# 3000 raw ideas equals 1 commercial success !

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Significant odds facing would-be innovators are confirmed by an analysis of consistent data from new product development, patenting activity and venture capital experience.

Overview:

Improvements in the standard of living depend to a remarkable degree on the success of industrial innovations, but the odds of any one idea becoming an economic success are so very low that many **ideas** are needed. Success curves for industrial innovation have been developed from three major sources, including: the project literature, patent literature and experience, and venture capitalists. Remarkably similar results were found from all three sources of information. Understanding success curves is important for at least three reasons: 1. To set expectations of those involved in industrial innovation; 2. To benchmark one's own process against others in the industry; and, 3. To calculate future expected benefits from current innovation spending as a function of the stage of the new product development process and the typical success rates found for each stage.

Across most industries, it appears to require 3,000 raw **ideas** to produce one substantially new commercially successful industrial product. We illustrate this with a logarithmic plot of the number of new project **ideas** that advance to the next stage of development (Figure 1). The derivation of this "universal success curve" is the topic of this paper.

First, however, we point out that although we are confident that the curve reflects the reality of most industries (including mechanical parts and industrial chemicals) there are segments of industry that have different success curves. For example, the literature indicates that drug companies typically require a higher number of starting **ideas** (6,000-8,000 or more) for every successful commercial new product than domanufacturers of typical industrial products (3,000 or so). Likewise, if a company is developing product line extensions (instead of substantially new products), then we believe far fewer **ideas** are needed for each commercial success.

Figure 1 shows that it takes about 3,000 raw **ideas** (Stage 1) to come up with 300 **ideas** on which the idea generator is willing to take minimal action, such as performing a few simple experiments, filing a patent disclosure or discussing them with management (Stage 2). (Many other authors begin their idea success curves at Stage 2.) Moving from 3,000 to 300 **ideas** is largely a self-screening process.

Approximately 125 of the 300 **ideas** in Stage 2 advance to Stage 3 to become a small project, usually having a high probability of receiving a patent (if applicable). Approximately nine projects survive to Stage 4 and develop into significant projects (large development efforts). Four of these advance to Stage 5 to become major development efforts. Of the four major developments, approximately 1.7 are commercially launched (Stage 6). Of 1.7 projects commercially launched, on average only one (59 percent) is typically commercially successful (Stage 7).

Why Success Curves Matter

One reason for understanding the odds of success in the innovation game is to set the expectations of those involved by establishing some reasonable benchmarks. Without benchmarks, a significant improvement in the innovation process (real success) might be misinterpreted as failure, because the great majority of new **ideas** in any system will not be commercially successful. "Commercially successful" as we use the term does not just mean that someone is buying the product or licensing the concept, but that the concept is providing economic profit to the parent company. In other words, the money returned is greater than all the money invested in creating that product, including the cost of capital (both depreciation and opportunity cost), raw materials and manpower used throughout the entire project.

A second reason for understanding the success curve is that it is needed to determine the percent of funding that is effectively spent on innovation, so that the potential value of improvements can be calculated.

A third reason is to clarify the debate surrounding success curves. At the outset, we could not find a satisfactory success curve covering the entire range of project activity from ideation to commercialization, although individual sections of the curve are described, if not always fully documented, elsewhere. There is a great deal of confusion and debate in the literature about the "true" shape of success curves for industrial innovation. Do 60 percent of new products succeed? Or does only one out of 3,000 **ideas** succeed? The answer to both of these questions appears to be "yes," depending at which stage of the success curve--or the new product development (NPD) process--one starts counting.

Different people begin counting the percentage of success from different points on the curve: At one extreme, success can be counted based on how many of the new products commercially launched were successful (approximately 60 percent is typical). At the other extreme, the chances of success can be judged on the number of raw **ideas** it takes to get one commercial success (approximately 3,000).

What constitutes a new product is also debatable. Are "new and improved" products with minimal change really"new," or should "new" be reserved for products with "significant" change? As used here, "new" generally refers to products or services with significant change that are substantially new (for instance, believed to be patentable). Our definition of substantially new products would include significantly different new processes for manufacturing existing products, because a new process is itself a new product in the broad sense of the word. However, the NPD literature dealing with NPD projects is at best imprecise on this point.

The topic can sometimes become emotional because organizations generally like to present themselves in the most positive light; they take exception to success curves showing low odds of success and often misinterpreted as "failure" if not put into the proper context. The best measure of success is the economic profit earned over time from NPD efforts. As long as positive economic profit is earned, then the NPD efforts are successful, even if hundreds of relatively high-quality **ideas** are required to identify a single commercial one. A valid complaint notes that over a sustained period of time an economic profit has not been earned by one's total NPD efforts. An invalid complaint cites numerous singular examples of failed **ideas** in an attempt to point out the folly of NPD. The problem with this latter complaint is there are almost always more failures than successes, so it is irrelevant as long as economic profit is earned.

