

THE TTO, A UNIVERSITY ENGINE TRANSFORMING SCIENCE INTO INNOVATION

KOENRAAD DEBACKERE

LEAGUE OF EUROPEAN RESEARCH UNIVERSITIES

Universiteit van Amsterdam - Universitat de Barcelona - University of Cambridge - University of Edinburgh - Albert-Ludwigs-Universität Freiburg - Université de Genève - Ruprecht-Karls-Universität Heidelberg - Helsingin yliopisto (University of Helsinki) - Universiteit Leiden - Katholieke Universiteit Leuven - Imperial College London - University College London - Lunds universitet - Università degli Studi di Milano - Ludwig-Maximilians-Universität München - University of Oxford - Université Pierre et Marie Curie, Paris - Université Paris-Sud II - Université de Strasbourg - Universiteit Utrecht - Universität Zürich

Author

The author of the paper is:

Prof. Koenraad Debackere (K.U.Leuven)

LERU thanks the wider community of Technology Transfer Officers and Vice-Rectors for Research in its member universities and other experts who provided valuable input for the paper and comments during the drafting process. The LERU Research Policy Committee and Rectors generously contributed their advice.

EXECUTIVE SUMMARY

Industry-science links have become a key dimension in both innovation management and innovation policy. In this paper, it is argued that the growth and the development of academic Technology Transfer Organizations (TTO's) which support those links deserve careful attention, thus articulating the critical success factors that enable the deployment of effective TTO operations. In doing so, LERU wants to contribute to a better understanding of the fundamental role of the TTO in the process of translating the results of academic research into a form which can be more readily adopted by industry and commerce. In this advice paper, a set of insights are presented that can underpin universities' TTO deployment.

First of all, university leadership should provide the TTO with the necessary level of governance autonomy, strategic flexibility and financial autonomy within the (traditional) university structures. The autonomy and flexibility are illustrative of the respect and understanding that academic leadership (and by extension, the academic community) has towards the inner, proper logic governing industry-science interactions. Flexibility and autonomy should be implemented in a pragmatic manner, taking into account structure and process that best fit the university's specific institutional context.

Second, it is important that the academic TTO function can operate in an external environment that fully supports industry-science links, including a proper legal framework for universities to engage in technology transfer activities and clear, transparent rules as to the ownership of intellectual property rights. Since the vast majority of (European) universities operate within the space of public funding, it is imperative that public authorities create a legal environment that is conducive to and facilitates the transfer of research results from the public funding space in which they originate to the market space. Furthermore, it is necessary to articulate the expectations of all stakeholders towards the objectives pursued by technology transfer activities (e.g. job creation, contribution to the university's income, translation of research results for the broader public good, etc.).

Third, the TTO will install appropriate incentive and code-of-conduct schemes for the academic community, stimulating, but also monitoring, the technology transfer activities and behaviours of the researchers. These schemes have to be approved and accepted by the university's leadership.

Fourth, the leadership of the TTO should consider integrating or aligning front- & back-office operations. Through its governance autonomy, the TTO has the degrees of freedom necessary to achieve this managerial integration. Relevant TTO key performance indicators should be put in place.

Fifth, central support by the TTO should spread its interventions across the university through the implementation of a transversal structure. The research departments that breed the scientific insights enabling and leading to successful technology transfer are the premier loci of technology transfer activity. Researchers often have to be personally involved in transforming and translating their scientific insights into a format useful for industry and business. A transversal structure within the university can help achieve this.

Sixth, in line with the Triple Helix concept, TTO activities will also innovate the technology or knowledge transfer process itself. As a consequence, "traditional" contract and consortium research schemes are complemented with innovation-driven joint research platforms where academic researchers work alongside industry researchers, co-creating and co-developing new basic research and application routes. Effective management of these co-creation platforms, including the design of workable schemes as to the intellectual property developed jointly, will definitely become a critical success factor in the years to come.

Seventh, TTO activities should be coordinated alongside and (where relevant) integrated into the core missions of education and research of the university. This is the so-called "inclusive" nature of the modern TTO (i.e. encompassing Education, Research, Translation).

Eighth, in order to build an effective spin-off operation and depending on the local context in which the TTO operates, the TTO may need a mandate to operate within its region as a networked incubator. This mandate includes the freedom to operate and participate in infrastructure projects (science parks and incubator facilities), to participate in seed-funding schemes, etc. Moreover, a mandate to participate in cross-border regional knowledge transfer and development activities may gain importance in the years to come as cross-border collaborative research becomes more prominent at the level of European innovation programming.

Ninth, in order for the TTO to successfully interact with the academic community through the transversal structure described above, it is advised that the TTO staff has a thorough, in-depth understanding and experience with the academic environment, its *modus operandi*, its norms and values, its intricacies and behaviours. At the same time, a profound understanding of the needs of industry and business is an absolute necessity. As a consequence, an effective TTO operation requires experts able to “see both sides”; who are capable of translating the needs and objectives of the one side into the language understood by the other side.

