"Spin-In" Technology Transfer for Small R&D Bio-Technology Firms: The Case of Bio-Defense

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ABSTRACT. This study investigates the types of factors which can lead to government acquisition, or the "spin-in" of bio-defense technologies from small bio-technology firms. Empirical findings suggest that for small biotechnology R&D firms desiring to increase "spin-in" technology transfer, there appears to be two distinct and important influence groups—the scientific community within federal agencies, institutes, and centers, and the more managerial, policy-oriented decisions makers. We found that personal communication and networking appear to be the primary factor that leads to a successful technology transfer, however, the form and substance of personal communication and networking will differ between the two influence groups.

JEL Classification: O32

1. Introduction

Since 9/11 (world trade) and 10/4 (anthrax) there has been an increasing interest on the part of the federal government to encourage the "spin-in" transfer of new and innovative defense technologies from the private sector to various government homeland defense agencies. This is an interesting twist from the often discussed problem of technology transfer from government research to the private sector.

Recognizing that historically the majority of both public and private sector technology transfers ultimately fail (Heslop *et al.*, 2001), there is a rapidly developing literature addressing the salient factors that appear to encourage successful technology transfers. Within this literature it is well recognized that technology transfer is essentially a person-to-person process (e.g. Wei, 1995; Tsang, 1997; Kremic, 2003). Thus, a number of empirical studies have suggested that personal communication and networking are considered among the most important factors for successful technology transfers (Roberts and Hauptman, 1986; Lundquist, 1997). Other often cited factors include technical sophistication, market attractiveness, research team excellence and management support (see Heslop *et al.*, 2001 for summary).

One problem associated with moving technology between the private and public sector lies in the contextual differences between the two sectors. As Kremic (2003, p. 157) notes, "Government and corporations view technology transfer differently. The motives are different for these sectors and for different levels within each sector." Whereas the profit motive, intellectual property concerns, and competitive market responses result in a more focused and selective form of technology transfer for private sector firms, the organizational mandates of the public sector typically result in a less focused technology selection and a "broadcast" form of technology communication. It is in the interest of the government to make the technology needs available to the public and hence, makes its technologies known through a variety of methods, such as solicitations, consortia, websites, and publications.

The vast majority of the technology transfer literature, however, has focused on the problem of commercialization within the private sector, and

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Journal of Technology Transfer, 29, 377–382, 2004

more recently, on the commercialization into the private sector of technology from government agencies, such as universities (e.g., Samson and Gurdon, 1993; Nicolaou and Birley, 2003) and military research labs (Galbraith *et al.*, 1991). A relatively understudied arena of technology transfer lies more in the realm of private sector to public sector technology transfer. Thus, the purpose of this study was to investigate the types of factors which can lead to government procurement or acquisition of bio-defense technologies. In particular, we focus on the ''pre-product'' stage of R&D, when experts and decision makers are still in the process of acquiring information, forming opinions, and developing models for possible future procurement prior to the actual development of a dominant technology or purchase of the actual technology.

2. Bio-defense ''spin-in'' technology transfer

Unlike many other homeland defense related technologies which are typically controlled by prime contractors, the acquisition of bio-defense technologies and therapies tend to be more influenced by opinions and decisions within the various homeland security and defense agencies such as the United States Army Medical Research Institute for Infectious Disease (USAMRIID), the National Center for Infectious Disease (NCID) and other Center for Disease Control and Prevention (CDC) units within the Department of Health & Human Services (DHHS), and the National Institute of Allergy and Infectious Diseases (NIAID) within the National Institute of Health (NIH) that have strong embedded medical, health and scientific workforces. In addition, with the creation of the Department of Homeland Security (DHS) there are a number of other relatively new government organizations that can significantly influence the bio-defense technology transfer process, such as the DHHS' more policy-oriented Office of Public Health Preparedness (OPHP), the Council on Private Sector Initiatives (CPSI), and the Chemical and Biological subgroup of the Technical Support Working Group (TSWG). While there are a number of current proposals to centralize both the validation and acquisition of bio-defense tools and methods, to date the bio-defense technology transfer effort remains highly decentralized (Takafuji, 2003).

Typical of most highly advanced technology sectors, there are several competing, and perhaps, complementary technological approaches to addressing specific homeland security and defense-related challenges. In the case of anthrax, for example, we can: (a) vaccinate against a potential anthrax infection (an ''active'' immunotherapy strategy), (b) treat the anthrax infection after exposure with antibiotics and/or use antibiotics prophylactically, or (c) develop pathogen specific antibodies (a so called, antidote or ''passive'' immunotherapy strategy) to neutralize anthrax-related toxins. Theoretically, pathogen-specific antibodies could be used within a two to three week window, before or after an anthrax exposure.

