DISTRIBUTION OF PATENTS ACCORDING TO NUMBER OF INVENTORS

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I

Sole Inventors Dominant

A striking feature of contemporary U. S. patent annals is the continuing importance of individual contributors -- of "sole inventors", as they are designated in legal parlance. Indeed, in firm after firm and in many technologically progressive or economically strategic industries, individuals still account not only for many more new patents than pairs, trios, or any other size-group of "joint inventors" but also for more new patents than all size-groups combined. Exceptions are, of course, also evident -- for example, in the chemical and pharmaceutical field, where collaborative patent activity has long been common. But it is the hardiness of the sole inventor that invites attention because the phenomenon may seem at variance with a complex of well-publicized trends.

Let us briefly note some of these trends. In recent decades, the proverbial garret inventor has largely been displaced by another stereotype -- a species of organization man. The typical modern inventor is a school-trained engineer or scientist. He works, not for himself, but for an employer -- say, a corporation, a government agency, a foundation, a university. He also relies on his employer for needed apparatus and instruments. He usually has an assigned task in a larger project, which in turn fits into a larger research and development program. Indeed, he frequently operates nowadays as a member of a team, performing a defined role in a joint mission with colleagues of the same or other disciplines.

Institutional and other Factors

Any serious effort to explain the continuing prominence of single patentees would have to range widely, to encompass psychological, legal, economic, and sociological, as well as technological, factors.[1/] The topic of this paper does not require a methodical treatment of such factors, but several comments are offered for the benefit of readers who may wish to look behind the statistics. These comments suggest that the cards are not "institutionally" stacked in favor of sole inventors.

Surely, competitiveness is no less characteristic of creative people than of other kinds; and an individual is more likely than a group to be interested in patent recognition, to respond to incentive awards, to persevere in a quest for honors. Even in a team environment, one person often stands out in performance of his specialty; and, since the unit of invention is not legally rigid, a motivated individual whose colleagues are not patent-oriented may isolate his own creative contribution to a joint project, cast it into legally appropriate form, and seek public credit for it.

Companies and other organizations that have positive patent policies and adequate patent counsel probably encourage and facilitate joint application to a greater degree than they promote filing by sole inventors. Such organizations especially assist the prosecution of joint applications from teams completing their work or already broken up and redistributed among other projects; and they are also well equipped to act in instances in which some co-inventors either refuse to participate in a joint filing or cannot be located readily after a change in employment. Even companies that offer awards for disclosures and for issued patents

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* The author's views do not necessarily represent positions of The W. E. Upjohn Institute for Employment Research. This paper, furthermore, is based primarily on studies conducted by the author for the Patent, Trademark, and Copyright Research Institute of George Washington University.

1/ For earlier discussion and references, see the following papers by I. H. Siegel: "Persistence of the Sole Inventor", Patent, Trademark, and Copyright Journal of Research and Education (later renamed IDEA), Summer 1961, pp. 144-149; "Individual and Joint Patent Production," ibid., Summer 1962, pp. 241-260; and "Dominance of Sole Patentees in Computer-Related Technology", IDEA, Spring 1964, pp. 45-50. In the preparation of the present paper, account was also taken of more recent information, such as that provided in Patent Counsel in Industry (Studies in Business Policy, No. 112), National Industrial Conference Board, New York, 1964.

are eager to minimize divisive staff competitiveness and accordingly prefer as generous a diffusion of credit as is feasible. Note should also be taken of the fact that the criteria of patentability, such as "usefulness", may in some fields (e.g., the chemical and pharmaceutical industries) oblige the division of labor, the distribution of tasks to persons best able to pursue them in the interest of the sponsoring company.

It is sometimes alleged that organizations attempt to "save" a joint contributor for possible use as an informed but "disinterested" witness in interference proceedings. If this strategy is indeed employed, it would seem more practicable when there are more than two actual inventors, in which case the proportion of recorded sole inventors is not affected. On the other hand, a patent may be voided if information supplied in an application is incorrect or incomplete; the U. S. law and its administrators frown on the malpractices of "nonjoinder" (improper omission of a inventor) and "misjoinder" (improper designation as a coinventor). 2/

II

We now turn to statistical evidence on the distribution of patents according to the number of recorded inventors. Advantage is taken here especially of material already presented in reports prepared under the auspices of the Patent, Trademark, and Copyright Research Institute of the George Washington University. 3/ For convenience in presentation, the data are arranged in two ways, according to technological fields and by companies.

2/ See, for example, G. M. Naimark, A Patent Manual for Scientists and Engineers, Charles C. Thomas, Springfield (Ill.), 1961; and Rules of Practice of the United States Patent Office in Patent Cases, Washington, June 1960, pp. 20-22.

