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IS LICENSING AN EFFECTIVE ALTERNATIVE FOR ACHIEVING COMMERCIAL BENEFITS OF R&D RESULTS?

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INTRODUCTION

Despite twenty years of involvement in research, teaching, and consulting on the management of industrial research and development, I have seldom encountered situations in which the licensing of R&D results was seen to be a major opportunity. The issues I have encountered, primarily in large U.S. corporations, have generally focused on efforts by those corporations to achieve significant commercial impact from their research and development activities. Although various policy and structure questions have been posed, as well as approaches sought to improving effectiveness of large-scale R&D, engineering and technical organizations, organizations that are developers of technology seem to have relatively little concern about the licensing of their technology.

In this article I want to: (1) Put into perspective the role of technical development with respect to licensing activities; (2) Identify some of the reasons why licensing has relatively little impact on the payoffs received by large technology-producing firms; and (3) Suggest some changes that might create higher likelihood of both generating and utilizing improved technological developments as they emerge from large-scale industrial organizations.

[+] Based on a presentation at the International Conference of the Licensing Executives Society, in Utrecht, The Netherlands, on May 10, 1978.

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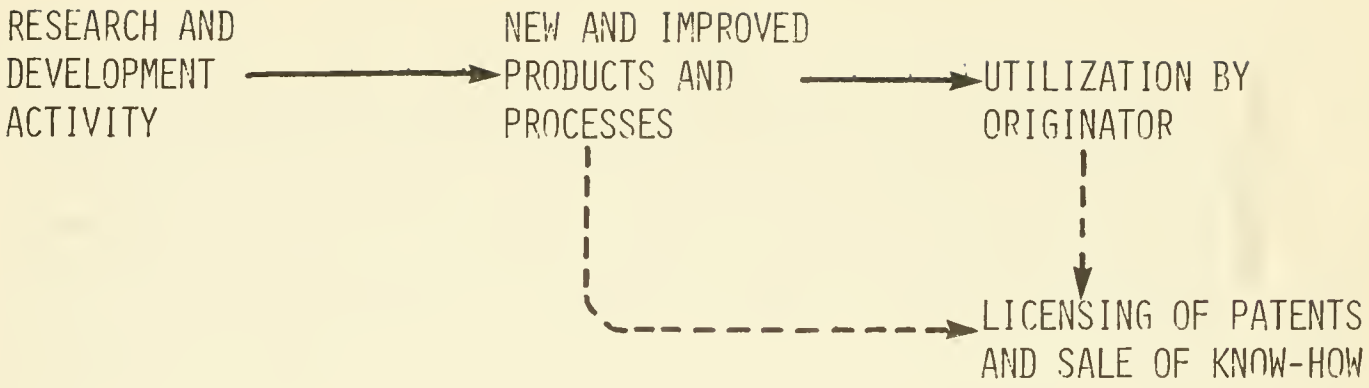

FIGURE 1. ACHIEVING COMMERCIAL BENEFITS FROM R&D RESULTS

Figure 1 pictures loosely the general flow of R&D-related activities that take place in the industrial firm. In identifying research and development activity as the originating source of these flows I am using the words R&D broadly to try to embody all aspects of engineering and technical development activities as well, not just focussing upon advances in basic or applied research. R&D in the corporation generates two kinds of outputs: (1) On the one hand, it produces new and improved products; in fact, the bulk of industrial research and development has as its primary output the development of advances and improvements in the product line of a manufacturing company; (2) Secondly, R&D produces new and improved processes, better approaches for manufacturing the product line of the company. The primary usage of these two kinds of technological advances is by the originating firm; i.e., the company that carries out the R&D, engineering or technology development principally does this for its own sake, for manufacturing and selling those new and improved products, and for internally employing the new and improved processes. As a possible side-stream flow, as a possible but not usually intended by-product, the diagram also shows the licensing of patents for new and improved products and the licensing of patents and sale of know-how for new and improved

processes, sometimes taking place in parallel along with the company's own utilization of that know-how. It is important at the outset to recognize that the licensing of product and process patents and related know-how are seldom intended primary consequences of industrial research, but rather are merely by-product activities.