Tenth, the professional development of the TTO function will comprise continuous benchmarking, i.e. positioning and comparing its own approaches against the “best available practices” in technology or knowledge transfer as they develop and grow. Therefore, a successful TTO should become part of the broader TTO community that has grown and developed over the last decade.

I. SETTING THE STAGE

1. Industry-science links have become a key dimension in both innovation management and innovation policy. In order to support and develop the links between the worlds of science and industry, professional technology transfer organizations (TTO's) have been created at universities around the globe. LERU therefore argues that the growth and the development of those technology transfer organizations deserve careful attention and should be analyzed in more detail, looking at the critical success factors that enable the deployment of effective TTO operations. In doing so, LERU believes that it can contribute to the crucial role of the TTO in the process of translating the results of academic research into a form more readily adoptable by industry and commerce. The TTO can be ideally positioned at the nexus “inside – outside” world in order to manage industry access to academia's discoveries, inventions and improvements. One might advocate the use of the concept of “Knowledge Transfer Organization” rather than “Technology Transfer Organization”. The ever evolving role of the TTO, encompassing a variety of knowledge

transfer activities that move beyond the strict realm of “technology”, supports and advocates such a view. However, as the concept of a TTO is by now well embedded in the professional innovation community (AUTM, ASTP), LERU will use the acronym TTO throughout this advice paper, be it understood that “technology” needs to be interpreted in its broadest, fully knowledge-based, sense when using the term.

II. TTO'S: WHAT'S IN A NAME?

2. Ever since Robert Solow wrote his seminal article, featuring the prominent role of technology in the aggregate production function¹, technology has been propelled to the forefront as a premier production factor driving economic growth and development. The corporate sector is and remains, of course, the main engine transforming technology progress into business. The origins and the subsequent rise of the corporate R&D function in the beginning of the 20th century mark the endogenous character of modern science and technology development. Based on decades of research into the economics of science and innovation, the complementary nature and the interaction dynamics of large firms and young innovative companies along the innovation value chain have received ample attention². Those dynamic complementarities between young innovative companies and large incumbents are grounded in the differences both groups of firms experience on dimensions like risk appetite, strategic and organizational flexibility, impact of going concern, etc. This phenomenon of complementarities and interactions, however, is no longer limited to large firms and young innovative companies. Over the last decade, the complementarities and the interactions between the worlds of science and business, the so-called industry-science links, have come to the forefront of economic theory on innovation. Their nature and intensity have been shown to critically affect innovation performance and outcomes.
3. At the same time though, empirical evidence shows that the flow of basic research into economic exploitation is not without obstacles. Although

¹ Solow, Robert, 1957, Technical change and the aggregate production function, *Review of Economics and Statistics*, Vol. 39, No. 3: 312-320.

² Andries, Petra, Debackere, Koenraad, 2007, Adaptation and performance in new businesses, *Small Business Economics*, Vol. 29: 81-99.

those obstacles have been identified in many countries, they have received particular attention in Europe. i.e. the so-called “European Paradox” that has been documented in various papers and reports of the European Commission. As a consequence, the development of professional TTO’s, linking academia to industry, has received detailed scrutiny and attention at various policy levels. The academic technology transfer function attempts to provide one of the many answers needed to the challenges raised by the European Paradox. It is worthwhile therefore to scrutinize the emergence, the rise and the growth of this new function in academia. In doing so, one should not forget the many intricacies, uncertainties and ambiguities, and complexities involved in bringing new research insights to commercial application and use. The non-linear, iterative nature of the innovation process itself is by now well known and extensively documented. TTO operations should thus be understood from the perspective of uncertainty and non-linearity characteristic of the innovation process.

4. Recent studies, using various linkage indicators, all suggest an intensification of the deep, knowledge-driven interactions between universities and industry over time³. For instance, research has shown that the number of scientific references in corporate patents has nearly tripled throughout the 1990s, although they are still highly concentrated within a limited number of patent classes. So-called “science-based technologies” (defined as fields with frequent references to scientific knowledge) are biotechnology, information and communication technologies, nanotechnology, new materials technology and optical technology. These science-based technologies are strong contributors to technological progress, as for instance observed through the increasing share of patents in these fields.
5. This trend in knowledge development is accompanied by a change in the institutional environment, with an increasing number of public policies designed to encourage the exploitation and subsequent commercialisation of scientific discoveries. Universities and other public research institutes are now expected not only to be producers of basic knowledge. The know-how they generate should,

whenever relevant, be better and more quickly transferred into commercial activities. The recent surge in university patenting in the US is mostly attributed to the Bayh-Dole act of 1980, which gave the universities the right to license inventions from federally funded research. On the demand side, companies look more extensively towards public science as one of the premier external sources of inventive and creative activity, allowing rapid and privileged access to new knowledge, especially in the aforementioned science-based technologies. At the same time, there is a utilitarian argument as well. Public research institutions in many countries are searching for new funding alleys to compensate for the budgetary stringency of public R&D funding that persists despite major policy targets like the European 3% GERD-norm. As a result of these diverse trends, both material and immaterial, the worlds of science and business have become intertwined in so-called open innovation ecosystems⁵.