For all the above reasons, success curves for industrial innovation were carefully pieced together from a number of sources. They all attempt to account for the percentage of **ideas** surviving each stage of the innovation process. The four sources used to assemble the "best" composite success curves are:

- Patent activity.
- Project activity in large companies.
- Venture capitalist activity.
- Independent inventor activity.

We developed the composite "universal success curve" by combining the best information from these sources for each stage of the innovation process. It is a rough approximation, because there are no absolute numbers available. Absolute numbers for success rates are not kept by industry, and success rates change with the type of industry as well as over time. Having pointed out some of the limitations of the exercise, and thus qualified the success curve developed here, we consider it to be one of the most complete and well-documented success curves for industrial innovation developed to date. It should allow companies to better benchmark their own NPD efforts for "substantially new" products.

Success Curves from Patent Activity

Examining patterns of patent activity is one of the better approaches to determining how many **ideas** are required today to yield a commercially successful product, for two reasons: Tracking systems are typically used (if somewhat loosely) to follow patents as they progress through the formal patent process, and the patents involve substantially new **ideas**. Indeed, only in the case of patents is the definition of a "new" product reasonably well defined. In order to receive a U.S. patent, the invention can not be known of, described in earlier publications or used by others, prior to one year before the date of the patent application. In addition to needing to be new, by law the idea must also not be obvious to one skilled in that art. Hence, patented **ideas** represent one of the best defined categories of "substantially new" NPD **ideas**.

The percentage of **ideas** that advance through each stage of the patent process provided in this section are "best estimates" from a variety of sources. As such, the estimates usually cover a range (such as: 5 to 10 percent of patents have some commercial utility).

Precise data on the number of **ideas** advancing through the patent system are not kept at the early stages of the idea generation process, prior to the submission of written patent disclosures. However, fairly good estimates are available regarding patents for most of the other stages in the NPD process leading to commercial success.

The Patent Process

The process leading up to receiving a patent starts with ideation activities that create many **ideas**, most of which are in a raw, undeveloped state. The rule of thumb we generally used is that there are least 10 raw **ideas** for every one submitted to the patent department. (This is one of the least-well-documented numbers on the success curve.) Many of the **ideas** are too wild to make it into an idea or data book for witnessing, but may serve as a stimulus for additional **ideas**. The better **ideas** are recorded and witnessed. To be submitted to the corporate patent department or to a patent attorney as a patent disclosure, the **ideas** typically have to pass though many of the following informal screen elements:

- The idea passes muster with an informal peer review and literature review.
- The idea seems to actually work in the laboratory, and it is likely to be reducible to practice.
- The concept has a glimmer of commercial utility.
- The idea appears to the inventor to be new and novel.
- Laboratory management, if present, sometimes wants to help decide whether the disclosure should be submitted.

It takes a great deal of time, effort and skill on the part of the patent attorney and the inventor to write a good patent application. Usually the inventor has to generate significant additional laboratory data on the topic as a result of the patent disclosure, to differentiate the invention. Submitting patent disclosures to the corporate patent department or to a patent attorney is generally not undertaken lightly because of the work and expense involved, both in generating the patent application and in maintaining the patent should it be granted.

## Counting the Crown-Jewels

After the idea enters the corporate patent department as a patent disclosure for action, it is possible to begin tracking success rates somewhat more quantitatively. We conducted interviews with eight top invention management directors and patent attorneys for two large midwestern chemical companies that handle over 9,000 active patents between them. Most of the managers interviewed were retired, one for over 17 years, and they spoke frankly. The interviews included most of the invention management directors from the last 15 years, so a fairly accurate picture could be assembled with data from a time period much longer than 15 years. All of the interviewees had thought about the issue a great deal because their lives revolved around it.

The findings were very similar for both companies interviewed, and are as follows. Of approximately 100 disclosures sent by employees into the corporate patent offices, roughly 50 are deemed appropriate for submission as patent applications to the U.S. Patent and Trademark Office.

Of the 50 patent applications prepared (from the original set of 100 patent disclosures) and submitted by the corporate patent offices to the U.S. patent office, approximately 75 percent (or 37.5 percent of the original 100 disclosures) receive U.S. patents. (The number of original cases that receive a patent is closer to 66 percent, but the number rises to 75 percent when the patents are altered during the patent examination process.)

Of those inventions that are granted U.S. patents, the best composite estimate from invention management directors is that 5-10 percent have potential for at least marginal commercial utility, including licensing fees and/or defensive value. Assuming that 8 percent have the potential for at least marginal commercial significance, that leaves 3 percent (8 percent x 37.5 issued patents = 3 percent) of the original 100 submissions having marginal commercial utility. Note, however, that the licensing fees collected by the organizations studied tend to be minimal, accounting for just 1-2 percent of the total annual R&D budget. Hence, the great majority of patents in the group with "potential commercial value" in actuality have minimal economic value, and return an insignificant fraction of the cost of R&D.