OUTCOMES OF PATENTING ACTIVITIES

Let us further examine the issue of patent licensing. Table 1 sum-

1. Many ideas are "filed"
2. Most "files" are patented
3. Few patents are "licensed"
4. Few licenses generate much income
5. Results differ widely by industry
   --electronics vs. chemicals, pharmaceuticals

Table 1. Results of Patenting and Licensing of New/Improved Products

marizes the findings from data collected from industrial organizations which indicate that large numbers of ideas are developed within R&D, engineering and technical groups. Many of these ideas are suggested as possible areas for patenting, and out of productive R&D organizations many of the suggested ideas are filed as the bases for patent applications. Most applications eventually result in patents, yet few of the patents that are issued are ever licensed. And few of the licenses that are negotiated generate much income, certainly not much from the perspective of the originating firm. Of course, these results differ widely by industry as well as by originating country. For example, the electronics and mechanical fields tend to be heavily in agreement with Table 1's specifications, whereas industries such as chemicals and pharmaceuticals, perhaps food, are areas where these comments are less true. Indeed,

process licensing for chemicals, pharmaceuticals and food does generate significant income for a number of firms.

Figure 2 begins the display of some data to back up these observations,

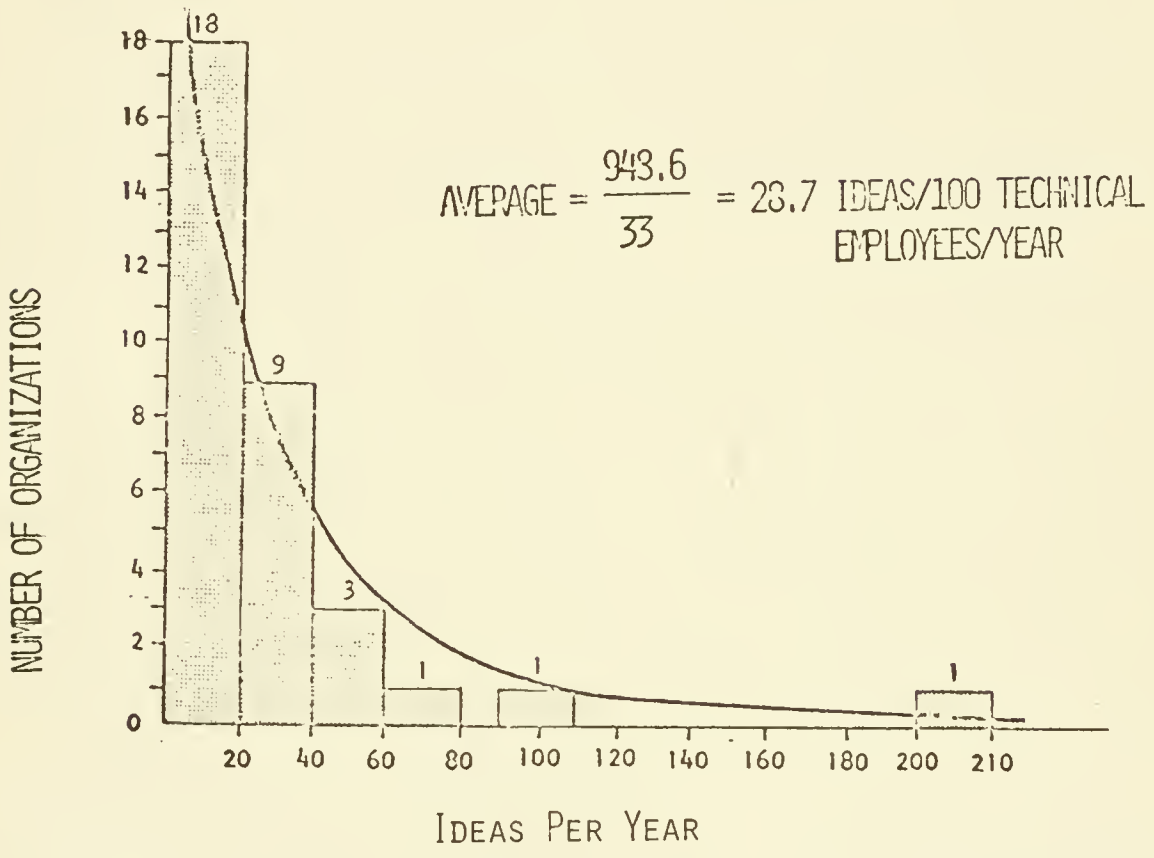

FIGURE 2. HISTOGRAM OF NUMBER OF IDEAS PER 100 TECHNICAL EMPLOYEES PER YEAR FOR 33 ORGANIZATIONS

drawn from a study of 33 large American corporations.* The companies were spread across different fields, some chemical, some pharmaceutical, some aerospace, some electronics. They are not a statistically representative sample of American industry. Indeed, they were chosen under the assumption that they were technology-productive organizations, reputed to create large numbers of technical ideas.

