INVENTORS AND INVESTORS:

TECHNOLOGY TRANSFER BY PERSONAL CHEMISTRY

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INTRODUCTION

This section of the Proceedings is devoted to the problem of technology transfer and each of the other papers describes what I would call a formal approach to the problem. That is, they describe organizations with specific charters to perform technology transfer (such as the EPRI NDE Center) or specific contracts to bridge the gap between the laboratory and the production floor (such as the RFC program). My purpose is to explain how it REALLY happens in the majority of cases. Specifically, I will describe the key role played by individual entrepreneurs and the personal chemistry that is needed to spark the separate steps along the treacherous trail of technology transfer.

If one inverts the problem and asks, "How did today's important technologies actually achieve general utility?" the studies show that small businesses and garage inventors played a significant or even a dominant part. The U.S. Department of Commerce study, "Technological Innovation: Its Environment and Management," (Charpie Report—1967) quotes a Jewkes study of 61 important inventions and innovations in this century in which it was found that over half of those inventions came from individual inventors working on their own behalf with limited resources. The National Science Foundation concluded in "Science Indicators, 1976" that "... on the basis of a sample of major innovations introduced to the market between 1953 and 1973, small firms (with less than 1,000 employees) were found to produce about 24 times as many major innovations per R and D dollar as did large firms (with over 10,000 employees) and four times as many as medium-sized firms." An MIT study for the Department of Commerce on "The Job Generating Process," (David L. Birch, February 1979) showed
that, "Small firms with 20 or fewer employees created 66 percent of all net new jobs in the private sector between 1969 and 1976."

The moral of these results is that if you want to encourage innovation, transfer technology, and create new jobs, then you should encourage the lone inventor or the small businessman. In short, help the entrepreneur practice his trade. It is the contention of this paper that the process by which an innovation is carried through to utilization involves a unique interaction between an inventor and an investor. This is a very personal process and occurs only in a free enterprise system such as we enjoy in the United States. I like to view it as a chemical reaction in which the entrepreneur plays the role of a catalyst. Hence my subtitle, "Technology Transfer by Personal Chemistry."

INVENTORS AND INVESTORS

In order to establish this process of technology transfer, it is important to define exactly who inventors and investors are and to view what personal traits bring them together. Both are deeply dedicated to the performance of innovation utilization but they view the process from quite different perspectives. Fig. 1 depicts how an inventor views technology transfer in terms of the growth of his "acorn" of an idea into a giant oak tree that provides financial shade for all the participants. The investor simply attends to the

Fig. 1. An inventors view of technology transfer.
watering of the young tree and, of course, rightfully shares in the ultimate harvest. On the other hand, the viewpoint of the investor is that of a wise shopper who buys a calf when it is small and inexpensive. As Fig. 2 shows, he is able to convert this little calf into a productive "money cow" after which he retires to contemplate his next "good buy." Naturally, he shares his ultimate good fortune with the calf's original owner by buying him another baby cow to be raised.

Although these figures describe the fundamental motivation for technology transfer in a cartoon format, it is a true process that actually takes place. In fact, it works so well that it is a major means of converting laboratory ideas into commercial hardware, as the studies referenced above clearly demonstrated. Thus, it is the small businessman acting as an individual who overcomes the many barriers that block the smooth transition of technology to the marketplace. Let us now examine these barriers and see what the entrepreneur or small businessman does in order to accomplish his mission in life.

**BARRIERS TO TECHNOLOGY TRANSFER**

In every organization, there are well established boundaries to channel the flow of ideas and resources toward the goals of that organization. It is clear that an individual who has no set
organization can easily accomplish a specific technology transfer objective and then collect any and all of the rewards for that accomplishment. As a result, it is common practice for the individual to blame the rigid organization channels of a bureaucratic corporation for failure to exploit all of his new concepts that are generated in their research laboratories. However, the real reasons for corporate failure to transfer technology may be much more subtle and the blame for the failure cannot be placed solely at the feet of big business. Government research laboratories and even the Great Universities have their own unique barriers to moving ideas across the development gap. The list below provides a summary of few of the less obvious barriers in organizations that tend to suppress the easy transfer of technology.

