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"Current Comments"

Journal Citation Studies. 21. Engineering Journals

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According to *OED, engineering* first appeared in the English language in the 14th century.[1] Since then, engineering has become almost impossible to define by traditional methods. *Webster's* definition, which follows, gives further evidence of this problem: ". . . the science by which the properties of matter and the sources of energy are made useful to man in structures, machines, and products."[2] Leonardo DaVinci would have readily accepted this definition as descriptive of his main interests and employment. Replace the word *science* in *Webster's* definition with either *study* or *experimentation*. You'll find that the result will inevitably apply to, or even define, many types of research. Most people would find it difficult to associate them in any way with 'engineering'

The trouble may be that the terms *engineer* and *engineering* are now used as unsuffixed suffixes equivalent to *-ology* and *-ologist*. Whereas we have elsewhere in science people like gerontologists, radiologists, urologists, anthropologists, etc., in engineering we have to use compound terms. Hence, *Webster's* tells us to "see chemical engineering, civil engineering, electrical engineering, hydraulic engineering . . . "

Thus, among other things, journal citation studies can help us define terms like *engineer* and *engineering*, as they are 'used' in the real world. The citation study which follows tells us a great deal about engineering today--or at least as it was in 1969.

In this study we've used the same approach as in several previous ones, the most recent of which discussed agriculture.[3-6] We've taken a large group of engineering journals and treated them as if they were a single journal. We then asked and determined what journals this 'macro-engineering journal'[7] cites, and what journals cite it

The journals chosen for the study are listed in the *1969 Science Citation Index®* [*SCI®*] *Guide*[8] under the *Engineering* categories (general, chemical, civil, electric and electronic, mechanical).

We arbitrarily omitted other *SCI* categories such as *Aeronautics, Computers and Cybernetics, Electronics.* In most cases relevant journals from such categories appeared under the categories selected.

Engineering journals are in one aspect 'different' from other scientific and technical journals. In engineering journals, heavily cited

works tend to be books rather than journal articles. In an unpublished ISI®study, we've found that of 900 items cited nine times or more in 1973, two-third were books.

Figure 1 shows the 50 journals most frequently cited *by* our macro-engineering journal. The figure shows how often each journal was cited by about 2,000 scientific and technical journals; the number of times cited by the engineering group; data on self citation and finally impact.[9]

The most frequently cited journal was *Proceedings of the Institute of Electrical and Electronics Engineers.* You'll note that our engineering base accounts for little more than half the citations received by *Proc. IEEE.ISI's Journal Citation Reports*™[10] shows that the other half of the citations received by *Proc. IEEE* come from basic physics journals. Thus, *Proc. IEEE* is as much a basic physics journal as it is an 'engineering' journal. Further, only 20% of the citations of *Proc. IEEE* in this study were self-citations. It is important to note that fact, because high self-citation frequently pushes a journal to a high rank on lists like these.

For example, note that *Thermal Engineering USSR* [*Toploenergetika*] ranks 17th. 'Engineering' citations account for 88% of the citations of the journal. However, self-citations account for 93% of them.

The ubiquitous *Science* and *Nature* also appear on this list. If this is not surprising, then perhaps you'll be surprised to find that the following are heavily cited: *Physical Review, Proceedings of the Royal Society* (London), *Journal of the American Chemical Society, Journal of Chemical Physics, Journal of Physical Chemistry.*

I will not labor the point, though recent Congressional commotions[11] prompt me mightily to do so. If another example of the dependence of applied science and technology on basic research is necessary, this list provides it. We cannot, on the other hand, demonstrate that these same basic research journals cite engineering journals very much--because it just ain't so. I have no sympathy for the notion that basic research can be adequately funded through spill-overs from large-scale technological projects.

In Figure 2, you'll find journals that most frequently cite the engineering group. A completely unexpected discovery is the fact that the heaviest citer of all is the *Doklady Akademii Nauk SSSR.* If the list in Figure 2 is extended to include several hundred journals that cite the engineering group, you'll eventually reach *Nature* (with 37 citations) and *Science* (with 33). The top rank of the leading journal of the Soviet Academy of Science indicates the heavy technological orientation of Soviet research. The *Proceedings of the National Academy of Sciences USA* didn't appear at all.

A further verification of this now "obvious" characteristic of the *Doklady* is evident when one scans its contents page in *Current Contents.*

The fact of its heavy technological orientation is paralleled by another. Only three Russian journals appear among the top fifty most cited by the engineering group in Figure 1.

