The Untapped University Resource

Invisible barrier separates industry from resource in university scientists; can initiatives be activated to create cooperative relationship?

BY EDWARD L. MacCORDY*

Driving across the Southwest from Beaumont, Texas through El Paso and into New Mexico and Arizona you cross bridge after bridge spanning stream beds which are either dry or marked by only a small trickle. The watersheds feeding these streams and the cloud-pocked sky above seem endless, but most of the time the downstream settlements, large and small alike, can expect little from the streams to satisfy their needs, much less to support future growth.

The day may be approaching when the full potential of the resources of the Southwest could be realized if we use our ability to influence nature to produce more rainfall for the downstream users, thereby providing relief from excessive dependence on the limited supply from local wells. Tampering with Mother Nature may hold the prospect for both national and localized benefits but it is a bold undertaking which can succeed only with initiative by imaginative leaders and with the active support of those who would be the prime beneficiaries. It's a challenging and complex undertaking, or should we, unlike our enterprising forefathers, be content with the arid status quo?

It appears that there is a somewhat analogous situation nationally with respect to the supply of new technology. New fundamental knowledge from American universities is no longer confined to the American industrial scene but passes freely through modern communications to be used by all industrialized nations.

Meanwhile, in the region of American business evidence mounts that the local wells of industrial R&D are producing at capacity or even at a somewhat diminished rate. Although the technology transfer conduits from the vast fields of academic science to industry have been increased in recent years, there is little evidence that the flow of new technology from universities has not stabilized at the level of a trickle.

In the national interest as much as the self-interest of individual American companies it is time to question whether or not university-industry collaboration has the potential to make major contributions to the growth of American technology on a continuing basis commensurate with the tremendous research resources at work in the university sector.

Associate Vice-Chancellor for Research at Washington University, St. Louis, Missouri.

Deficiencies

Deficiencies which are preventing development of a productive university/industry partnership are fourfold:

1. The excessive dependence of university technology development and transfer programs on the vagaries of federal patent policy.
2. Universities do not detect all of the innovative technology being created on campus today.
3. Industry does not directly influence and stimulate the development of innovative technology in universities.
4. An effective two-way information system between industry and universities does not exist.

With initiative and leadership in these areas the full potential of an industry/university partnership serving the needs of society and working to preserve American leadership in technology could be realized. Or shall we opt for the status quo?

INNOVATION AT UNIVERSITIES

Universities often state their objectives as an integrated triad: Education, Research and Public Service. These universities expend almost $5 billion annually for research of which 67% is performed for agencies of the Federal government and 3% is performed for industry. While the higher education establishment consists of several thousand institutions only one quarter perform R&D. Two-thirds of this massive and diverse $5-billion academic R&D program is performed at 50 universities.

If you think these top 50 research universities have highly-productive technology transfer programs you are mistaken. There are a few shining lights, among which are Stanford and Wisconsin (WARF), and commendable efforts by others including the service programs of University Patents and Research Corporation.

But overall the amount of new technology flowing through the transfer pipeline to industry from the multi-billion dollar annual research program at these 50 R&D intensive universities may well have reached a plateau at a relatively low level. The reason for this appears to be that while the innovative process in universities is quite susceptable to positive influence without disturbing traditional activities in these hal-

lowed halls of ivy, the positive stimuli are not presently active to the extent necessary to produce significant results. If more is to be accomplished it will be by university and industry leadership working in concert, not by further well meaning intervention by the government.

The best measure of potential for innovation at universities is the number of doctoral-level scientists and engineers engaged in R&D at these institutions. National Science Foundation statistics on doctoral level scientists for 1975 reported:

Activity Type	Academic	Industry
Basic research	21,143	4,320
Applied research	7,700	14,382
Total Research	28,843	18,402
Development	681	7,467
Total R&D	29,524	26,169

Recognize that the separation of research into basic and applied categories is often an exercise in semantics and may have little meaning in this discussion, for as NSF explains these categories differ "chiefly in terms of the objectives of the investigator" not necessarily the nature of work performed. this takes on additional meaning when you consider that only 12% of university R&D support comes from NSF, the primary "basic" research sponsor, with the remaining 88% coming from "mission agencies" (DOD, NIH, EPA, etc.) and similar sponsors seeking "applied" answers to perceived societal problems.

