These publications were added to the master file to create a new HistCite collection. Adding them to the collection gives more meaning to the visualization in the historiograph (see Figure 3 for the historiograph). The collection 'van Raan w/citing papers plus' is available at: <http://garfield.library.upenn.edu/histcomp/vanRaan_citing-cr/>.

Percentile rank index

To supplement our HistCite study, we also made use of a relatively new bibliometric indicator called the percentile rank index (PRI) (Pudovkin and Garfield, 2009). The PRI is a citation-based ranking that compares a target paper's current citation score to the current citation scores of other papers published in the same journal and in the same year as the target paper.

$$PRI = (N - R + 1)/N*100,$$

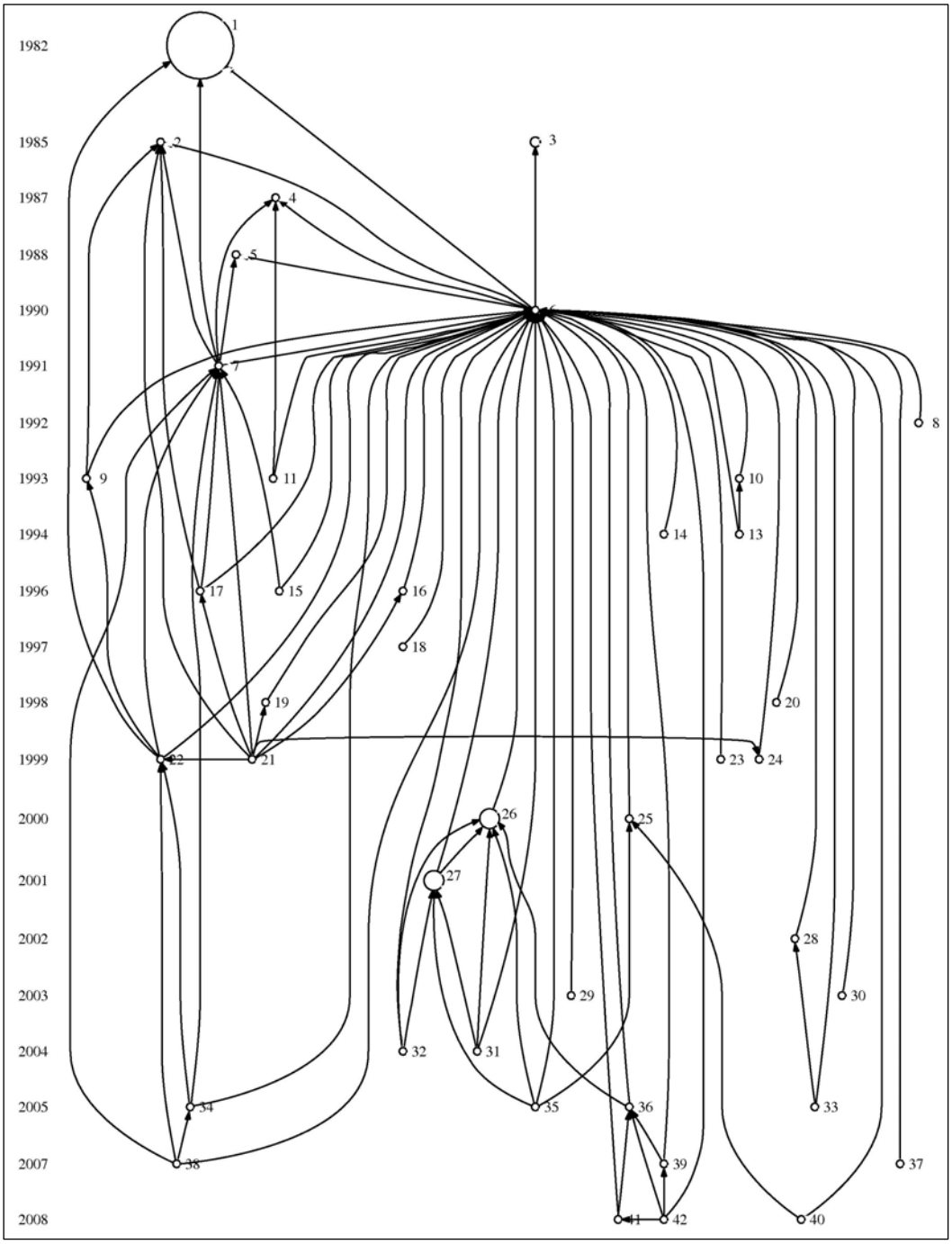

Figure 2. GCS historiograph from Van Raan fractals HistCite
Source: <http://garfield.library.upenn.edu/histcomp/van-raan_fractals-nature/>

where *N* is the number of papers in the year set of the journal, *R* is the descending citation rank of the paper (among the *N* papers of the journal published in the year of the target paper). In case of ties (papers having the same citation frequency), each of the tied values is assigned the average of the ranks for the tied set. Thus, if a target paper is the most cited paper in a journal in a year, its PRI = 100. It immediately demonstrates the impact status of an author among his/her peers, that is, the authors of papers in the topical journal of the target paper as judged by the peers, the scientists who cite the target paper including usually those who also publish in the target journal. This approach reduces the citation bias of fast-moving scientific fields and the effect of age.

