

## Re-imagining University Knowledge Transfer through Spin-off Firms

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### Abstract

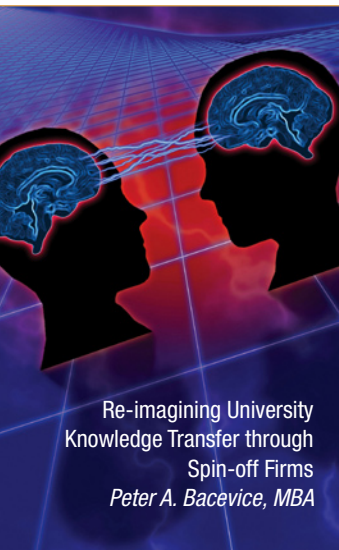
University technology transfer professionals work under the mission of doing what is best for the technologies within their portfolios and for using those portfolios to position their respective universities as agents of innovation and economic development. The complexity of this knowledge transfer task puts technology transfer professionals in the role of broker between higher education and industry in that they are responsible for the interinstitutional transfer of knowledge resources.

Sometimes the most appropriate knowledge transfer action for a particular aspect of scientific research is the licensing of a patent to a company that has the absorptive capacity to develop and commercialize the intellectual property. Alternatively, the most appropriate path to commercialization is the launch of a

spin-off company—the purpose of which is to cultivate the knowledge of the founding scientists through the help of business professionals to develop a proof of concept for the marketplace.

This latter route of academic spin-off formation is an emerging topic for both knowledge transfer scholars and technology transfer professionals alike. Unlike patent licensing, which involves the transfer of codified knowledge, the launching of an academic spin-off company is a socially and organizationally complex phenomenon and involves the complex transfer of tacit knowledge.

The universities from which spin-off firms emerge continue to play a key role in the success of these firms. Innovation is not a solitary activity. A spin-off firm is, by definition, innovative because of its work in developing new technologies from abstract form into commercial proof of concept. These firms owe their success, in part, to the ties they maintain to the university as well as to other networks in the business community. This paper is a review of relevant academic literature on the complex relationship between universities and their spin-off firms. This is a complex knowledge transfer



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relationship that is rooted in the networks that people maintain for the sharing of complex knowledge.

The paper is organized as follows. It begins with a brief overview of the concepts of *knowledge* and *knowledge transfer*. It is then followed by an overview of the link between knowledge and innovation to illustrate the collective aspects of innovation. Given this collective perspective, the paper then reviews a variety of *structural* and *relational* conditions drawn from organizational and network research that coincide with knowledge transfer between universities and spin-off firms. Each condition is summarized with practical considerations that will hopefully spark useful discourse among technology transfer professionals—especially those concerned with the successful cultivation of spin-off companies in their portfolios.

## **Knowledge and Knowledge Transfer**

This paper works with deceptively simple constructs—*knowledge* and *knowledge transfer*. Knowledge can be captured in forms such as books, articles, formulas, patents, and equations. Knowledge in this form is easily reproduced and can be transferred among individuals and organizations as much as technology can facilitate the reproduction and transfer process (i.e., through e-mail, shared databases, video conferencing, etc.). However, knowledge also resides with the knower—as people often know more than they can articulate.<sup>1</sup> In this case, knowledge is not so much reproduced as it is learned.<sup>2</sup>

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Organizations, especially new business ventures, face market and contextual uncertainties, and they are, inherently, problem-solving, information-seeking, and sense-making entities.<sup>6</sup>

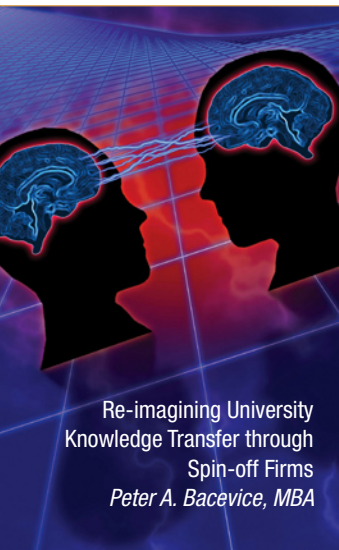
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Among the most commonly cited variance in the nature of knowledge is the distinction between *tacit knowledge* and *explicit knowledge*. Tacit knowledge

is the deep know-how that is not easily articulated, but it is that which affects actions.<sup>3</sup> Explicit knowledge is that which can be codified and is often synonymous with the transfer of *information* (for example, in the form of books, journals, magazines, patents, etc.). Possession of codified information does guarantee that the possessor has learned or has a tacit understanding of the material.