Of primary interest is the fact that in total there are considerably more doctoral scientists and engineers engaged in research in universities than in industry. However, of much greater importance is the obvious fact that each individual company has access only to those few industry research scientists and engineers that it employs, but has free and equal access to the national resource of 29,000 university doctoral research scientists and engineers, their supporting staffs and well-equipped laboratories.

The $5-billion annual level of university research nationwide, as well as the level at individual institutions, is rather stable. This is a natural consequence of dominant use of university research capabilities by federal agencies and the relatively stable level from year to year of the university segment of the federal R&D budget.

However, this calmness on the surface masks extreme competition for available support among the scientists from each university. For example, at Washington University during a year you would find about 1,200 formal research proposals going to a wide variety of external sponsors, predominantly government agencies, which might result in about 800 projects being approved and funded totaling approximately $50 million.

Individual research projects would range from those costing several thousands of dollars each to a few with annual expenditures of over a million dollars each. Thus, at the top 50 R&D universities up to 50,000 projects are being conducted at any given time with new projects being proposed, approved and started each month. This is a measure of the magnitude and dynamics of the university potential for innovation.

THE SHADOW OF GOVERNMENT

Why does government sponsorship dominate university research and how does this dominance impact technology transfer from unviersities to industry?

Academic scientists seek support from government research programs because these programs (1) cover the complete spectrum of scientific disciplines, (2) are directed at attacking important problems and filling gaps in man's scientific knowledge, (3) are well funded with a new infusion of capital by Congress each fiscal year, (4) provide reasonable project funding levels and performance periods sufficient to undertake in-depth investigations, (5) are of a stable nature and continuous from year to year, and (6) are formally structured and well publicized as to program scope, deadlines, agency contact persons, etc. In summary, there is an established relationship between universities and government agencies supported by a comprehensive information system which communicates the needs of these agencies to the universities.

The ground rules are standardized, well understood and in general mutally acceptable. Only the government has the public mandate and supporting public resources necessary to sponsor diverse research in universities to the tune of billions of dollars each year. Obviously, the government will continue to exercise an influence commensurate with its dominant financial position, but in the area of technology transfer policy this influence has become counter-productive and in need of replacement by a new alternative policy that better serves the needs of society.

Primary Objective

Expansion of knowledge, not the creation of new technology, is the primary objective of government-sponsored research and it will remain so regardless of action industry may take to stimulate university innovation. However, by its financial dominance of university research the government has been able to shape and effectively regulate university licensing programs all in the name of protecting the public interest in the research investment and the consumer from abuse in the marketplace.

Save for a few realistic voices from deep within a very few agencies (Norm Latker at DHEW deserves special praise) the government's attitude concerning technology transfer activities is consistently one that looks with distrust at American business, fails to comprehend that industry alone can bring new technology to society via the commercial marketplace, and gives little support to normal business incentives essential to the functioning of the free enterprise system.

The future for an enlightened government patent policy for universities does not look bright and may well be characterized as very remote, the introduction of the Thornton bill notwithstanding. The Washington scene is one confusing, emotion-laden mess involving ever-present conflict among agency personnel at various levels, senators, congressmen, consumer advocates, the Antitrust Division of the Justice Department, small business, universities, and on and on.

Prospects for a uniform and positive government patent policy with a sound basis in law, which places faith in the free enterprise system, are becoming so remote that universities and industry are well advised to seek a closer working relationship removed from the shadow of uncertainty and negativism inherent in government regulation.

UNIVERSITY IMPROVEMENT

Engineering, physical sciences and life sciences constitute 77% of the $5-billion annual university R&D program. This is the massive program segment from which the trickle of innovative technology flows to industry. Two fundamental questions arise:

1. Is more than a trickle of innovative technology being created but not making its way into the transfer process?
2. Are universities capable of creating significantly more technology of commercial interest without detracting from their traditional functions?

Light can be shed on the first of these by an examination of current transfer efforts. The continued growth of new university technology transfer initiatives is no longer evident on any significant scale due in large measure to the reluctance of universities to make further speculative financial investments for additional staff or outside service agents. Such investments essentially represent the diversion of scarce university resources from support of the critical needs of the educational program and can only be justified by a solid promise of reaching at least a break-even point within a reasonable time and not thereafter falling back into the red ink. With this formidable uncertainty it is not surprising that the flow of technology from universities has probably stabilized at the level of a trickle in line with the limited transfer capabilities now in place.

