Synergistic Effects Through Licensing

Closer ties between academia and industry can benefit both and profoundly affect nation's scientific and technical assets

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I INTRODUCTION

An analysis of past trends and the current situation reveals that the business environment of the United States has undergone dramatic changes in recent years. A number of factors are converging that will result in new incentives and new opportunities for a vigorously expanded licensing activity. For example:

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- Many corporations, once considered growth companies, now find themselves in the classification of maturing industries in a strongly competitive situation.
- Capital investment is high.
- Interest rates are up.
- Profit margins are down.

Changing Environment for Research and Development

As a result of these factors, research is on the defensive, and pressures are growing to demonstrate a payoff and to shorten the time from R&D to the commercial plant. Consequently, industrial R&D programs have become shorter range, with continued cut-backs in basic and exploratory research in many laboratories. Data from the National Science Foundation indicates that industry is performing less than 20 percent of the basic research in this country, and the amount of research supported by industry in our universities is a small fraction of the total. At the same time, government support of research programs has been decreasing on our campuses. Today we are faced with a drop in significant new discoveries, and avenues for diversification have been closing.

These trends are contrary to the best interests of our country, for an examination of business and economic trends since World War II reveals an increasingly close relationship among science, research, invention, innovation, technology, economic health, and social well-being.

Pertinent to this area of concern are the following comments made by Guy Stever, Head of the National Science Foundation, and Science Advisor to the President:

"This country's leadership in high technology is being strongly challenged in many ways in many parts of the world. . . . There comes a time in every industry and every country when more basic and applied research is essential to bring totally new products and services — and even better ones at lower prices — into the marketplace. World conditions are telling us that that time is here and now, if not past due."

Dr. Stever's comments reflect serious concern in many quarters and a growing realization that we cannot afford to continue to downgrade the importance of research and

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research applications in our nation. The time has come for decisive and meaningful action, and it is becoming increasingly clear that we must turn to our universities, not only for training of our people, not only for basic research to learn more about nature's secrets, but also for new scientific and technical discoveries.

The goal from the industrial side is a working and mutually beneficial relationship to move from scientific discovery or invention to technical innovation to public use through new or improved products and processes. In the end analysis, this means bringing university inventions into effective commercial development and industrial application, through technology transfer.

II. SYNERGISTIC EFFECTS IN TECHNOLOGY TRANSFER: RELATIONSHIPS INVOLVED

As we address ourselves to the matter of synergistic effects in university-industry-cooperation in scientific and technical areas, it might be well to start with an examination of the basic relationships involved in technology transfer — which is an activity that is gaining increased recognition as an important factor in successful innovation.

Technology Transfer

Although the term itself has found increasingly popular use in recent years, there is a lack of agreement or understanding on what is meant. The word technology has several definitions. In its broadest sense, is defined as "the totality of the means employed to provide objects necessary for human sustenance and comfort". In the sense of this discussion the narrower definition will apply, namely, "A technical method of achieving a practical purpose". Thus, we shall be principally concerned with transfer of research results, new ideas, and inventions that can be applied to new or improved commercial products, processes and techniques.

Synergistic Effects: University-Industry

This brings us to the matter of synergistic effects between university and industry. The current Webster's Collegiate Dictionary defines synergism as, "Cooperative ac-

tion of discrete agencies, such that the total effect is greater than the sum of effects taken separately". In the matter of university inventions and industrial application, the final synergistic effect is manifested in an end result that is more useful or more valuable than the simple sum of the results if each side of the licensing transaction had worked independently.

For the optimum synergistic effect a close working relationship or partnership is needed. Indeed, industry today does depend on the university for trained people in all areas of activity. Although the primary role of the university is *education*, advancement of knowledge through fundamental research is an important adjunct to an effective educational process. Academic research can play an important role, beyond revealing nature's secrets. In the partnership with industry, the university can expand our store of useful technical information and open new doors for investigation through scientific and engineering breakthroughs and inventions.