However, each of these first level defense strategies have drawbacks given the current technological state-of-the-art. Anthrax vaccinations require a multi-dose drawn-out regime, have negative side-effects, and cannot be used with some population cohorts that have severely deficient immune systems. Antibiotic treatments, on the other hand, are only effective against the anthrax infection and not the deadly anthrax toxins produced after infection, and therefore, are generally effective for only the first couple of days after exposure. Developing anthrax antibodies requires advanced recombinant research and development, and at the time of this study (early 2003) no one had yet produced an effective anthrax antibody capable of commercialization. As expected, during 2003 and 2004 several firms (e.g. Avanir, Medarex, QED) have announced substantial progress in these areas, but the technology generally remains in preliminary testing status.

Within each class of bio-defense there are also competing technologies to consider. For example, under the passive immunotherapy strategy, monoclonal and polyclonal antibodies to anthrax toxins, as well as other Category-A bio-agents, can be theoretically developed using a variety of different proprietary techniques, including transgenic mice, chimeric mice, phased display and humanization. Each of these techniques approaches the problem somewhat differently, and the resulting antibodies will have slightly different characteristics and functionalities. These different approaches might have implications from a policy perspective since biases often exist in the defense community regarding various bio-defense strategies (Krieg, 2003). It has been suggested, for example, that military-oriented communities have historically favored vaccinations (Hilleman, 2002) while public health communities appear to prefer antibiotic treatments (Gursky *et al.*, 2003).

3. Survey

This study was intended to better understand the factors that lead to successful "spin-in" technology transfer for smaller bio-technology firms, and to assist in developing normative recommendations to facilitate bio-technology transfers for purposes of homeland security.

Sample

One hundred-seven individuals were identified in federal and associated agencies that were considered "experts" or "decision makers" in the field of bio-defense. The sample was identified by in-depth interviews with senior management officials at four different agencies (CDC, OPHP, USAMRIID, and CPSI) and a review of other bio-defense experts identified by conference attendance and press articles on bio-defense. Thirty-three usable responses were received for a response rate of 30.8%. The survey was conducted in late-2002 and early-2003.

Questionnaire

The survey included the following five categories of questions, all based on a five point Likert scale: (1) the current "need to develop effective therapies" for the six NIAID category-A priority bio-agents/pathogens: anthrax, small pox, botulism, tularemia, the plague and the viral hemorrhagic fevers, (2) the level of familiarity or "expertise" the respondent had with the range of current and future treatments for the category-A bio-agents, (3) the sources of information the respondents used in forming their own personal opinions of various bio-defense therapies, (4) the importance of various organizations/communities, such as congressional staff versus government scientific community, in forming the general opinions in the respondent's organization regarding treatments for category-A bio-agents, and (5) the importance of nine different strategic activities in encouraging a "small R&D bio-technology firm's" success in transferring their technology ("spin-in") for purposes of homeland defense.

4. Analysis

Respondents were asked to rate the importance of developing effective therapies for various bio-agents. In ranking the mean scores across all respondents, small pox and anthrax were ranked first and second, respectively, with the plague ranked last. While all were ranked important in an absolute sense, the differences between the six bio-agents were statistically significant ($p < 0.05$).

In order to understand the sources of information used to form personal opinions regarding appropriate therapies, the responses to the "source of information" questions were grouped together by means of a factor analysis. This resulted in the following three "sources of information" factors: (1) "Scientific Information"—combined the variables of academic journals, scientific magazines, academic and defense-related conferences, and personal discussions with scientists, (2) "Popular Information Sources" included the variables of TV news reports, news magazine articles, newspaper articles, and discussions with non-scientific co-workers, and (3) "Internal Sources" combined the factors of internal reports/memos and government defense conferences.

A similar analysis was performed for the nine technology transfer "strategic activity" variables resulting in the following three factors: (1) "Networking" combined the variables of personal attendance and presentation at conferences, direct personal contact with government decision makers, and partnering with large, well-known defense contractors, (2) "PR image" combines the variables of visibility in press and news reports, strong web site and links, efforts to change the image of the technology, and partnering (alliance) with a large, well-known defense contractor and (3) "Technology Alliances" combines the two variables of alliances with large, well-known "non-defense contractor" firms and consortiums of smaller, R&D firms.

To determine the relative importance of the various "strategic activity" factors in influencing technology transfer success, a weighted average of the three "strategic activity" factors was created based upon the factor coefficients. For the full sample, this approach resulted in "networking" being ranked the highest in importance (3.23). This finding closely parallels the substantial literature regarding the importance of direct personal contact and communication for successful technology-related transfers into the private sector (e.g. Samson and Gurdon, 1993; Spivey *et al.*, 1997; Lundquist, 1999; Tsang, 1997). Following the networking factor were "technology alliances" (2.92) and "PR image" (2.39). Of the individual variables, presenting at conferences scored the highest (3.58), while changing the image of the technology ranked the lowest (2.21).

These results suggest a possible dichotomy of opinions reflecting philosophical differences between the scientific community and the managerial community in both the private and public sectors. To examine this issue, bivariate correlations were computed between the factors representing "sources of information" and the factors representing "strategic activities." There were strong positive and statistically significant correlations between, (a) "scientific information sources" and "technology alliances" ($\rho = 0.626, p < 0.01$), (b) "popular information sources" and "PR image" ($\rho = 0.225, p < 0.10$), and (c) "internal information sources" and "networking" ($\rho = 0.430, p < 0.01$). These findings suggest that the more that one relies on scientific information sources, the more one believes that technology alliances lead to successful technology transfer. Likewise the more an individual relies on popular information sources, the more they believe that PR image is important for technology transfer success, and the more one uses internal information sources the more they suggest the importance of "networking" for successful technology transfer to the federal government.