The number of issued patents that represent a real corporate crown jewel (not just providing a minimal licensing fee or potential defensive value) was judged by most interviewees to be well under 1 percent of the issued patents. Assuming the number is as high as 1 percent, this translates to 0.37 percent (or less) of the original disclosures having true commercial significance.

To summarize, it typically takes 3,000 raw **ideas** to produce 300 patent disclosures to the corporate patent office. Fifty percent of the disclosures (or 150) are filed as patent applications with the U.S. patent office. Seventy-five percent of the disclosures, or 112, are issued as U.S. patents. Of these, 8 percent, or about nine patents, have some commercial significance, while less than 1 percent represent "crown jewels" with major commercial significance. Hence, the crown jewel patent analysis represents at least a 3,000-to-1 reduction (1/3,000 = 0.03 percent) from **ideas** to major commercial successes providing economic profit.

## Foreign Patents

Another way to approximate the percentage of patents having commercial utility is to examine the number of patents that are kept active overseas. In all parts of the world, there are fees associated with maintaining patents. Over the life of a patent, these fees can be very expensive, running into hundreds of thousands of dollars.

Fees are much steeper for maintaining foreign patents (as in Europe) than U.S. patents. Often a patent is initially sought with fairly broad global coverage. However, over time, the invention is frequently found not to have the commercial significance originally hoped for. Hence, the fees are not paid and the foreign patent is not maintained. It can be assumed that both foreign filing and maintaining foreign patents through paying fees are good measures of the commercial importance of a patent. If a U.S. patent is not filed overseas, or if the fees are not maintained, then the invention has been determined by the originating organization to have minimal value. As before, the data on foreign patent activity vary over time, so precise numbers are not available.

The two companies studied in this research obtained foreign patents on 35-40 percent of the patents granted in the United States. Of the 35-40 percent that were patented overseas, as in Europe, only about 20-25 percent (or 7-10 percent of 100 granted U.S. patents) are maintained, due to the higher costs of maintaining a patent overseas. Hence, of the original 100 U.S. patents granted, only about 7-10 percent are deemed to have at least marginal or potential commercial utility. This result is in very close agreement with the 8 percent estimated number of patents having at least marginal commercial utility from the earlier patent analysis.

## Licensed Government Patents

While the above patent analysis comes specifically from two midwestern chemical companies, we believe the results are typical for most other industries as well as for government R&D labs.

For example, the result for the number of patents with marginal commercial significance is confirmed from an analysis of 28,000 patents generated by U.S. government researchers. Of the U.S. government-generated patents,

5 percent have been licensed and generate just $4 million per year in revenues (1,2). Hence, 5 percent of governmental patents are judged by the marketplace to have at least marginal commercial value. Again, far less than 1 percent of the total are probably truly significant commercial products that return more than the total costs of developing them.

## Summary of Patent Analyses

We believe that the review of the patent analyses provides some of the most reliable information for determining industrial success curves. The summary data in Table 1 naturally sort into six categories, or stages, based on the decision points in the patenting process. (In contrast, the success curves developed independently that follow this section end up with seven to 11 stages. The number of stages chosen is somewhat arbitrary, and depends on the number of activities included in each stage. For the final "best overall" success curve, we use seven stages.)

## Success Curves from Project Reviews Broad Project Reviews

The most difficult aspect of deriving success curves from the reviews by others that have been conducted of hundreds of industrial NPD projects is that what constitutes a "new product" is not nearly as well defined as for patents. Even so, in this section we have emphasized those reviewers attempting to limit their work to "substantially new" products vs. line extensions. For example, a study by The Conference Board covered "major new products only," not line extensions (3). In 1968, Booz Allen & Hamilton defined new products as those that are new to the company, even if not new to the world, while acknowledging that there are many categories of new products with varying degrees of "newness" involving both new technologies and new markets (4).

Americo Albala surveyed the literature on industrial innovation **ideas** surviving to commercialization. Table 2 summarizes Albala's broad project reviews (5). The numbers are all from slightly different perspectives than we present. Albala's references appear to correspond to "Stage 1.5" (i.e., between Stage 1 and Stage 2) for industrial and chemical innovations, as defined in the previous patent section. (No analysis was found in the literature covering the stages of NPD going all the way back to raw **ideas**.) Hence, if one moves back up the success curve (Figure 1) from an imaginary "Stage 1.5" to Stage 1 (the earlier "raw idea" stage), the number of starting raw **ideas** in Table 2 would probably increase about five-fold (instead of the ten-fold increase between Stage 2 and Stage 1 as presented here.) This would provide an overall success rate for American industry of roughly 0.04 percent (when starting with raw **ideas**), which agrees closely with the results from the patent analysis (which showed 1 in 3000, or 0.03 percent). The study quoted by Albala for chemical companies involved 20 chemical companies, with data developed by the Commercial Chemical Development Association (4, 5).