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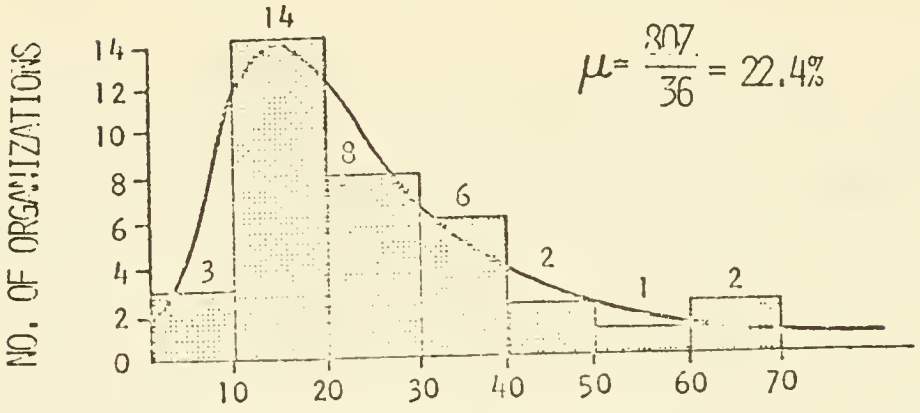
* My sincere thanks to Dr. George Morgenthaler for his efforts in assembling the data.

First let us examine the information gathered from the 33 companies on the number of ideas generated each year per 100 technical employees that are suggested as possible sources of patents. Figure 2 shows that idea productivity varies all the way from close to zero ideas per 100 technical employees all the way up to one company which estimated 200 ideas per 100 technical employees or two per employee per year. On the average 28.7 ideas per 100 technical employees were generated annually as candidate ideas submitted for possible patent applications for the firm.

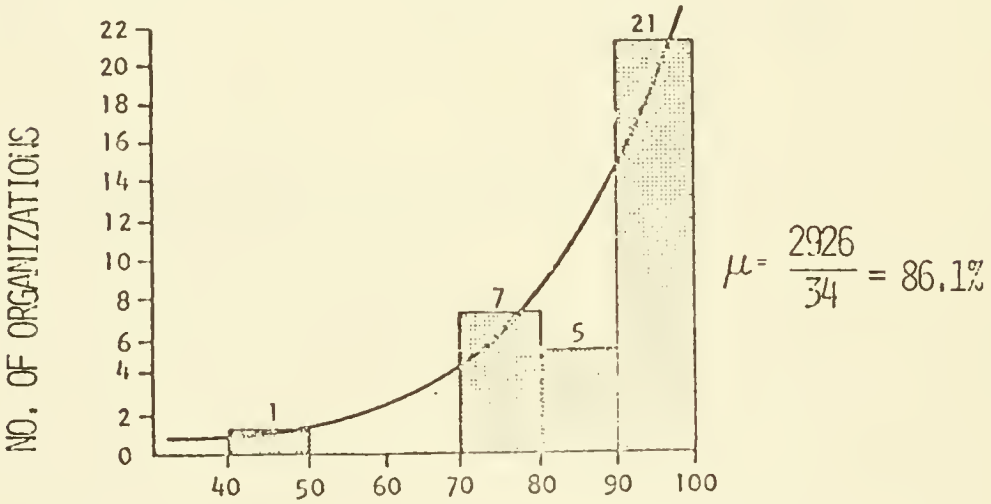
What happens to the ideas that are submitted as possibilities? Figure 3 shows three different charts which trace the life cycle of these ideas. At top are the percentages of ideas actually submitted for patenting in the organizations studied. The distribution across those organizations widely varies, but the average is that 22% of the ideas submitted for internal consideration were eventually filed in the form of patent applications. The center figure indicates the percentage of those filed ideas which issue, and again wide variation exists across the organizations. 21 of 33 organizations in this group had from 90 to 100 percent of their filings eventually issued as patents, with the arithmetic average being 86.1 percent for the entire sample. (This percentage is relatively high, indicating a fortunate bias in the data sample. Not only were organizations selected that were supposed to be technologically productive, but they also turn out apparently to be especially successful in their dealings with the U.S. Patent Office!) Clearly, most of the applications for patents eventually issue. The bottom chart in Figure 3 shows that overall the percentage of ideas which were originally submitted that finally resulted in issued patents was about 20 percent, indicating a significant cut-out ratio between having an idea and eventually getting a patent.