3/ See papers of I. H. Siegel mentioned in footnote 1; and Edgar Weinberg and I. H. Siegel, "Analysis of 203 Transistor Patents," Patent, Trademark, and Copyright Journal of Research and Education, Fall 1960, pp. 201-207. Additional material was obtained for the present paper, as the text indicates, from recent issues of the IBM Journal of Research and Development and from Index of Patents Issued from the U. S. Patent Office for 1963 and 1964.

Some Evidence for Fields

Let us first consider patents that largely fall into the electric-electronic category -- or simply "electrical", as it is designated by the Patent Office. About four-fifths of the items classified as "electrical" in the December 17, 1963 issue of the weekly Official Gazette were credited to sole inventors. Approximately the same ratio (79 percent) was derived in an analysis made during 1960 of the contents of the Patent Office file for transistors and related devices. An examination of the new patents selected for listing in 1962-63 issues of Computer and Automation, a monthly trade and technical magazine, revealed that single inventors accounted for about two thirds of the total, pairs of inventors for slightly more than a quarter, and larger groups for roughly one sixteenth. The share of single inventors in the patents listed in the same publication in an earlier year, 1956, was still higher -- about three quarters.

On another technological frontier, atomic energy, individuals also dominate, though not so overwhelmingly as in the electric-electronic area. An examination of 1266 patents released by the Atomic Energy Commission for royalty-free, nonexclusive licensing showed 56 percent credited to sole inventors, 31 percent to pairs, and 13 percent to larger groups of joint inventors (up to 6). A distribution of 250 additional patents released subsequently showed approximate corresponding percentages of 51, 30, and 19.

A frequency analysis of 888 chemical patents reported in the four weekly issues of the Patent Office's Official Gazette for June 1962 showed individuals still dominant but accounting for slightly less than half the total. Thus, sole inventors were credited with 48 percent of the patents, pairs for 36 percent, trios for 12 percent, and larger groups of joint inventors (up to 10) for only 4 percent.

Some Evidence for Companies

Proceeding to company data, we note first some electric-electronic examples. An updated calculation for International Business Machines Corporation, referring to the 2740 patents listed in the company's Journal of Research and Development for the period January 1957-July 1965, shows 69 percent attributed to sole inventors, 23 percent to pairs, and 8 percent to larger groups of joint inventors (up to 7). Fairly similar distributions are

indicated by IBM's figures for shorter periods, and by figures for fewer patents relating to the Western Electric Company and the International Telephone and Telegraph Corporation. A higher ratio for sole inventors -- 73 percent -- is derived from information for patents assigned to General Electric Company, as reported in the 1963 Index of Patents.

The dominance of sole patentees in companies classifiable in the Patent Office's "mechanical" category also seems decisive. For example, individuals are identified with 77 percent of the patents listed for Ford Motor Company in the 1963 Index of Patents and with 64 percent of the patents listed for General Motors Corporation. In two tire companies, Goodyear and B. F. Goodrich, the individual shares in 1964, according to the Index, were 84 and 73 percent, respectively.

Results obtained for chemical and pharmaceutical firms are more equivocal. Individuals there still contribute more patents, as a rule, than any size-group of joint inventors; but conspicious exceptions are evident, and individuals frequently account for less than half the total patent output. For example, in 1964, individuals contributed about the same number of assigned patents as did paired inventors in W. R. Grace, Merck, Hooker, and Allied Chemical; and they contributed fewer than pairs did in Esso Research and Engineering, American Cyanimid, and Rohm and Haas. On the other hand, they showed clear dominance, accounting for over half the total, in Pfizer, Pennsalt, Air Products, Upjohn, and Norwich; and they also led all other size-groups in some companies, such as Monsanto and Air Reduction, where, however, they failed to produce,or barely exceeded, a majority.

The statistical variation from firm to firm (like the fluctuations also observed in data for the same company over time)[4/] probably reflects important differences in (1) the mix of product and process research and (2) the way in which product research is organized, either for daily operations or for ad hoc exploitation of a chance discovery. To establish the usefulness of a "composition of matter" for patent purposes may require skills and backgrounds different from those that are effective in discovery. Legal ability, which may score tellingly in assuring the "novelty" and "unobviousness" required of a product or a process in patent law, also varies from firm to firm.

III

Variety of Distributions

The different company distribution patterns reported in this paper do not correspond to a single probability model, although it is possible, of course, to give a specious unity to the various imputable stochastic processes by writing a very general formula and then liberally manipulating the parameters.

