

## **Advancing Innovation via Multidisciplinary Partnerships: The Role of Technology Transfer and University-Industry Collaboration**

**Dr. Gideon M. Albrecht**

Faculty of Innovation Studies, Rheinberg Institute of Technology, Düsseldorf, Germany

**Dr. Lucía E. Santoro**

School of Business and Technology, Instituto Europeo de Innovación, Milan, Italy

**Prof. Rohan C. Ellery**

Centre for Innovation Economics, Southbridge Commonwealth University, Melbourne, Australia

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### **Abstract**

One of the most important ways that modern innovation systems turn scientific discoveries into societal, economic, and commercially viable products is through technology transfer and cooperation between universities and businesses. Regional competitiveness, entrepreneurship, industrial rejuvenation, and problem-oriented innovation are some of the new areas where universities are making a difference, expanding their traditional roles beyond teaching and fundamental research. To supplement in-house R&D, cut down on innovation cycles, and tap into specialized knowledge, infrastructure, and talent, businesses are turning to external knowledge networks. This essay takes a look at the ever-changing, multidisciplinary, and policy-relevant topic of technology transfer and university-industry partnership. It contends that a broader ecosystem of relational, organizational, and institutional processes linking science, engineering, management, public policy, and market application is more important than formal intellectual property transactions for accelerating innovation. Collaboration between universities and industries, technology transfer offices, open innovation, obstacles to collaboration, and types of partnerships are all discussed in this article, along with key findings from conceptual research and systematic reviews. It delves into the field's history, the main types and reasons for collaboration, the function of multidisciplinary collaborations, the obstacles to successful transmission, and the policy and governance requirements for long-term effects. According to the article's findings, cooperation architectures that bring together public agencies, businesses, and educational institutions must have trust, absorptive capacity, institutional flexibility, and strategic alignment in order to have innovation systems that function well.

### **Keywords**

Technology transfer; university–industry collaboration; interdisciplinary partnerships; innovation systems; knowledge transfer; open innovation; commercialization; research partnerships

## **Introduction**

Nowadays, one of the most distinctive aspects of innovation systems is the partnership between academics and industry. In a knowledge-based economy, research in the scientific community, the creation of new technologies, and their commercialization are no longer seen as distinct functions performed by different organizations. Universities, businesses, governments, investors, middlemen, and end users are all interconnected in ever-increasing networks, and it is via these networks that new innovations are born. As part of this larger shift, university-industry partnerships and technology transfer have become more important tools for transforming research capacities into useful and beneficial social outcomes.

It was commonly believed in the old innovation model that new ideas would follow a strict chronological order, beginning with scientific discovery and ending with market diffusion. According to that approach, knowledge was created in universities, then marketed by firms, and last regulated or funded by governments. That simplicity has been questioned by modern innovation study. Knowledge today travels in various directions throughout iterative, collaborative, and frequently interdisciplinary processes that produce innovation. Various stakeholders, including industry, institutions, and public policy, can influence research objectives, commercialization efforts, and the conditions under which collaboration takes place.

Because of this change, discussions on the social function of higher education, entrepreneurial ecosystems, regional development, and university-industry partnership have centered on this topic. Along with teaching and publishing, universities are being pushed to do more through innovation focused on missions, such as patenting, licensing, contract research, spin-offs, collaborative laboratories, venture formation, and more. In the meanwhile, businesses are on the lookout for ways to boost their innovation capacity and competitive positioning by gaining access to cutting-edge knowledge, research facilities, and scientific experts.

However, there is no magic formula for seamless and effortless cooperation between academic institutions and businesses. Time horizons, incentive structures, corporate cultures, regulatory requirements, and success criteria are all areas where universities and businesses diverge. Rather than occurring in a vacuum, technology transfer is an iterative process that necessitates the codification of knowledge, the development of relationships, the management of intellectual property, the evaluation of the market, the backing of institutions, and the ability of the receiving side to absorb new information. Because of these facts, working together is not only very beneficial, but also extremely taxing on institutions.