As the other member of the partnership in achieving the desired synergistic effect, industry provides the financial means and the techniques for converting technical knowledge and inventions to constructive use. Involved in this effort are most or all of the following:

Further research
Product and/or process development
Economic evaluation
Market research
Market analysis
Market development
Engineering research
Management decision
Product and/or plant design
Plant construction and

Development of sales or marketing channels to bring the final product to the customer.

Most of the foregoing are activities that the university cannot or ordinarily does not pursue. A partnership relation with industry is essential if we are to realize effective application of the results of university research.

There are several routes to achieve the desired ends via technology transfer from academia to industry. Some of the possibilities include:

Publications: A very important goal of those in academic life is publication. There is a mistaken conception on the part of some academic scientists, however, that publication in a scientific or technical journal is sufficient to effect technology transfer. Actually, publication in itself will have little impact, for, "What belongs to everybody belongs to nobody". In other words, an important incentive for commerical risk is lost.

Consulting: Transfer of valuable scientific and technical information is made through consulting arrangements. Some academic scientists, however, limit their consulting activities to theoretical discussions or do not have a full grasp of practical industrial aspects of a problem.

Licensing: The most promising route for technology transfer is through inventions stemming from university research. They can provide broad and economically important foundations for new products and processes. However, academic inventions are largely undeveloped, and manufacturers are understandably reluctant to develop them into a marketable product or service without a proprietary position. Patent protection, therefore, is an important base for motivation of the industrial firm.

Some schools have well-developed patent assessment and patent prosecution procedures, whereby the results of university projects are carefully screened by a patent review board. Those schools that are better attuned to industrial needs offer exclusive licenses. Many universities, however, do not have a strong mechanism for identifying inventions from their research nor for obtaining patent coverage as a basis for licensing. The rewards for increased effort in this area could be substantial to the university as well as to industry.

III. BENEFITS AND INCENTIVES FOR UNIVERSITY-INDUSTRY LICENSING PROGRAMS

University Incentives and Rewards

Personal visits to a number of schools has revealed a growing realization that much is to be gained through a well-defined patent policy and patent licensing program. Experience by a number of universities has shown that when scientific discoveries and technical advances are put through a careful patent screening program they have the best chance of adequate evaluation and useful application.

Universities that participate in the opportunity for increased patent activity stand to gain in a number of ways:

Institutional and Professional Recognition

In terms of benefits to the university, patents and patent activity provide a pathway to increased recognition of the institution and also recognition for the researcher. Issued patents constitute concrete evidence, not only of a first or early date in a given area of scientific or technical activity, but also of original and novel research. At the same time, patent activity need be no bar to continued publication. Furthermore, a patent carries as much or more weight to people in industrial circles as does publication in technical journals, for an issued patent has passed a more stringent board of review.

Attention to patents is of growing importance as a pathway to recognition in government circles as well as industrial circles. As a result of the growing awareness of, and attention to the importance of the university-industry interface by government agencies, those universities with strong patent programs and those professors involved are receiving increasing attention.

Financial Rewards

Shrinking federal budgets for support of research programs on our campuses have brought the universities to the realization that they must turn to other sources for funding. A strong patent program can provide potential for substantial monetary return through licenses, as has been proved by some schools. Furthermore, evidence of patent activity in specific areas can be used as feedback information to provide a basis for decisions by industry to fund academic research, over and above payments as licensing royalty. The results can be a continuing synergistic effect — with licensing income and research grants providing for expansion of meaningful research programs.

"Relevance"

During the period of demonstrations and student uprisings on our U.S. campuses, one of the strong issues was the cry for relevance in academic programs, with the charge

that many professors in their ivory towers were out of touch with the real needs of society. The points presented in the foregoing comments are directly in tune with the theme of increased relevance to human and national needs; in fact, "making science useful" should be recognized as a moral responsibility as well as a means for providing an outlet for good basic and theoretical research.

Education Role

In the final analysis, the major role of the university is to select and train young people to enter productive careers that will serve society's real needs. Increased interaction with industry via patent and licensing activity can very strongly support the basic educational role and enhance the soundness of the education process. It can make more meaningful, more exciting, and more attractive the results from our academic programs — along with relating scientific and technical breakthroughs to true inventions and a base for significant patents.