Figure 1. Journals Most Frequently Cited by 'Engineering' Journals. An asterisk indicates that the journal also appears on the list in Figure 2. A = total citations by all journals. B= total citations by 'engineering' journals. C = self-citations. D = B/A ('engineering' citations in terms of total citations). E = C/A (self-citations in terms of total citations, self-cited rate). F = C/B (self-citations in terms of 'engineering' citations). G = Impact factor.

		JOURNAL	A	B	C	D	E	F	G
1.	*	Proc. IEEE	1601	870	175	54.3	10.9	20.1	1.372
2.		Indust. & Eng. Chem.	1582	659	101	41.7	6.4	15.3	1.123
3.		Trans. ASME	409	631	0				0.320
4.	*	J. Geophys. Res.	3556	520	–	14.6			3.665
5.	*	J. Appl. Phys.	5274	493	–	9.4			1.936
6.	*	Radiotekhnika i Elektronika	575	475	380	82.6	66.1	80.0	0.756
7.	*	IEEE Tr. Power App. & Syst.	460	451	434	98.0	94.4	96.2	0.631
8.		IEEE Tr.	763	396	–	51.9			–
9.	*	Bell Syst. Tech. J.	690	395	149	57.3	21.6	37.7	1.990
10.		J. Am. Chem. Soc.	26307	384	–	1.5			5.859
11.	*	Tr. Met. Soc. AIME	1348	384	292	28.5	21.7	76.0	4.942
12.	*	J. Fluid Mech.	962	370	243	38.5	25.3	65.7	2.376
13.	*	AICHE J.	554	362	71	65.4	12.8	19.6	1.559
14.		Phys. Rev.	20666	334	–	1.6			3.679
15.	*	Proc. IEE	489	312	130	63.8	26.6	41.7	0.809
16.	*	AIAA J.	1247	301	–	24.1			1.228
17.	*	Therm. Eng. USSR	336	295	275	87.8	81.9	93.2	0.572
18.	*	Chem. Eng. Sci.	425	290	66	68.2	15.5	22.8	1.514
19.	*	IEEE Tr. Ant. Propag.	335	287	135	85.7	40.3	47.0	1.568
20.		J. Chem. Phys.	13687	255	–	1.9			3.180
21.	*	Radio Science	363	243	194	66.9	53.4	79.8	2.508
22.		Appl. Phys. Lett.	1318	215	–	16.3			3.688
23.		J. Electrochem. Soc.	1371	204	–	14.9			0.797
24.	*	IEEE Tr. Microwave Theory & Techn.	273	203	138	74.4	50.6	68.0	1.242
25.	*	IEEE Tr. Inform. Theory	263	199	95	75.7	36.1	47.7	0.946
26.		Proc. Roy. Soc. London	4789	192	–	4.0			2.998
27.		J. Phys. Chem.	4678	183	–	3.9			2.429
28.		Nature	15310	181	–	1.2			2.244
29.		J. Chem. Soc.	13978	180	–	1.3			3.123
30.	*	IEEE Tr. Autom. Contr.	222	175	112	78.8	50.5	64.0	0.684
31.	*	IEEE Tr. Electr. Dev.	298	172	94	57.7	31.5	54.7	0.792
32.	*	Nucl. Sci. Eng.	485	172	165	35.5	34.0	95.9	1.290
33.		J. Cryst. Growth	232	171	–	73.7			2.277
34.	*	IEEE Tr. Circ. Th.	265	166	91	62.6	34.3	54.8	1.344
35.		Textile Res. J.	446	158	149	35.4	33.4	94.3	0.882
36.	*	J. Acoust. Soc. Amer.	1203	152	–	12.6			0.563
37.		J. Atmos. Terr. Phys.	482	152	–	31.5			1.642
38.		Chem. Eng. Progr.	229	145	3	63.3	1.3	2.1	0.162
39.		Solid-State Electr.	348	139	33	39.9	9.5	23.7	1.993
40		Planet. Sp. Sci.	496	138	83	27.8	16.7	60.1	2.753
41.		J. Phys. Chem. Solids	1419	137	–	9.7			2.073
42.	*	J. Catalysis	428	131	111	30.6	25.9	84.7	2.448
43.		Phys. Fluids	1294	126	–	9.7			1.581
44.	*	Electronics Lett.	311	125	–	40.2			0.810
45.	*	J. Spacecraft & Rockets	166	117	113	70.5	68.1	96.6	0.448
46.		Chem. Eng.	251	112	41	44.6	16.3	36.6	–
47.		Phys. Rev. Lett.	6544	110	–	1.7			5.114
48.		Tr. Faraday Soc.	2911	109	–	3.7			2.149
49.		Science	9739	105	–	1.1			2.894
50.		Vest. Mashinostr.	134	105	–	78.4			0.557

Figure 2. Journals that Most Frequently Cited 'Engineering' Journals. An asterisk indicates that the journal also appears on the list in Figure 1. **A** = total citations of all journals. **B** = total citations of 'engineering' journals. **C** = self-citations. **D** = **B/A** ('engineering' citations in terms of total citations. **E** = **C/A** (self-citations in terms of total citations, self-cit*ing* rate). **F** = **C/B** (self-citations in terms of 'engineering' citations). **G** = impact factor.

