Robotics Licensing In Canada

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Results of investigation into mechanism for most effective technology transfer

This paper presents the results of a study conducted during 1993 on university-industry technology transfer in robotics and intelligent systems in Canada. In spite of the considerable robotics expertise in Canadian universities and the relevance of the subject to industry, there is generally thought to be little in the way of successful technology transfer, as measured by university research results licensed to industry. The objectives of the investigation were to determine which mechanisms for technology transfer are most effective and how to increase successful technology transfer.

The motivation for looking at this one field in isolation was to explore the hypothesis that the best approaches for knowledge dissemination depend on the type of knowledge being disseminated. In robotics and intelligent systems, advances are generally incremental and nonexclusive, building on a vast body of knowledge available to all researchers. This study shows that the best methods for transmitting and exploiting knowledge in this field involve accessing the knowledge source directly (as opposed to acquiring the knowledge produced), building relationships, and focusing the research effort on a particular application or need.

This is in contrast to other fields such as pharmacology, where advances tend to be well-defined, and exclusive; often entailing quantum departures from the available knowledge. Here licenses, often of the multimillion-dollar variety, seem to be the prevailing method for transmitting knowledge. The findings of this study offer support to the hypothesis that the best techniques for knowledge transfer and exploitation depend on attributes of the knowledge itself, but a more convincing corroboration will require a similar examination of successful technology transfer in other fields. The goal of the study, however, was to understand how to best transfer knowledge in robotics and intelligent systems by responding to the following three questions:

- What are the benefits of university-industry technology transfer?
- Which technology transfer mechanisms are most effective?
- How can effective technology transfer be increased?

METHODOLOGY

In order to respond to these questions, both the academic and industrial communities were surveyed using two different questionnaires. The academic questionnaire was sent via electronic mail to 139 academics working in robotics and related fields. Fifty-two researchers responded, providing a good representation of academic opinion on the subject. The industry questionnaire was sent via fax to 375 individuals. The 133 industry respondents are a much less homogeneous group. The companies represented range from large multinational corporations for whom robotics is secondary to their primary business objectives, to small start-ups for whom robotics is their *raison d'etre.* Regardless, 67% of the responding firms conduct research in robotics or intelligent systems. For both groups, the geographical distribution of responses across Canada was representative of current activity levels.

BENEFITS

In response to the question of whether university-industry interaction is desirable, we found that 82% of academics wished to increase their contact with industry. When the academic was employed by a university where the impact of industry interaction on getting tenure was positive, the figure rose to 100%. Similarly, 100% of academics without experience in interacting with industry wished to increase their level of interaction.

In contrast, the industry desire for increased contact with university researchers was less clear. Only 52% of all respondents wished to interact more. However, 77% of firms that had previous experience with academics and a self-assessed high ability to absorb the technologies to which they had been exposed by university researchers, wished to interact more.

Both groups of respondents were asked to compare their interest in interaction with that of their counterparts. Academic interest in interaction was rated higher than industry interest in interaction by both the academic and industry respondents. This difference is important and may, in part, be the result of government pressure on academics for industrial relevance.

The concerns of many academics on that subject were very well put by one respondent. "If the insistence is one-sided, the net impact of technology transfer may well be negative. It is fair to ask university researchers to interact more with industry only if one asks, at the same time, industry to participate more with university research. Participating means putting in real cash

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and changing to improve the receptor capacity for the results of university research. Insisting only that university researchers interact more while industry maintains the outmoded status is a recipe for disaster."

Benefits of Interaction With Industry for Academics

The benefits of interaction with industry for academics include:

- Exposure to interesting and relevent problems.
- Seeing real-life implementation of results.
- Jobs for students.
- An opportunity to help Canadian industry.
- Good projects for students.

In looking at the most significant benefits of interaction, it's encouraging to note that they are all realistic and inherent to the activity. The five benefits rated most highly by university researchers are all intrinsic in nature. This is in contrast to the common, but uncharitable, thinking that academics wish to interact with industry to improve their opportunities for funding. This stands to reason. Academics are generally intrinsically motivated individuals who choose to work in universities to pursue challenges they find interesting and rewarding.

A closer examination of the academic responses revealed that industrially-oriented academics assigned higher ratings to these five benefits than did those academics who are not industrially-oriented. In particular, close to the highest possible rating was assigned to the first benefit by industrially-oriented academics. This suggests that the most effective incentive for increasing industry interaction on the part of those academics most inclined to partake in the activity, would be the availability of interesting and relevant industrial research problems.

For industry, "access to university expertise" was the overwhelming benefit. Other benefits mentioned occasionally included: "leveraging research funds" and "developing long-term relationships."