Corporate Channels

In a large corporation, the decision to pursue or drop a promising technology is often made in a series of steps along a chain of command that channels and packages promising ideas from the research labs into a form suitable for presentation to the next level of management. Not only does this process take time, but one negative vote along the way usually terminates that particular transfer process completely. In many cases, the decision makers are part of an overall management training program so individuals get promoted into other positions faster than the idea progresses along the channel. In this case, the idea may have to be returned to a particular level for review (and possible rejection) several times during its lifetime. Obviously, only those ideas that are carried through the channels by a personal champion can survive this "black ball" technology transfer procedure.

Government Channels

In our democratic society, every idea has a divine right to be heard and reviewed by a governmental funding agency. Thus, good ideas will always find their way into development and on to practical use by society. Unfortunately, the chain-of-command problems that beset the corporation simply become multiplied and the number of channels proliferates to accommodate the variety of ideas being presented. As a result, potential new technologies can be suppressed by referring them to another channel or by pointing out that it was not in the particular budget planned for this year. If these mechanisms do not deter a good idea, the prize for successfully navigating a channel is to get your proposal sent out for bids.

In defense of the government channel system, it must be agreed that some ideas do survive the process and technology does indeed get transferred by government agencies even though it may take a long time. The important point to be made here is that an examination of the successful transfer cases will usually show that
an individual who championed the cause was key to the success and that he served as a catalyst to drive the reaction toward a positive result.

**Intellectual Channels**

Since the university champions individual achievement and maximizes freedom of expression, it should be free of the organizational channels that suppress technology transfer and thus should shine as a fountainhead of useful innovations. Unfortunately, the surveys mentioned above show that this is not entirely the case. Although the university laboratories do show a very high ratio of innovations per R and D dollar, they do not surpass performance of the individual inventor working in his own behalf. The reason for this can be traced to restraints from what I will call intellectual channels wherein the individual university staff member must get the approval of his peer group to survive. If his ideas are viewed as not "good science" or if they fall outside of the current fad at the professional society meeting, his ideas can be suppressed as thoroughly as does a veto in the corporate management meeting or as a government proposal rejection. It is only full professors with tenure who can afford to champion a practical application and curtail the performance of good, basic research.

**ROLE OF THE ENTREPRENEUR**

There exists in our population an interesting individual called an Entrepreneur. He is usually born rather than made and our government actually encourages his growth and freedom. Fig. 3 depicts this character and shows how he may be recognized. It also lists the tools needed to become one. The most important pieces of hardware are the tools needed for tunneling between the channels of an organization. The most important personal traits are self-confidence, singlemindedness, and aggressiveness. It should be pointed out that these tools and traits include a technical background only as a nice addition and not as a fundamental requirement. Entrepreneurs usually have a variety of educational backgrounds and can enter the technology transfer game either as scientists with a practical bent or as business majors with technical interests. They do have to know the right people and that is why the person in Fig. 3 holds a set of skeleton office keys. By already knowing the right people or by getting to know them, the entrepreneur uses personal chemistry to achieve the separate steps along the route to his goal. He befriends a scientist for technical input, deals with salesmen for facilities, finds a sympathetic banker for a loan, gets legal advice from a relative, and most important, raises money by selling his vision of success to a venture capitalist. All of these key processes are accomplished by personal contacts and a feeling
of trust between individual people. Hence, it is technology transfer by personal chemistry in its most blatant form.

TO BUILD A BUSINESS

The conclusion to be reached from the preceding arguments is that if you want to see a laboratory demonstration or a theoretical result become a useful product in society, you should find (or become) an entrepreneur and form a small business and go do it in spite of all advice to the contrary.

