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Communication
Trends in Research Rankings of American Chemical Engineering Schools*

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IN this work, the total number of research publications from American chemical engineering schools over selected 5-year periods, as compiled from the Corporate Index of the Science Citation Index [1], was used to develop research program rankings. Specifically, such rankings were developed for different but overlapping 5-year periods in the decade of the 1980s, as well as for disjoint 5-year periods beginning with 1965. Ranking results are presented for the top 30 such schools, based upon the 1985-89 figures. A seven-fold growth in the total American academic chemical engineering literature since 1965 is also indicated.

THE ranking procedures employed in this current work were essentially the same as those described in an earlier article [2] on chemical engineering research rankings. The various limitations associated with these procedures were discussed in that earlier article. Good accord between the research rankings derived from literature publications, on the one hand, and those rankings published by Gourman [3] and the NAS [4], on the other hand, was also demonstrated.

The first composite SCI was published for the 10-year period of 1955 to 1964. There was no Corporate Index published with this first SCI, however. It is the Corporate or CI Index in which literature publications are organized by the originating academic (or any other, for that matter) unit. Five-year composite SCIs then appear for the succeeding periods of 1965–1969, 1970–1974 and 1975–1979; a CI is also published with each of these composites. No more multi-year composite indices appear beyond this point, presumably because of the exploding growth rate of the literature. Succeeding indices are thus compiled on an annual basis. Actually, issues of the SCI along with a CI currently appear every two months.

The identification of American academic chemical engineering publications from Corporate Index listings and the development of rankings therefrom thus necessarily follow the chronology and availability of information in these indices. Below are presented rankings for different but overlapping 5-year periods in the decade of the 1980s. These results are then followed by rankings for disjoint 5-year periods beginning with 1965. Lastly, attention is drawn to the exploding growth in the subject literature over the past 25 years, and its portents for the future.

Rankings of the top 30 American chemical engineering schools during the decade of the 1980s, as determined from the total number of literature publications listed in the appropriate CIs over given 5-year periods, are summarized in Table 1. The results for the period of 1981–1985 also appeared in the earlier article [2], in which this methodology was first presented. A total of 105 American chemical engineering schools were analyzed in that earlier work; that number was increased to 140 such schools in this present work, for purposes of completeness and greater integrity in the reporting of total publications.

It is clear from Table 1 that, based upon this ranking method, Minnesota has undeniably been the top research school among American chemical engineering departments during the decade of the 1980s, followed by the Massachusetts Institute of Technology (MIT) and the University of California at Berkeley, in that order. Indeed, there has been no change at all in the order of the top five ranked schools during this period, and very little change at all in the top ten such.

In the feature article of the March 19, 1990 issue of *U.S. News & World Report* [5], the five best American chemical engineering graduate schools, in order, were listed as: MIT, Cal/Berkeley, Minnesota, Illinois and Wisconsin. Four of these five schools (with the exception of Illinois) also appear in the top five departments shown in Table 1.

There is considerably greater volatility in the research rankings of the same 30 American chemical engineering schools over the 25-year period from 1965 to 1989, as Table 2 indicates. This latter table provides such rankings for five successive, disjoint 5-year periods, beginning with 1965. Thus, the periods of 1980–1984 and 1985–1989 are

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Table 1. Rankings of the top 30 American chemical engineering schools during the 1980s

	1980–84 5-year		1981–85 5-year		1982–86 5-year		1983–87 5-year		1984–88 5-year		1985–89 5-year	
	Pubs.	Rank	Pubs.	Rank	Pubs.	Rank	Pubs.	Rank	Pubs.	Rank	Pubs.	Rank
Minnesota	496	1	567	1	585	1	686	1	756	1	803	1
Mass. Inst. Tech.	365	2	419	2	449	2	515	2	595	2	627	2
Cal/Berkeley	351	3	364	3	383	3	444	3	494	3	510	3
Wisconsin	257	4	311	4	323	4	353	4	368	4	385	4
Purdue	238	5	277	5	285	5	307	5	322	5	341	5
Texas	180	8	203	10	224	10	266	9	302	7	328	6
Stanford	226	7	253	6	243	8	278	8	300	9	315	7
Buffalo, SUNY	171	11	227	8	281	6	300	6	304	6	313	8
Delaware	233	6	236	7	251	7	288	7	302	7	311	9
Princeton	179	9	211	9	229	9	261	10	282	10	290	10
Cal Tech	155	13	167	13	173	14	199	14	229	11	243	11
Massachusetts	124	19	156	14	173	14	197	15	222	14	239	12
Penn. State	119	22	151	16	175	13	207	12	216	15	239	12
Georgia Tech	95	34	112	33	140	24	163	21	203	17	234	14
Michigan	104	30	140	22	155	19	180	16	216	15	234	14
Cornell	174	10	199	11	197	11	214	11	223	12	229	16
Carnegie-Mellon	160	12	181	12	194	12	207	12	223	12	217	17
Cal/Santa Barbara	96	33	115	31	125	31	144	29	177	23	214	18
Texas A & M	105	29	116	29	134	25	164	20	194	19	214	18
Washington (U. of)	116	25	129	24	146	23	172	18	197	18	203	20
N.C. State	113	28	129	24	133	27	158	23	179	22	202	21
Lehigh	58	52	85	43	116	37	139	32	180	21	192	22
Illinois	116	25	142	21	164	16	170	19	177	23	176	23
Pennsylvania	124	19	149	18	147	22	153	26	160	27	172	24
Syracuse	124	19	129	24	133	27	144	29	157	29	172	24
Northwestern	129	18	149	18	164	16	177	17	182	20	171	26
Florida	93	36	114	32	123	34	156	24	171	26	170	27
Rice	89	37	112	33	122	35	145	28	175	25	170	27
Pittsburgh	117	24	144	20	153	20	148	27	155	30	156	29
Virginia Tech	136	16	154	15	134	25	159	22	159	28	156	29
Sub Totals	5,043		5,841		6,254		7,094		7,820		8,226	
110 Other Schools	3,525		3,951		4,289		4,692		5,291		5,704	
Grand Totals	8,568		9,792		10,543		11,786		13,111		13,930	

repeated from Table 1. It follows from these 5-year rankings that the University of California at Berkeley was the top American chemical engineering research school over the period of 1965 to 1979, before being overtaken by Minnesota in this position in the 1980s, and then by MIT.