HISTOGRAM OF THE PERCENT OF SUBMITTED IDEAS FOR WHICH A PATENT IS REQUESTED



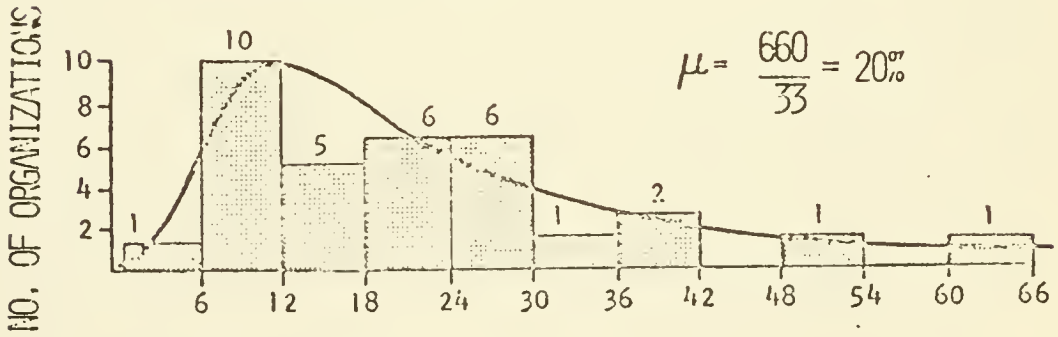
% IDEAS FILED FOR PATENT

HISTOGRAM OF THE PERCENT OF PATENTS APPLIED FOR WHICH FINALLY ISSUE



% OF FILED IDEAS WHICH ISSUE

HISTOGRAM OF THE PERCENT OF SUBMITTED IDEAS WHICH RESULT IN PATENTS ISSUED



% PATENTS WHICH ISSUE

FIGURE 3. STAGES IN PATENT LIFE-CYCLE

But getting a patent is only the entry stage to generating income from licenses. Figure 4 presents the data on how long it took to generate the first licensees, based on information from all 33 industrial organizations.

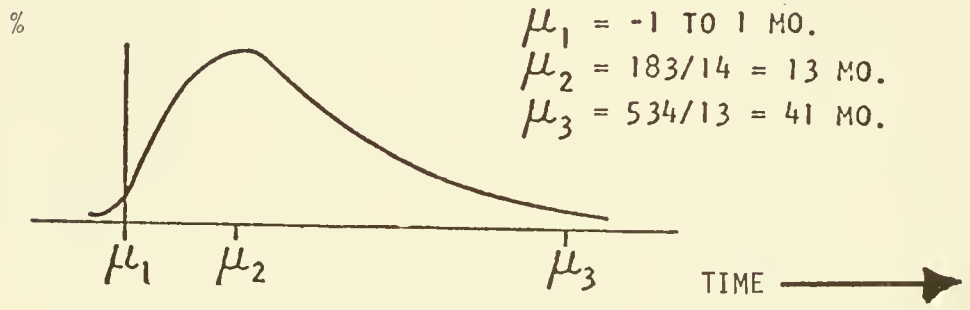


FIGURE 4. ESTIMATED DISTRIBUTION OF TIME SPENT TO FIND THE FIRST LICENSEE

The lowest "time delay" that arose in the study was minus one month, a case in which the first licensee was established prior to the receipt of the patent. The other extreme of the distribution was approximately 41 months to find a first licensee, with the typical time delay being approximately 13 months after receipt of patent approval.

However, finding one or more licensees still does not guarantee income generation. Figure 5 contains license income data curves from five different companies--companies # 6, 8, 10, 12 and 20 in the sample. The data points are the distributions of their licenses in terms of income received over different royalty intervals spread across the bottom of the chart. The ranges shown are zero to 1000 dollars per year in the first cluster, $1000 to $5000 per year in the second group, etc. Note that beyond $50,000 per year essentially all the data of these companies have been exhausted.