The PRI calculations were completed using WoS data, which were not edited or unified as described for the creation of the HistCite master file. We do not believe the rankings would change significantly for those in the highest percentiles. Table 2 lists 29 papers by Van Raan and co-authors, for which PRIs are 90 or higher. Full bibliographic citations for 14 of the top papers are given in Table 3.

Co-author and citing influence spheres

As Blaise Cronin has emphasized, citation analyses do not always give us a complete picture of the influence of many gatekeepers of science (Cronin *et*

Table 1. Cited references list for the 'van Raan and citing papers' HistCite

Anthony F.J. van Raan & the citing papers Historiographs

Glossary HistCite Guide About
Grand Totals: LCS 6319, GCS 19790, CR 58531
Collection span: 1971 - 2009

Cited Reference List (33619) including 876 records (top 200 shown)

27 November 2009

Records: 1529, Authors: 1960, Journals: 372, Cited References: 33619, Words: 2647, Tags: 2
Yearly output | Document Type | Language | Institution | Institution with Subdivision | Country

#	Author / Year / Journal		Recs
1	MOED HF, 1985, RES POLICY, V14, P131	WoS	131
2	GARFIELD E, 1979, CITATION INDEXING	WoS	127
3	HIRSCH JE, 2005, P NATL ACAD SCI USA, V102, P16569	WoS	124
4	VANRAAN AFJ, 1996, SCIENTOMETRICS, V36, P397	WoS	98
5	SMALL H, 1973, J AM SOC INFORM SCI, V24, P265	WoS	97
6	VANRAAN AFJ, 2006, SCIENTOMETRICS, V67, P491	WoS	90
7	MARTIN BR, 1983, RES POLICY, V12, P61	WoS	89
8	BRAAM RR, 1991, J AM SOC INFORM SCI, V42, P233	WoS	88
9	PRICE DJD, 1965, SCIENCE, V149, P510	WoS	88
10	PRICE DJD, 1963, LITTLE SCI BIG SCI	WoS	84
11	VANRAAN AFJ, 1988, HDB QUANTITATIVE STU	WoS	81
12	CALLON M, 1986, MAPPING DYNAMICS SCI	WoS	74
13	NARIN F, 1976, EVALUATIVE BIBLIOMET	WoS	72
14	SMALL H, 1974, SCI STUD, V4, P17	WoS	71
15	VANRAAN AFJ, 2005, SCIENTOMETRICS, V62, P133	WoS	69
16	MOED HF, 1995, SCIENTOMETRICS, V33, P381	WoS	67
17	BRAAM RR, 1991, J AM SOC INFORM SCI, V42, P252	WoS	64
18	MOED HF, 2005, CITATION ANAL RES EV	WoS	61
19	VANRAAN AFJ, 1971, PHYSICA, V53, P45	WoS	60
20	VANRAAN AFJ, 2004, HDB QUANTITATIVE SCI, P19	WoS	60
21	VANLEEUWEN TN, 2001, SCIENTOMETRICS, V51, P335	WoS	55
22	BORNMANN L, 2005, SCIENTOMETRICS, V65, P391	WoS	54
23	GARFIELD E, 1972, SCIENCE, V178, P471	WoS	54
24	MACROBERTS MH, 1989, J AM SOC INFORM SCI, V40, P342	WoS	52
25	MERTON RK, 1968, SCIENCE, V159, P56	WoS	52
26	WHITE HD, 1998, J AM SOC INFORM SCI, V49, P327	WoS	51
27	SEGLEN PO, 1997, BRIT MED J, V314, P498	WoS	50
28	CALLON M, 1983, SOC SCI INFORM, V22, P191	WoS	49
29	LOTKA AJ, 1926, J WASHINGTON ACADEMY, V16, P317	WoS	49
30	MOED HF, 1985, SCIENTOMETRICS, V8, P177	WoS	48
#	Author / Year / Journal		Recs
31	SEGLEN PO, 1992, J AM SOC INFORM SCI, V43, P628	WoS	48
32	BALL P, 2005, NATURE, V436, P900	WoS	47
33	CRONIN B, 2006, J AM SOC INF SCI TEC, V57, P1275	WoS	47
34	KESSLER MM, 1963, AM DOC, V14, P10	WoS	47
35	SCHUBERT A, 1989, SCIENTOMETRICS, V16, P3	WoS	47
36	EGGHE L, 2006, SCIENTOMETRICS, V69, P131	WoS	46
37	KING J, 1987, J INFORM SCI, V13, P261	WoS	46
38	PRICE DJD, 1976, J AM SOC INFORM SCI, V27, P292	WoS	44
39	SMALL H, 1999, J AM SOC INFORM SCI, V50, P799	WoS	44

Source: <http://garfield.library.upenn.edu/histcomp/vanRaan_citing/list/or-pubs.html>

al, 2003). Among these are journal editors and administrators. But even if there were a complete 'acknowledgement' index to the literature, it would not necessarily reflect their full influence since administrators and editors are rarely acknowledged formally. It is taken for granted that their functions imply great influence. Since Tony has served on the editorial board of *Scientometrics* and also has served as editor of *Research Evaluation*, one could not easily measure his influence in those areas of his professional career. And even the citation analysis provided here would not completely demonstrate the influence of his research activities. To do that one would have to also analyze the work of his numerous colleagues at the Center for Science and Technology Studies at the University of Leiden where Tony serves as Director. Not the least of these is his most frequent co-author, Henk Moed.