Tacit knowledge affects organizing around the transfer of deep know-how, while explicit knowledge affects organizing around the transfer of information. Tacit knowledge transfer involves a more complex social process than explicit knowledge (or information) transfer because knowledge is tightly coupled to a knower and cannot stand independent of the knower, while information is loosely coupled to the knower and can stand independent of the knower.<sup>4</sup> A writer can publish a book about something but cannot articulate and reproduce everything he or she knows about that topic—as Dorothy Leonard and Sylvia Sensiper note, “The marvelous capacity of the human mind to make sense of a lifetime’s collection of experience and to connect patterns from the past to the present and future, is by its very nature, hard to capture. However, it is essential to the innovation process.”<sup>5</sup>

Knowledge is both an organizational and interorganizational construct. Organizations, especially new business ventures, face market and contextual uncertainties, and they are, inherently, problem-solving, information-seeking, and sense-making entities.<sup>6</sup> As such, network organizational scholarship has conceived of the organization as a body of knowledge.<sup>7</sup> It means that an organization is a collection of people sharing information and learning from one another. Effective interorganizational relationships, which include those between universities and business firms, are organized as such that they facilitate and simplify the access of



knowledge resources in both codified and tacit forms among individuals.<sup>8</sup> This is the concept of the *knowledge-based view of the firm*.<sup>9</sup>

John Seely Brown and Paul Duguid posit that an organizational knowledge base is not limited to organizational boundaries but instead exists within "its embeddedness in broader structures."<sup>10</sup> As such, a university is a local organizing mechanism for a vast knowledge base that exists in wide communities of scholars across disciplines. Additionally, a university is a regional knowledge hub that focuses on the recombination of tacit knowledge.<sup>11</sup> Universities have traditionally categorized, controlled, and legitimized knowledge.<sup>12</sup>

A particular university knowledge base is embedded in communities of disciplines. Likewise, the knowledge base of a particular firm that was spun off from a university is embedded in the university community and relevant disciplinary communities from which it emerged. Successful spin-off firms depend on these connections to the university, especially connections with the faculty community.<sup>13</sup>

A working definition of *knowledge transfer* is the way in which organizational actors share or exchange that which they know by way of reproduction or learning to meet specific organizational learning needs. In the context of university technology transfer activities, licensing agreements and patent filings reproduce and codify specific aspects of scientific research. Likewise, the organization of networking events that brings scientists, venture-capital professionals, and other university personnel together is a form of knowledge transfer facilitation because it allows people to form connections and share ideas and resources and learn from one another.

Thus, the technology transfer office is an important agent of university knowledge transfer. The transfer of a patent in the form of a license is the transfer of explicit knowledge. The deal-making of patent

licensing is a relational process, but the license itself represents explicit, codified knowledge. The practice of launching new companies from a university is also a very relational process that involves significant relational interaction. The actual transferred knowledge between the university and the spin-off firm is ambiguous, and it is an ongoing process and a back-and-forth exchange between the university and the firm. University researchers who launch their own companies and maintain a role in the university community often blur the boundaries between the university and the business firm, but this blurred boundary is critical for knowledge transfer.

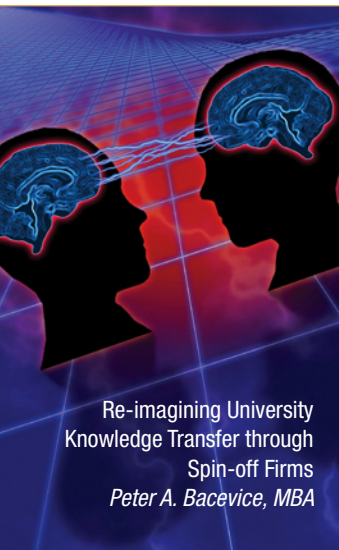
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Universities wishing to engage in and prioritize the transfer of tacit knowledge should pursue the launching of new companies from within their academic communities.<sup>15</sup>

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Tacit knowledge is critical for successful university technology transfer offices, especially those that involve themselves in business-venture creation. Technology transfer offices must draw from management school expertise, intimate knowledge of faculty research, connections to the venture capital community, and a talent base from which to draw and form management teams for new companies.<sup>14</sup> This is highly tacit knowledge that draws upon relationships and social exchange. Spin-off companies are a form of knowledge transfer that is unique in their organization around specific expertise and tacit knowledge. Universities wishing to engage in and prioritize the transfer of tacit knowledge should pursue the launching of new companies from within their academic communities.<sup>15</sup>

Because academic scientists bring their expertise to their own spin-off firms, their tacit knowledge moves between the university and the firm. These firms are rooted in what Dorothy Leonard and Walter Swap refer to as the *deep smarts* of the founding scientists. Deep smarts are



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highly personal to the individual mind and makes knowledge all the more valuable, especially when it is difficult to codify and cogently articulate.<sup>16</sup>

The transfer of tacit knowledge, which is indicative of academic spin-off companies, is heightened by the complex interinstitutional relationship between higher education and industry. Higher education and industry have different cultures, norms, expectations, time frames, motivations, and they often have mutually different uses for knowledge.<sup>17</sup> Thus, it's helpful to consider these complexities and the ways in which academic spin-off firms relate to both the university and business communities.

### Knowledge and Innovation

Knowledge is an antecedent of innovation.<sup>18</sup> Several empirical studies indicate this trend by showing that the quest for knowledge sharing and mutual learning brings organizations together.<sup>19</sup> This trend brings a diversity of perspectives together. Diverse perspectives make for a cacophony of viewpoints. Well-managed cacophony creates positive energy and results in what Dorothy Leonard and Sylvia Sensiper describe as *creative abrasion*: "intellectual conflict between diverse viewpoints producing energy that is channelled into new ideas and products."<sup>20</sup> Bringing scientists and businesspeople together for interaction can create cacophony (technology transfer professionals are well-aware of this), but successful interactions do yield insights, discoveries, and business opportunities.