So, to answer the first question it is well to look at evidence from a few university experiences. If a research university has no technology transfer mechanism few, if any, inventions will surface. However, create a functioning transfer capability, even as a collateral duty for a research administrator, and disclosures appear where there were none before. But go a step further with an additional investment of effort in the form of frequent face-to-face solicitations of disclosures from the research faculty and you will be surprised.

A very sharp initial increase of disclosures will likely inundate you. This initial surge apparently has an effect similar to "flushing the pipeline" and it may reasonably be expected that some drop off will occur thereafter. But then, should this solicitation effort cease the decay curve of new disclosures will rapidly bring you back to the lower level previously experienced.

This conceptual model is based on the experiences of several universities, a recent set of experiments conducted by the Research Corporation for the National Science Foundation, and the general pattern noted by University Patents as they have acquired new university clients. The evidence clearly indicates that the university research scientist desires to and will respond to positive stimuli. But, no one has gone beyond the active internal program stage to consider the potential results if university scientists were encouraged and guided directly by industry, the knowledgeable consumer of their innovative technology.

Thus, on average universities are identifying and transferring only a portion of the innovative technology presently being created within their research programs. New technology is being lost in laboratory notebooks and the massive scientific literature as well as being prematurely dismissed from the minds of academic scientists for want of any strong motivation to pursue its development.

The loss to society will continue until universities either take the gamble and invest in dynamic programs with well-qualified, full-time licensing personnel (Stanford, Minnesota, MIT, and WARF especially come to mind) or turn to dynamic service organizations which assume the initial personnel investment, work aggressively with faculty on campus and return a "fair" share of the proceeds to the university (the model of University Patents comes to mind).

But keep perspective. Expansion of university technology transfer capabilities by either of these means will, at best, reveal only the technology which is *presently* being created by academic research scientists as an outgrowth of their research for noncommercial sponsors. It will not bring into service the *full* potential of university research to contribute to the maintenance and growth of national prominence in technology in world markets. With just licensing program improvement the transfer pipeline will still run only at a relatively low level while the major opportunities continue to drift by untapped.

INDUSTRY INFLUENCE LACKING

In contrast to university operations, company management determines the new product objectives and thus the R&D objectives and is faced with the problem of making the best use of whatever limited R&D capability the company possesses. R&D resources are always "limited" in some way; amount, availability, diversity, creativity, etc.

If this is not recognized then such limitations are probably causing new product objectives to be less ambitious, imaginative and farsighted than society needs and national and world competition may dictate. Obviously, it is not cost-effective to attack R&D objectives by applying overwhelming resources in the style of the Manhattan Project. Rather, the critical first breath of life for innovative R&D comes from the right creative scientist who perceives a particular need and produces a unique insight that mysteriously occurs to few, if any, of his colleagues.

This phenomena dictates that a wise management will look for innovative ideas wherever they may be found and nurture them to maturity. Such should be the primary basis for university/industry cooperation.

The present concept of university licensing doesn't allow much opportunity for an aggressive executive in the typical company to satisfy his new product objectives in the university sector. At best he can hope that university research somewhere, which was designed to meet the needs of others (the sponsors), will fortui-

tously produce an innovation that might match one of his objectives.

Should this Haley's Comet-like event actually occur, he waits in ignorance of such occurrence with some small possibility that the originating university will offer to license the innovation to his company rather than to his competitors. If offered he hopes it will come close to satisfying his specifications. With such a complete lack of coordination between the new product objectives of companies and the R&D objectives of university scientists, it is no wonder that present prospects of fulfilling a company's needs from university research are comparable to the chances of capture for the sack holder in a snipe hunt.

Aggressive, innovative companies searching for new products should approach universities with one overriding purpose — to influence university scientists who are working in appropriate areas and who may have innovative ideas, to extend their interest and research objectives in a desired direction.

In its relations with the university world the company should not simply sit and hope for a gratuitous sip from the existing trickle of university byproduct technology but rather should seek means to influence academic scientists to create a flow in product areas of specific interest to the company. These university scientists can be influenced to incorporate industry's needs in the mainstream of university research.

One approach has been used successfully nationwide by a prominent company and other productive approaches may have been used on an isolated basis at one university or another. But no attempt has been made to institutionalize them as standards for productive, widespread university-industry cooperation.

GUIDANCE TO SCIENTISTS

It must be recognized that research scientists in universities presently are concentrating on the program objectives and priorities of current not-for-profit research sponsors, mainly the government, and these objectives only rarely specify innovative end products with commercial potential as the desired research result. Instead these sponsors' objectives aim at a better understanding of chemical processes, biological functions, disease processes, material properties, etc.