By giving the universities a greater spectrum of potential relevant areas for *sound* basic research, a patent and licensing program can also serve to give students a greater freedom of choice by providing their professors with expanded horizons in their consideration of research programs, leading those programs to mission-oriented areas. The student gains not only a better education but also improved opportunities for placement after graduation.

Rewards to the professors include:

- The ability to attract better students
- More significant publications
- Financing higher levels of research
- Improved opportunities for meaningful consulting

Industry Incentives and Rewards

In considering industry incentives, the first item on the list is productivity. Numerous statements have been made that our decrease in industrial productivity and our loss in world balance of trade are linked with cuts in innovative research and a decrease in new discoveries on the part of industry in the United States. To obtain specific numbers I contacted the U.S. Patent Office and obtained the following information: Of the total patents issued in the United States, the percentage of U.S. corporations declined from 59 percent in 1961 to 50 percent in 1974 — a drop of 9 percent — while U.S. patents issued to foreign corporations increased from 11 percent to 24 percent — an increase of 13 percent.

A recent editorial in *Chemical and Engineering News*[1], citing specific declines in productivity, analyzed the situation as follows:

> If we can improve technology transfer, the value of much of our research expenditure is expanded significantly. And with all of this, the "real" value of a research and development effort becomes more visible and its funding becomes a more tangible matter. Research and its impact on our national productivity is too important to be left so completely in the realm of "intangibles".

Alternatives for New Development Programs

Closely tied to increased productivity is the importance of more and better alternatives for new development programs.

A continuing study of leading companies and management of new products is conducted by Booz-Allen-Hamilton (Management Consultants) and brought up to date periodically. An early study revealed that it takes some 40 ideas to go through the stages of screening, development, testing and preliminary commercialization to yield one successful new product. A more recent survey[2]* shows that of all the dollars in new product expense, "almost three-fourths go to unsuccessful products. About two-thirds of these waste dollars are in the development stage". In terms of technical effort "about four out of five hours devoted by scientists and engineers to development of new products are spent on projects that do not reach commercial success".

It is extremely important, therefore, that the best possible array of alternatives be available as a basis for commercial development. This is a more critical consideration than previously because of rather sharp reductions in research budgets by many companies in recent years and — as previously mentioned — because much of industry's on-going research is of shorter-range nature.

The cost of finding a new or novel idea for further development via university support is considerably less than the cost of doing the exploratory, innovative research in the industrial laboratory.

Improved Relations with Universities

An active patent and licensing program on the campus and the resulting interactions of university people with industrial representatives will provide improved insights into industry's problems and needs — and hopefully will erase some of the popular misconceptions regarding industry's motives and operations that prevail in too many of our universities. The net result, on the one hand, will be in a flow of better-trained people and an improved image of industry; on the other hand, industrial representatives will gain a better understanding of university problems and will be inclined to provide increased support to the university — both moral and financial — with mutual benefits to both sides.

IV. BARRIERS TO TECHNOLOGY TRANSFER THROUGH LICENSING

The foregoing comments have dealt with the incentives and rewards from an active university patent and licensing program. However, this presentation would be unrealistic and incomplete if it did not call attention to a number of problems that need to be recognized, understood, and dealt with if industry applications of university inventions is to reach its potential. Some of these problems were defined as follows by the National Academy of Engineering Report Committee[3]:

> ... A plethora of structural and institutional barriers exist in the Federal Government and in the private economy to prevent the efficient and effective utilization of technology developed through government supported research. ... There has been inadequate concern about financial risk, lack of patent protection, or other start-up problems that impede the private sector's ability to bring technology to market.

Government

Pertinent to barriers stemming from the government side was a recent survey conducted by Technology Transfer Associates. This study revealed serious concerns regarding patent and licensing rights connected with

government-funded research projects. A typical comment:

> ... There is a growing tendency in Washington to demand full rights, not only on the specific research covered by a given contract, but also previous research and background rights related to the area of the contract. Since 1971 the situation has become considerably more serious as the result of actions by certain members of Congress, as well as those on the judicial side.