The HistCite collection lists Tony's 46 co-authors, among whom are T N van Leeuwen, E C M Noyons, H P F Peters and R J Tijssen. (Table 4 includes the 12 colleagues who have co-authored four

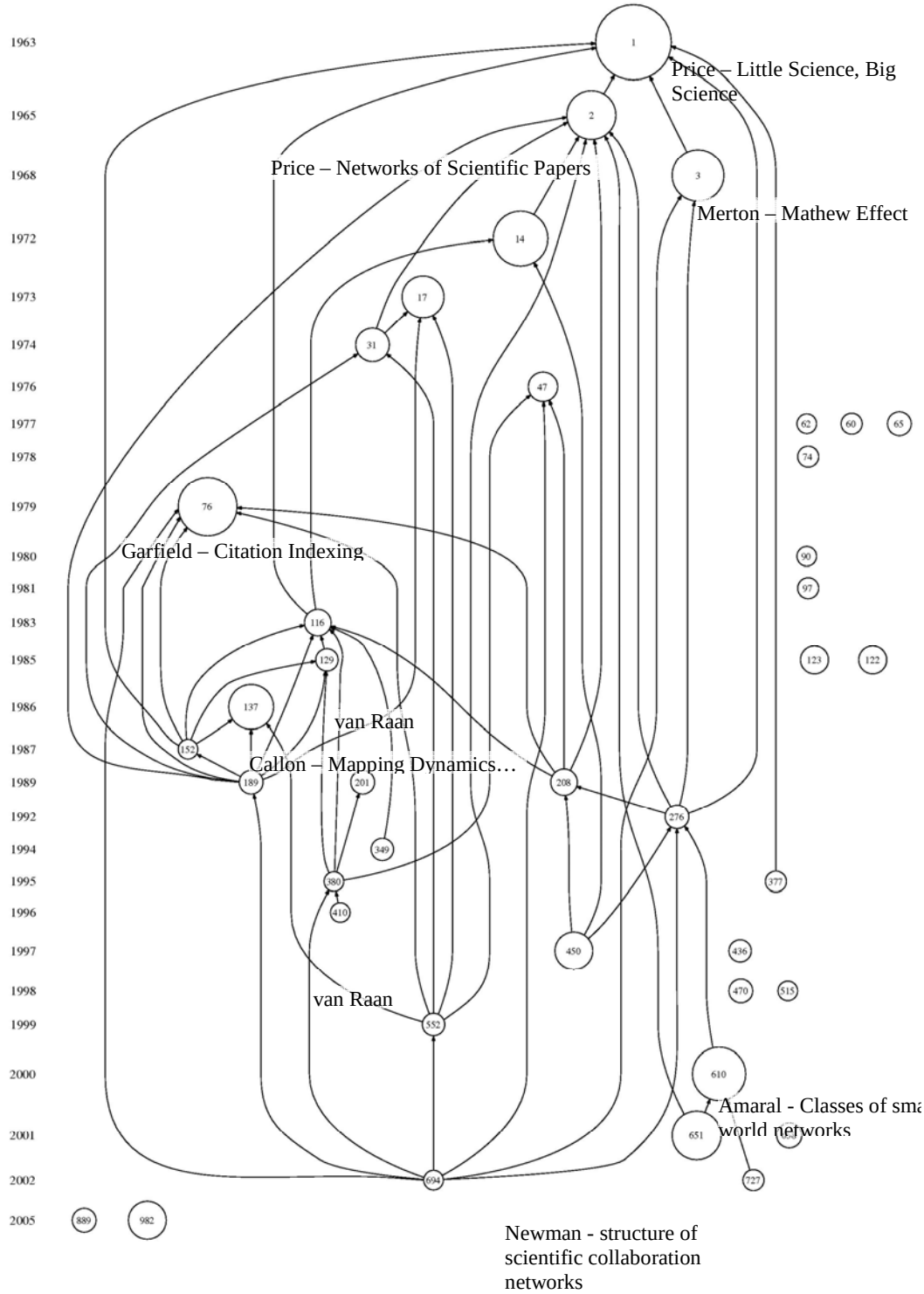

Figure 3. Highly cited papers associated with Van Raan's work, a GCS historiograph from the 'van Raan and citing papers plus' HistCite

Source: <http://garfield.library.upenn.edu/histcomp/vanRaan_citing-cr/>

or more papers with him. For the complete list go to: <http://garfield.library.upenn.edu/histcomp/vanRaanauth/list/au-pubs.html>.)

To further demonstrate Van Raan's influence, of the more than 1,400 papers that have cited his work, there are no less than 2,000 authors included. Table 5 shows the top of this list, which includes 35 authors with nine or more papers in the HistCite of 'van Raan and the citing papers'. To see the complete list, go to: <http://garfield.library.upenn.edu/histcomp/vanRaan_citing/list/au-pubs.html>.