This essay delves into the ways in which interdisciplinary relationships facilitate technology transfer and university-industry collaboration, which in turn accelerate innovation. It argues that in order for collaboration to be effective, we need to expand our thinking beyond the traditional concept of transfer as a formal transaction and instead consider innovation ecosystems as a whole, where different fields, individuals, and organizations work together to create something of immense value. The article continues by exploring the theoretical underpinnings of university-industry partnerships,

the development of technology transfer models, the many types and reasons for collaborating, the significance of interdisciplinary work, the challenges and opportunities associated with partnership, and the necessary policy frameworks to enhance innovation results.

### **The Changing Role of Universities in Innovation Systems**

Throughout their history, universities have been linked to the creation and sharing of new information via various forms of instruction and research. Nevertheless, universities considerably expanded their institutional function in the late twentieth and early twenty-first centuries. The role of universities as catalysts for regional competitiveness, technical innovation, economic growth, and entrepreneurship became more widely acknowledged. A common metaphor for this shift is the "third mission," the broader social and economic impact that colleges have outside traditional spheres of influence like classroom instruction and research.

There was context in which this new responsibility arose. It mirrored shifts in the larger political economy of knowledge production, which includes things like stricter regulations, shorter product life cycles, higher research costs, more demands on public funding, and higher expectations that publicly funded science should have a positive impact on society and the economy. Consequently, academic institutions ramped up their efforts in commercialization, industry collaborations, and knowledge exchange systems.

Because of this change, entrepreneurial programs, scientific parks, innovation centers, incubators, and technology transfer offices have been on the rise. By assisting universities in spotting discoveries with commercial potential, safeguarding intellectual property, negotiating agreements, and facilitating the establishment of spin-offs, these frameworks hope to increase the accessibility of academic research to enterprises and investors. Concurrently, colleges get access to resources, challenges, tools, input from the labor market, and new ways to make their work relevant to society through partnerships with businesses.

This change, however, is still debated. While proponents of entrepreneurial colleges point to their ability to spur innovation and competitiveness, detractors point to concerns about mission drift, over-commercialization, conflicts of interest, and the loss of academic freedom. Not that these conflicts justify not working together; rather, they highlight the importance of maintaining a healthy institutional equilibrium. When universities are both strategically open to outside involvement and maintain high standards of scientific integrity, they are able to produce the most public value.

### **Understanding Technology Transfer Beyond Commercialization**

A common and limited definition of technology transfer is the process by which universities license their patented inventions to businesses. The research demonstrates that technology transfer encompasses a far broader and more complex phenomenon, while this process is still significant. Included in this are the following: official and informal guidance, research instruments, prototypes, methodologies, software, trained graduates, organizational learning, tacit knowledge, and collaborative problem-solving.

There are two main arguments in favor of taking a more holistic approach of technology transfer. To begin, patents are not the only means by which significant ideas are advanced. Collaboration in research and publishing, consultancy, student placement, shared facilities, and frequent contact with academic specialists are all ways in which businesses might benefit. Second, market validation, product development, project management, regulatory adaptation, user learning, and intellectual property are all necessary but supplementary procedures for commercialization to succeed.

The easiest way to see technology transfer is not as a formal legal transfer but as a social and organizational process. At least four critical factors are involved: the source of knowledge, the means of transfer, the recipient's absorption ability, and the institutional setting in which the transfer occurs. What gets transferred matters, but so do the people involved, the structure of the relationships, the incentives, and the recipient organizations' abilities to perceive, absorb, and use the information.

This intricacy is further supported by systematic review studies on models of technology transfer. It demonstrates that intermediaries, objects, senders, recipients, behavioral characteristics, and context may all be included in various models of technology transfer. In cases where academic institutions and businesses do not share common language, expectations, or evaluation criteria, a technology transfer agency or broker can serve as an essential mediator. Here, translation and coordination are just as important as invention when it comes to technology transfer.

#### **University–Industry Collaboration as an Innovation Process**

Collaboration between universities and businesses is best seen as an ongoing effort rather than a static contract. Collaboration is defined in the literature study as an inter-organizational connection that aims to encourage the flow of knowledge and technology between firms and higher education institutions. Contract research, licensing agreements, strategic alliances, and the formation of concentrated joint organizations are all possible outcomes of this process, as are casual encounters and student placements.