Another comment:

> ... Recent events in Washington have made life very difficult. For example, certain congressmen represent a destructive negative influence as far as legislation is concerned. There are also others in Washington who misinterpret the laws we do have and who make it very difficult to carry out meaningful programs.

The matter of patent rights came into bold review in two days of hearings in July before the Joint Sub-committee on Economic Growth. A strong message in these hearings was that the Federal Government represents one of the most serious barriers to technological innovation.

Concern regarding government policy on ownership of patents is not a recent happening. For example the problems involved in complete government ownership of patents were basically defined in 1969 by Lawrence Hofstad,[4] Vice-President of Research Laboratories, General Motors:

> The key question is "what happens next *after* the patent is turned over to the public?" If the manufacturers shun the patent since they no longer have any hope of protecting their chance of recovering high development or tooling costs — then the high sounding operation of "giving the patent to the public" becomes a completely useless gesture, regardless of its political appeal. In fact, it is worse then useless; it is negative. By giving the patent to the public in such instances, it ensures that no manufacturer can pick it up, and the public will not receive its benefit in the market place.

University

Turning to the university, we find that many people are geared to fundamental or basic research which is scientifically meticulous, and which lends itself to publication, but in many cases in a narrowly restricted way — rather than research which deals with real-world problems as viewed in the light of business needs and the needs of society.

Attitudes on some university campuses are reflected in a session on University-Industry Relations sponsored by the Industrial Research Institute. Commenting on the attitudes fostered by some of his collegues, one university professor said, "The student is given the impression that making science useful is somehow degrading. By example if not by word, he is taught that theoretical or pure research is the only career in science that is worthy of superior minds."

As another university participant put it, "There is a reluctance to undertake any substantial activity which can be interpreted to be of direct use or benefit to individual private interests. In some schools there is an underlying philosophy that patenting or licensing and invention is unethical and selfish."

Industry

Perhaps the major barrier to licensing of university inventions from the industry side is a reluctance to accept and follow through on discoveries or technical developments that come from the outside. In some cases this is a matter of pride. Still another barrier is an inherent resistance to move from established routines or beyond existing products. This situation was the subject of a recent comment in Industry Week.[5]

> Standing between ingenuity and accomplishment is a time-honored but archaic attitude known as the "not-invented-here" syndrome. For too many years, the technical community has looked down its collective nose at applying another man's work to a specific problem.
>
> The Japanese are not so inhibited. They have been buying five times as many technology licenses from U.S. firms as we have from theirs. They have used unabashedly what they learned from others to build themselves into an industrial power.

Hopefully, the attitudes in the United States are changing. Evidence to this effect is the rising pressure from industry to alter licensing policies on patents generated under government funds. Also, on the basis of personal experience as well as feedback from others — such as members of Research Corporation, Battelle Development Corporation, and Dvorkovitz Associates — it would appear that the NIH barrier is not as serious as in the past.

V. RECENT PROGRAMS TO ENCOURAGE TECHNOLOGY TRANSFER

The barriers to innovation just outlined have been a matter of concern by a number of organizations. Continuing efforts have been made to improve the situation and to establish meaningful programs for enhanced technology transfer from universities to industry.

Government

The formation in 1972 of the Science and Technology Policy Office as part of the National Science Foundation represents a specific measure to enhance the stature of our academic research efforts and to make these efforts more useful in serving our national needs. As one of its goals, the new office in the National Science Foundation has stressed the encouragement of new forms of participation and interaction between industry and academia — with government backing and encouragement.

Patent Awareness Program

A recent development that merits special mention in the context of this paper is the Patent Awareness Program, sponsored by the National Science Foundation, organized last year, and now underway. Principle objectives of this project are:

- To develop an awareness of the value of university inventions
- To build on the results of university research by encouraging attention to patents
- To step up the application of university discoveries through licensing activities.

To this end the project is designed to encourage closer working relations with government granting agencies and to overcome the antitechnological climate among some college students and professors. The Patent Awareness Program is designed to lead to a better understanding of what industry and industrial developments are all about, and as a corollary, to give corporate management a greater appreciation of the value and importance of the university.