Innovation is the product of networks of people from different organizations and institutions that mutually diversify otherwise disconnected knowledge bases for shared benefit. This is consistent with the concept of *requisite variety*. Requisite variety posits that external disruptions to a system are more adequately confronted by that system when its own resources are more evenly matched to the disruption.<sup>21</sup> An organization—for example, a university spin-off firm—is unable to singularly meet

ever-evolving market challenges within its own system. Thus, as an organizational system, the spin-off firm must broaden the requisite variety of its system. It can do so by broadening its knowledge and innovation base through its alignment with other organizational systems, including those within universities.<sup>22</sup>

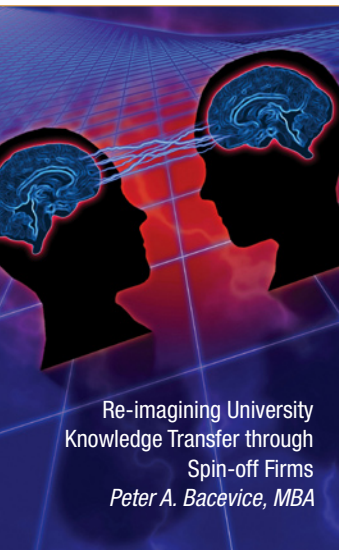
Many entrepreneurial startup firms have emerged in recent years to confront major societal challenges. On a micro level, individual business firms increase their requisite variety by broadening their knowledge bases. They do so by ensuring that they have access to university communities of expertise and skill and that they have access to marketplace partners such as investors who provide access to capital and the knowledge of market intelligence.

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Therefore, technology transfer professionals must consider their role as agents of the public good through their ability to broker relationships that strengthen firm-level requisite variety at a micro scale and community-level requisite variety at a macro scale.

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On a macro level, large-scale innovative challenges—for example, the confrontation of rising energy costs—require an alignment of networks among universities, business firms, and governments. Collaborative efforts of spin-off firms and universities highlight the power of requisite variety that exists at the community level in that clusters of firms and universities have more resources at their disposal when they ally themselves in the fight against certain challenges. Requisite variety at the community level stimulates the sharing of knowledge and learning across organizational boundaries, and this is the fuel of innovation.<sup>23</sup> Therefore, technology transfer professionals must consider their role as agents of the public good through their ability to broker relationships that strengthen firm-level requisite variety at a micro scale and community-level requisite variety at a macro scale.



## Conditions that Facilitate University–Firm Knowledge Transfer

The argument thus far is that organizational innovation does not happen alone. A university spin-off firm, like any other business firm, is strengthened through its collaboration with other organizations and the mutual sharing of knowledge. The university remains a key partner to these spin-off firms because of the knowledge that continues to flow among the networks of academic and industrial scientists. Thus, the remainder of this literature review explores the various conditions that facilitate this knowledge transfer.

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As a practical matter, readers might want to consider these various conditions as the basis of new metrics for the measurement of university knowledge transfer impact.

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Some scholars have noted sets of conditions that facilitate interorganizational knowledge transfer.<sup>24</sup> However, little is known about the specific conditions of university–firm knowledge transfer. After an extensive review of the literature streams on interorganizational knowledge transfer as well as university–firm relationships, two thematic categories emerged as conditions worthy of further inquiry. This literature review covers *structural* and *relational* conditions of interorganizational actor networks that facilitate university–firm knowledge transfer. In simple terms, this literature review will explore the ways in which individuals from both universities and spin-off firms are linked (structural) as well as the nature of their interactions when linked (relational).

As a practical matter, readers might want to consider these various conditions as the basis of new metrics for the measurement of university knowledge transfer impact. Some scholars have argued that technology transfer professionals must begin to consider metrics beyond the traditional

financial metrics of technology transfer licensing.<sup>25, 26, 27</sup> The conditions presented in the subsequent sections of this paper can be approached as managerial heuristics for developing a broader array of knowledge transfer metrics. The theoretical description of each knowledge transfer condition in the subsequent sections will conclude with a summary table, which includes questions of practical consideration that can be used to stimulate discussion around the development of metrics.

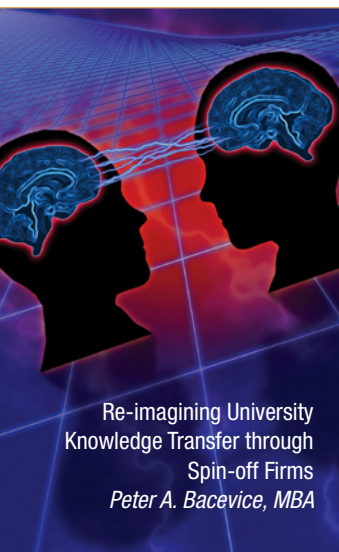
## Structural Conditions

A university–firm relationship is a dyadic, interorganizational relationship. A dyadic interorganizational relationship is a function of its organizational actors. Actors organize and establish boundaries that become organizations. When actors from one organization establish ties to actors of another organization, these organizations form ties with one another to the extent that the actors facilitate those ties. Structure is a way of understanding the way in which organizational actors connect or could potentially connect to one another in network space. This section will explore the literature on organizational structure and how variance in the structure of organizational actors relates to the transfer of knowledge between their respective organizations.