The review's most important result is that there are multiple recurrent elements to university-industry collaboration, including: types of collaboration, reasons for participation, activities for formulation and operationalization, factors that facilitate or hinder collaboration, and the outcomes of the collaboration. By viewing collaboration as an ongoing process rather than a discrete event like the signing of a research agreement, this process approach helps to preserve its inherent value. On the contrary, it stresses the need of continuously building, managing, adapting, and evaluating innovative collaborations.

Why there is such a wide range of results from collaborations can be better understood using the process view. Along with new goods, patents, and long-term strategic alliances, some partnerships produce outstanding innovation performance. Some partnerships fail because there is a lack of commitment, poor communication, bureaucratic hurdles, or misplaced expectations. Therefore, the design and governance of the relationship are more important than abstract collaboration for determining success.

Collaboration between universities and businesses is about more than just the transfer of information from schools to businesses. Mutual learning is also a key component. Companies provide information such as commercialization strategies, market data, production limitations, and problem descriptions based on real-world scenarios. The scientific capacity, specialized knowledge, laboratories, and exploratory research capacity are all assets that universities bring to the table. When interdisciplinary collaborations facilitate the interaction of different types of information, rather than keeping them apart, they become extremely powerful.

### **Forms of Collaboration and Technology Transfer Mechanisms**

Contrary to popular belief, there is a much wider variety of channels for university-industry partnership. Research on reviews has shown a wide range of official and informal communication styles. On one end of the spectrum are more casual and personal connections, such as those formed at conferences, through colleagues, through the exchange of information, through consultancy, or in informal advisory positions. Trust building, tacit information exchange, and exploratory problem framing are all greatly aided by these forms, yet they are frequently disregarded in policy debates due to the lack of a visible contractual trace they leave.

The second category includes more established forms of personal partnerships, such as internships for students and faculty, cooperative supervision of graduate work, shared use of facilities, and industry involvement in academic projects. In the processes of talent circulation and capability formation, these mechanisms are crucial. The transfer of knowledge from one company to another is also facilitated by this, and it is one of the most long-lasting avenues of transfer.

Intermediary or third-party structures are categorized as a third group. Some examples of such groups are innovation brokers, government-supported transfer networks, technology transfer agencies, and industry alliances. When universities and businesses want assistance in converting research results into a format that businesses can understand, or when the complexity of the relevant laws and regulations prevents them from working together, their position becomes even more crucial.

Formal targeted agreements make up the fourth category. These include sponsored research, collaborative development arrangements, patenting and licensing, contract research, and cooperative research and development programs. Because of their relative ease of measurement and institutional regulation, these types tend to receive the greatest attention. Nevertheless, previous relationship quality and organizational capacity are typically determining factors.

Endowed chairs, research gifts, long-term sponsorships, and general frameworks for collaboration are examples of wider and less specific partnerships, which make up the fifth type. In many cases, these setups stabilize interaction over time, which paves the way for future innovation. Last but not least, institutions like incubators, science parks, university-industry centers, consortia, and spin-offs provide long-term settings where collaboration is more permanent than temporary.

Because it shows that innovation acceleration is rarely dependent on one process alone, the diversity of different forms is significant. Knowledge can flow through formal intellectual property channels, companies, projects, and individuals all at once in high-performing ecosystems.

### **Motivations for University–Industry Collaboration**

If you want to build relationships that work, you need to know why universities and businesses work together. According to the reviewed research, there is a wide range of interests at play, including financial, intellectual, reputational, and developmental concerns, on both sides. Universities and businesses often collaborate for distinct reasons, while there is some overlap.

The availability of funds is a key factor for educational institutions. When universities and businesses work together, they can raise money for things like scholarships, applied projects, research, and equipment that would not be able to get enough support from the government alone. The relevance of the work is another factor; when students and teachers work together, they gain exposure to real-world issues, cutting-edge technology, and real-world business settings, all of which improve classroom instruction, course design, and research implementation. Legitimacy and public expectations also play a role in motivating universities. Governments and societies are placing more and more expectations on universities to actively contribute to economic and technological progress.