INDUSTRIAL NEED AND INDUSTRIAL RECEPTOR CAPACITY

Several comments made by industry respondents reflect the strongly held view of industry that interaction with university researchers must be motivated by industrial need. This is further supported by their selection of "industry control of research goals" as the most important criterion in the assessment of a subsidization program for joint university-industry research. Incidentally, the criterion selected as least important was "a high level of funding."

For their part, several academics focused on the commonly-lamented lack of a receptor capacity in Canadian industry. In seeking to respond to anticipated future industrial needs, which may at present be poorly understood, university researchers often feel themselves confronted by this inability on the part of industry to absorb and exploit their research findings.

An interesting result of the study is that this lack of a receptor capacity on the part of Canadian industry all but disappears as a barrier to technology transfer if the academic declares themselves to be highly interested in interacting with industry. In other words, it is seen as a much higher barrier to interaction by those who rate their own interest in interaction as being low.

KNOWLEDGE TRANSFER PATHS

Technology Push	**Market Pull**
Markets	Markets
↑	↓
Product/Service	Product/Service
↑	↓
Company Expertise	Company Expertise
↑	↓
University Research	University Research

Figure 1

Figure 1 provides a framework for understanding the role of industrial need and the perception that Canadian industry lacks a receptor capacity for university research results. The column on the left illustrates the traditional path of industrially relevant university research results.

Results developed to advance the technological or scientific state of the art, which are thought to be of possible commercial value over the long term, are offered to Canadian industry. The candidate firm is then faced with the task of realizing the commercial value of technology for which there is no obvious market. The resulting reluctance of the firm to invest in the technology is what has been described as a lack of a receptor capacity.

The column on the right illustrates the path of needs: first observed in markets and subsequently expressed in terms of industrial research problems posed to university researchers.

Should the university researcher be willing and able to provide the required expertise, the prospects for mutually rewarding interaction are high. In spite of the considerable difficulties posed by the process depicted on the left, it would be ill-advised to ignore its potential. University researchers are well-placed to alert industry to opportunities presented by technological advances. The overwhelming challenge in this approach is to translate these technological advances into market opportunities. Until this is achieved, however, the firm has no choice but to resist investing in university research results.

EFFECTIVENESS OF TECHNOLOGY TRANSFER MECHANISMS

The least effective technology transfer mechanisms include:

- University Research Chairs.
- Licensing.
- Seminars and Workshops.
- "Member" Company Programs.
- Newsletters.

So far, we've established that university-industry interaction is considered a worthwhile activity that benefits those who engage in it. Now we turn to the relative effectiveness of various technology transfer mechanisms. Of the 11 mechanisms presented to university and industry respondents, the five listed above (in order of de-

creasing effectiveness) were, on average, considered to be the least effective. Overall, it's safe to say that nobody likes newsletters! The largest discrepancy between academic and industry opinion is on the subject of licensing and industry-sponsored university research chairs. Industry respondents consider licensing the single *least* effective technology transfer mechanism. That alone might explain why there are so few examples of university research results licensed to industry in robotics in Canada. Industry sponsorship of university research chairs is considered the second worst strategy by industry.

The most effective technology transfer mechanisms include:

- Collaborative Research.
- University Sabbaticals in Industry.
- Contract Research.
- Industry Visits to Universities.
- Consulting.
- Student Projects and Work Terms in Industry.

The most effective mechanisms for technology transfer in robotics and intelligent systems involve accessing the knowledge source directly, rather than acquiring the research results made available through licensing or open dissemination. The six mechanisms listed above (in order of decreasing effectiveness) share one of two characteristics. Either the university researcher focuses his research activities on a specific industrial need, as is the case with collaborative research, contract research, consulting, and student projects and work terms in industry (in which case the researcher is the student, or there is a long-term change of scene for one of the participants, as is the case with university sabbaticals in industry, industry visits to universities, and student projects and work terms in industry. In all cases, there is sufficient contact between the individuals concerned for a relationship based on an understanding of each other's objectives to develop.

BARRIERS

Barriers for academics include:

- Other Deadlines Get Priority.
- Publications Gain Respect of Peers.
- Logistical Overhead.
- Lack of an Industrial Receptor Capacity in Canada.

Barriers for industry include:

- Different Time Frame and Sense of Urgency.
- Academics Not Interested in Industrial Problems.

Of the four barriers selected by academic respondents as being the most significant, it's encouraging to note that the first three represent their own situation rather than some perceived failing on the part of Canadian industry. When academics are segmented into those that are industrially-oriented and those that are not, the differences in the assessment of industry's receptor capacity become quite pronounced.

As mentioned earlier, for those who are industrially-oriented, the alleged inability of Canadian industry to exploit university research results almost disappears as a barrier to interaction. Conversely, for those academics who are not industrially-oriented it alternates as the highest barrier to interaction, with "lack industrial contacts."