LCS and GCS are two acronyms that appear throughout HistCite. LCS is the 'local citation score'. This is, for a particular paper, the number of times it has been cited by papers in the collection. GCS, 'global citation score' is the number of times that paper has been cited by all the papers within the WoS database. The HistCite collections can be sorted by either of these of criteria. TGCS refers to 'Total GCS' and is the sum of the GCS scores of all the papers in that particular set. TLCS likewise refers to 'Total LCS'. For example, Tony's 115

Table 2. Twenty-nine papers by Van Raan and co-authors, for which percentile rank index values are 90 or higher

No.	Journal title, volume: page	Year	Cites	No. of papers in the journal	Citation rank	Average citation	PRI
1	*Scientometrics*, 36: 397	1996	83	99	1	10.8	100
2	*Scientometrics*, 67: 491	2006	84	145	2	6.84	99
3	*Scientometrics*, 62: 133	2005	62	129	2	5.91	99
4	*J. Am. Soc. Information Sci.*, 42: 233	1991	87	100	3	15.94	98
5	*Scientometrics*, 47: 347	2000	34	89	3	8.37	98
6	*Scientometrics*, 38: 205	1997	32	81	3	9.02	98
7	*Scientometrics*, 51: 335	2001	54	115	4	9.15	97
8	*JASIST*, 59: 461	2008	7	227	7.5	1.22	97
9	*Scientometrics*, 42: 423	1998	35	89	4	9.33	97
10	*ASIST* monograph ser.: 301	2000	10	55	3	1.27	96
11	*Res. Evaluation*, 9: 155	2000	11	24	2	2.46	96
12	*Phisica*, 53: 45	1971	58	314	15	14.46	96
13	*J. Am. Soc. Information Sci.*, 57: 408	2006	17	204	10.5	4.84	95
14	*Res. Evaluation*, 10: 195	2001	9	21	2	3.71	95
15	*Scientometrics*, 43: 129	1998	27	89	6	9.33	94
16	*J. Am. Soc. Information Sci.*, 49:68	1998	41	187	12	10.43	94
17	*J. Am. Soc. Information Sci.*, 42: 252	1991	62	100	7	15.94	94
18	*Scientometrics*, 20: 235	1991	24	83	6	8.14	94
19	*Evaluation Review*, 18: 98	1994	26	39	3.5	10.31	94
20	*Scientometrics*, 8:177	1985	47	62	5	16.32	94
21	*Research Policy*, 22: 23	1993	38	31	3	15.55	94
22	*Research Policy*, 14: 131	1985	129	28	3	38.39	93
23	*Scientometrics*, 27: 157	1993	22	62	6	8.98	92
24	*J. Am. Soc. Information Sci.*, 46: 9	1995	34	121	11	11.26	92
25	*Scientometrics*, 59: 467	2004	24	101	9.5	9.25	92
26	*Scientometrics*, 50: 59	2001	22	115	11	9.15	91
27	*Scientometrics*, 26: 169	1993	21	62	7	8.98	90
28	*Scientometrics*, 57: 257	2003	23	94	10.5	9.04	90
29	*Res. Evaluation*, 9: 81	2000	5	24	3.5	2.46	90

publications in this collection have a TGCS of 2,212. Therefore, those 115 publications have received a total of 2,212 citations.

It is axiomatic that we can tell something about an author from the people he has cited; in other words, the authors who have influenced his work (see Table 6). Why, for example, would Tony have cited eight times a paper in a medical journal (*Journal of the American Medical Association*) written by the Canadian D F Horrobin? The paper in question concerns 'The philosophical basis of peer-review and the suppression of innovation' (Horrobin, 1990). This tells us something about Tony's interests in peer review and his role as an editor.

Similarly, his frequent citation of M Callon from France reveals an interest in co-word analysis. 'From translations to problematic networks – an introduction to co-word analysis', as we know, is an oft-cited paper that reflects an alternative and/or supplemental approach to mapping science to that of co-citation analysis (Callon, 1983).

Moving up the list of Tony's most referenced papers, there is the work of the father of scientometrics, Derek Price, and his classic paper on 'Networks of scientific papers' (Price, 1965).

The paper by the British group, P Healey, H Rothman and P K Hoch, on 'An experiment in science mapping for research planning', is a further illustration of my point. For didactic purposes I should point out that the HistCite list of the works most cited by Van Raan does not include their titles, but they were easily retrieved by clicking on the WoS link provided in the HistCite display. (See the full list of publications most cited by Van Raan at: <http://garfield.library.upenn.edu/histcomp/vanRaan auth/list/or-pubs.html>.)

Figure 4 demonstrates how citation linkages automatically separate Van Raan's work in physics from his later work in research evaluation.

In contrast, let us now turn to the HistCite collection of 33,619 references cited in the papers citing Tony's work <http://garfield.library.upenn.edu/ histcomp/vanRaan_citing/>. This collection tells us the authors that are co-cited with Van Raan. Table 1 lists the most-cited papers in the collection that includes the papers that cite Van Raan's publications. Those listed in blue are included in the collection as records, those in black are not.

Remarkably the work of Jorge Hirsch, the inventor of the H-index, is near the top of the list. I say this because it is of such recent vintage. The historiograph reveals that this is highly associated with Tony's recent 2006 paper (see node number 6 of the HistCite collection at: <http://garfield.library.upenn. edu/histcomp/van-Raan_hirsch/>).

The other highly cited authors in this list include Henry Small, Ben Martin, Derek Price, Per Seglen, M Callon and E Garfield.