The grand totals at the bottom of Tables 1 and 2 give the total number of publications, over the subject 5-year period, listed in the Corporate Indices as emanating from the 140 American chemical engineering schools included in this survey. These numbers show almost a seven-fold growth in the total number of such publications over the 25-year period from 1965 to 1989, specifically rising from 2,048 to 13,930.

These grand totals are plotted in Fig. 1, wherein an exponential growth of this literature with time is indicated. Specifically, these data were correlated via least-squares regression analysis by the following exponential equation:

$$y = 6.272e^{0.08675xx}$$

wherein y represents the total number of publications from 140 American chemical engineering schools over the 5-year period ending 19xx. From its intercept value, this equation suggests the amusing, but not necessarily ludicrous, result that there may have been six such publications during the

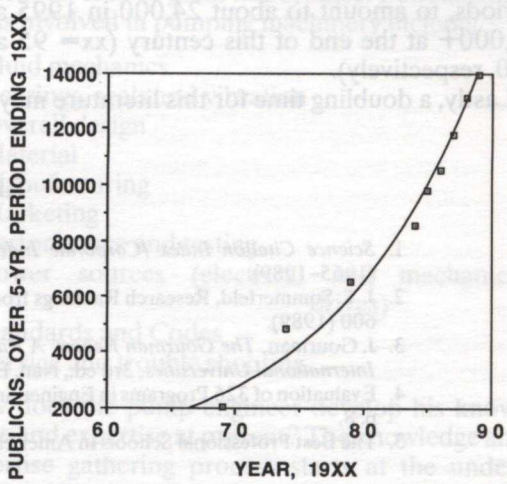

Fig. 1. Growth in the American academic chemical engineering literature over the past 25 years.

Table 2. Rankings of the top 30 American chemical engineering schools since 1965

	1965–69 5-year		1970–74 5-year		1975–79 5-year		1980–84 5-year		1985–89 5-year	
	Pubs.	Rank	Pubs.	Rank	Pubs.	Rank	Pubs.	Rank	Pubs.	Rank
Minnesota	109	3	211	2	329	2	496	1	803	1
Mass. Inst. Tech.	112	2	123	7	221	3	365	2	627	2
Cal/Berkeley	205	1	334	1	398	1	351	3	510	3
Wisconsin	57	8	144	4	169	7	257	4	385	4
Purdue	38	15	99	11	185	6	238	5	341	5
Texas	83	5	107	9	123	10	180	8	328	6
Stanford	71	6	91	12	144	8	226	7	315	7
Buffalo, SUNY	24	27	128	5	99	16	171	11	313	8
Delaware	36	16	106	10	202	4	233	6	311	9
Princeton	55	9	176	3	198	5	179	9	290	10
Cal Tech	33	18	58	30	79	26	155	13	243	11
Massachusetts	9	53	81	16	106	15	124	19	239	12
Penn. State	10	48	48	35	72	34	119	22	239	12
Georgia Tech	17	35	38	44	58	44	95	34	234	14
Michigan	101	4	78	19	77	28	104	30	234	14
Cornell	25	25	63	28	107	14	174	10	229	16
Carnegie-Mellon	14	40	69	25	117	11	160	12	217	17
Cal/Santa Barbara	4	72	36	48	55	50	96	33	214	18
Texas A & M	17	35	27	60	58	44	105	29	214	18
Washington (U. of)	39	14	86	15	72	34	116	25	203	20
N.C. State	15	38	78	19	94	20	113	28	202	21
Lehigh	15	38	61	29	76	31	58	52	192	22
Illinois	13	41	74	21	70	36	116	25	176	23
Pennsylvania	27	23	113	8	134	9	124	19	172	24
Syracuse	46	11	81	16	89	21	124	19	172	24
Northwestern	54	10	67	26	99	16	129	18	171	26
Florida	44	12	91	12	81	24	93	36	170	27
Rice	34	17	81	16	69	38	89	37	170	27
Pittsburgh	21	30	74	21	74	33	117	24	156	29
Virginia Tech	17	35	18	74	48	53	136	16	156	29
Sub Totals	1,345		2,841		3,703		5,043		8,226	
110 Other Schools	703		2,014		2,851		3,525		5,704	
Grand Totals	2,048		4,855		6,554		8,568		13,930	

five-year period ending in 1900. Closer to the present, and presumably of greater interest, this correlation predicts the total number of publications from these 140 American chemical engineering schools, over the respective preceding five-year periods, to amount to about 24,000 in 1995 and 36,000+ at the end of this century (xx= 95 and 100, respectively).

Lastly, a doubling time for this literature may be inferred from the first-order growth rate constant of 0.08675 yr^{-1} in the above correlating equation. Specifically, division of this value into 0.693 [$=1n_e(2)$] yields a doubling time of 7.99, say 8, years. This result is clearly in line with various estimates or opinions voiced that the world's technical literature is doubling on the order of every five to ten years.

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