Another reference puts the number of **ideas** required to find one successful pharmaceutical concept much higher, at one commercial success for every 8,000-10,000 compounds screened (6).

Success Rates for Small R&D Projects (Stage 3)

Another approach to determining success rates is to evaluate the numbers of projects that survive at different stages of the development process.

In one estimate, about one in 50, or 2 percent of the **ideas** on which some minimal level of research is done, prove to be commercially profitable (7). From the descriptions given, this would correspond to moving from Stage 3 or "3.5" to Stage 7 of the "universal success curve."

In another estimate from The Amoco Chemical Company, of 100 new **ideas** being worked on at least minimally in R&D, four typically result in concepts that receive broad company sponsorship and development (8). This is consistent with moving from Stage 3 (Small Projects) of the "universal success curve" to Stage 5, Major Developments.

Cooper has found that the typical commercial success rate of projects being very actively developed as in Stage 5 (but not necessarily all being commercially launched) is about one in four (9). This corresponds to the success rate shown from Stage 5 to Stage 7 of Figure 1.

Further evidence for the shape of the success curve from Stage 3 on comes from internal studies of projects in a large Midwestern chemical company. A rule of thumb at this firm is that for every 100 small projects taking one to three man-years of effort, approximately 25 are scaled up in the lab. Approximately 8 make it to market development (Stage 4), and approximately 3 are launched full-scale commercially (Stages 5 and 6). Successes (Stage 7) totaled 44 percent of the projects that went to full commercial launch. Launch means that a full-scale plant was built, sales literature was prepared, and the field sales force and technical service personnel were trained and deployed.

Hence, about 1 percent (3 launched x 44 percent successful = 1.3 percent) of the small projects initiated become successful products. These data correspond closely to the earlier observations that have been reported related to product development, and are also supported by the data from the patent analysis, which show that somewhere under 1 percent of patents have true commercial significance. The agreement between the numbers should come as no surprise, as patents typically arise from small research projects.

Success Rates for Major R&D Efforts (Stage 4)

Other project estimates show higher probabilities of success, most likely because they appear from the description given to start counting from NPD stages farther down the success curve. In two large studies of industrial innovation by Mansfield, between 1 in 5 to 1 in 8 research projects turn out to be economically successful (10). A 1982 study from Booz Allen & Hamilton suggests that 1 in 7 serious **ideas** are commercialized (11). Still earlier studies from Booz Allen & Hamilton show that between 1 in 7 to 1 in 10 major development projects in chemical companies is successfully commercialized (4,12). Still another study shows commercial success for 1 of 11 "serious **ideas** or concepts" (13).

The difference between these results and the preceding data can be explained by when the project starts being counted as such. From this set of literature references, the odds are in the 1-in-7 to 1-in-10 range for "serious" **ideas** for projects, which usually include significant exploratory R&D spending along with preliminary business analysis and market segmentation efforts. Such R&D efforts would appear to correspond to the level of activity typically associated with Stage 4 of the "universal" success curve (Figure 1).

One Company's Experience

Analysis of 284 projects at a large Midwestern company over a 10-year period supports these findings. After closely analyzing high-quality projects involving a significant R&D effort for commercial utility (Stage 4 projects in Figure 1), we found that about 1 in every 8 were "money makers," with a positive return on sales net of all expenses (35 "money makers"/284 = 12.2 percent). This is very close to 1 in 9 from the average estimate on the universal success curve. Hence, the success rate is closer to 1 percent for small projects (Stage 3), and is approximately 10-13 percent for significant innovation efforts that correspond to Stage 4 of the "universal" success curve.

## New-Company Survival Data

Another estimate that falls into this range is provided by looking at the number of companies that survive. Only 10 percent of all companies survive beyond five years after their founding. Among high-technology firms, only 15 percent, or about 1 in 7, become significant financial successes (14).

This is a similar estimate to the success rates for serious research efforts, again corresponding to Stage 4 of the "universal" success curve (Figure 1). In assigning new company start-ups to Stage 4 of the process, it is acknowledged that many new companies do not yet have products to sell, but do have major developmental programs underway.

## Commercially Launched Products (Stage 6)

The success rates for new industrial products that have been commercially launched have been studied by a number of researchers, and are well known. The sources of the data and their findings are summarized in Table 3. Success rates for these products are consistently in the range of 40-65 percent.

Most literature sources indicate that while the success rate for launching major new industrial products is about 60 percent (Table 3), it has not been improving over time

Although more than 30 years have passed since new product development began to receive increasing attention from practitioners and academics alike, these figures suggest that little improvement has been made in raising the new product success rate of companies as a whole (15).