Recent discussions with Dr. Willard Marcy, Vice-President of Research Corporation, reveal that the program is going quite well. In its initial stages it has involved visits to several schools with personal contacts at the top administrative levels and a series of seminars involving department heads and professors.

Government Patent Policy

Directly in tune with the present Patent Awareness Program is a series of activities on the part of various arms of the United States government relating to patent policy.

Despite these efforts, we are still far from a workable policy on exclusive licensing of patents flowing from government grants. But the fight goes on. There have been many contradictory and conflicting points of view and some highly vocal disagreements on policy from various factions in Washington.

Recent moves, however, have been designed for further liberalizing of patent policies to speed up licensing of inventions that came from government-sponsored research. A specific case in point is the recently revised patent rights provision of the Armed Services Procurement Regulations — with specific attention to university resources and university research.

Recent personal visits to Washington headquarters of the National Science Foundation and the Energy Research and Development Administration revealed other currently active policy programs and specific moves to encourage exclusive licensing of university research supported by Government funds.

VI. INDUSTRY-UNIVERSITY ACTIVITIES

Industrial Research Institute

As previously mentioned, the Industrial Research Institute has set up an Educational Liaison Committee to promote interactions and understanding between academia and industry. Illustrative of this effort is the fall program for the meeting in Cincinnati and the titles of two of the three major symposia:

"University Trends as they Relate to R&D"

"University and Industrial Interactions"

American Chemical Society

The American Chemical Society, through the Division of Chemical Education and Industrial and Engineering Chemistry, sponsored a symposium held in August on:

"Science and Technology in the Changing Economy: The Need for a Tripartite Relationship; University/Industry/Government"

Participants in the symposium included recognized national leaders from chemical education and industrial and university research, as well as those who had served in top positions in the U.S. government. Among the speakers was LES member Robert Gottschalk, who spoke on "Patents and Industry, Academia, and Government".

He reviewed possible mechanisms for the academic community to share in industrial research and development. On the basis of his background as former U.S. Commissioner of Patents and his experience in industry, he outlined the important role of patents in the industry-university relationship. Mr. Gottschalk further emphasized the need for an enlightened patent and licensing policy to aid and to promote university, government, industry cooperation. In his comments he specifically referred to some of the problems touched on in previous sections of this report. Some quotes from his presentation follow:

> ... Today the patent system is under attack because of the connotation of monopoly assigned to a patent grant ... It is easy to say that the government is not in business, therefore it doesn't need the protection of the patent. It's easy to say that the universities are not in business, therefore they don't need the protection of the patent.
>
> ... Patents are an important key to future progress — in translating scientific discoveries and knowledge to constructive use by industry. Furthermore, patent portfolios (and their use in licensing activities) by universities can be a stimulating constructive influence in university research — at the same time serving industry and the public at large.
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> ... Currently the Washington scene as regards exclusive licensing of patents from government supported research vs. a free license to all is in a state of confusion — with pressures from Congress to do away not only with exclusive licensing but also to force contractors to give up rights to their own previous research which involved their own funds in a given area.
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> ... With the proper use and assignment of patents we can bring industry-university-and-government together in a constructive relationship serving the best interests of the U.S.A.

VII. THE LINKING MECHANISM: MAKING TECHNOLOGY TRANSFER WORK

To foster the desired constructive relationship we need to ask: "Where do we go from here?" and "What further can we do to make technology transfer work in moving university inventions to industrial applications and successful commercial enterprises?"

Technological Forecasting

First of all in considering licensing as "A Businessman's Tool" in terms of university inventions, it must be recognized that timing can be all-important.

Many discoveries and many successful laboratory programs have gone unused because of poor timing. Research costs much more and loses much of its effectiveness if it comes too early; it can be a total loss if it comes too late. In planning a commercial development, an estimate must be made of the time required from the invention stage to the commercial product or process.

Technological forecasting, therefore, if properly conceived and conducted can be a useful planning tool by defining business trends and opportunities, in identifying corresponding technical requirements, in evaluating optimum paths and *timing* to gain the required technology.