Before closing I would like to publicly thank Tony for his contribution to my 75th birthday *Festschrift* which he cleverly titled: 'The Pandora's box of citation analysis: measuring scientific excellence — the last evil?' This is an excellent review of the work of his group. While it has been cited in about

Table 3. Fourteen papers by Van Raan, for which percentile rank index values are 95 or more.

No.		Cites	PRI
1	Van Raan, A F J 1996. Advanced bibliometric methods as quantitative core of peer review based evaluation and foresight exercises. *Scientometrics*, **36**(3), July/August, 397–420	83	**100**
2	Van Raan, A F J 2006. Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment for 147 chemistry research groups. *Scientometrics*, **67**(3), June, 491–502	84	**99**
3	Van Raan, A F J 2005. Fatal attraction: conceptual and methodological problems in the ranking of universities by bibliometric methods. *Scientometrics*, **62**(1), January, 133–143	62	**99**
4	Braam, R R, H F Moed and A F J van Raan 1991. Mapping of science by combined cocitation and word analysis .1. Structural aspects. *Journal of the American Society for Information Science*, **42**(4), May, 233–251	87	**98**
5	Van Raan, A F J 2000. On growth, ageing, and fractal differentiation of science. *Scientometrics*, **47**(2), February, 347–362	34	**98**
6	Van Raan, A F J 1997. Scientometrics: state-of-the-art. *Scientometrics*, **38**(1), January, 205–218	32	**98**
7	Van Leeuwen, T N; H F Moed, R J W Tijssen, M S Visser and A F J van Raan 2001. Language biases in the coverage of the Science Citation Index and its consequences for international comparisons of national research performance. *Scientometrics*, **51**(1), May, 335–346	54	**97**
8	Van Raan, A F J 2008. Bibliometric statistical properties of the 100 largest European research universities: prevalent scaling rules in the science system. *Journal of the American Society for Information Science and Technology*, **59**(3), 1 February, 461–475	7	**97**
9	Van Raan, A F J 1998. The influence of international collaboration on the impact of research results: some simple mathematical considerations concerning the role of self-citations. *Scientometrics*, **42**(3), July/August, 423–428	35	**97**
10	Van Raan, A F J 2000. The Pandora's box of citation analysis: measuring scientific excellence – the last evil? *ASIST* monograph series, 301–319	10	**96**
11	Van Leeuwen, T N, H F Moed, R J W Tijssen, M S Visser and A F J van Raan 2000. First evidence of serious language-bias in the use of citation analysis for the evaluation of national science systems. *Research Evaluation*, **9**(2), August, 155–156	11	**96**
12	Van Raan, A F J, J P Dejongh, J Vaneck and H G Heideman 1971. Absolute cross sections for excitation of helium by electrons (20-2000ev) and polarization of emitted radiation. *Physica*, **53**(1), 45–	58	**96**
13	Van Raan, A F J 2006. Statistical properties of bibliometric indicators: research group indicator distributions and correlations. *Journal of the American Society for Information Science and Technology*, **57**(3), 1 February, 408–430	17	**95**
14	Van Leeuwen, T N; L J van der Wurff and A F J van Raan 2001. The use of combined bibliometric methods in research funding policy. *Research Evaluation*, **10**(3), December, 195–201	9	**95**

Note: The numbers correspond to those in Table 2

Table 4. Van Raan co-authors with four or more papers

#	Author	Recs	TLCS	TGCS
1	van Raan AFJ	115	227	2212
2	Moed HF	18	41	531
3	van Leeuwen TN	15	21	216
4	Noyons ECM	8	7	100
5	PETERS HPF	8	17	159
6	Rinia EJ	8	17	95
7	Tijssen RJW	7	11	133
8	van Vuren HG	7	17	91
9	BRAAM RR	5	12	188
10	NEDERHOF AJ	5	14	100
11	VANECK J	5	8	101
12	Bruins EEW	4	3	33
13	Visser MS	4	2	94

Source: <http://garfield.library.upenn.edu/histcomp/vanRaan_auth/list/au-pubs.html>
Key: TLCS = Total local citation score; TGCS = Total global citation score

32 papers since it appeared in 2000 it is unfortunate that, like so many other papers that appear in printed collective monographs, they are generally less cited resources because today authors rely so heavily on electronic resources away from their libraries. The full text of this monograph has not yet been made available online. However, Tony's paper and all the others in that *Festschrift* are covered in the *Web of Science* and included in the HistCite collection.

In conclusion, the limitations of the print format make it difficult to show all the variant parameters that can be investigated by these methods. The reader should use the posted URLs to explore these possibilities in more detail.

Appendix

One of the most useful features of the HistCite software is the ability to create historiographs, graphical representations of the historical development of a research field or HistCite collection. Shown in the main text and below are several historiographs created from the various collections of Tony's work.

When creating historiographs, the user can choose either a custom set of records or the highest ranked papers by GCS or LCS. The exact threshold is set by the user. The size of the nodes on the map corresponds to the chosen criteria. For example, in an LCS map, papers with highest LCS will be depicted with the largest circle size.