## NETWORKS: THE STRUCTURE OF CONNECTIONS

Network analysis offers a partial explanation of the relationship between organizational structure and knowledge transfer. In simplified terms, network analysis “is rooted in the empirical observation that patterns of interaction of many actors can be looked at as networks”—an aspect of which is the study of structure and the belief that social structure explains social phenomena.<sup>28</sup>

Two often-contrasted views of networks and the way in which information flows within them offer some insight into the



relationship between organizational structure and knowledge transfer. The work of Ron Burt and James Coleman suggests that the redundancy of network ties coincides with the redundancy of information available from those ties.<sup>29</sup> In Burt’s *structural hole* model, networks that are structured such that they contain inroads and access points to other networks yield nonredundant information for those within such networks.

In contrast, Coleman’s *closure* model suggests that networks that are structured such that the ties within them are close and redundant yield redundant information (and, thus, tacit knowledge) for those within such networks. Thus, knowledge transfer between two organizations is a function of the redundancy of ties among the organizational actors and their respective interpersonal networks. “From the perspective of the knowledge creation view, the more collaborative ties an organization has, and the greater the diversity of its partners, the more likely it will be successful at generating new knowledge.”<sup>30</sup>

Networks of actors can solely exist within the organization (i.e., networks that don’t exceed the organizational boundaries) as well as between the organization and the outside (i.e., networks that exceed organizational boundaries). A physics department faculty body, by itself, would be an intraorganizational network that exists

solely within the university organization. However, a network of condensed-matter physicists from within one university might also be part of a professional network of condensed-matter physicists from other universities, thus exceeding the boundaries of one particular university. The variation of interorganizational networks as well as intraorganizational networks of the actors of a particular organization are important to knowledge transfer.

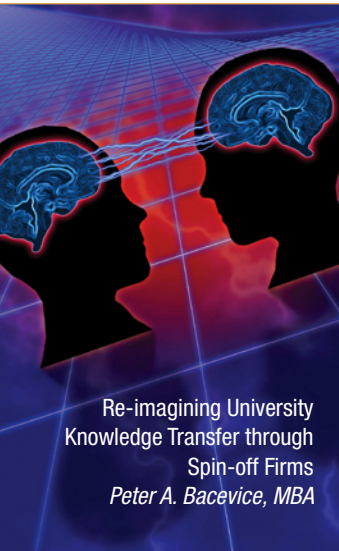
The networks of organizational actors are never static. They continuously evolve as people change cities, change jobs, or change careers. An organization’s turnover rate coincides with its ability to retain knowledge.<sup>31</sup> Tacit knowledge is linked to the knower and, if someone leaves an organization and falls away from that organization’s network, then that tacit knowledge is potentially lost.<sup>32</sup> Yet turnover can be a good thing for an organization in that it exposes the organization to new sources of knowledge. In a sense, knowledge transfer depends on dynamic organizations. A static organization would yield a static number of knowledge inputs.

## BOUNDARY SPANNING: INDIVIDUAL LINKS BETWEEN NETWORKS

Of particular interest to the study of knowledge transfer between universities and spin-off firms is the concept of boundary spanning. Boundary spanning

**Table 1. Summary of the Relationship between Network Variance and Knowledge Transfer**

Network Variance of Knowledge Transfer	Practical Considerations
Network redundancy: structural holes or closure	<ul style="list-style-type: none"> <li>• Consider the spin-off firm’s network.</li> <li>• With whom do firm scientists collaborate?</li> <li>• Is collaboration bringing the firm in contact with new sources of information?</li> </ul>
Network boundaries: internal or external to the organization	<ul style="list-style-type: none"> <li>• How many scientists are involved in networks that exist solely within the company itself?</li> <li>• How many scientists are involved in networks that go beyond the company (i.e., networks of scientists from multiple universities or professional associations)?</li> <li>• Each of these internal and external networks will yield different kinds of idea sharing. How do these ideas differ?</li> </ul>
Network turnover: static or dynamic	<ul style="list-style-type: none"> <li>• How often do people come and go from the firm?</li> <li>• What sorts of insight do new people bring to the business of the firm?</li> </ul>



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is a specific aspect of network structure because of its focus on the individuals who cross organizational and institutional boundaries. Thus, this area of scholarship focuses on the individuals who bring universities closer to business firms.

The crossing of such boundaries can be a major change in routine for the boundary spanner as they go from a state of certainty to a state of ambiguity. Manuel Crespo and Houssine Dridi note that spin-off creation “constitutes an important transformation of university researcher practices since they cross the bridge that insulates them from the world as they enter rapidly into an industrial change.”<sup>33</sup> Nevertheless, these individuals can serve as network ties that bridge organizations and bring them together, and they can serve to pave the way and reduce some of the ambiguity for those who follow as boundary spanners. In this context, boundary spanners are those who maintain a position in both the university and business firm and bring two otherwise disconnected organizations together.