Competitive advantage and the ability to innovate are common drivers of motivation for businesses. Universities and businesses work together so that businesses can access cutting-edge research, specialized knowledge, cutting-edge technology, and talented graduates. They may be able to find future technologies ahead of the competition, mitigate innovation risk, augment their limited internal R&D capability, and address certain technical challenges if they work together. Universities' capacity for multidisciplinary research is particularly useful for companies operating in dynamic industries, where new ideas often need the integration of expertise in areas such as engineering, design, computing, biology, management, and regulations.

Additionally, there are common reasons. Gaining recognition, credibility, expanding professional networks, and access to larger innovation ecosystems are all goals that colleges and businesses may pursue. Public incentives, tax tools, mission-oriented initiatives, and regional development plans that promote cooperation between different sectors may elicit a response from both. Thus, the larger policy environment, in addition to bilateral motives, shapes university-industry partnership.

### **Interdisciplinary Partnerships as Drivers of Innovation Acceleration**

An increasingly crucial trend in modern innovation is the increasing need of collaboration across disciplines. There is no easy solution to many of society's most pressing technology and scientific problems since they transcend traditional academic or occupational boundaries. Complex problems including digital transformation, sustainable production, innovative materials, healthcare technology, intelligent infrastructure, renewable energy, and AI necessitate interdisciplinary teams with strengths in science, technology, law, management, and society.



As a result of universities' unique ability to compile information from a variety of fields, and firms' ability to offer context, application pressure, and implementation pathways, interdisciplinary university-industry cooperation are highly beneficial. For instance, in the biomedical device industry, a successful partnership may necessitate understanding of engineering, medicine, regulation, data science, industrial design, reimbursement, and marketing strategy. The development of new clean technologies may also necessitate expertise in environmental evaluation, systems engineering, chemistry, materials science, policymaking, and finance.

In a number of ways, interdisciplinarity speeds up the invention process. To start with, it broadens the type of issues that can be tackled by group efforts. Second, it makes innovations more likely to be technically sound and applicable to organizations. Third, implementation hurdles including legal restrictions, user requirements, market mismatch, or sustainability issues can be identified sooner. As a result, the workforce is better equipped to handle complex innovation systems, and the fourth benefit is that it improves learning environments for students, researchers, and practitioners.

On the other hand, coordination issues can arise from interdisciplinary collaboration. The terminology, procedures, evidentiary standards, and time spans used by various fields are distinct. Interdisciplinarity, in the absence of effective leadership, runs the risk of causing more harm than good. Accordingly, frameworks that incentivize behavior that crosses boundaries, common problem definitions, translational responsibilities, and integrative leadership are all necessary for productive collaborations.

### **Open Innovation and the Expansion of Transfer Logic**

Open innovation's rising profile has widened the scope of rationale for partnerships between academic institutions and businesses. According to the tenets of open innovation, companies can not rely just on in-house R&D to generate value; they also need to tap into other resources, such as collaborations, networks, and external knowledge sources. According to this model, colleges and universities play a significant role in how businesses source technology and seek out new innovations from outside sources.

The way technology transfer is perceived is altered by this viewpoint. With open innovation, colleges are not seen as repositories of patents waiting to be exploited, but rather as hubs for ongoing knowledge sharing, complementary skills, and joint experimentation. Furthermore, it stresses the significance of both incoming and outward flows of intellectual property, personnel, prototypes, and ideas.

A number of factors, such as knowledge management, organizational resources, dynamic capabilities, research and development management, and the quality of relationships between universities and industries, have been identified as contributing to the success of university technology transfer initiatives that use open innovation. This shows that larger capacities for collaboration are more important than individual innovations for determining transfer performance. A view of innovation that is more ecosystem-based is also supported by open innovation. Collaborating with various public agencies, research institutes, start-ups, and universities is possible

for firms. As part of regional innovation systems, universities can take part in technology transfer initiatives that include incubators, VC, public procurement, mission-led programs, and entrepreneurial training. Network orchestration is just as important as bilateral partnering in these settings for accelerating innovation.