Table 6. Most-cited references from the HistCite of Van Raan publications

#	Author / Year / Journal		Recs
1	VANRAAN AFJ, 1996, SCIENTOMETRICS, V36, P397	WO5	28
2	MOED HF, 1995, SCIENTOMETR1CS, V33, P381	WO5	19
3	MOEO HF, 1985, RES POUCY, V14, PI3!	WO5	17
4	MOEO HF, 1996, NATURE, V381, P186	wO5	9
5	PRICE OJD, 1965, SCIENCE, V149, PSI0	WO5	9
6	RINIA El, 1998, RES POUCY, V27, P95	WO5	9
7	CALLON M, 1983, SOC SCI INFORM, V22, PI91	WO5	8
8	HORROBIN OF, 1990, JAMA-J AM MED ASSOC, V263, P1438	WO5	8
9	MERTON RK, 1968, SCIENCE, V159, PS6	WO5	8
10	MOED HF, 1995, J AM SOC INFORM SCI, V46, P461	WO5	8
11	HEALEY P, 1986, RES POLICY, VIS, P233	WO5	7
12	MARTIN 8R, 1983, RES POLICY, V12, P61	WO5	7
13	NEOERHOF Al, 1988, HOB QUANTITATIVE STU, PI93	WO5	7
14	NQYONS ECM, 1998, J AM SOC INFORM SCI, V49, P68	WO5	7
15	PORTER AL, 1985, SCIENTOMETRICS, VB, PI6!	WO5	7
16	SEGLEN PO, 1992. J AM SOC INFORM SCI, V43, P628	WO5	7
17	VANRAAN AFJ, 2004, HDB QUANTITATIVE SCI, P19	WO5	7
18	VANRAAN AFJ, 2005, SCIENTOMETRICS, V62, P133	WO5	7
19	ALBERT R, 2002, REV MOD PHYS, V74, P47	WO5	6
20	BRAAM RR, 1991, J AM SOC INFORM SCI, V42, P233	WO5	6
21	MOED HF, 1983, MEASUREMENT RES PERF	WO5	6
22	MOXHAM H, 1992, SCI TECHNOLOGY POLIC, P7	WO5	6
23	NARANAN S, 1971, J DOC, V27, PS3	WO5	6
24	NEDERHOF AJ, 1987, SCIENTOMETRICS, V11, P333	WO5	6
25	NEDERHOF AJ, 1989, SCIENTOMETRICS, VI7, P427	WO5	6
26	SMALL H, 1973, J AM SOC INFORM SCI, V24, P265	WO5	6
27	TUSEEN RJW, 1987, SCIENTOMETRICS, V11, P351	WO5	6
28	VANRAAN AFJ, 1990, NATURE, V347, P626	WO5	6
29	VANRAAN AFJ, 2006, J AM SOC INF SCI TEC, V57, P408, D0I 1O.lOO2/ASI.20284	WO5	6
30	DOROGOVTSEV SN, 2002, ADV PHYS, V51, P1079, DOI 10.1080/00018730110112519	WO5	5
31	GARFIELD E, 1979, CITATION INDEXING	WO5	5
32	MACROBERTS MH, 1986, SOC STUD SCI, V16, P151	WO5	5
33	MERTON RK, 1988, 1515, V79, P606	WO5	5
34	NEDERHOF AJ, 1992, J AM SOC INFORM SCI, V43, P249	WO5	5
35	PETERS HPF, 1988, INFORMETRICS 87 88, P17S	WO5	5
36	PETERS HPF, 1993, RES POUCY, V22, P23	WO5	5
37	PETERS HPF, 1993, RES POLICY, V22, P47	WO5	5
38	RINIA EJ, 2001, RES POLICY, V30, P357	WO5	5
39	SMALL H, 1985, J INFORM SCI, VII, P147	WO5	5

Source: <http://garfield.library.upenn.edu/histcomp/vanRaan_auth/list/or-pubs.html>

After the set of papers is defined, HistCite maps the papers chronologically and represents citations among those papers as arrowed lines. While it is possible to draw a historiograph with a large number of papers, the citation network becomes increasingly complex.

All historiographs shown here are available online. To identify the full bibliographic information for each node, go to the corresponding URL where they are identified.

Figure 1 is an LCS map taken from the Van Raan fractals collection. Nodes 1–5 are the publications cited by Tony's 'Fractal dimension of cocitations' (node 6) and illustrate the crossover nature of this particular work. Node 1 is Mandelbrot's *The Fractal Geometry of Nature* and node 2 is the work of Small and Garfield.

In contrast to Figure 1, Figure 2 is a GCS historiograph from the same collection. Because Mandelbrot's book is cited over 7,000 times, its circle area dominates the map.

Figure A1 is an LCS historiograph from the Van Raan and H-index collection. Node 1 is Hirsch's paper and node 6 is Van Raan's highly cited study, 'Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment for 147 chemistry research groups' (Table 3, item 2).

Figure 3 is a GCS historiograph from the collection 'van Raan and citing papers plus' HistCite. As described above, this collection includes publications identified from the cited reference list of the master file that were not initially included in search results. Regardless of their citation frequency within the master file collection, they are important historical works that influence Tony's discipline. Some of these important publications are identified here on the historiograph. Table A1 identifies the papers added to create the new collection.

Table A2 shows an example of HistCite's 'Institution List'. These are the institutions that appear most often in the address fields of the master file collection of Van Raan and the citing papers.

Note

1. In the HistCite software these references are colored blue, however the images in this paper have been converted to grayscale color format.