Boundary spanners are individuals who understand the idiosyncrasies of both parties and who act at the knowledge interface of the relationship—especially when the relationship seeks the transfer of tacit knowledge.<sup>34, 35, 36</sup> Boundary spanners are important for building trust in interorganizational relationships, but they also hold somewhat contradictory roles in that they foster trust between organizations while simultaneously protecting the interests of their own organizations.<sup>37, 38</sup> Technology transfer office staff play the role of boundary spanner between the university and the business community, but they also rely on entrepreneurial academic scientists with first-hand experience in both the academic and startup environments to act as boundary spanners.<sup>39</sup>

Increasingly, venture capital firms are looking to universities for the next big technological breakthrough. As an example of boundary spanning, some venture

capital firms hire university insiders to scope out students whose research has commercial potential. These insiders are usually students who have an entrepreneurial track record of starting their own companies and also understand the nature of university culture.<sup>40</sup>

Some empirical research has addressed issues of boundary spanning between universities and business firms through specific programmatic efforts. One study of various boundary-spanning initiatives at Georgia Institute of Technology demonstrates how the university is positioning itself as a hub of tacit knowledge transfer.<sup>41</sup> For example, the university’s Yamacraw Initiative focuses on the launching of spin-off companies in the area of broadband communication technology that enable the ongoing mutual transfer of tacit knowledge with the university.

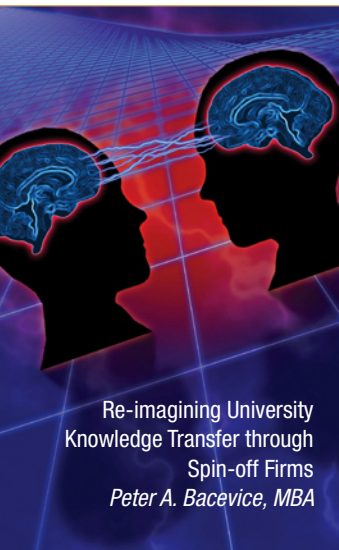
A separate study of biomedical departments at a group of universities in the United Kingdom considered the impact that fellowship programs had on serving as a bridge between academic and business networks and found that fellowship programs build bridges that strengthen the trust and entrepreneurial literacy of academic scientists.<sup>42</sup>

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Other areas of empirical research explore the boundary spanning impact of individual researchers. A study of university spin-off companies demonstrated the importance of entrepreneurial faculty members who remain at the university in legitimizing academic entrepreneurship and serving as entrepreneurial role models.<sup>43</sup> Another study of university spin-off firms notes that many spin-off company founders maintain some position with the



**Table 2. Summary of the Relationship between Boundary Spanning Variance and Knowledge Transfer**

Boundary Spanning Variance of Knowledge Transfer	Practical Considerations
Academic and industrial networks linked by programmatic efforts	<ul style="list-style-type: none"> <li>• Are there certain programs between the university and industry that make both sides mutually aware of each other's idiosyncrasies?</li> <li>• How do these programs enable the back and forth sharing of ideas?</li> </ul>
Academic and industrial networks linked by individual researchers	<ul style="list-style-type: none"> <li>• Who are the key individuals that bridge the university community with the business/industrial community?</li> <li>• How do these individuals legitimize or clarify the nature of the work of one side to the other?</li> <li>• How do these individuals enable the back-and-forth sharing of ideas?</li> <li>• What are some specific projects in which university and firm scientists are mutually involved?</li> <li>• What sort of mutual insight is gained by such efforts?</li> </ul>

university (either part time or full time).<sup>44</sup> It suggests that these boundary-spanners maintained such ties because of the long-term relationships they had established within their departments. These relationships were built on trust. As time progressed, these relationships were a conduit for knowledge.

Two studies by Fiona Murray offer some insight into these boundary-spanning individuals.<sup>45</sup> She finds that science and industry networks often center on individuals with dual roles in the academic research community as well as the industrial community.<sup>46</sup> Knowledge spillover in these networks often occurs through joint research and publication efforts. She also finds that the presence of academic scientists in spin-off firms is a source of tacit knowledge for the firm.<sup>47</sup> These individuals are also an important source of human capital for the firm in that they build networks between their academic and industrial contacts.

Scott Shane and Toby Stuart's study of MIT-based spin-off firms and their academic inventors found that these boundary-spanners also benefited from additional ties to the venture capital community.<sup>48</sup> Their study is an elaboration on what it means to span boundaries. There is a benefit to spanning boundaries between the university and the firm, but it is also important to have ties to others

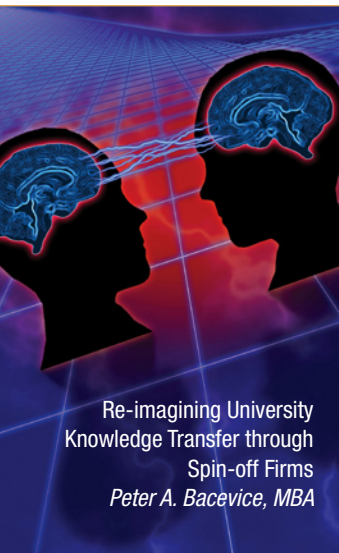
in the business community. In this study, additional ties by the founder to the venture capital community meant that these academic spin-off firms had a higher likelihood of success than firms whose founders did not have ties to the venture capital community.