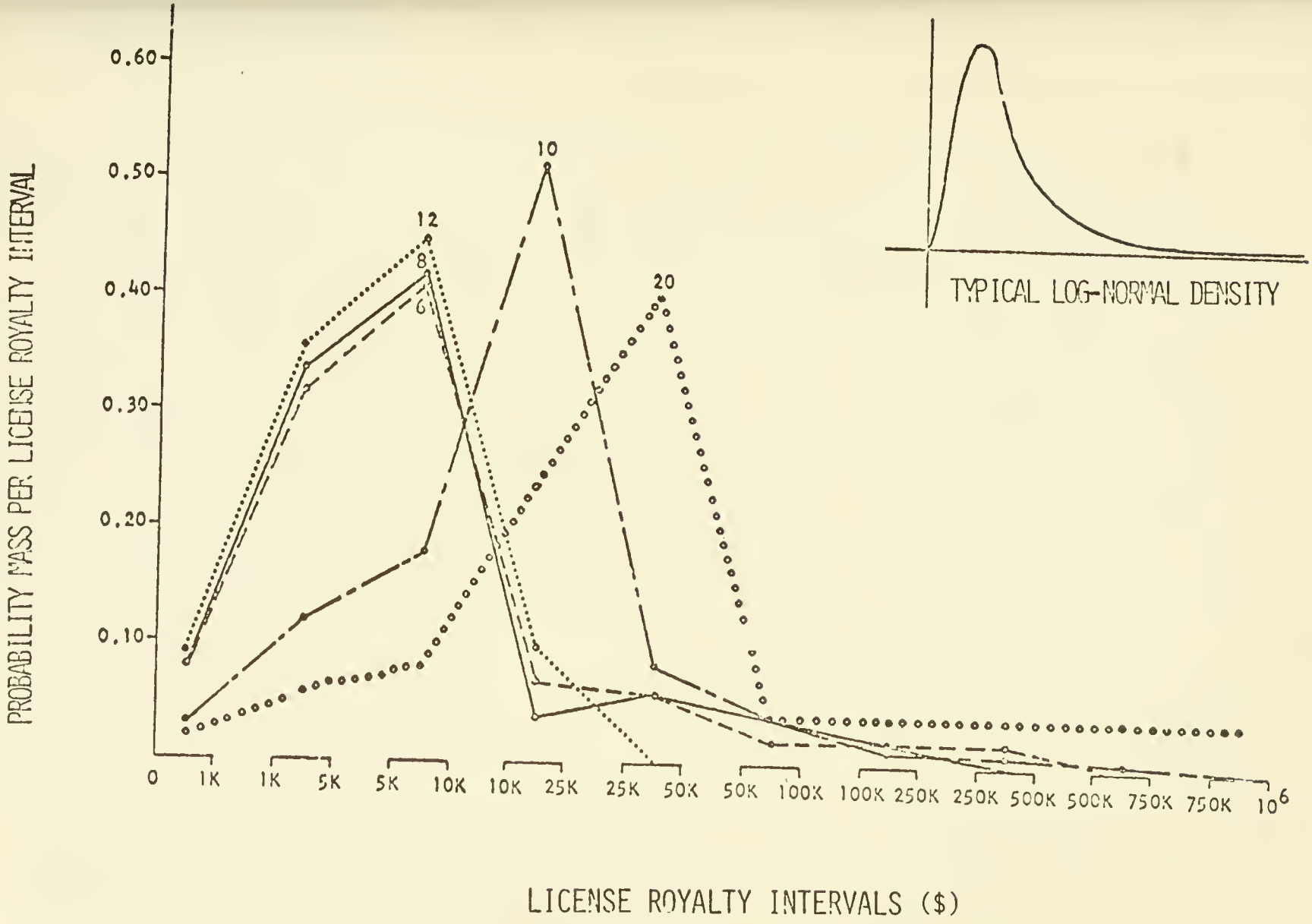


FIGURE 5. APPROXIMATE LOG - NORMAL SHAPE OF SEVERAL ROYALTY DENSITIES (ALSO INDICATING VARIABILITY OF DATA)

Although the curves go all the way up to one million dollars per year per license, the curves are dominated by the bulk of the experience being annual income of the order of magnitude of $1000 to $5000 or $5000 to $10,000 per licensed patent. These data suggest the curve shown at the top of Figure 5, which mathematicians call a log-normal density distribution, as the kind of experience you would probably find for most technology-originating firms. The distribution of income that patents generate usually clusters rather intensely around very low income per patent. While the distribution may spread to include large numbers, a key characteristic of the spread is that only on highly infrequent occasions does any particular patent generate any significant amount of income.