In the period from 1963 to 1968, 67 percent of all new products introduced were successful--that is, they met company-specific financial and strategic criteria. From 1976 to 1981, a 65-percent rate of success was achieved. The dichotomy of the major findings is obvious. More companies are using a more sophisticated new product process.... Yet, there has been virtually no change in the rate of successful introductions (11).

The overall rate of new product failures remains high, perhaps as high as 25 years ago ... most causes of failure are (or should be) amenable to marketing research. We have 50 years of technological developments, a growing body of psychological and mathematical hypotheses ...., a reasonably complete literature, excellent journals, an eminently successful association (The American Marketing Association), a solidly established educational system, and a collection of practitioners which would compare favorably with that of any profession. Why, then, do we have such a high rate of new product failures? Is it possible, as some of the research studies suggest, that the problem is one of people, not technology? If so, just what is wrong?" (16).

Clearly, there is a need for both improved NPD systems for industry, as well as a need for industry to better use the processes that have been developed. We shall address these issues in subsequent papers.

## The 90-percent Failure Myth

It is worth noting that there are many other references that cite average new product success rates from commercial launch (Stage 6 of the NPD process) of only 10-20 percent (i.e. failure rates of 80-90 percent). However, none of these are well documented (although widely quoted), and appear, from an in-depth study of the topic, to be individual "guesstimates" with absolutely no supporting data (19). There are undoubtedly certain companies that have 90-percent failure rates, but to suggest this is an average across industries would be misleading. Therefore, when benchmarking corporate innovation efforts, one should not take solace (as is often done) by noting that "our corporation's innovation efforts are at least better than the 90-percent failures found in the literature."

In specifying either success or failure rates, one must qualify the stage in the NPD process, because both of the following statements are true: "60 percent of NPD projects succeed!" (from Stage 6, "Launch"); or "99.7 percent of **ideas** submitted fail!" (from Stage 2, "**Ideas** Submitted").

Table 4 summarizes project success information based on the information presented in this article. The first two entries in Table 4 (the number of raw **ideas**, and the number of those that are translated into minimal action) come from the earlier patent analysis.

Success Curves from Venture Capitalists

Venture capitalists observe similar trends. CSC Index Alliance Corporation has made the following observation (20):

Out of hundreds and hundreds of good **ideas** and good strategies, only one or two deserve funding, and only half of those will be a success in the marketplace. Good execution and good management--in a word, good people--are rare.

A semi-quantitative estimate of the survival curve of **ideas** handled by venture capital groups was obtained from a review and compilation of visits to over 10 major venture capital firms, mostly located in California (21). These findings are summarized in Table 5.

As with **ideas** submitted to corporate patent departments, the starting **ideas** received by venture capitalists have been self-screened by the innovators. It is reasonable to assume that the innovators have had many other raw **ideas**--at least ten--that they did not deem suitable for submission to the venture capitalists for every one idea that was more refined.

Most of the **ideas** submitted to venture capitalists for funding appear to be "substantially new," at least to the company desiring to commercialize them. Approximately 3 percent of **ideas** submitted (or 0.3 percent of the original raw **ideas**) survive the multiple-step screening process described in Table 5, and are ultimately financed by venture capitalists.

A breakdown of the results from companies backed by venture capitalists reveals: 50 percent end up failing completely, and return nothing. Twenty to 35 percent (or 0.6-0.9 percent of initial **ideas** submitted) provide a rerum of 8-10 percent, which is to say they come close to breaking even vs. the cost of capital, but do not earn an economic profit. These are definitely not successes, but neither are they total losses. (Marginal value may rise if the patents of these firms provide some marginal licensing value, or if the company ends up being sold via an LBO to a group of employees).

Ten to 15 percent of the firms financed by the venture capitalists provide at least better returns than the cost of capital. In that sense, 0.3-0.45 percent of the original **ideas** submitted are true business successes. Approximately 5 percent (0.15 percent of original **ideas** submitted) return significantly more than the cost of capital, and less than 1 percent (<0.03 percent of the original raw **ideas**) return spectacular results. The latter two categories (0.15 percent of the originally submitted **ideas**, or 0.015 percent of the raw **ideas**) are where the venture capitalists make most of their money.

The results look considerably worse when viewed from the perspective of a longitudinal study of initial public offerings. IPOs are a later stage of the venture capital process, reserved for those companies that are most likely to be profitable and are therefore marketable. A study of IPOs first made in 1962, and evaluated again 20 years later, found that only 2 percent of them appeared to have been worthwhile investments as of 1982. The study notes that small company entrepreneurship often looks more attractive than it is because history remembers only the successes (22).