6. However, the highly uncertain and non-codifiable nature of scientific know-how results in high transaction costs and systemic failures in the market for this know-how, explaining the challenges in organizing industry-science links. A factor that has received ample attention as a condition for smooth science-business links is the presence of a well articulated intellectual property rights regime. From a governance perspective, the allocation of ownership to the academic sector has provided universities with both an obligation and an incentive to exploit the business potential of their research activities. The internal allocation of incentives (i.e. between the institution and the individual researcher) has also received increasing attention, though it is often left at the discretion of the research institute.
7. A major issue that universities are facing in this context is whether their researchers have sufficient incentives to disclose their inventions and to induce their cooperation during the development following license agreements. The university needs to have proper license contracts in place as well as clear incentive and code-of-conduct schemes, specifying amongst others the share for the inventors in the royalties or equity to be obtained (when it comes

3 Debackere, Koenraad, Veugelers, Reinhilde, 2005, The role of academic technology transfer organizations in improving industry-science links, *Research Policy*, Vol. 34: 321-342.

4 GERD = Gross Expenditures on R&D (OECD definition, see Frascati Manual).

5 Chesbrough, Henry, 2003, *Open innovation*, Harvard Business School Press.

to the creation of a spin-off company or closing a licensing deal). The presence of proper incentive and code-of-conduct schemes helps to alleviate moral hazard problems and related agency issues.

8. Even when disclosure is remedied through appropriate incentive schemes, not all academic inventions will be patented and licensed by the university which may have to “shelve” inventions. This relates to another problem in the market for technology transfer, namely the asymmetric information between science and business on the value of the inventions. Firms can typically not assess the quality of the invention *ex ante*, while the technology transfer office may find it difficult to assess the commercial profitability of certain inventions.
9. A partner’s lack of understanding of the other partner’s culture as well as conflicting objectives among partners may further impede good industry-science relations, notably the conflict of interest between the dissemination of new research findings versus the commercial appropriation of new knowledge. The articulation of a code-of-conduct scheme is critical in this respect. A code-of-conduct scheme should tackle issues such as conflicts of interest and commitment⁶.
10. All the considerations listed above have been at the origin of the genesis and growth of the academic TTO. It is a dedicated unit within the university that supports and articulates the institution’s technology transfer policy and its implementation. We recognize that the TTO should receive a formal mandate from the university’s top leadership to achieve this major academic policy objective. Although they may adopt a variety of forms and structures, we argue that the TTO’s at universities serve a relevant and important academic objective: facilitating, enhancing and implementing the transfer of knowledge and technology created and developed within the institution towards economic value creation by translating the results of scientific activity into formats readily adoptable and absorbable by industry and commerce. TTO’s have deployed activities across three

main “business” areas: (1) collaborative research with companies and provision of consultancy services, (2) patenting and licensing, and (3) nurturing and developing spin-off companies. Given the strong Triple Helix character of certain types of collaborative research (e.g. collaborative research in the context of European or national grant schemes, involving public support both for industrial and academic partners), grant support management may be part of the first business area mentioned.

III. THE RELEVANCE OF THE TTO, ORGANIZATION DYNAMICS

LERU advocates an autonomous but “integrated” model of technology transfer fully embedded in the university.

11. When assessing the relevance of the TTO to its parent institution, attention should be paid to its organizational embeddedness and researcher proximity inside the university as a condition for building effective and efficient industry-science links⁷. Universities with a strong record in science-business interactions most often opt for an “integrated” model of technology transfer, i.e. the responsibilities for transfer activities are executed by a professional TTO staff that operates in close proximity (managerial, physical and intellectual) to the research groups and the individual scientists. Linked to this integrated model is the organization of adequate administrative support that allows the researchers to concentrate on their R&D efforts and the related knowledge exchange activities, leaving administrative and contractual issues associated with the transfer activities (such as legal agreements, financial management, personnel issues etc.) with the specialized function. Furthermore, this specialized support function will include exploitation of

⁶ For a more detailed analysis on the various issues raised in the paragraphs 2-to-9, see Koenraad Debackere and Reinhilde Veugelers, 2005, *op. cit.* Also see: Koenraad Debackere, 2011, The university as an engine of economic growth, *The Review of Business and Economics*, Vol. LVI, April – June: 167-180.

⁷ Proximity to the science base is considered an important organizational success factor that aids the transformation and translation of scientific discovery into knowledge useful to industry. This has been one of the main reasons to organize the TTO inside the academic institution. From time to time, experiments with TTO structures outside the university have occurred, often with mixed results. Today, the dominant model is one of embedding the TTO within the university. It will be interesting therefore to monitor and examine the establishment of SATTs (Société d’Accélération du Transfert de Technologie) in France, as technology transfer companies that will serve all their shareholders which have been authorized by the Ministry of higher education and research, for a given territory, to contribute in their capital.