Technical and Business Planning

In working from the technological forecast on through the technical and business planning procedure, consideration of university inventions and research results need to be weighed objectively from the standpoint of augmenting internal research programs — including direct licensing of existing available technical packages. In planning programs combining technical packages from the outside with internal efforts, significant savings in lead time (and dollars) can be realized by acquiring appropriate packages that have come out of university programs.

To achieve the desired goals, appropriate steps must be taken to bridge the gap between university sources and industry needs. As expressed by Dr. David in *Industry Week*, "... Industry must work with academia to establish programs which emphasize work-a-day technology and sound methodology. It means new ways of involving students in practical problem-solving situations."

Personal experience has demonstrated the value of direct contacts with professors and students on the campus in bridging the gap and in achieving the desired results. However, it would appear that more attention and effort are called for in this kind of activity. For example, during the course of visits to a number of universities, a common observation by deans and department heads has been that all too few industrial representatives have been around to the universities to talk in terms of specific interests — much less the commercial possibilities of the research underway.

Of importance in university contacts are clearly defined and well articulated needs, even those aimed at solving actual engineering, manufacturing, or product quality problems — as well as new services and new products. With such needs defined in terms of technical implications of interests to my industrial clients, I have found the response on the campuses to be warm and positive in personal visits and discussions.

Through intimate contacts with more than 30 universities, including personal visits to 25 campuses, a wide spectrum of areas of interest have been explored. The companies I represented have developments in petroleum and petrochemicals, heavy chemicals, specialty chemicals, agricultural chemicals, pharmaceuticals, and consumer-end products. Following is a partial list of major areas of interest:

Agricultural Technology	Enzymes, General
General Biosciences	Health Care
Energy: Sources	Materials
Energy: Transformation	Ocean Technology
Environmental	Polymers: Novel Systems
Enzyme Catalysis, Novel Systems	Reaction Systems

In the case of *each* of these areas, three or more significant research results or specific inventions were identified that have proved to be pertinent to my client's interests. In dealing with inventions from university campuses, however, it would be an oversimplification to say that the technology transfer operation is always easy. In many cases a basic patent position is not possible because patents have not been filed and publication by the university involved had long since appeared. In other cases, however, it is possible — even though the university does not have a well-defined patent and licensing system — to obtain rights to the invention and to work with the inventor(s) to initiate filing procedures or to work out a basis for arranging for a meaningful technology transfer program.

An important consideration in all cases is the personal factor, not only on the business and administrative side, but also with professors and students. Care and consideration should be given to the following elements:

- Incentives or "rewards" for the people directly involved as inventors or research leaders
- Optimum continued freedom in publishing in technical journals — in harmony with —
- Protection of necessary confidential information in the best interests of the company involved.

CONCLUSION

As we look at interactions with academia in the perspective of the theme of this meeting — "Licensing, A Businessman's Tool" — the following major synergistic effects are worthy of note:

- Proprietary protection in exploratory thrusts into new areas as part of the corporate diversification program.
- Reduced risk by starting with proved scientific breakthroughs and demonstrated novel research results.
- Viable supplementary inputs and/or creative expansion of on-going programs.
- Provision of viable alternatives in the search for the best technology to serve the purpose at hand.
- Substantially shortened time between discovery and development, or between development and commercialization.
- Lower cost for the company's R&D effort — or alternatively, increased benefits for a given cash outlay.

In addition to mutual rewards to industry and academia closer ties and working relationships can play a significant role in developing the full potential of our nation's scientific and technical assets. With licensing as an ultimate goal technology transfer from university to industry can aid in bringing about the following benefits:

- Strengthening our national balance of trade
- Improving our nation's general standing in the international technological community
- Solving our domestic environmental problems
- Meeting our basic energy and raw materials needs
- Continued improvement of our overall national well-being.

NOTES:

1. Albert F. Plant. *Chemical and Engineering News,* September 8, 1975.
2. Booz-Allen-Hamilton, "Management of New Products," December 1974.
3. *Chemical and Engineering News,* page 16, April 29, 1974.
4. *Research Management,* XII No. 2 (1969), Page 107.
5. Dr. Edward E. David, *Industry Week,* Page 40, April 7, 1975.