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Callon, M, J P Courtial, W A Turner and S Bauin 1983. From translations to problematic networks – an introduction to co-word analysis. *Social Science Information Sur Les Sciences Sociales*, **22**(2), 191–235.

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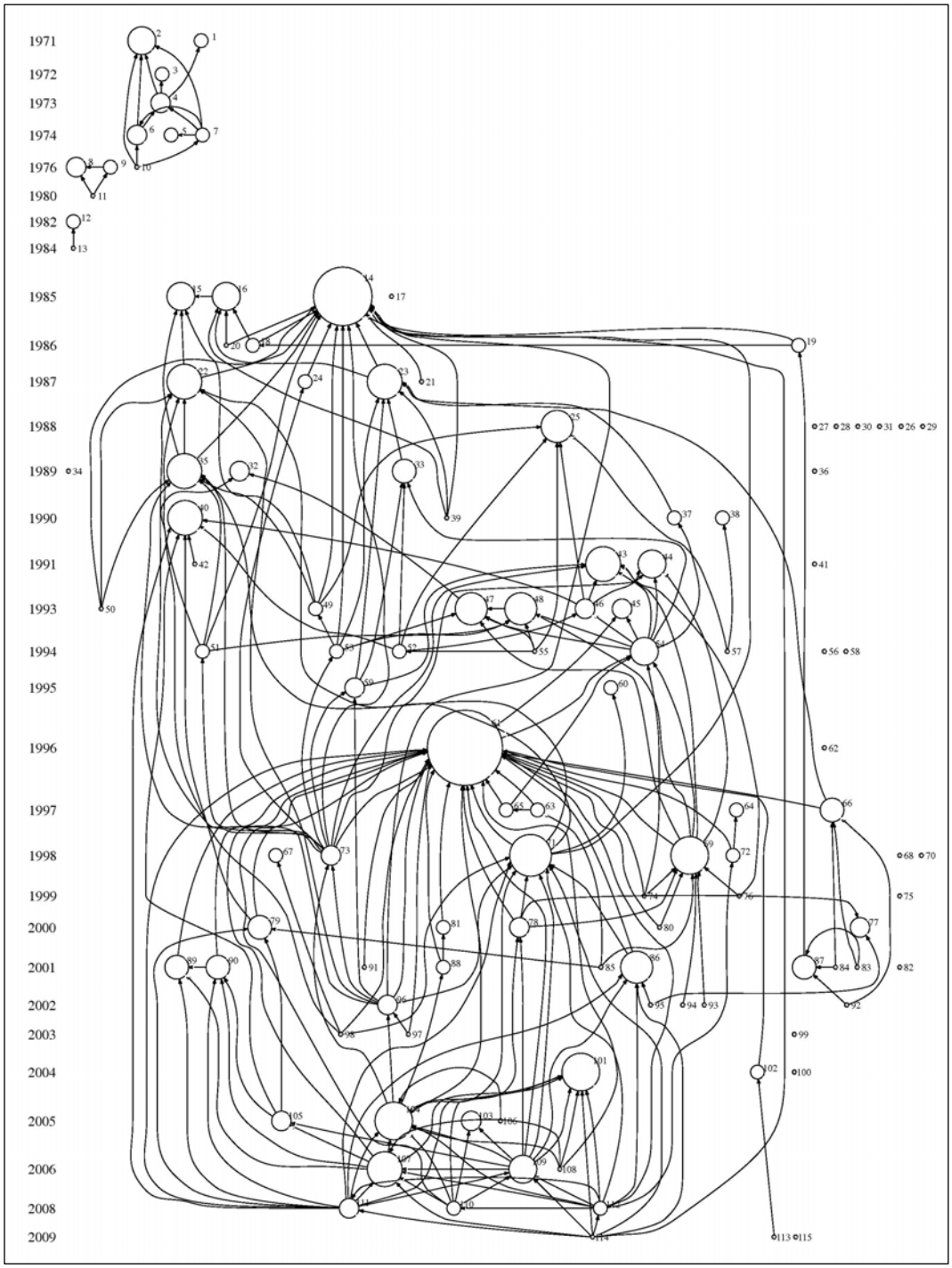

Figure 4. Historiograph of 115 Van Raan publications
Source: <http://garfield.library.upenn.edu/histcomp/vanRaan_auth/>

keying citations corrects errors! *Current Contents*, **7**, 14 February, 5–7. Reprinted in *Essays of an Information Scientist* (1977–1978), **3**, 42–44. <http://www.garfield.library.upenn.edu/essays/v3p042y1977-78.pdf>