R&D results via spin-off creation, and via patenting and licensing; i.e. areas where specific legal and marketing know-how is needed. It should be noted that this “integrated” approach is not a simple top-down “command and control” modus operandi. It can and should be fine-tuned to the specific institutional context within the university. At research-intensive universities such as the LERU institutions two elements are central to TTO operations: (1) a specialized, professional staff serving business and academic community in transforming and translating scientific discovery into a format absorbable by industry and (2) strong transversal support lines throughout the academic community. The presence of a multi-disciplinary professional staff cannot be mentioned and stressed sufficiently. We recognize that the quality of staff members will ultimately determine the quality and performance of the TTO operation. This staff should, of course, understand the academic environment and its modus operandi. However, the TTO should also consist of people who have the necessary insight in and experiences with the business environment, thus facilitating the transformational role of the TTO --- making scientific discovery “fit for use” by industry and commerce.

12. As part of this “integrated” model of technology transfer, the TTO function should have sufficient autonomy for developing transformational relations with business mandated by the university’s leadership. The presence of and mediation by the TTO provide a good “buffer” against possible situations of conflict of interest between a commercial exploitation agenda and the research and teaching activities. The TTO fosters in-depth specialization in supportive services and infrastructures, most notably the management of intellectual property and business development and incubation, including the necessary links to the physical infrastructures (e.g. science parks and incubator facilities). A significant degree of strategic, financial and managerial autonomy for the TTO (mandated by the university’s leadership) facilitates the relations with third parties, such as venture capitalists, investment bankers and patent attorneys. This autonomy has come to the forefront as one of the main success factors determining effective TTO operations, alongside the need for clear frames on intellectual property rights and contractual arrangements.
13. In addition, the TTO is instrumental in reducing the asymmetric information problem typically encoun-

tered in the market for scientific knowledge exchange. A TTO has an incentive to invest in expertise to locate new inventions and sort the relevant from the less relevant ones. The sunk costs to acquire and articulate this expertise can be overcome if the size of the invention pool is large enough so that the TTO can exploit economies of scale and scope in sharing expertise. Looking at the multiple benefits a TTO can deliver, there is also the focal issue of scale as smaller institutions often lack the resources and the technical skills to effectively support the organizational arrangements and investments required to function at an optimal level. A virtual, collaborative model of TTO organization may offer a solution to overcome this scale problem.

14. At the same time, the professional service structure of a TTO needs to maintain close enough relationships and direct (including informal) contacts with the researchers in the different academic departments. As a consequence, the “integrated” TTO should maintain strong transversal links throughout the academic community. This mode of operation allows for the combination and integration of a central, professional service structure (“the office”) with the local research infrastructure where the transfer activity actually originates and occurs. This local research infrastructure is embedded in the line organization of the university (i.e. the faculty and department structures characteristic of a university organization).
15. While basic research results can either be channeled to industry via collaborative research schemes or licensing arrangements of patented university inventions, spinning-off is the entrepreneurial route to commercialize academic research. The latter attracts a lot of policy attention in the current wave of startups and new venture creation policies in many countries. New technology ventures originating from universities act as a bridge between curiosity-driven academic science on the one hand and strategy-driven corporate innovation on the other hand. These ventures have the potential to introduce technological disequilibria that change the rules of competition in existing industries. They allow for a multitude of experiments with often competing “dominant design” approaches⁸ and “business models,” only a few of which will ultimately survive. Hence, new ventures are the gene pool from which new industries may emerge in the longer run. Academic entrepreneurship in biotechnology probably offers the most

8 Utterback, James, 1994, *Mastering the Dynamics of Innovation*, Harvard Business School Press, Boston, MA.

striking case when it comes to describing these phenomena. Universities may play an important role in this process, as they can be a breeding ground for new venture creation.

Strong and unambiguous university leadership support is critical to the continuous growth and development of a professional tto operation.

16. The insights described above have grown gradually, as universities experimented with their TTO function, resulting in the subsequent growth and professionalization of this function. Over time, the rise and growth of the TTO function is marked by three stages of development⁹.
17. Before 1995, TTO's operated mainly as "isolated islands of technology transfer activity" within the university. Technology transfer occurred, it was tolerated and situated rather at the periphery of the academic activity spectrum. No well grounded TTO business model existed and TTO activities were confined to the legal aspects of contract negotiation and monitoring. TTO performance was not taken into account when assessing academic performance of individual scientists. This "stage 1 mode of operation" lasted well into the mid-nineties. It was characteristic of the first generation of TTO activities. Their impact and visibility within the university were quite limited.
18. From 1995 onwards, we see the advent of a second stage or generation in TTO development. Rather than being situated at the periphery of academic activities, the TTO becomes the centerpiece in the fulfillment of the so-called "third mission" of the university. TTO activities are deployed university-wide and the professionalization of the TTO operation occurs rapidly and effectively. Integrated business models appear, encompassing professional and university-wide intellectual property management practices, the management of a complex and diverse contract portfolio (both bilateral and multilateral contracts), and business development through spin-off creation, including a pro-active stance marked by an increasing impact on regional development. Technology transfer is the third mission of the modern research university, alongside education and (of