During the conduct of this research the university scientist often develops new knowledge useful in the creation of new technology and may even generate innovative ideas for such that are worthy of pursuit. But his charter is limited and his reward system is in the hands of his research sponsors and his academic peers, neither of which have commercial interests or objectives.

There is no significant influence being applied to encourage the faculty scientist to develop appropriate new technology. He has no management pressing for inventions and he assumes industry somewhere is successfully applying its own R&D resources to satisfy each and every material need of society. He is acutely aware that were he to shift any significant portion of the fixed resources provided by his sponsor over to the search for applied technology he, the sponsor and his peer reviewers would recognize this as a de-emphasis of the sponsor's primary objectives, weakening his case for continued research support.

Not Surprising

It is not surprising that, lacking any motivation to invent, the academic scientist doesn't, except possibly a rare non-diversionary byproduct. He is not being influenced to go in that direction. But notice that in those universities where a technology transfer program has created an awareness among the faculty that there is an outlet for new technology and a possibility of some personal recognition and reward, the output of innovative technology has made its initial appearance or increased in volume.

Technology transfer programs in a few universities are essentially the only motivating force in this direction working on the academic scientist, but they are neither a direct, strong nor guiding influence.

Direct involvement with industry in the search for new product technology can influence academic scientists to couple this search with its inseparable supporting companion, the search for new knowledge. The desired result is the joining of the creation of new knowledge with its realistic application to product needs of society in a tighter time frame.

Is any purpose served by dependence on the circuitous process of disseminating new scientific knowledge from universities via the professional literature for application to practical uses by someone else, somewhere in the world, at some future time?

This encouragement and influence can come only from industry, the consumer of the scientist's ideas, and it must be as effective as the influence of current sponsors in stirring the university scientist to action. With due respect to the past efforts of many companies which have sent copies of their annual reports and listings of their current product lines or broad areas of interest to universities, this does not constitute effective motivation of the university research scientist any more than Thomas's Register does.

Rather, it says if, as a result or byproduct of your research for others, you invent something in our area we'll look at it but you should have completed its reduction to practice. Nor are the visitation programs of several companies effective for they too tend to be unilateral fishing expeditions for completed inventions. Companies should keep in mind that through present licensing programs universities take the initiative and have little difficulty finding interested, prospective licensees for the relatively small amount of commercially viable technology already reduced to practice in their research programs.

Commitment

University scientists will actively and aggressively search for new technology in their own areas of expertise if they perceive that each company seeking their participation is also ready to make a comparable commitment. Commitment by a company is the investment of time and energy in defining meaningful technology objectives, understanding the research work and interests of university scientists, and bringing the two together.

Furthermore, if a company is to successfully influence creative academic scientists, it must demonstrate

its commitment by selectively providing supplemental financial support for the pursuit of the company's new technology objectives by such scientists as an integral part of their research work. A company cannot reasonably expect the financial resources provided by government or other sponsors to be diverted from their intended purpose to the benefit of the company. Rather, support furnished by others to advance their own objectives must be supplemented by the company, in one of several ways, so that the dual objectives of the research sponsor and the company can be pursued in concert by an expanded effort to the mutual benefit of all.

I am concerned that if American industry doesn't move in this direction to use the relatively untapped innovation resources of universities, in time foreign companies may take the inititative with preemptive commitments.

METHODS OF INDUSTRY INFLUENCE

The three suggested methods outlined hereafter are not intended to exhaust all possibilities for productive approaches, nor should each be considerd mutually exclusive of the others.

Variations applied to one soon reveal overlap with another. All seek, to the degree feasible in given circumstances, to avoid entanglement with the patent regulations of research sponsors, most notably the government, a problem inherent in most university technology being licensed today.

These methods of influencing university scientists to serve the needs of society as defined by industry are intended for thoughtful tailoring to the specific circumstances faced by each individual company. For success, all require definite commitment to a close collaboration by the university scientist and the participating company, not a distant buyer-seller relationship.

COMPETITIVE IDEAS

One of the most successful recent examples involving university scientists rising to the challenge of the product needs of industry is the now annual Technicon program covering the areas of biomedical and industrial instrumentation. This type of single company program involves a request to scientists nationwide for their ideas for innovative technology which meet needs specified by the company.