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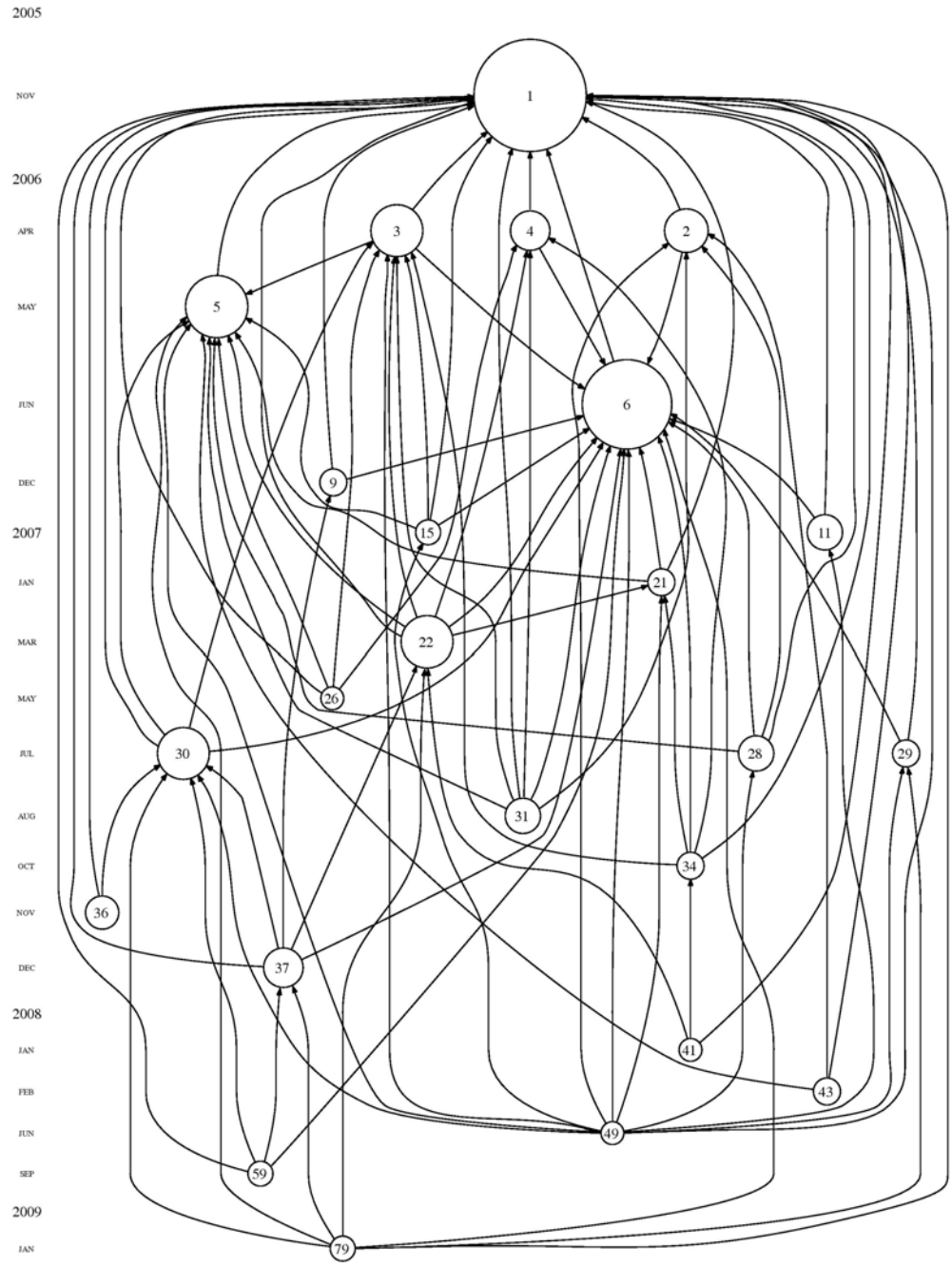

Figure A1. Local citation score historiograph of papers citing Van Raan and the H-Index
Source: <http://garfield.library.upenn.edu/histcomp/van-Raan_hirsch/>

Table A1. Records added to create the 'van Raan and citing papers plus' HistCite

Records added to the collection	**Times cited in the collection**
Garfield, E 1979. *Citation Indexing*	127
Small, H 1973. *J. Am. Soc Inform. Sci.*, **24**, 265	98
Price, D J D 1965, *Science*, **149**, 510	90
Martin, B R 1983, *Res. Policy*, **12**, 61	89
Price, D J D 1963, *Little Sci. Big Sci.*	87
Callon, M 1986, *Mapping Dynamics Sci.*	74
Narin, F 1976, *Evaluative Bibliomet*.	72
Small, H 1974, *Sci. Stud.*, **4**, 17	71
Moed, H F 2005, *Citation Anal. Res. Ev.*	62
Garfield, E 1972, *Science*, **178**, 471	55
Bornmann, L 2005, *Scientometrics*, **65**, 391	54
Merton, R K 1968, *Science*, **159**, 56	52

Table A2. Institution list from the 'van Raan and the citing papers' HistCite

#	Institution	Recs	TLCS	TGCS
1	Leiden Univ	158	2226	2696
2	Katholieke Univ Leuven	40	160	304
3	Hungarian Acad Sci	38	186	304
4	Unknown	37	388	680
5	CSIC	32	84	211
6	Royal Sch Lib & Informat Sci	25	58	171
7	Univ Granada	25	31	121
8	Australian Natl Univ	23	47	161
9	Univ Amsterdam	23	85	332
10	Wolverhampton Univ	23	52	243
11	Drexel Univ	20	156	571
12	Univ Sussex	20	74	255
13	Indiana Univ	19	142	483
14	Natl Inst Sci Technol & Dev Studies	18	47	126
15	ETH	17	83	139

Source: <http://garfield.library.upenn.edu/histcomp/vanRaan_citing/list/in-pubs.html>