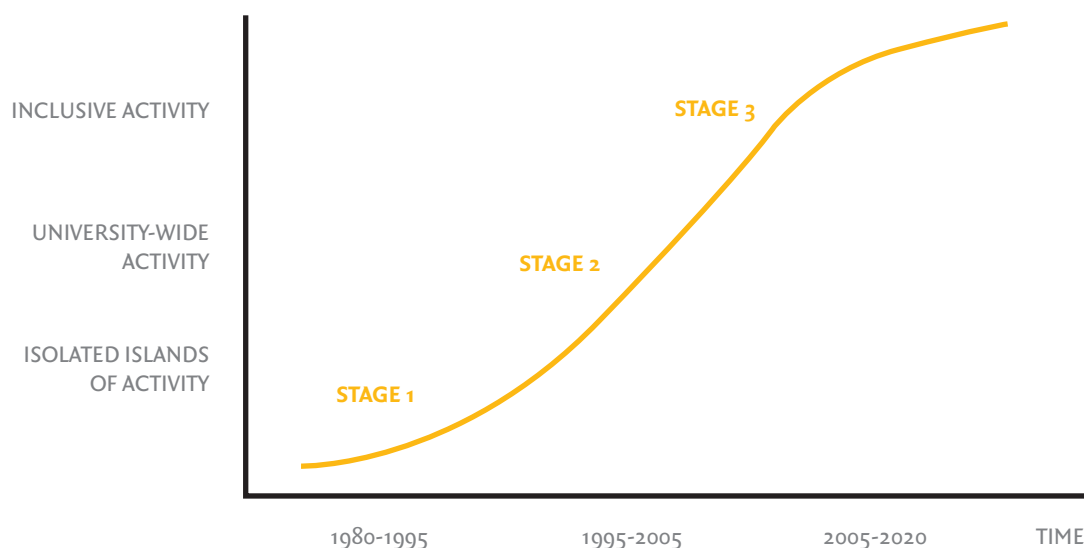
course) frontier research. TTO achievements are taken into account when assessing academic performance, both at the institutional level and at the individual level. This "stage 2 mode of operation", also called the university-wide activity of the TTO, developed during the years 1995-2005 and can still be observed at many universities. TTO impact and visibility have increased rapidly during this second stage of TTO development.

19. In recent years, we have observed the development of yet another, ever more inclusive, activity pattern of the TTO within its academic context. This "stage 3 mode of operation" can be summarized as the "inclusive TTO operation". Rather than "just" being the centerpiece of the university's third mission operations, the TTO activities now diffuse and interweave across and alongside the two core missions of education and research. The TTO is fully embedded within the university while technology transfer activities generate a variety of relevant spillovers (cognitive/intellectual as well as financial) towards the education and research activities of the university. The omnipresence of the TTO throughout the full internal value chain of the university turns it into a truly and fully inclusive activity. This third stage or generation of TTO development is expected to take full effect in the decade to come. It will further heighten the impact and the visibility of TTO operations in academia.
20. To summarize, the evolutionary model shown below visualizes the path-dependent growth of the academic TTO over the last decades, including its impact and visibility within academia and along the innovation value chain. This evolutionary model also exemplifies the prominent role of today's universities in the new economics of technology and innovation policy.¹⁰ In line with current evolutionary economic thinking, the economy is in a constant process of change, with economic activity proceeding in a context that is never completely familiar to the actors, or perfectly understood by them. There is no theoretical optimum since the range of possibilities for economic action is continuously changing, generally growing, but in ways that cannot be predicted or specified in detail. Universities and their TTO operations have become important and visible agents in this evolutionary process.

⁹ Debackere, Koenraad, 2010: "The rise of the academic technology transfer organization," *Review of Business and Economics*, Vol. LV, No. 2: 175-189.

¹⁰ Foray, Dominique, 2009: *The New Economics of Technology Policy*, Edward Elgar, Cheltenham, UK.

TTO IMPACT & VISIBILITY: 3 STAGES OR GENERATIONS



IV. GOVERNING AND ORGANIZING THE TTO

LERU recommends structure, process and people to be key dimensions in developing a successful tto operation.