All the observed distributions are skewed. They commonly resemble a reversed J, with the frequency for sole inventors equaling or exceeding half the total. Sometimes, as the data for the chemical and pharmaceutical companies show, the single-inventor bar of the histogram is shorter than, or about equal in height to the frequency column for paired inventors; and, in such instances, the frequency mass is still concentrated to the left, with the average number of inventors per patent remaining below 2. The tail seldom extends beyond 7 on the right, although larger groups of joint inventors are occasionally encountered. (Perhaps the largest number in patent history, 21, was recorded in 1963 -- for a compact computer system of the National Cash Register Company.)

Most of our frequency distributions follow what M. G. Kendall has called "the-higher-the fewer rule". In this connection, he cites the Zipf "least-effort"formula, the special case of this formula that is celebrated in Pareto's income law (which H. T. Davis has shown to be applicable also to many non-income phenomena), and the more comprehensive frequency function that H. A. Simon has christened the "Yule distribution". Among the other eligible models are the

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4/ For example, sole inventors in Upjohn accounted for 50 out of 70 patents in 1964, while paired inventors contributed 20; they accounted for 48 out of 111 in 1949, while pairs contributed 42; and they accounted for 8 out of 13 in 1949, while pairs contributed 3.

truncated Poisson distribution (omitting the zero class)[5] and the geometric distribution.[6]

Geometric Law: IBM Data

As an empirical probability law, the geometric distribution appears fairly applicable to the electric-electronic category. In particular, a one-parameter version gives a close fit to the frequency data for International Business Machines Corporation, as may be seen from the accompanying table. The single parameter is P_1, the observed proportion of patents for sole inventors; and the percentage shares for this class and for larger size-groups are given by the formula

$$P_i' = P_1 (1-P_1)^{i-1},$$

where P_1 occurs a second time and $i=1,2,3, \ldots$.

In the accompanying table, the distribution observed for 2740 patents reported in the complete file of the IBM Journal through July 1965 is compared with the percentages computed according to the formula. Since P_1 = 69.09 percent (the observed proportion for sole inventors), the computed percentage for pairs of inventors is 21.36 (=69.09 x 30.91); for trios, 6.60 (=21.36 x 30.91); for quartets, 2.04 (=6.60 x 30.91); etc.

The closeness of the observed and computed ratios is impressive. An agreeable property of the computed figures is that they sum to 1 in the limit; the sum for the only occupied IBM classes, 99.97 percent, is virtually exhaustive. The derived theoretical mean number of inventors per patent, 1.45 ($=1/P_1$), is very similar to the observed (weighted) mean, 1.42. Of course, still better results are obtainable (for the variance as well as the mean) if refinements in the basic formula are introduced; but refinement means the addition of parameters, the reduction of degrees of freedom. Even though one would hardly claim that the geometric probability law represents the purified model of IBM's actual experience, there is at least an aesthetic charm in a one-parameter formula that permits good mental estimates to be made for all size-groups of joint inventors once the contribution of sole inventors is known.

Distribution of IBM Inventors According to Number of Inventors*

Inventors per patent	Actual Patents		Computed Patents,
	Number	Percent	Percent (P_i')
1	1893	69.09	69.09
2	624	22.77	21.36
3	164	5.99	6.60
4	43	1.57	2.04
5	13	.47	.63
6	2	.07	.19
7	1	.04	.06

* Data for actual patents were obtained from the entire file of IBM Journal of Research and Development, January 1957-July 1965. Computed percentages in last column were estimated from the formula presented in the text.

5/ An intriguing alternative to truncation is to regard the whole corpus of inventive activity as a Poisson system including a very large zero class. This class would then represent non-inventions -- e.g., ineligible rediscoveries and discoveries that are screened out by corporation committees and patent counsel or that fail for other reasons to progress to patent status. In this Poisson universe, the probability of of occurrence of invention is small, as it is in the real world. Against such a complete Poisson model, a truncated Poisson distribution refers only to the "tail" of successes (i.e., to patents awarded).

6/ On this paragraph, see M. G. Kendall, "Natural Law in the Social Sciences," Journal of the Royal Statistical Society, Part 1, 1961, pp. 1-16; H. A. Simon, "On a Class of Skew Distribution Functions," Biometrika, December 1955, pp. 145-164; G. M. Kaufman, Statistical Decisions and Related Techniques in Oil and Gas Exploration, Prentice-Hall, Englewood Cliffs, 1963, pp. 107, 113-114; H. T. Davis, Theory of Econometrics, Principia Press, Bloomington, 1941, pp. 23-51; and E. A. G. Knowles and D. S. Stewart, "Characterisation of the Flow of Events -- A Problem of Simulation," Applied Statistics, June 1963, pp. 113-128.