	JOURNAL	A	B	C	D	E	F	G
1.	DAN SSSR	7647	958	837	12.5	11.0	87.4	0.572
2.	* Radio Science	2083	689	194	33.1	9.3	28.2	2.508
3.	* AIAA J.	2616	652	502	24.9	19.2	77.0	1.228
4.	* IEEE Tr. Power App. & Syst.	1122	622	434	55.4	38.7	69.8	0.631
5.	Instr. Exp. Techn.	1513	583	469	38.5	31.0	80.5	0.357
6.	Ind. Eng. Chem.	2952	562	101	19.0	3.4	18.0	1.123
7.	* Radiotekhnika i Elektronika	1451	538	380	37.1	26.2	70.6	0.756
8.	* J. Acoust. Soc. Amer.	1440	524	443	36.4	30.8	84.5	0.563
9.	* J. Appl. Phys.	5811	503	–	8.7			1.936
10.	* Proc. IEEE	1702	465	175	27.3	10.3	37.6	1.372
11.	Vysokomol. Soed. A	1750	411	289	23.5	16.5	70.2	0.559
12.	* Electronics Lett.	744	379	108	50.9	14.5	28.5	0.810
13.	* Proc. IEE	891	376	130	42.2	14.6	34.6	0.809
14.	Telecomm. Radioeng. USSR	738	326	48	44.2	6.5	14.7	–
15.	* J. Fluid Mech.	1271	347	243	27.3	19.1	70.0	2.376
16.	J. Appl. Mech	1090	319	103	29.2	9.5	32.3	–
17.	* J. Spacecraft & Rockets	1638	313	113	19.1	6.9	36.1	0.448
18.	* Tr. Met Soc. AIME	1706	312	292	18.3	17.1	93.6	4.942
19.	* IEEE Tr. Electr. Dev.	773	311	94	40.2	12.2	30.2	0.792
20.	* IEEE Tr. Microwave Theory & Techn.	697	306	138	43.9	19.8	45.1	1.242
21.	* Therm. Eng. USSR	770	302	275	39.2	35.7	91.1	0.572
22.	IEEE Tr. Magnetics	1244	299	162	24.0	13.0	54.2	1.340
23.	* IEEE Tr. Ant. Propag.	622	274	135	44.1	21.7	49.3	1.568
24.	Internat. J. Electronics	784	260	43	33.2	5.5	16.5	–
25.	Electr. Comm. Japan	804	247	39	30.7	4.9	15.8	–
26.	* IEEE Tr. Autom. Contr.	649	245	112	37.8	17.3	45.7	0.684
27.	J. Basic Eng.	1010	243	24	24.1	2.4	9.9	–
28.	Chim. Ind. (Milan)	1068	233	44	21.8	4.1	18.9	0.240
29.	Annu. Rev. Fl. Mech.	943	229	–	24.3			
30.	* Bell Syst. Techn. J.	505	215	149	42.6	29.5	69.3	1.990
31.	Tr. Amer. Nucl. Soc.	2019	211	–	10.5			0.388
32.	* Chem. Eng. Sci.	425	200	66	47.1	15.5	33.0	1.514
33.	Meas. Techn. USSR	525	199	186	37.9	35.4	93.5	–
34.	Ind. Eng. Chem. F.	816	187	67	22.9	8.2	35.8	–
35.	* IEEE Tr. Inform. Theory	483	181	95	37.5	19.7	52.5	0.946
36.	IEEE Tr. Computers	489	172	94	35.2	19.2	54.7	0.821
37.	* Nucl. Sci. Eng.	813	168	165	20.7	20.3	98.2	1.290
38.	Phys. Stat. Sol.	4973	166	–	3.3			1.578
39.	Ind. Eng. Chem. Proc. D&D	350	162	–	46.3			–
40.	* J. Geophys. Res.	3671	161	–	4.4			3.665
41.	Tr. Inst. Chem. Eng.	787	158	30	20.1	3.8	19.0	0.583
42.	* IEEE Tr. Circ. Th.	381	153	91	40.2	23.9	59.5	1.344
43.	Autom. Rem. Contr. USSR	437	152	138	34.8	31.6	90.8	0.340
44.	* J. Catalysis	610	148	111	24.3	18.2	75.0	2.448
45.	* AICHE J.	351	137	71	39.0	20.2	51.8	1.559
46.	Eur. Polym. J.	1308	131	–	10.0			–
47.	Nachrichttech. Z.	512	128	–	25.0			–
48.	Russ. J. Phys. Chem. USSR	2527	127	–	5.0			0.838
49.	IEEE Tr. Nucl. Sci.	652	121	64	18.6	9.8	52.9	0.722
50.	Nucl. Instr. Meth.	1656	119	–	7.2			1.016

But nine appear among the top fifty that cite engineering as shown in Figure 2. How much this relationship depends on the number of Russian engineering journals included in the study will be determined in a follow-up of more recent data. Certainly more Soviet journals are covered in *SCI* now than were covered in 1969.