Table 1, below, provides a list of all the major requirements for establishing a technical business and also suggests where to go to procure each of these requirements. Naturally, it is necessary to have a novel invention to start with. This is usually obtained from your own knowledge or experience. Either a lot of originality or some very good friends form the other possible sources for this fundamental starting point. Although it is easy to have a "gut-feeling" that there is a market for the technology, this ingredient is the most important and most difficult to obtain reliably. Usually a new, high technology company will sell its products to the government but the private sector is a much broader and more profitable market base on which to start a business. It is a wise entrepreneur who seeks out and evaluates market information from unprejudiced sources so that he does not end up selling his product primarily to himself.
Table 1. Key ingredients needed for starting a business to transfer technology.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Possible Source</th>
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<tr>
<td>An Invention</td>
<td>Knowledge, experience, originality, good friends.</td>
</tr>
<tr>
<td>A Market</td>
<td>Government, corporations, small businesses, self.</td>
</tr>
<tr>
<td>Facilities</td>
<td>University lab, corporate lab, contract lab, own garage.</td>
</tr>
<tr>
<td>Guidance</td>
<td>Lawyers, business schools, accounting firms, one's own nose.</td>
</tr>
<tr>
<td>Money</td>
<td>Bank, partnership, joint venture, user industries, venture capitalists, stock sales, own savings.</td>
</tr>
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Facilities for performing demonstrations of prototypes and for manufacturing the final product are an obvious necessity but do not have to be a serious obstacle. A corner of the corporate or university laboratory often harbors a test rig whose data output looks very impressive in a three-color handout at a technical meeting or show. Contract laboratories (such as Battelle, Southwest Research, A. D. Little, etc.) are always available to perform critical tests that demand special equipment and they have the additional expertise to help the small inventor commercialize his idea. No new entrepreneur is a self-contained encyclopedia of all the technical, legal, and financial knowledge needed to successfully start a new business, even though he may contend that this is the case for him. Guidance from some professionals, no matter how trivial, can be the key ingredient that makes the difference between profit and bankruptcy.

The most often cited problem with getting an idea to market is the obtaining of money—usually in the form of a lot of cash. This is where the inventor's persuasive powers get tested and his ability to accept guidance become paramount. It is also where personal chemistry plays its most important role. Forming partnerships or joint ventures are clearly very personal processes and borrowing money from a bank usually reduces to the personal trust of a particular banker. Although the launching of a company through the sale of stock to a lot of faceless stockholders would seem to be a very impersonal process, it demands the personal interaction of the company officers with a very human and conservative stockbroker or
By far the most important need for personal chemistry arises with the always necessary interaction between the inventor and the venture capitalist. Almost every business needs starting capital and these funds usually come from an individual who is willing to take special risks with his money. Therefore, the inventor and the investor must meet and learn to work together early in the process using talents that demand excellent personal rapport.

THE INVENTOR/INVESTOR INTERACTION

Since the interaction involves two people who come from different backgrounds, it is important to start with a clear understanding of the viewpoint each brings to the first meeting. Fig. 4 shows how each member may view the other at the outset of their relationship. To the inventor, an investor is a harsh taskmaster who defends his vast sums of money with demands for financial predictions and personal sacrifices far in excess of the value to be derived from the inventor's little idea. On the other hand, the investor sees the inventor as a hungry giant whose idea will easily devour every free penny available to the small investor.

Once the preliminaries of establishing the boundary conditions on the business deal have been completed, the two future partners can get down to the detailed negotiations. Fig. 5 shows that here

Fig. 4. Different viewpoints on the investor/inventor relation-
again some preconceived notions can influence the outcome. The inventor expects to have all the money he needs to establish a first-rate R and D facility while the investor sees a rapid conversion of scientific knowledge into a handsome return on investment. Needless to say, harsh reality soon overtakes the couple and they find themselves sharing each other's professional skills in order to make the venture survive. Figure 6 describes this ultimate state-of-affairs.

CONCLUSIONS

Although presented in a cartoon format, this paper has described the serious effort involved in achieving technology transfer by the formation of a small business. Statistics accumulated by the federal government indicate that a very large number of new technologies have reached their goal of full utilization by using this path so it is important to have it recognized as a viable approach. Recent legislation on the federal level has encouraged the use of this method of technology transfer by establishing Innovation Centers associated with universities and by setting aside R and D funds specifically for small, high technology businesses. The Innovation Centers provide a place for individual inventors to go for help in getting their ideas
Fig. 6. After the formation of a partnership, each member finds new challenges.

Fig. 7. Characterization of the actual process by which technology is actually transferred.
out of their garage laboratories and into the marketplace. The small business set-asides now required in government budgets insure that money will be available for performing the applied research needed to transfer basic concepts into working models that can excite the imagination of even the most cautious of venture capitalists.

It has been a secondary purpose of this paper to point out the fundamental importance of the individual in making technology transfer happen. This is very clearly emphasized by the role of the entrepreneur in transporting an idea through the maze of formal channels to a useful product. Since individuality is such a key ingredient, it is obvious that personal interactions, i.e., personal chemistry, can block or expand each step along the way. Fig. 7 graphically summarizes the message to be taken from this paper.

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