To further explore differences in opinions within the government bio-defense community, the sample was split into two equal sub-groups based upon the responses to the questions regarding the degree of familiarity with treatments and therapies for bio-agents. For this analysis, respondents scoring in the lower half of the sample were classified as "less informed" and those scoring in the upper half of the sample were classified as "more informed". The "more informed" sub-sample reported statistically significant higher levels of "scientific information sources" than those "less informed" ($p < 0.01$); and no statistical differences in the other two factors representing sources of information. It is, therefore, reasonable to conclude that the "more informed" sub-sample generally comes from the scientific community.

Table I
Factors of transfer success and source of general opinions regarding bio-defense technology: "more informed" vs. "less informed" sub-samples

Factor transfer success (factor scores are normalized)	Less informed	More informed
Importance of networking of firm	0.084	-0.079^{ns}
Importance of PR/Image of firm	-0.312	0.331*
Importance of technology alliances of firm	-0.428	0.455***
Source of forming organization's general opinions about bio-defense (mean values for responses)		
Influence of cabinet/presidential staff	3.24	2.00**
Influence of university/private sector scientists	3.35	4.63***
Influence of government agency scientists	3.24	4.88***
Influence of congressional community/staff	2.41	2.25^{ns}
Influence of news/press reporting community	2.47	2.13^{ns}
Influence of product announcements	2.65	1.75*

Note: *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$; ^{ns} = not significant.

Regarding the importance of different organizations/communities in forming general attitudes about bio-defense technology, Table I shows the mean differences between the "more informed" and "less informed" sub-samples.

With respect to the "strategic activities" seen important for successful technology transfer, the "more informed" sub-samples clearly support the importance of technology alliances versus the "less informed" sub-samples ($p < 0.01$). Interestingly, the "more informed" sub-sample also places greater importance on PR image than the "less informed" group ($p < 0.10$). However, no statistical difference is noted on the "networking" factor. For general opinions about bio-defense technology, the "more informed" sub-sample reports that the university, private sector, and government sector scientific community influences general opinion in their organizations to a much greater degree than the "less-informed" sub-sample. Contrasting this, the "less informed" sub-samples report a much greater impact of cabinet/presidential staff, congressional staff, news reporting, and product announcements in forming general opinions regarding bio-defense in their organizations.

Finally, the more and less informed groups had, in general, similar responses regarding the priority of developing effective therapies for the six category-A bio-agents. The more informed group ranked small pox first, followed by anthrax with tularemia ranked last, whereas the less informed group ranked anthrax first, small pox second, and the plague last. Overall, however, these differences were minor and not statistically significant.

5. Discussion and conclusion

Findings suggest that for small biotechnology R&D firms desiring to increase "spin-in" technology transfer, particularly for those involved in early-stage and pre-dominant technology designs, there appears to be two distinct and important influence groups, (a) the scientific community within federal agencies, institutes, and centers, and (b) the more managerial, policy-oriented decisions makers. While leaders of these R&D firms would probably be quite comfortable in interacting with the scientific community influence group, additional efforts will be needed to establish a fruitful dialogue with the more managerial and policy-oriented decision makers. For many private sector bio-entrepreneurs, this is often an area of underdeveloped knowledge and skills. Each influence group obtains their information about technologies from different sources, the scientific community from academic and scientific sources, and the managerial community from more popular and internal sources. Thus, to influence policy and managerial decision-makers, smaller firms might need to take a multi-prong approach to their marketing and strategic activities, such as increasing their communication efforts with the more popular homeland defense and military journals. These communications might affect the image of smaller R&D firms that tend to be overlooked by technology decision makers and experts within federal agencies.

In addition, personal communication and networking appear to be primary factors leading to successful technology transfer. Less informed individuals may engage in more personal communications and networking with cabinet/presidential staff while more informed individuals communicate and network with government and academic scientists.

Little is known about the "spin-in" side of technology transfer, particularly in the area of very early stage bio-defense technologies. Since interest in government procurement and acquisition of bio-defense technologies has been substantially heightened since 9/11, more research is needed to support best practices in spin-in technology transfer. Also, it is incumbent upon the smaller technology firms to learn more about the decision processes and unique procedures associated with doing business in the public sector, both for sources of potential funding for R&D and future revenues.

Notes

1. This study was conducted as part of a larger technology transfer study effort funded by the Center for Commercialization of Advanced Technology (CCAT). CCAT, a Department of Defense (DoD) and U.S. Navy SPAWAR funded consortium, has a specific mission of encouraging "spin-in" technology transfers from smaller, private sector R&D firms to both government agencies and prime defense contractors

who are involved with developing and improving homeland and military defense systems.

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