### **Barriers to Effective Collaboration and Technology Transfer**

Despite the obvious advantages of working together, there are substantial obstacles to fruitful university-industry cooperation, as shown in the literature time and time again. Cultural, organizational, and procedural factors also play a role, in addition to structural ones.

Misalignment of incentives is the first obstacle. While businesses place a premium on timeliness, secrecy, competitive advantage, and publishing, universities tend to place a premium on openness, long-term investigation, academic recognition, and speed. Intellectual property, publication delays, project results expectations, and deliverables are all areas where these disagreements can lead to friction.

Reduced absorption capacity is an additional obstacle. It can be challenging for businesses, particularly SMBs, to find, implement, and profit from the scientific, managerial, and financial resources available at universities. The same is true for universities: they might not have the necessary personnel, knowledge, or resources to help bring their technologies to market.

Bureaucratic red tape is a third obstacle. Dealing with ownership rights, confidentiality restrictions, license terms, and contracts may be an expensive and time-consuming ordeal. This is where technology transfer offices come in; nevertheless, how well they do their jobs depends heavily on factors including institutional flexibility, professional competency, organizational resources, and incentive structures.

A relational barrier is the fourth. The importance of trust, open communication, and mutual understanding in a successful partnership has been stressed time and time again. Even when the research is solid, projects that seemed promising can nonetheless fail due to a lack of understanding between partners regarding language, work rhythms, and expectations. Trust, on the other hand, can compensate for uncertainty over time and pave the way for more ambitious teamwork.

Disintegration of disciplines and institutions is the subject of a fifth obstacle. Coordination issues might arise in interdisciplinary initiatives within each partner entity as well as between the university and business. Weak innovation performance can be caused by disjointed decision-making, muddled leadership, and inadequate cross-departmental integration.

Collaboration fails less frequently due to a flawed idea than to inadequate institutional circumstances for implementation, according to the research on university-industry collaboration. This result is both simple and crucial.

### **The Role of Technology Transfer Offices and Intermediaries**

A key component of contemporary university-industry partnerships is technology transfer offices. Intermediaries between the academic and business sectors, they are frequently requested to find innovations, oversee disclosures, determine patentability, negotiate licensing deals, back spin-offs,



and more. Their ascent underscores the realization that top-notch science is not a guarantee of effective transmission.

Technology transfer offices excel when they translate, broker, and coordinate. Researchers can use their assistance to present their findings in a form that is understandable to businesses and financiers. They guide businesses through the maze of university processes, IP policies, and possible partnership openings. In addition, they help with portfolio management by figuring out which inventions would be good to license, which ones would benefit from incubation, and which ones may be better transmitted through staff mobility or joint research.

On the other hand, TTOs are not enough, according to the literature. The larger institutional setting in which they function, such as university administration, researcher incentives, regulatory frameworks, regional innovation networks, and the accessibility of downstream partners, all impact the performance of transfers. Just as a very entrepreneurial research community may nonetheless face challenges due to overly bureaucratic transfer support, a badly connected TTO cannot make up for a weak cooperation culture.

This suggests that effective intermediation is more dependent on ecosystems than on administrative processes alone. In order for TTOs to be most effective, they should be connected to investor networks, applied research platforms, incubators, regional agencies, and functions that encourage entrepreneurship. Integrating them into a broader innovation support framework enhances their effectiveness.

### **Policy and Governance for Stronger Collaboration**

The level and quality of cooperation between universities and businesses are greatly influenced by public policy. The attractiveness, feasibility, and social productivity of collaboration are affected by various factors, including but not limited to: intellectual property regulations, funding methods, tax incentives, legal frameworks, regional development programs, and innovation strategies focused on missions.