21. The governance of the TTO focuses on an appropriate structure, processes and context within the university. An appropriate structure should provide adequately designed incentive and organizational mechanisms, which translate into effective processes, i.e. day-to-day operations, of knowledge creation and innovation management within the academic environment. Processes central to managing academic R&D toward commercial exploitation are related to knowledge management, administrative project support and new venture creation. But, of course, an appropriate structure needs to be embedded in a supportive context and vice versa. Context is related to the institutional and policy environment, the culture and the history that have unfolded within the academic institution. It shapes and configures the norms, values and attitudes of academic researchers towards combining “curiosity-driven” research and actively seeking and supporting the “market-relevant” opportunities that originate from this research. It is obvious that an appropriate organizational structure for the TTO should be attuned to the institutional context in which the TTO operates. We

understand that different institutional contexts will therefore need different structural approaches.

22. In order for structure and process to be effective, LERU recommends that TTO’s be staffed with high-calibre, highly professional experts who operate in a multidisciplinary way, combining a deep understanding of the world of science with thorough knowledge of the business environment. This combination will allow for adequate, responsive and effective interaction with the world of industry and business. As a consequence, LERU is in favour of instruments and policies aimed at the professional development of TTO staff.

LERU recommends the structure of the TTO to be attuned to the institutional history and context of the university.

23. In addition, effective TTO governance requires a sufficient level of autonomy for the TTO operation within the university. Industry-science links have to follow a logic that reconciles academic as well as business values and norms. The differences in values and norms between both worlds are well known (e.g. in time horizon, incentives, objectives, communication habits and information dissemination imperatives, freedom versus control of activities, choice of research agenda’s, etc.). In the meantime TTO’s operating in stage 2 and stage 3 mode have learned how to handle and reconcile those differences and turn them into valuable, cre-

ative tensions that also stimulate the quality of the research done both in academia and industry: recent research¹¹ has indeed shown that collaboration with industry and involvement in patenting activities, alongside publication activities, tend to positively influence academic research performance. Hence, rather than being opposing forces, academic research and involvement in industry-science links tend to reinforce the core missions of both.

TTO autonomy advocated by LERU is both strategic and operational.

24. In terms of autonomy, one should not just think of the autonomy needed to support and conduct the core, front office activities of collaborative research, of patenting and licensing, and spin-off creation. The administrative back-office supporting the administration, the financial management and the personnel management of the front office activities, should also be able to operate along lines and principles of sufficient autonomy and freedom-to-operate. Under specific circumstances, it may even be advised that those back-office activities are integrated within the TTO itself, complementary to, but organizationally separated from, the standard back-office operations (finance, personnel) of the university. Relevant TTO key performance indicators are the size and (financial) volume of: (1) the collaborative research portfolio, (2) the portfolio of discoveries, patents and licences, and (3) the spin-off portfolio.
25. The integration of back-office activities in the TTO will require an appropriate governance culture that allows the TTO function to be well integrated within the university, but still be managed according to its own logic and imperatives, driven by the need to interact effectively and efficiently with industry; while simultaneously maintaining incentive and code-of-conduct schemes in a proper balance within academia. This healthy balance is at the heart of inclusive TTO management and it fully characterizes third-stage TTO development.
26. In terms of incentive mechanisms, the structure of intellectual property rights (IPRs) and the evaluation system are important. The ownership of IPRs creates strong incentives for universities to look for commercial applications of their research. While owner-
- ship of publicly funded research has been shifted from the state to the research sector, the allocation of ownership within the research sector (i.e. between the institution and the individual researcher) is often left to the research organization, given the high coordination costs of managing, enforcing and exploiting IPRs. But to ensure the researcher's interests in commercialization, he or she should enjoy a fair share of any resulting lump-sum payments or royalties. At the same time, evaluations of researchers should not be exclusively based on research criteria, but take into account that excellence in research and teaching has become, at least partly, more tied to applications in industry.
27. Integration of professional services, transversal connections and researcher proximity are important dimensions of the TTO structure. These dimensions will have to be attuned to the specific institutional context of the university. Creating a specialized, integrated technology transfer office within the university is instrumental to secure a sufficient level of autonomy for developing relations with industry, allowing for specialization in support services, reducing the transaction costs in markets for scientific knowledge exchange, and adapting scientific discoveries and progress to a form absorbable by industry.

LERU recognizes that an integrated TTO should operate in close proximity to the researcher community through strong transversal links with the university science base.