To summarize briefly, while the natural break points between the stages of the venture capitalists' decision-making criteria are not exactly the same as from the patent analysis or from the project analysis within a company, they are very similar. Again, starting with approximately 3,000 raw **ideas** (or 300 submitted to the venture capitalist) one ends up with nine offers accepted by venture capitalists, subsequently leading to 0.9 to 1.4 economic successes. This makes the overall rate of success 0.03-0.045 percent using raw **ideas** as the starting point. The result is virtually the same as independently derived in the earlier analysis of idea success from the patent literature.

Confirmation of the findings related to the funding of venture capital has been reported in Pratts Guide to Venture Capital Sources (23). The authors found that 60 percent of projects were rejected after scanning for 20-30 minutes, and another quarter were rejected after a lengthier review. Of the remaining 15 percent, two-thirds were rejected because of basic flaws in the business plan.

Hence, 5 percent were deemed to be worthy of investing, and in 3 percent of the cases, investments were negotiated. (These numbers are the same as found by Cronenberger (21). Success rates after investment were not reported in Pratts).

## Success from the Inventor Group Perspective

The invention promotion industry is a $100-$200 million per year industry in the United States. It is populated by 20 major firms that collect fees averaging $6,000 from roughly 20,000 amateur inventors per year and then attempt to market their concepts. The industry has recently come under attack from inventors and subsequently the Federal Trade Commission. Inventor complaints relate to the extremely low success rates for their inventions. In one recent case, American Inventors Corp. of Westfield, Mass. acknowledged that its customers' success rate is well under 2 percent. In another case, several thousand customers had not received fees in excess of what they paid (24).

There are undoubtedly unscrupulous invention management companies. However, the success rates experienced in the industry appear to fall within the expected range from the success curves already discussed, given that their sources of **ideas** are relatively raw, undeveloped and un-researched concepts.

## The "Best Fit" Success Curve

Figure 2 and Table 6 summarize the information from the three different industrial success curve analyses: the patent analysis, the new project development analysis, and the venture capitalist analysis. They also provide the data for one overall "best fit" success curve. The screening steps do not exactly correspond with each other for the three methods of mapping a project because the steps in each process are inherently different. Hence, they were divided into 11 stages so there would be at least one stage for each step. However, when graphed together, in Figure 2, there is generally very good agreement between the three analyses.

All of the above findings are then used to assemble the "best fit" table and graphs which follow. For the "universal" success curve graphs, a seven-step process was arbitrarily chosen, as shown at the right of Table 6. (More steps could have been chosen, but by convention most new product development "stage gate" processes have seven or fewer stages.) A brief description of each of these seven stages in the NPD process is provided in Table 7 with the stage numbers that correspond to Figure 1. (Figure 1 shows the information in Table 7 logarithmically on a "universal success curve" for industrial innovation.)

The success curves show that, typically, 3,000 raw **ideas** in Stage 1 of the innovation process in Table 7 result in 300 **ideas** that get minimally explored in Stage 2. Usually the screening between Stage 1 and Stage 2 is done by the inventor himself. The rule of thumb we used is that inventors have at least 10 **ideas** for every one they take action on. Action taken in Stage 2 could include submitting a patent disclosure or seeking financing. Stage 2 normally represents a tiny R&D effort, of perhaps 1/20th to 1/4 of a person per year.

By the start of Stage 3, the number of **ideas** has been reduced to approximately 125. This would represent approximately 125 patents allowed or soon to be granted, or 125 small research efforts of perhaps one to three persons. During Stage 3, a brief analysis of the following factors further reduces the number of **ideas**: fit in the organization, strength of market need, size of potential market, competitive advantage and odds of technical success, market opening, and analysis of value.

The literature discussed here shows that the number of projects deemed worthy to proceed onward to Stage 4 is approximately 7 percent of those from Stage 3. Stage 4 typically represents a significant expenditure of resources, with now perhaps 10 people working in R&D, and a few in an advanced marketing function. A far more in-depth set of answers is developed for the same set of questions asked in Stage 3. In addition, detailed requirements research is often undertaken for each market segment evaluated, along with more detailed economic evaluations to ensure that the offering represents a high-value proposition at several levels of the marketing chain.

About 44 percent of the projects from Stage 4 advance to Stage 5, which involves major development, often including a pilot plant and test marketing.

Approximately 43 percent of the projects from Stage 5 move ahead to Stage 6, which is full-scale commercial launch, with full-scale production plants built, and the marketing and sales people trained and running. Of the substantially new industrial products that are launched commercially, on average 60 percent become economic successes in Stage 7. Hence, it typically takes about 300 partially developed **ideas** (or 3,000 raw **ideas** of the type generated during brainstorming sessions) to develop one commercially successful, substantially new, industrial product.

We have now established an improved and more detailed benchmark for industrial success as a function of the stage of a project (Figure 1), which has been confirmed from a number of independent sources. The "universal success curve" can be used to measure the performance against approximate industry averages to determine the relative effectiveness of a corporation's industrial new product development efforts for substantially new products.