Finally in Figure 6 are the data showing the cumulative distributions for the sampled companies, i.e. the total amount of annual license royalties for a given patent as a probability statement. 20 percent of the licenses result in one thousand dollars or less per year in income; 40 percent of the licenses generate less than $5000 each in total annual income; 60 percent of the licenses produce less than $10,000 each per year in income; 90 percent of the licenses contribute less than $50,000 per year income; and 95 percent of the licenses generate less than $100,000 per year income. Going nearly to the end of the data gathered in this 33 companies study, Figure 6 reveals that 99.95 percent of the licenses fall under the $1,000,000 per year income mark. From the view of the originating large corporate organizations, all of these numbers are wholly inconsequential and insignificant. None of the 33 originating organizations could be interested financially in income-generating opportunities of the magnitude just described. Consequently, the income-generating potential of patents for a technology-originating firm is not usually a subject matter of concern to the primary policy-makers of the organization or even to the developers of technology of the organization.

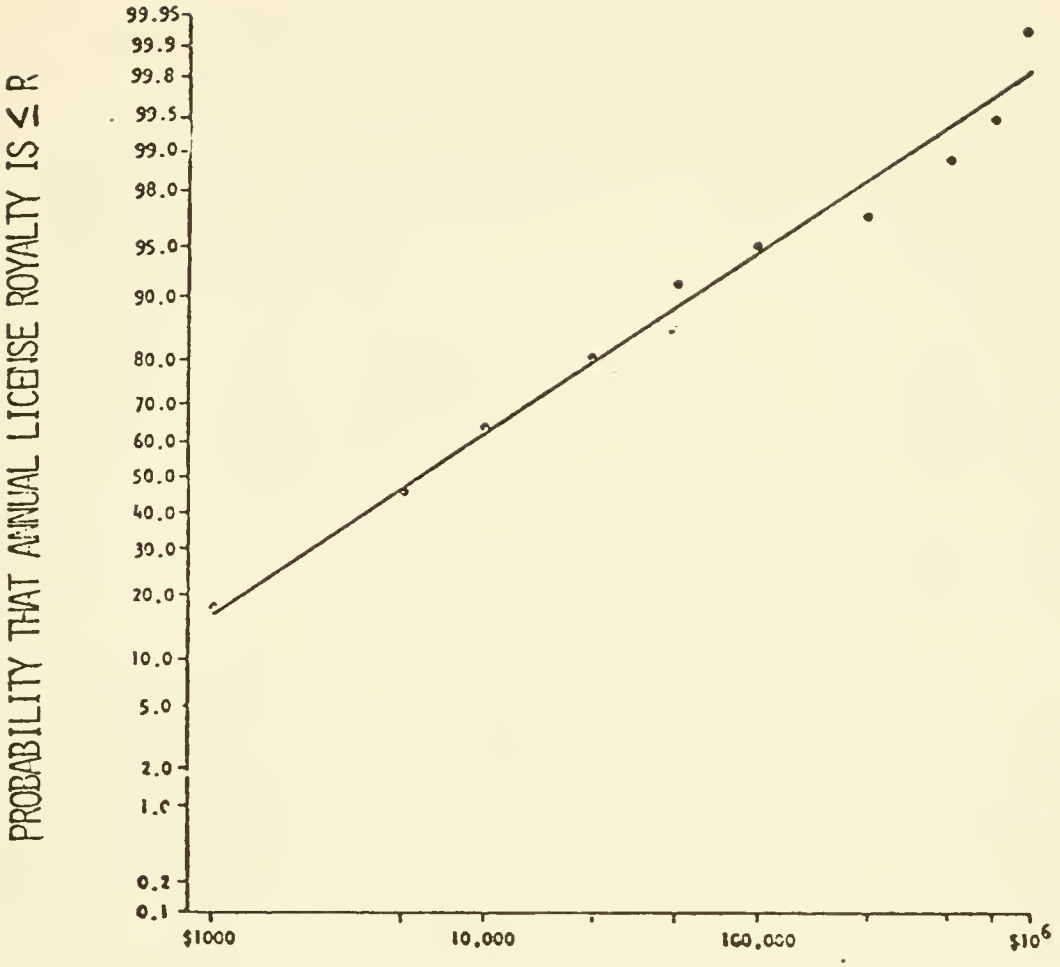


FIGURE 6. STRAIGHT LINE FIT TO CUMULATIVE DISTRIBUTION FUNCTION FOR ANNUAL LICENSE ROYALTIES

To be sure, with a focus upon process as opposed to product, looking especially at the generation of new more efficient processes for manufacturing particular chemicals or for a new pharmaceutical, opportunities exist for the sale of technological know-how that are more significant. As listed in Table 2 these fall especially in three key areas:

1. Processes that produce unique products
   (A product-process system)
2. Processes that achieve important advantage for an existing high-volume product
   -- Decrease cost
   -- Improve quality
3. Significant income opportunities in sale or joint venture utilization

Table 2. Keys to Selling Technological Know-How on New/Improved Processes

(1) Processes for manufacturing unique products, what I would call a product-process system where the product and the process are inseparable; in these areas, potentially on a world market basis, corporations originating those unique systems may well be able to generate significant returns on their technical investment;

(2) Processes that achieve important advantages for an already existing high-volume product, the advantages in particular of decreasing manufacturing cost or significantly improving quality, can also potentially generate significant "licensing" income; and, finally,

(3) Processes that provide significant income opportunities in sale or in joint venture utilization; such processes allow a monopolistic opportunity to negotiate joint venture entry into other countries or into special relationships under joint venture conditions.

MORE ACTIVE ALTERNATIVES FOR ACHIEVING COMMERCIAL BENEFITS

The data presented thus far indicate that conventional patent licensing, and even the direct sale of technological knowhow, seldom provide attractive income to the technology-developing firm. Large industrial firms have available a number of alternative commercialization strategies for the technology that comes from their organizations. These alternatives are arrayed in Figure 7 in order of the degree of corporate involvement required by the strategy. The most active strategy, and the one whose potential benefits dominate all others in Figure 7, is internal product and process change. That was the motivation and

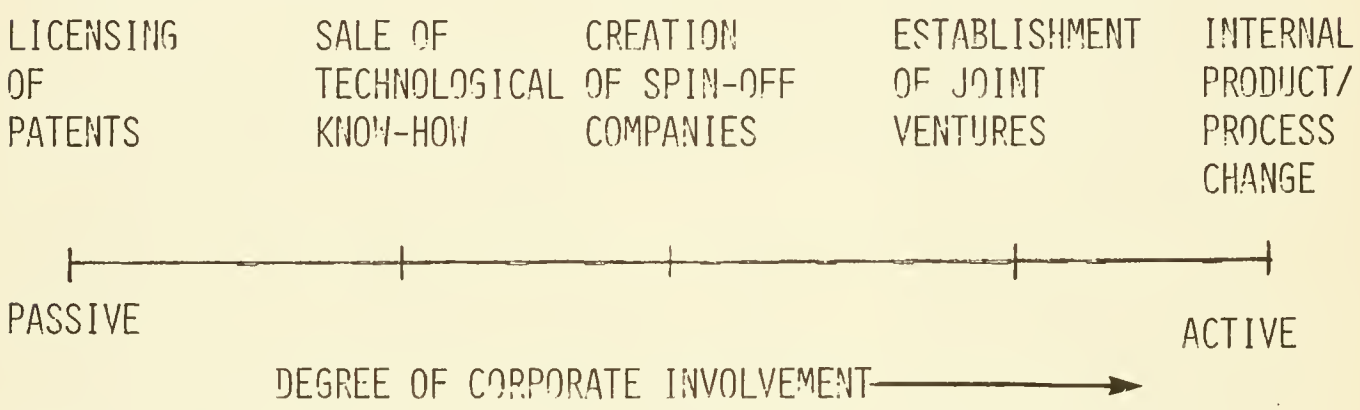


FIGURE 7. ALTERNATIVE TECHNOLOGY COMMERCIALIZATION STRATEGIES

is the primary source of returns that come from commercialization of technical innovation. Along with that strategy, at one extreme of the commercialization spectrum, are listed other usually less attractive alternatives. As indicated, the licensing of patents is at the opposite extreme, the most passive alternative, and is a questionable strategy for making money from technology. The sale of technological know-how, relating more often to process than to product, is the third possibility that has already been described, desirable in some circumstances.

The last two alternatives in this spectrum, not yet described, are more active approaches toward technolgy utilization, and offer more income-generating potential. Both parallel licensing in that technology gets transferred to outside companies, but both require the on-going relationship of the technology originator and transform the technology base into stock-holdings instead of a direct income stream.

These alternatives defer the financial pay-off but may escalate its magnitude enormously.