28. Different organizational arrangements within the university may result in different propensities to engage in the commercial exploitation of the university's (basic) research. If the university opts for an organizational arrangement known as the professional bureaucracy, marked by traditional faculty and departmental boundaries and structures, without a professional TTO operation, one can assume the university's exploitation orientation to be limited. Universities that organize their activities solely along disciplinary lines show little strategic intent to engage in the exploitation of their research results.
29. As the strategic intent to exploit their (basic) research

11 Reference can be made to: (1) Van Looy, Bart, Ranga, Marina, Callaert, Julie, Debackere, Koenraad, Zimmermann, Edwin, 2004, Combining entrepreneurial and scientific performance in academia: towards a compounded and bi-directional Matthew-effect, *Research Policy*, Vol. 33: 425-441, & (2) Van Looy, Bart, Callaert, Julie, Debackere, Koenraad, 2006, Publication and patent behavior of academic researchers: conflicting, reinforcing or merely co-existing? *Research Policy*, Vol. 35, No. 4: 596-608.

commercially develops and grows, universities will find their traditional disciplinary boundaries and departmentalization less fit for setting up linkages with industry. Most often, the next step in the evolution towards the development of full-fledged industry-science links consists in the creation of a separate TTO structure which mission is the exploitation of the know-how and intellectual property of the university. This approach often results in the university setting up a dedicated division for research exploitation or even an autonomous holding structure¹². The advantage of this set-up is that it clearly demonstrates the strategic intent of the university to engage with industry and to allow for the necessary economies of scale in support services. The disadvantage, however, is that such a divisional structure very often creates new boundaries within the institution, making the smooth, transversal integration of basic research, education and exploitation of research at the level of the research groups difficult. In other words, divisional TTO structures do demonstrate the institution's strategic intent towards commercial exploitation, though they may lack the proximity and incentive mechanisms that are required to engage and involve the researchers and their research groups as active partners in the exploitation process.

LERU recognizes the need to provide proper incentives to the academic community to engage in technology transfer activities.

30. A next step in the evolution towards a professional TTO function is the creation of a transversal structure within the institution, alongside the central TTO operation. This approach allows the research groups to be actively involved and engaged in the exploitation of their research findings. In this matrix-like structure, the activities of research exploitation are integrated within the research groups themselves. The central TTO experts assist the local organization with professional input and support like intellectual property management, contract drafting & negotiation, and business plan development for spin-off creation. They also take care of the financial and personnel management issues that occur when the local organi-

zation interacts with industry in projects, consortia and licensing schemes. By adopting this transversal structure, the university assumes a strong exploitation orientation since it does not only commit resources to exploit (basic) research findings (capitalizing on economies of scale and scope in support services), but it also directly incentivizes its researchers and their groups to actively participate in the process. Indeed, in this transversal structure, accountability (both with respect to revenues and expenses) is situated at the level of the research group, which should act as a direct incentive for the researchers to actively manage and grow their portfolio of explorative and exploitative research activities. The central support function of the TTO monitors the exploitation activities, thus avoiding potential conflicts of interest and commitment at its research base.

31. In terms of processes, LERU sees potential benefits when the TTO function integrates the front and back-office activities related to the industry-science links. First of all, it is important to note that the three TTO core processes of contract and consortium research, patenting and licensing, and spin-off creation are closely interrelated and therefore deserve to be managed in a tightly coupled manner. Moreover, in the emergent Triple Helix environment¹³, industry-science links often take on the format of joint research activities, thus further stressing the need for explicit transversal arrangements linking TTO staff to local research groups and departments. Critical processes the TTO operation should thereby manage, are: (1) contract negotiation and management, (2) intellectual property management, (3) business development and spin-off creation, (4) assistance with project administration, (5) financial management of contracts and licenses, and (6) management of all personnel issues related to the successful execution of contracts.

32. In terms of context, LERU advocates that the university should position and enable the TTO to operate at stage 2, and preferably stage 3, level as previously explained. In order for these evolutionary dynamics to happen, the following intra-university actions are of prime importance and relevance. First of all, the leadership of the university should position technology transfer as an integral component of the university's

12 The concept of a holding structure is used to indicate the creation of a legal entity owned or co-owned by the university, operating alongside the legal structure of the university. In some institutional settings, this approach may be required given the legal context in which the university operates. For the holding structure to be effective, though, close proximity to the academic community will need to be articulated and implemented.

13 Etzkowitz Henry, Leydesdorff, Loet, 2000, The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university-industry-government relations, *Research Policy*, Vol. 29: 109-123.

mission statement. LERU recommends that university leadership will give explicit recognition to the TTO as a full-blown university operation, resulting in a visible mandate for the TTO to set and implement its agenda, accompanied by appropriate incentive and code-of-conduct schemes for the researcher community, and showing a willingness to interact with industry in an open and transparent manner. Second, the TTO function should be embedded within the university taking into account best practices in terms of structure and process that fit the institutional context of the university. As explained earlier, a strong transversal organizational approach signals the willingness towards the academic community to be directly and actively involved in technology transfer activities. The integration of front- and back-office processes into the TTO function signals the willingness to engage efficiently into industry-science links. Third, the TTO operation needs appropriate levels and channels of funding within the institution. A valuable approach may consist of allowing the TTO operation to become self-supporting on the basis of the revenue volume that is being generated via its portfolio of core activities. Ventilating the cost of the TTO operation into the cost structure of the projects and contracts funnelled via the TTO enables this. Fourth, in order to develop and maintain an effective TTO, intense information dissemination and training sessions on the topic of technology transfer and its operational execution within the academic community are advised. Fifth, but not least, the TTO should engage in developing a highly professional, multidisciplinary expert team. Those experts are the single most important resource that will enable the TTO to thrive and move between the worlds of science and business.