Most interesting is the comparison between the most significant barrier for academics with the most significant barrier for industry. The notion that academics have a "different time frame and sense of urgency" may be the outside view on the reality that for academics, "other deadlines get priority." Some academics feel that interaction with industry actually has a *negative* impact on getting tenure at their university. No wonder then that this activity is sometimes not given the attention it deserves.

MEASURING EXCELLENCE

If excellence in technology transfer were to be taken into consideration when evaluating and rewarding academic performance, then it would have to be measured. The survey responses revealed little consensus on how to do so as there seemed to be two types of responses. Those that dealt with the evaluation of the technology on its own merits, suggested counting publications and patents or otherwise evaluating the novel technologies that had been created. Those responses that dealt with how to evaluate the transfer, suggested considering whether the results were used, whether they increased industrial output, whether the research enjoyed financial support from industry, and so on. In all probability both the quality of the research and the effectiveness of the transfer should be considered.

The responses to the question of who should do the measuring were equally divergent but seemed to suggest that three bodies be represented: industry in general, the academic community, and the company that was involved in the transfer. Academics were asked if excellence in technology transfer should always be taken into account when considering candidates for tenure or promotions and the answer was a resounding "no." When the question was altered to ask if candidates for tenure or promotions should have the option of having their achievements in technology transfer considered, the response was positive, especially the response of those who were classified as being industrially-oriented.

INCREASING EFFECTIVE TECHNOLOGY TRANSFER

Strategies for increasing effective technology transfer include:

- Involve Industry in Applied Research.
- Increase Industrial R&D Investment.
- Promote University-Industry Communications.
- Increase Funding for Most Effective Transfer Mechanisms.
- Change Academic Environment to Promote Industry Interaction.

We now turn to the question of the strategies for increasing successful technology transfer that received the most support from respondents. Industry wishes to be involved in both the setting of research goals and the evaluation of applied research. Academics support the participation of industry in the evaluation of applied research, but their endorsement of the setting

of research goals by industry would probably depend on a number of factors including who was funding the research.

Academics would like to see Canadian industry increase its spending on research and development. They would also like to be able to communicate with their colleagues from industry using electronic mail. If industrially relevant research is best undertaken in response to a known industrial need, then better these needs are defined and articulated the easier it will be for university researchers to respond to them. Both university and industry respondents supported the development of a database of industrial research problems.

Academic respondents selected increased funding for each of: "collaborative projects with industry," "university research sabbaticals in industry," and "student projects and work terms in industry," as the three best strategies for increasing successful technology transfer.

The final strategy for increasing successful technology transfer consists of reducing the most significant barriers. Until universities recognize and reward excellence in technology transfer, the priorities of academics will continue to reflect traditional performance criteria, and academics will all perish from publishing. In addition, universities must provide support to those academics engaged in excellent technology transfer, in the form of reduced teaching loads, and assistance with the administration and marketing of industrial research.

CONCLUSION

To conclude, we return to the three questions posed at the beginning of the paper. Although academics are more interested in interacting with industry than the other way around, university-industry interaction is felt to be sufficiently beneficial that the majority of respondents from both groups wish to increase their level of participation in it. More importantly, both groups report significant intrinsic benefits from successful technology transfer.

Academics are provided with exposure to interesting and relevant research problems and get to see a real-life implementation and development of their research results. Companies, in turn, are provided with access to university expertise in the form of knowledge or systems.

The three most effective technology transfer mechanisms are: collaborative research projects, university researcher sabbatic leaves in industry, and contract research. These three activities involve building relationships between university and industry researchers. It is through these relationships that the ongoing needs of industry are best addressed.

And finally, how can effective technology transfer be increased? First, the ability of industry to absorb and exploit university research results is directly related to the degree to which the research responds to a known industrial need. Receptor capacity can be acquired, albeit slowly, and a company's motivation to increase its receptive capabilities will come from its positive assessment of the link between technological advances and market opportunities.

Involving industry in the setting of research goals and the evaluation of applied research will ensure that known industrial needs are addressed. But industry must be proactive in the pursuit of an enhanced receptor capacity and this will be achieved only through the investment of more resources and energy in research and development.

Increased funding for the three most effective transfer mechanisms mentioned earlier will also promote more successful university-industry linkages. With regard to the academic situation, the fact that academics have other priorities was cited as the largest obstacle in the path of successful technology transfer.

This question of time constraints may be especially important in fields such as robotics where relationships are such a key feature of the transfer process. To surmount this barrier, technology transfer must become an allowable priority for academics and it must be properly facilitated, evaluated, and rewarded.

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