## GEOGRAPHY: THE PHYSICAL SPACE BETWEEN NETWORKS

Another structural variable is the geographic, or spatial, distance that exists between organizations and their actors. One study suggests that there is a spatial variable to knowledge transfer.<sup>49</sup> Various business firms, social institutions, and universities cluster at the local and regional level. This sort of clustering brings educated and diverse people together, which stimulates creativity to create knowledge and innovation.<sup>50</sup>

A long line of research holds that the transfer of knowledge between individuals and organizations becomes more difficult as distance between them increases and, conversely, becomes easier as proximity between them increases, in part because of the contextual nature of knowledge, the demonstrable qualities of tacit knowledge, and the interpersonal nature of tacit knowledge transfer.<sup>51</sup>

David Audretsch and Paula Stephan conducted a study of firms and the university-based scientists affiliated



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**Table 3. Summary of the Relationship between the Variance in Geographic Distance and Knowledge Transfer**

Geographic Variance of Knowledge Transfer	Practical Considerations
Physical proximity between individuals from universities and spin-off firms?	<ul style="list-style-type: none"> <li>• What is the distance between the university and its spin-off firms?</li> <li>• How easily do university and firm scientists connect and interact with each other?</li> <li>• Given the proximity between the university and its spin-off firms, what is the level of complexity of the knowledge that is shared?</li> <li>• How does the region in which the university is located generally interact with entrepreneurial firms?</li> <li>• Are spin-off firms regularly engaging with the university?</li> <li>• Do university spin-off firms stay in their home region, or do they leave for other regions?</li> </ul>

with those firms.<sup>52</sup> Their sample of firms consisted of biotechnology companies that underwent an initial public offering during a specific time frame. In doing their study, they found that firms varied widely in their use of localized talent.

For example, the San Diego, San Francisco, and Boston regions utilized a higher percentage of university-based scientists than several other regions. They hypothesized that the use of localized university-based talent depended on the role that scientists were expected to play. They further hypothesized that, when firms wanted to tap into the tacit knowledge of scientists, they tended to reach out to local talent. Such tacit knowledge represents access to the knowledge of local university research labs.

Peter Lindelöf and Hans Löfsten studied science parks that house new university spin-off firms and found that firms that were in proximity to universities enjoyed the intangible benefits of being in a networked environment with those universities.<sup>53</sup> They argue that networks,

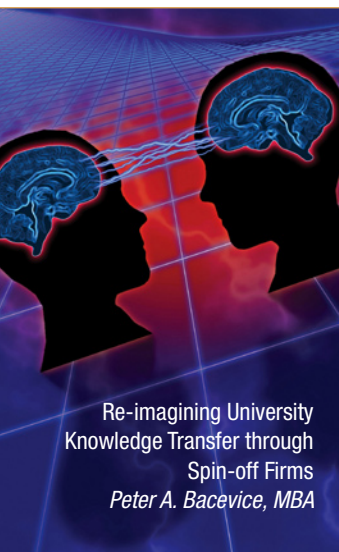
including those with research universities, are valuable to firms for the discovery and testing of new ideas.

One caveat to this line of study is the variability among regions. Clusters organize in various ways depending on the local norms of a city or region.<sup>54</sup> There are many studies of urban regions in the United States such as Boston, the San Francisco-Bay Area, San Diego, and the North Carolina Research Triangle. Yet regional dynamics vary even among these bellwether regions (see, for example, AnnaLee Saxenian’s 1994 comparative ethnography of Silicon Valley and Boston).<sup>55</sup> An increasing number of studies are looking at other regions, both within and outside the United States, to determine the geographic-spatial conditions of university–firm knowledge transfer in different contexts.

For example, one qualitative study looked at three different universities in noncore areas in Australia and the roles that each university played on the innovative activities of each respective region.<sup>56</sup> The study concluded that the university–

**Table 4. Summary of the Relationship between the Variance of Tie Strength and Knowledge Transfer**

Variance of Tie Strength in Knowledge Transfer	Practical Considerations
Strong-weak	<ul style="list-style-type: none"> <li>• How intense is the relationship between the university and its spin-off firms?</li> <li>• To what extent is the university–firm relationship an ongoing source of new insight for either party?</li> <li>• To what extent does the university–firm relationship create opportunities for the mutual learning of deep insights?</li> <li>• To what extent does the university–firm relationship create opportunities for the mutual sharing of information resources?</li> </ul>



firm dynamic varies based on a number of regional, industrial, and university characteristics. Thus, geographic proximity between universities and firms matters to knowledge transfer, but the variability among regions highlights other relational dynamics of knowledge transfer.

### Relational Conditions

The structure of interorganizational relationships provides insights into the channels through which knowledge transfers. However, structure is only part of the knowledge transfer picture.<sup>57</sup> The structure of interpersonal and interorganizational ties does not describe how individuals relate to one another within those ties. This section is a review of literature on the relational variation within interorganizational relationships and how such variation coincides with knowledge transfer.