Technicon is apparently quite pleased with the approximate 200 proposals it received as a result of this past year's solicitation and plans to continue the program. Interestingly enough, responses also included new concepts falling outside of Technicon's stated needs but which the company subsequently determined to be worth further investigation.

This method of working with university scientists consists of a periodic announcement that as of a specified date the company will receive competitive proposals for new ideas in stated product areas, and that the company will evaluate these proposals and negotiate support agreements, up to some specified limit, for the reduction to practice of those it determines to be of value.

A company might, like Technicon, choose a two-stage, energy-saving process whereby a preliminary submission is confined to a relatively brief summary of the idea sufficient to determine whether or not the scientist should be further encouraged.

Full-blown proposals then are requested from only those passing the first screen. The program announcement should be as specific as possible in defining the product objectives and should also outline preconceived terms and conditions covering licensing arrangements, royalty rates, publication rights, as well as any other essential requirement of the development support being offered.

While this method may not be the approach of choice for all companies it should be encouraged in industry as an effective means of involving university scientists in the accomplishment of new-product objectives. It is mutually beneficial to the company and the scientist.

The company is able to directly tap a large pool of innovative ideas from which it can select the best, guide their development, and obtain a proprietary position probably free of government involvement. The university scientist responds because he perceives a sincere intent by the company to select innovative ideas and to support their development, and is further motivated by the offer of an equitable arrangement whereby he and his university will share with the company on a reasonable basis in future proceeds from the success of his creation in the marketplace.

The approach is one viable method of opening communication channels between industry and university scientists throughout the country to a mutually productive and beneficial end.

JOINT INVESTIGATION

This second method is directed at increasing technological innovation to satisfy company needs as an integral segment of the mainstream, $5-billion annual university research effort. To appreciate this method, as well as the next, an understanding of the relatively open scope of typical university research projects is necessary.

These projects result from a university scientist making a proposal to investigate an unknown or vague area of knowledge and a government agency or other sponsor awarding a grant to the university for conduct of the proposed research. Although there is a research plan, the boundaries of the investigation are intentionally left relatively undefined to give the scientist the freedom to pursue promising leads in any direction.

Normally, neither the scope of investigation nor the research objectives call for the creation of any product prototype with future commercial potential and there is little incentive for the scientist to work in this direction. However, the net result in such a typical unbounded project is that *any* invention which happens to occur during the conduct of the research project, regardless of its nature, comes under the sponsoring agency's control by default.

The sponsor's funds invariably get used to make such inventions, and the sponsor's patent clause is thereby quite properly invoked. Disposition of such inventions thereafter is controlled by the sponsor

under the rationale of protecting his (usually the public's) investment.

From this situation comes the concept of a joint investigation, the key element of which is establishment of a boundary between the "knowledge" research project sponsored by others, and a closely related, company supported effort to create innovative product technology. This approach requires selective action by a company to identify those research projects, proposed by university scientists to not-for-profit sponsors, in which both the company and the academic scientists share strong convictions that knowledge from these research projects will provide a good basis for the development of technology appropriate to the company's product objectives.

Based on such a common conviction the company would agree to support additional effort, free from control of the research sponsor but complementary to the primary research project, which has precise and mutually agreeable new technology objectives. The intent is to extend the scientist's scope of work to include application of knowledge gained from the research project in the creation of specific new technology of interest to the company.

If, when the independent university-company agreement is first negotiated, the scientist has fairly definite ideas about new technology possibilities, the complementary scope of work supported by the company can be reasonably well focused on developing these ideas. Otherwise, at the start the company could support less well defined exploratory efforts of a modest scale with provision for later increases in support if the new ideas which emerge from the exploratory work are of sufficient interest to the company.

This joint investigation method, like the method to follow, would allow industry and not-for-profit sponsors to operate jointly in a mode appropriate to the acknowledged roles of each, wherein each pursues its own objectives and provides only that support necessary to accomplish its own objectives.

However, both this and the succeeding method may raise a question in the minds of some as to the propriety, if not the legality, of attributing inventions solely to the complimentary effort supported by a company. After all, might not the knowledge base used to create an invention have been derived, at least in part, from the concurrent research project supported by the not-for-profit sponsor? Notice that the question does not even arise if the two efforts are sequential, especially if separated by a respectful period. So, in order to isolate ideas for independent development under the joint investigation approach one general condition must exist: when the scientist's "knowledge" research project is proposed and accepted by the sponsor it must not have as a research objective, and the sponsor must not have been led to expect, the creation of new technology. A university scientist who is actively interested in coupling his knowledge and technology investigations in this manner, is well advised to document the existence of this condition and to make his intentions clear to the sponsor when his research proposal is first submitted. The effective linkage of the creation of new knowledge, its application to produce new technology, and its transfer to industry for delivery to society in this manner by a well coordinated and productive tri-party arrangement should not call for apologies from or to anyone.