Because it changed incentives around university patenting and licensing, legislation like the Bayh-Dole Act in the US is frequently mentioned as a turning point. Regulatory shifts along similar lines in other parts of the world also contributed to the institutionalization of technology transfer becoming the norm. However, ownership regulations alone will not guarantee a successful policy. Funding mechanisms that encourage proof-of-concept work, interdisciplinary consortia, translational research, and early-stage collaboration are also necessary for effective policymaking. Reducing coordination costs and supporting long-term partnership structures are two ways governments can promote collaboration. Support for scientific parks and incubators, regional innovation clusters, knowledge-transfer collaborations, challenge-based research projects, and competitive grants that require multi-actor engagement all contribute to this goal. Small businesses, which stand to gain the most from university collaboration yet have the greatest obstacles to entry, need policies that help them overcome these obstacles.

The level of governance within universities is also important. Institutions should implement incentive programs that promote teamwork without lowering standards of education. Recognizing the time and effort required for high-impact information exchange—which frequently includes contributions that are not entirely apparent in traditional academic metrics—is crucial for development criteria, workload models, legal backing, and leadership messaging.

Lastly, a more comprehensive set of outcomes, including problem-solving capacity, talent development, regional upgrading, social innovation, multidisciplinary learning, and long-term ecosystem strength, should be used to evaluate collaboration policies, rather than just patent counts or licensing income. Limited measures could fail to capture the true value of collaboration.

### **Toward a Strategic Framework for Interdisciplinary Collaboration**

Problem identification is the first step in developing a framework for strategic university-industry partnership that has a significant impact. When partnerships are structured around important problems that have implications for both science and industry or society, they are more likely to be successful. In place of transactional convenience, this establishes a foundation for aligned commitment.

Complementarity between partners is the second component. It is important for universities and businesses to recognize what they can bring to the table in terms of expertise, resources, connections, and ability to put plans into action before beginning a partnership. Although complementarity does not eradicate conflict, it does lay a firmer groundwork for the joint production of value.

Governance design is the third component. It is important to establish early on who is responsible for what, when, how, what is owned, how to escalate, and what the publication standards are. While adaptable leadership is crucial, vagueness is not the same thing. Effective teamwork necessitates just the right amount of structure to deal with uncertainty without stifling risk-taking.

Capability to traverse boundaries is the fourth component. The ability to bridge domains, communicate ideas, and establish connections between scientific, technical, managerial, and commercial viewpoints is crucial for effective multidisciplinary collaboration. Thus, research institutions and businesses should put money into hybrid leadership, translational training, and interface positions.

Institutional backing is the fifth component. These encompass a wide range of services, including as incubators, legal teams, prototyping resources, translational funding, and transfer offices. When partners are not left to wing it for every support function, collaboration quality goes up a notch.

Evaluation and learning are the sixth component. The evaluation of partnerships should take into account both the short-term results and the capacity development that will occur in the future. In order to facilitate quicker and more successful innovation in the future, the most beneficial partnerships frequently generate cumulative advantages by enhancing trust, habits, and absorptive ability.

## **Conclusion**

In today's innovation systems, technology transfer and cooperation between universities and businesses are essential components. Their importance stems from their ability to bridge gaps in scientific understanding, industry capacity, public policy, and multidisciplinary problem-solving, as well as from the commercialization of academic innovations. The strength of these connections will have a greater impact on economic resilience and social advancement as the complexity and dispersion of innovation issues grow.

Getting beyond myopic, transaction-focused perspectives on technology transfer is essential for productive collaboration, as this paper has contended. In order to speed up innovation, ecosystems of interaction, trust, intermediaries, talent mobility, institutional backing, and alignment of strategies are necessary. The contributions of universities extend beyond inventions; they encompass a breadth of disciplines, the ability to explore, and the human capital that is produced. Applications, market knowledge, implementation pressure, and commercialization channels are all areas where firms can make a contribution. Governments establish norms and provide incentives that foster long-term partnerships.

Collaborations across disciplines are crucial because they mirror the way modern invention really works: it defies categorization. Collaboration models that incorporate both formal transfer methods and more adaptive, networked, and learning-focused partnership structures tend to be the most effective.

The task for policymakers is to facilitate better collaboration, not just to promote more of it. For this, we need to focus on governance, incentives, trust, absorption capacity, and the development of ecosystems over the long run. When these factors come together, partnerships between academic institutions and businesses can be a game-changer when it comes to boosting innovation in the modern era.

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