### STRENGTH OF TIES: THE INTENSITY OF RELATIONSHIPS

One particular aspect of network research focuses on the structure of ties. Yet the structure of ties—or the ways in which actors organize in network space—is not a sufficient explanation of how networks vary. Networks also vary based on the intensity of the relationships that people have with one another. Thus, the strength of ties differs from the structure of ties.

The scholarship of Mark Granovetter discusses ways in which the strength of ties varies and how such variance coincides with the transfer of knowledge.<sup>58</sup> The variability in the strength of ties coincides with

the redundancy of knowledge as evidenced by the transfer of either new information or existing information. On the one hand, *weak ties* are beneficial because they are easily acquired and because many weak ties are access points to new information.

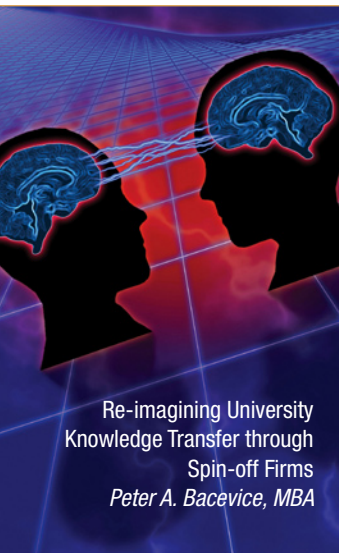
On the other hand, *strong ties* yield information overlap, which can lead to the transfer of tacit knowledge.<sup>59</sup> Strong ties lower the transaction costs of knowledge transfers, but over time, the strong ties can become problematic in that knowledge shared within these strong ties becomes as homogeneous as the ties.<sup>60</sup>

### FORMALITY OF TIES: THE STRUCTURE OF INTERACTION WITHIN RELATIONSHIPS

University–firm relationships can also be classified by the formalities of the ties between them. Some relationships can be quite formal and mirror the characteristics of a formal alliance in that the organizations and their respective actors are bound to adhere to the provisions of a formal contract such as a technology license. A formal alliance can encompass “a constellation of agreements characterized by the commitment of two or more partner firms to reach a common goal, entailing the pooling of their resources and activities.”<sup>61</sup> Despite the formal agreements that bring organizations together, many of the ties that exist between individuals and their respective organizations may be very casual and informal and not bound by any agreement other than the basic norms of trust and reciprocity.

**Table 5. Summary of the Relationship between the Variance of Tie Formality and Knowledge Transfer**

Variance of Tie Formality in Knowledge Transfer	Practical Considerations
Formal-informal	<ul style="list-style-type: none"> <li>• How structured are the interactions between individuals from the university and from business firms?</li> <li>• To what extent are ideas and insight spontaneously shared (i.e., through informal networking) in the context of university–firm interactions?</li> <li>• To what extent are ideas and insight sought through rigid or controlled interactions (i.e., formal brainstorming sessions) between individuals from the university and from business firms?</li> </ul>



Research that has explored university-based spin-off firms has looked at the formality of the ties between firms and their universities, ranging from formal to informal. University-spin off firms depend on the university for a variety of knowledge resources. Small numbers of strong ties, characterized by high levels of trust and informality, are typical of these university–firm relationships.<sup>62</sup>

The formality of ties also matters in the context of physical proximity and knowledge transfer. In David Audretsch and Paula Stephan’s study of firms and the ties that they have with university-based scientists, they argued that physical proximity between the firm and the scientist mattered when knowledge transfer was informal.<sup>63</sup> However, when knowledge was transferred within formal ties between firms and scientists, physical proximity was less important because the transfer of knowledge was a planned activity. This suggests a relationship between the formality of ties and the spontaneity of knowledge transfer.

## TRUST: THE ORGANIZING PRINCIPLE OF RELATIONSHIPS

In much of the research on the relational aspects of interorganizational relationships, the issue of *trust* frequently emerges. Trust is a complex phenomenon, with consensus in the literature regarding this complexity. While recognizing this

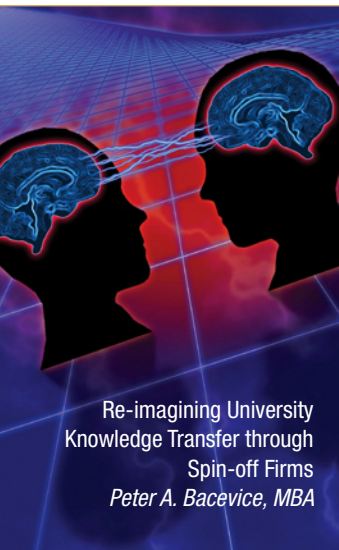
One study of university–firm relationships suggests that trust is the glue that holds such relationships together, whether the relationship is based on the transfer of tacit or explicit knowledge.<sup>77</sup> It suggests that trust is an area for future research, specifically its temporal nature and the way in which trust interacts with other contextual factors.

complexity, Bill McEvily, Vincenzo Perrone, and Akbar Zaheer define trust as “the willingness to accept vulnerability based on positive expectations about another’s intentions or behaviours.”<sup>64</sup> They note that *trust* and *trustworthiness* are not interchangeable in that trust is an expectation while trustworthiness is a behavior. Placing trust in another entity (the expectation) never comes with a foolproof guarantee of trustworthiness (the behavior) by the other entity.