Example

An example of the use of the joint investigation approach might involve a university scientist's project sponsored by NIH for investigation of a little understood disease process such as emphysema. A company and the scientist might well prospectively see in the new knowledge to be sought by the investigation, the opportunity to explore possibilities of new or improved diagnostic products and new or more effective means to intervene in or prevent the disease process.

Should the scientist have appealing, though speculative, ideas as a basis for a separate university-company agreement, the company could support and collaborate in an expanded effort, over and above the effort involved in the NIH project, consisting of an additional increment of the scientist's time, an additional technician, additional supplies, etc. necessary to pursue the company's (and society's) new product objectives. For its initiative and investment the company can reasonably expect an exclusive position with the resulting technology, free of any involvement in government patent regulations.

As a note in passing, although the foregoing has treated the case of sponsored research projects which do *not* actively seek the creation of new technology, with slight modification the joint investigation approach can be applied to the sponsored project that *does* seek new technology. As long as the university's research agreement with the not-for-profit sponsor provides that worthwhile patent rights will be left with the university, well conceived inventions emerging from such research projects are available to any qualified company that would bring them to the public via the marketplace.

In this situation the segregation from the sponsored research project of innovative ideas which fall within the scope of that research project would be a breach of the university's agreement with that sponsor. But advance arrangements by the university with a company for a right of first refusal or other consideration in return for guidance, evaluation and modest support for expansion of applied work of special interest to the company, is quite proper and of mutual benefit.

BY PRODUCT COLLABORATION

This final method of influencing university scientists to contribute to new technology growth fills the void left if neither the competitive proposal nor the joint investigation method finds application by a company. This method is attractive when prospects for innovative technology from a research project are of possible interest but speculative to the point where a company would prefer to delay making any commitment of substance.

The features upon which this concept is based are (1) that new product ideas occur unexpectedly to research scientists as the result of stimulation by intermediate results or by new situations encountered during their research, (2) that the quanitity and quality of such

ideas will increase with appropriate guidance and encouragement of the scientist, and (3) that with timely action it is feasible to isolate and spin off such ideas for development separate from the research project.

Obviously, the ability to spin off ideas is present only in connection with "knowledge"-type research projects sponsored by others, the objectives of which are *not* directed at the creation of new technology. This approach has much in common with the joint investigation approach once an idea for new technology is identified and an agreement with a company is made, but before that point the research project is essentially unbounded by company commitments and spin off ideas from the project are not the exclusive domain of the company.

Thus, if an idea for innovative technology occurs to the scientist during the conduct of a sponsored research project, rather than proceeding with unquestioned investment of the not-for-profit sponsor's funds in the development of the idea, the research scientist would instead be encouraged to seek the support of industry to complete conception and reduction to practice of the invention.

By using company support rather than that of the research sponsor, research funds can remain concentrated on research objectives and an advantageous licensing position can be earned by the company free of involvement with patent regulations of the not-for-profit research sponsor. This procedure of establishing company sponsored spin-off projects to develop emerging ideas for new technology is not incompatible with regulations of and research agreements with the not-for-profit sponsors. Their patent clauses are addressed to (unintended) "inventions first conceived . . . in the course of or under research supported by . . . etc.," and conception is *not accomplished* by the initial rough idea or the creation of a general approach to achieve a desired result, but is only complete with the formulation of the physical structure to accomplish that result.

So, since invention is not an objective of their research projects, conception is not accidentally or unintentionally allowed to go to completion using their financial support.

Need Direct Influence

In this situation, as in the general university-industry relationship today, it is not productive for companies interested in university technology to hang back waiting for some not-for-profit sponsor's investment in research to show results in the form of innovative ideas as candidates for spin off. Without early and direct influence by interested companies the university scientist will still proceed through his research with weak motivation, if any, to create commercially viable new technology. However, the chances for the creation of worthwhile technology will be greatly improved if, at the outset of the research project, one or more companies communicate to the research scientist that his planned work is in a subject area closely allied with their product objectives, and that they stand ready to provide complementary support for development of innovative ideas for new technology meeting their specifications.