## A Disciplined, Iterative Process

An inference from the success curves is that the vast majority of **ideas**, even at the major development stage of NPD (Stage 5), turn out not to be commercially successful. Given that **ideas** come from creative people, this must mean that the intuitive process of invention, while absolutely essential, is almost always incorrect about commercial utility. The research presented here suggests that the starting hunches and **ideas** for new products are, on average, not commercially successful 99.7 percent of the time or less, although clearly some people do much better than this. (One commercial success in 300 recorded **ideas** = 99.7 percent; one commercial success in 3,000 raw **ideas** = 99.97 percent). Another way of saying this is that the initial idea is almost never the idea that ends up getting commercialized.

Organizations can benefit tremendously from a disciplined process of rigorously testing the commercial utility of these creative **ideas**, so long as the required discipline does not diminish the group's creativity. It is essential not to diminish group creativity because non-linear thought processes are apparently required tight up to the product launch stage in order to continually reshape the **ideas** and optimize the chances of creating commercially successful new products. Hence, understanding the success curve relates directly to the staffing and management of NPD efforts and therefore has profound implications for managing the new product development cycle itself.

An iterative process that continually reshapes new product **ideas** and converts uncommercial **ideas** into commercial ones would appear to be best approach. Such a system, requiting continuous reinvention oft he project throughout the NPD process, coupled with ongoing business evaluation and revision, will be discussed in a later paper. We also plan to investigate quantifying the value of improving the success rates of innovation, both to corporations and to society at large.

**Table 1--Survival Rates from Patent Activity**

Legend for Chart:

A - Patent Process
B - Stage of Patent Process
C - Best Est.
D - % Surviving Prior Stage

| A | B | C | D |
|---|---|---|---|
| Raw **ideas** | 1 | 3,000 | 100 |
| Patent disclosures | 2 | 300 | 10 |
| Patent applications | 3 | 150 | 50 |
| Issued U.S. patents | 4 | 112 | 75 |
| Patents with some value | 5 | 9 | 8 |
| Crown jewel patents | 6 | </=1 | </=10 |

**Table 2--Survival Rates for Industrial Innovation Ideas**

| | Survival Rates | Percentage Surviving |
|---|---|---|
| American industry overall | 1 in 500 | 0.2 (is equivalent to 0.04 see text) |
| Chemicals | 1 in 540 | 0.19 (is equivalent to 0.04) |
| Pharmaceutical companies | 1 in 2,875 | 0.03 |
| Drugs | 1 in 3,000 | 0.03 |

**Table 3--Success Rates for New, Commercially Launched, Industrial Products**

Legend for Chart:

A - Literature Reference
B - Commercial Success Rate from Launch (%)
C - Type of Company

| A | B | C |
|---|---|---|
| Booz Allen & Hamilton (4,11) | 67 | U.S., 1963-1968 |
| " | 65 | U.S., 1976-1981 |
| Robert Cooper (9) | 60 | 123 N. American |
| Robert Cooper (17) | 57 | Electrical |
| " | 66 | Equipment |
| " | 56 | Chem. & Pharm. |
| " | 55 | Components |
| " | 63 | Miscellaneous |
| " | 59 | All firms (103 total) |
| Hopkins/The Conference Board (3) | 62 | Industrial |
| " | 60 | All co's (148) |
| Edgett (15) | 60 | Japan, 1987-1992 |
| | 54 | U.K., 1987-1992 |
| Hussey (7) | 46 | U.K. |
| Large midwestern chemical co. (see text) | 44 | U.S., 1948-1986 |
| Mansfield (18) | 40 | Chemical, |
| | -- | 2 Drug |

**Table 4--Survival Rates from Project Information**

Legend for Chart:

A - Stage in NPD Process
B - Best Estimate
C - % Surviving Prior Stage
D - % Surviving from Raw Idea Stage

| A | B | C | D |
|---|---|---|---|
| 1. Raw **ideas** of inventors | 3,000 | 100 | 100 |
| 2. Idea submission and reshaping | 300 | 10 | 10 |
| 3. Small R&D projects | 100 | 33 | 3.3 |
| 4. Significant development projects | 8 | 8 | 0.27 |
| (and early market development) | | | |
| 5. Major development initiatives | 4 | 50 | 0.13 |
| 6. Launch | 1.7 | 43 | 0.06 |
| 7. Economically profitable | 1 | 60 | 0.03 |

**Table 5--Survival Rates from Venture Capitalists**

Legend for Chart:

A - Idea Stage in Venture Capital (V.C.) Evaluation
B - Best Estimate
C - % Surviving Prior Stage
D - % Surviving Original Submission (or % from raw idea stage)

| A | B | C | D |
|---|---|---|---|
| Raw **ideas** of inventors | 3,000 | 100 | -- |
| **Ideas** submitted for V.C. and given equivalent to 20 minutes each consideration by V.C. community | 300<br>-- | 10<br>-- | 100<br>(10) |
| **Ideas** evaluated by V.C. community for equivalent to 4 hours | 120<br>-- | 40<br>-- | 40<br>(4) |
| **Ideas** moving to analysis of market need, inventor, business-plan and management | 75<br>-- | 63<br>-- | 25<br>(2.5) |
| More in-depth analysis by venture capitalists | 45<br>-- | 60<br>-- | 15<br>(1.5) |
| Offers made by venture capitalists | 15<br>-- | 33<br>-- | 5<br>(0.5) |
| Offers from venture capitalists accepted | 9<br>-- | 60<br>-- | 3<br>(0.3) |
| Economically profitable successes | 0.9-1.4<br>-- | 10-15<br>-- | 0.2-0.3<br>(0.02-0.03) |

**Table 6--Survival to Commercialization for Substantially New Products, from Three Sources**

Legend for Chart:

A - Stage of Innovation
B - Arbitrary NPD Stage
C - Patent Analysis
D - Project Analysis
E - Venture Capital (V.C.) Analysis
F - Best Overall Success Curve
G - "Universal" NPD Stage

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| Raw **ideas** | 1 | 3,000 | 3,000 | 3,000 | 3,000 | 1 |
| Disclosures, or **ideas** sent to V.C. | 2 | 300 | 300 | 300 | 300 | 2 |
| Patent applications, small R&D, or **ideas** with 4 hrs. analysis | 3 | 150 | 100 | 120 | 125 | 3 |
| Issued patents | 4 | 112 | -- | -- | 112 | -- |
| Partial V.C. analysis | 5 | -- | -- | 75 | 75 | -- |
| More in-depth V.C. analysis | 6 | -- | -- | 45 | 45 | -- |
| Offers made by V.C. | 7 | -- | -- | 15 | 15 | -- |
| Patents w/marginal value, serious projects, or V.C. offers accepted | 8 | 9 | 8 | 9 | 9 | 4 |
| Major development initiatives | 9 | -- | 4 | -- | 4 | 5 |
| Commercial launch | 10 | -- | 1.7 | -- | 1.7 | 6 |
| Economic success | 11 | 1 | 1 | 1 | 1 | 7 |

**Table 7--Assimilated Data from All Sources, Used in Combined "Best" Success Curves**

Legend for Chart:

A - New Product Development Success Curve Data, Merged from all Sources, for Industrial Firms, for NPD Stages 1-7
B - Low Est.
C - % Surviving Prior Stage
D - Best Est.
E - % Surviving Prior Stage
F - High Est.
G - % Surviving Prior Stage

| A | B<br>E | C<br>F | D<br>G |
|---|---|---|---|
| 1. Raw **Ideas:** Ideation<br>Technology or market driven<br>Unscreened,<br>Un-researched<br>Not market-segmented | 1,000<br>100 | 100<br>6,000 | 3,000<br>100 |
| 2. **Ideas** Shaped and Explored<br>Tiny R&D effort: 0.1-1 man-year<br>Raw **ideas** screened<br>Patent disclosures submitted<br>Patent application filed<br>Secondary market research | 100<br>10 | 10<br>600 | 300<br>10 |
| 3. Small Project:<br>R&D effort: 1-3 man-years<br>Patents issued, or very likely to, but are of unknown value<br>Opp. analysis done before Stage 4 | 30<br>42 | 30<br>270 | 125<br>45 |
| 4. Significant Project:<br>Significant R&D effort: 10+/- men<br>Patents w/potential value exist<br>Market segmentation and analysis<br>Quantitative market size and critical requirements determined (preferably earlier, hopefully by now) | 1.5<br>7 | 5<br>21.6 | 9<br>8 |
| 5. Major Development Effort<br>Pilot plant R&D, product definition<br>Customer trials and test marketing prove competitive advantage<br>Scale-up engineering beginning | 0.6<br>44 | 40<br>10.8 | 4<br>50 |
| 6. Commercial Launch<br>Full-scale plant built<br>Sales force trained, market roll-out | 0.2<br>43 | 33<br>5.4 | 1.7<br>50 |
| 7. Commercial Success<br>Plant working, nearing capacity<br>Economic profit in sight<br>Crown jewel patents exist<br>Sustainable competitive advantage<br>Continuous improvement in place | 0.08<br>60 | 40<br>3.51 | 1<br>65 |

GRAPH: Figure 1.--This "universal industrial success curve" illustrates the number of "substantially new "product **ideas** surviving between each stage of the new product development (NPD) process.

GRAPH: Figure 2.--The success curves from three different sources are remarkably similar for the number of "substantially new "product **ideas** surviving between each stage of the new product development (NPD) process.

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