Relationships between organizations require some degree of trust. Differing information sources can create conflict and trust mitigates the accessibility and interpretation of information.<sup>65, 66</sup> Trust is an organizing principle a precondition, and a product of collaboration.<sup>67, 68</sup> Trust minimizes malfeasance, reduces transaction costs, and ensures that both parties to the partnership act responsibly and meet the expectations that the other party expects.<sup>69</sup> University–firm relationships are no different in this respect. Knowledge-sharing relationships between organiza-

**Table 6. Summary of the Relationship between Variance in Trust and Knowledge Transfer**

Variance of Trust in Knowledge Transfer	Practical Considerations
Trust or lack of trust	<ul style="list-style-type: none"> <li>• How much trust exists between the university and its spin-off firms?</li> <li>• Do individuals from the university and from business firms mutually share ideas and insight?</li> <li>• To what extent is it easy or difficult for parties from the university and from business firms to share ideas and insight?</li> <li>• To what extent do individuals from the university and from business firms engage in the sharing of deep insight?</li> </ul>
Temporal variance of trust	<ul style="list-style-type: none"> <li>• How long has the university been a trusted knowledge partner to business firms?</li> <li>• How much knowledge has been mutually shared between the university and business firms?</li> </ul>



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tions such as universities and business firms follow this same pattern.<sup>70</sup>

Trust is a precondition for informal communities, or self-authorizing groups that exist outside the constraints of formal organizational hierarchies and bring people together with shared expertise or passion for joint enterprise, and mutual learning.<sup>71,72</sup> When communities of individuals are embedded in the relationships between their respective organizations, interorganizational relationships benefit from a long-term outlook in that individuals forgo short-term personal gain for the long-term good of the interorganizational relationship.<sup>73</sup>

The scholarship of interorganizational trust describes its temporal variability. Trust has temporal variability in that there are levels of trust that vary at the formation of a relationship as well as levels of trust that vary at any given point throughout the duration of the relationship.<sup>74</sup> Trust evolves sequentially and intensifies throughout the relationship.<sup>75</sup> Mutual knowledge sharing and innovation intensify as trust deepens over time.<sup>76</sup> One study of university–firm relationships suggests that trust is the glue that holds such relationships together, whether the relationship is based on the transfer of tacit or explicit knowledge.<sup>77</sup> It suggests that trust is an area for future research, specifically its temporal nature and the way in which trust interacts with other contextual factors.

Some research considers variability between trust and the absence of trust. Rikard Larsson, Lars Bengtsson, Kristina Henriksson, and Judith Sparks argue that a lack of trust erects a barrier to the formation of interorganizational knowledge.<sup>78</sup> In a study of university–firm alliances, Michael Santoro and Patrick Saporito argue that relational trust is a more significant facilitator than self-interest in knowledge transfer.<sup>79</sup> Relational trust's association with knowledge transfer became stronger as the tacitness of the knowledge increased.

Likewise, Arthur Sherwood and Jeffrey Covin's study of firms engaged in technology transfer relationships with universities found that the firm's trust in the university was a significant predictor of tacit knowledge acquisition but was not a significant predictor of explicit knowledge acquisition.<sup>80</sup> Trust is also necessary in the sharing of privileged information among entrepreneurial academic researchers.<sup>81</sup>

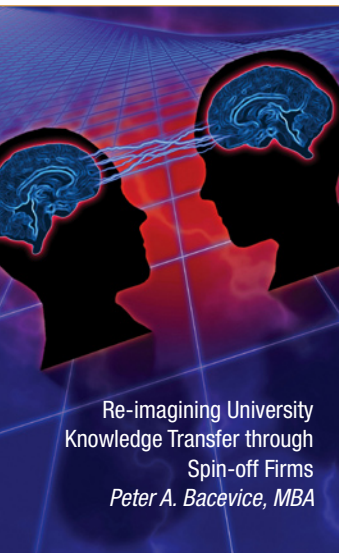
## Summary

This paper has suggested several conditions that influence the transfer of knowledge between universities and academic spin-off firms. Each of the major sections described one of these conditions and concluded with a list of practical questions for technology transfer professionals to consider. By asking these questions, technology transfer professionals can hopefully generate answers that can subsequently influence their practice of launching spin-off companies. ▽

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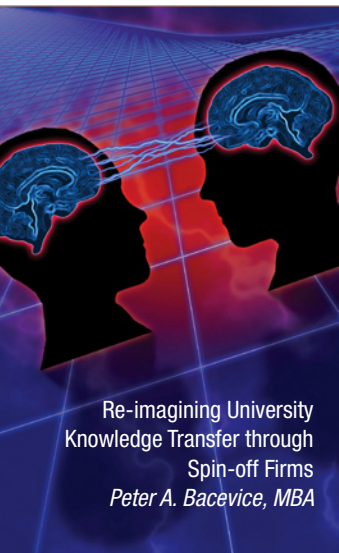
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