The fourth option shown is the creation of technology-based spin-off companies, where the company originating the technology may find opportunities to enter new fields of endeavor by establishing some form of subsidiary or affiliate. Many firms generate technological products and processes which end up not fitting their mainstream businesses. The options available for handling these by-product activities include: (1) scrapping the project; (2) trying to license the results externally; (3) setting up the project as an internal venture group, which may be too threatening to company standards and norms*; and (4) setting up the project as an external group, a sponsored spin-off company that may now be partially funded by outside sources of venture capital. The technology-originating firm retains an on-going interest in this spin-off by ownership of stock in the newly-created enterprise and the key individuals initiating the spin-off may also be provided stock ownership opportunities. Should the spun-off company grow and prosper, the originator will of course benefit, and may even want to buy back control of the operation to turn it into a new division. The General Electric Company has pursued this spin-off approach to technology exploitation for many years through its Technical Venture Operation.+ Unfortunately, GE's results from following this method have not yet been impressive, though several on-going companies have emerged.

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* See Roberts, E.B., "New Ventures for Corporate Growth", Harvard Business Review, vol. 58, no. 4 (July-August 1980), 134-142.

+ For more information on this option, see Sabin, S., "At Nuclepore, They Don't Work for G.E. Anymore", Fortune, December 1973, p. 145.

The final approach indicated in Figure 7 for possible commercialization of R&D results is the establishment of technology-based joint ventures, which I believe is potentially far more significant to the technology-originating firm than straight licensing. Companies that originate product and process innovations seek joint ventures for one or a combination of three motives, as itemized in Table 3. The first reason is to enter foreign markets that

1. Enter foreign markets
2. Secure critical raw material or lower cost labor supply
3. Combine technological innovation with marketing/ distribution strengths

Table 3. Joint Venture Motives

are not otherwise accessible because of restrictive trade practices of other countries. Second and often of comparable importance, joint ventures help secure access to critical raw materials or to lower-cost labor supply for producing a company's existing products for sale on a world market basis. Third, joint ventures enable the combination of technological innovation capabilities of one firm with the marketing and distribution strength of the partner firm. All three are important motivations. All offer potentially significant commercial-benefits to the technology-originating firm, far more than straight licensing and even more than offered by the income-producing sale of technology. Consequently, the joint venture approach to exploiting technology is more likely to get the attention of industrial originators of technical change.

In considering the joint venture option, it is important to realize that careful examination of the development of new technology reveals perhaps surprisingly that the sources of large numbers of innovations are not the major industrial corporations. Rather, in studies carried out in both the U.S.A. and Great Britain, the data have demonstrated that disproportionately the sources of key technological innovations are relatively small companies--companies that do not have instant access to world markets and world-distribution opportunities. Many of these smaller highly innovative companies would welcome the chance to enter into joint ventures with partners who see marketing and distribution of products as the primary focus of their undertaking.

PERSPECTIVE AND FINAL COMMENTARY

Putting these data into perspective, large firms should have relatively little interest in the income-generating possibilities of the more passive strategies, with least interest in the licensing of their own patents to others. The more active strategies are all technological approaches to business-building, whether indirect via spin-off companies or joint ventures, or more direct business development via internal product and process change.*

This passive-active dichotomy shows up as well in the typical role and participation of the patent attorney in the process of development and use of

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* In this same vein, seeking other companies' under-exploited technology for licensing can provide an inexpensive route for bringing additional technology to bear on a firm's business development endeavors. For decades Japanese companies have practiced and mastered the techniques of "importing" licenses and know-how and exporting new and improved products. Western firms can achieve significant commercial benefits by adoption of these techniques.

technology-based innovation. In most large corporations the patent attorney occupies a position within the legal staff of the firm, as opposed either to being in the commercial-oriented activity of marketing or perhaps even better in the technical organization itself. Thus the people in the large company who are concerned about licensing and the sale of know-how are far downstream from the source of origin of the technical innovation in the first instance.

A comparable situation existed in most large corporations up through the mid-to-late '60s with respect to marketing--marketing was also downstream from R&D. Beginning in the late '60s that role began to change--marketing organizations began to work in close collaboration with R&D to define opportunities and directions of emphasis that resulted in far greater productivity of commercially-oriented R&D during the next decade. Enhanced commercial benefits might also be obtained if professionals concerned with patenting and licensing took a more upstream position, joining their colleagues in marketing in attempting to look at the technical organization as a resource. A more effective role might be developed in helping to define ways of carrying out technical development, of targeting process improvement opportunities, and of including in the beginning specification of an R&D program the consideration of potential licensees. Providing licensing staffs the opportunity to move toward that upstream role of closer partnership with research and development would enable many of the numbers I have shown to change dramatically over the next ten years of corporate innovative activity.