I must point out two anomalies in Figure 1. If they surprise anyone, they won't surprise serials librarians and engineering information specialists. The third most frequently cited journal in Figure 1 is *Transactions of the ASME.* The eighth is *IEEE Transactions.* The high standing of these two factitious, if not fictitious, 'journals' is an indication of citation difficulty in engineering. This difficulty is caused either by haste, sloppiness, and lack of scholarship, or by the odd-ball titling, retitling, merging, splitting, etc. that is characteristic of many engineering journals. Consider that the *Transactions of the ASME* includes *Journal of Applied Mechanics, Journal of Dynamic Systems,* and some eight others, once including the *Journal of Basic Engineering,* which has since been retitled *Journal of Engineering Materials and Technology,* and, as far as I can determine, thereafter split into *Journal of Materials and Technology* and *Journal of Fluids Engineering.*

In the future, I hope to have the opportunity to discuss journal titles in greater detail. In the meantime, the *IEEE* may itself (though I doubt it) come to realize, like the *ASME,* that it is not really such a good idea to have dozens of journals with titles all beginning with *IEEE Transactions on . . .*, especially when they seem constantly subject to change. I recommend that the *IEEE,* and other organizations, study the admirable simplicity, directness (and documentability) of some favorite journal titles: *Gut, Brain, Blood.* A few suggestions for the IEEE are *Antenna Science Journal, Microwave Theory Journal, IEEE Nuclear Science Journal.*

In conclusion, despite the diversity of 'engineering' as a subject, our study demonstrates a by now familiar phenomenon. The 50 journals in Figure 1 account for 52% of all citations made by the 240 engineering journals. The 50 journals in Figure 2 account for 56% of all citations received by the 240 journals. This phenomenon of journal concentration (in citingness and citedness) has been demonstrated repeatedly in previous studies of fields as apparently discrete as pediatrics and as diverse as agriculture. Furthermore, the supposedly highly 'specialized' journals on both lists, are, with three or four exceptions, among the 500 journals most cited by all scientific and technical journals. Almost half the journals on the two lists are among the 152 most-cited journals listed in my first analysis of 1969 data.[9]

1. *The Compact Edition of the Oxford English Dictionary: Complete Text Reproduced Micrographically.* (New York: Oxford University Press, 1971), 2 vols., 4116 pp.; vol. 1, p. 867.
2. *Webster's Third New International Dictionary of the English Language Unabridged*. . . (Springfield, Mass.: G & C. Merriam Company, 1968), 2664 pp.; p. 752.
3. Garfield E. Journal citation studies. 9. Highly cited pediatric journals and articles. *Current Contents®* [*CC®*] *No. 29, 17 July 1974, p.* 5-9.
4. ----------. Journal citation studies. 15. Cancer journals and articles. *CC* No. 42, 16 October 1974, p. 5-12.
5. ----------. Journal citation studies. 18. Highly cited botany journals. *CC* No. 2, 13 January 1975, p. 5-9.
6. ----------. Journal citation studies. 20. Agriculture journals and the agricultural literature. *CC* No. 20, 19 May 1975, p. 5-11.
7. For an explanatory citation of this use of *macro—*, I am gratified to be able to refer the reader to that entry in *Webster's;* see reference 2, p. 1354.
8. *Science Citation Index 1969 Guide & Journal Lists.* (Philadelphia: Institute for Scientific Information, 1970), 106 pp. The subject category listing of journals covered appears on pages 6-10 of the *Guide*.
9. Garfield E. Citation analysis as a tool in journal evaluation. *Science* 178: 471-79, 1972. Reprinted in *CC* No. 6, 7 February 1973, p. 7-24. --The calculation and significance of a journal's impact is explained in this article.
10. ----------. The new *ISI Journal Citation Reports* should significantly affect the future course of scientific publication. *CC* No. 33, 15 August 1973, p. 7-8.
11. ----------. Congressional approval of NSF grants; the public wants in! *CC* No. 19, 12 May 1975, p. 5-7.