A mutually productive arrangement might well be for the university to offer a basic agreement to as many companies as desire to cooperate with the research scientist. By this agreement each company would specify appropriate technology, closely related to the scientist's planned research, in which they would be willing to make a development investment on a selective basis.

The companies and the scientist would agree that should an idea for new technology meeting any of these specifications emerge from the research, the scientist will submit it to the appropriate company(ies) and the company(ies) will promptly evaluate the idea. Should a company desire to support the completion of conception and reduction to practice, the idea would be spun off from the research project under a supplementary agreement with that company.

Thus, until a point is reached where one company secures an exclusive option on the idea by supporting its development, all companies who are cooperating with the scientist (and thereby receiving his disclosures) have an equal opportunity.

Can Be Encouraged

Just as in the joint investigation method, ideas for new technology arising from the research projects sponsored by others that *do seek* such new technology as a stated objective cannot ethically be spun off, but they can be encouraged, developed and licensed on reasonable terms. However, since in this situation the sponsored research project contains at least an implied charter to further develop particular ideas, participation by a company might be limited to collaboration with the scientist on development work and possibly a modest supplementary effort directed at developing a stronger patent position than the research support permits.

Obviously, the essential precondition in this situation is that the university's research agreement with the not-for-profit sponsor provide for meaningful patent rights to be left with the university.

In summary, all of these methods contain a common feature essential to an increase in the flow of innovative technology from university scientists. This feature is the early communication to the scientist by interested companies of their new technology needs closely related to his research together with evidence of their willingness to lend active support to the development of innovative ideas which fill these needs.

This input will provide stimulation, meaning and direction to the scientist's work that is presently lacking. Furthermore, he would then have confidence that he could turn to these interested companies for realistic evaluation of his ideas and for collaborative support to further develop any which a company judges to have good commercial potential.

INFORMATION EXCHANGE

There is an existing communication system which very effectively links university scientists and the not-for-profit sponsoring organizations. This system communicates the needs of these sponsors to where they may be located within the university's organizational structure, and shortly thereafter transmits the scien-

tists' proposals to satisfy these needs back to the appropriate sponsor.

While the sensitivity of the information to be exchanged by companies and universities requires special provisions to safeguard the interests of both parties, an efficient communication system comparable to the university-sponsor network, but sensitive to special conditions, is feasible and could be developed by a joint industry-university group, preferably within LES.

The required communication system must furnish university scientists with definitive information on the needs of individual companies (often in confidence and on a selective basis) and must identify those companies willing to actively participate in programs of the type proposed. The system must furnish companies with information of prospective university research and its relation to company product needs, the potential (scientists' ideas selectively transmitted in confidence) for satisfying these needs possibly accompanied by estimates of the incremental development effort required for this purpose, and the prospects for a proprietary position free of the patent regulations of others.

Finally, even though it is not part of the communication system both the individual universities and the individual companies need a model agreement(s) to guide them expeditiously and without endless, repetitive negotiations toward cooperative, productive and mutually beneficial collaboration.

As Don Peterson of Monsanto concluded in his March article "Industry View of Campus Licensing," improved communications between industry and universities is a clear and present need. Earlier, Roger Ditzel of Iowa State University in his June 1977 article "Promoting University Technology," examined the subject from the other side of the fence and came to a similar conclusion.

Thus, we seem to be in obvious agreement that there is little information being exchanged between universities and companies on which to base new and more productive relationships. In the meantime, companies continue their passive wait, with great or small interest, to see what, if any, new technology may pop out of the ivy-covered black boxes.

In isolation, university scientists continue their diligent pursuit of research responsive only to the objectives of their not-for-profit sponsors. This lack of active university-industry communications is but the evidence of a stagnant situation, not necessarily either the cause or the solution. The problem is the absence of any commitment by universities and industry to action programs which would put such university-industry communications to effective use.

CONCLUSION

As the technological leadership of this country is increasingly placed in question and the R&D efforts of other industrialized nations grow, an invisible barrier separates industry from the major untapped resource of innovative ideas lying dormant in the minds of university research scientists.

New initiatives to activate the latent interest of these scientists to create new technology are feasible and of growing importance. But the success of such initiatives depends on the willingness of industry and universities to overcome inertia, indifference and a whole raft of fears and prejudices, thereby to create a closer and more cooperative relationship than we find today. Or should we continue to opt for the status quo?