LERU advocates university leadership to help shape the external context where a tto can thrive.

33. An appropriate institutional context cannot and should not only be achieved within the university. This internal context needs to be complemented by an external context that shapes the broader environment where technology transfer takes place. It is important therefore that university leadership acts as a strong advocate towards public authorities in order for them to provide the proper legal context (e.g. regulation on intellectual property rights resulting from publicly funded research, arrangements for seed funding and venture creation, etc.) in which technology transfer can thrive.
34. Context also has a regional dimension. This implies that certain technology transfer activities, e.g. spin-off creation, have strong links towards the development and wealth creation in the region wherein the university and its TTO operate. As a consequence, the TTO may also receive a mandate to participate and play a role in the regional context to which it has to contribute. This implies the mandate to interact with local public authorities and governing bodies, as well as participation in regional infrastructures (e.g. science parks and incubator facilities, the creation of seed-fund operations) that enable the “technology transfer” function to be an effective contributor to new venture creation and economic growth in its regional environment.

V. IMPLEMENTING SUCCESSFUL TTO OPERATIONS: CRITICAL SUCCESS FACTORS

35. Based on the previous insights and reflections, LERU sees the following critical success factors for an effective TTO function and operation. This set of ten critical success factors (CSF) should enable the TTO to operate as a networked, Triple Helix inspired, industry-science innovation platform and incubator within and around the university.
36. CSF-1: university leadership should provide the TTO function with the necessary level of governance autonomy, strategic flexibility and financial autonomy within the (traditional) university structures. The autonomy and flexibility are illustrative of the respect and understanding that academic leadership (and by extension, the academic community) has towards the inner, proper logic governing industry-science interactions. Flexibility and autonomy should then be implemented in a pragmatic manner, taking into account structure and process that best fit the university’s specific institutional context.
37. CSF-2: it is crucial that the academic TTO function can operate in an external environment that fully supports industry-science links, including a proper legal framework for universities to engage in technology transfer activities and clear, transparent rules as to the ownership of intellectual property rights. Since the vast majority of (European) universities largely operate within the space of public funding, it is imperative that public authorities create a legal environment that

is conducive to and facilitates the transfer of research results from the public funding space in which they originate to the market space. Furthermore, it is important to articulate the expectations of all stakeholders towards the objectives pursued by technology transfer activities (e.g. job creation, contribution to the university's income, translation of research results for the broader public good, etc.).

38. CSF-3: the TTO will install appropriate incentive and code-of-conduct schemes for the academic community, stimulating, but also monitoring, the technology transfer activities and behaviours of the researchers. These schemes have to be approved and accepted by the university's leadership. Of particular importance are the incentive schemes stipulating the share the academics will obtain in the fair return resulting from licensing and spin-off operations.
39. CSF-4: the leadership of the TTO should consider integrating or aligning front- and back-office operations. Contract management, management of IPRs, support for project administration, management of business development, financial and personnel management, should all be professionally integrated within the TTO support function. Through its governance autonomy, the TTO has the degrees of freedom necessary to achieve this managerial integration. Relevant TTO key performance indicators are the size and (financial) volume of: (1) the collaborative research portfolio, (2) the portfolio of discoveries, patents and licences, and (3) the spin-off portfolio. The TTO should, of course, develop the necessary and appropriate processes and IT-systems to facilitate and support those management tasks. It should also build a team capable of dealing with those activities.
40. CSF-5: central support by the TTO should spread its interventions across the university through the implementation of a transversal structure. The research departments that breed the scientific insights enabling and leading to successful technology transfer are the premier loci of technology transfer activity. Researchers often have to be personally involved in transforming and translating their scientific insights into a format useful for industry and business. A transversal structure within the university can achieve the dual face of the integrated TTO: an autonomous, central (managerial and administrative) support function well connected to the day-to-day research operations of the research labs and departments via appropriate transversal organizational mechanisms.
41. CSF-6: in line with the Triple Helix concept, TTO activities will also innovate the technology or knowledge transfer process itself. As a consequence, "traditional" contract and consortium research schemes are complemented with innovation-driven joint research platforms where academic researchers work alongside industry researchers, co-creating and co-developing new basic research and application routes. Effective management of these co-creation platforms, including the design of workable schemes as to the intellectual property developed jointly, will definitely become a critical success factor in the years to come. The TTO will thus have to develop the people, process and structure skills required to operate effectively in those hybrid, Triple Helix, co-creation platforms.
42. CSF-7: TTO activities should be coordinated alongside and (where relevant) integrated into the core missions of education and research of the university. This is the so-called "inclusive" nature of the modern TTO (i.e. encompassing Education, Research, Translation). This coordination and integration requires a continuous process of information dissemination, communication and training throughout the academic community. It also implies that the TTO has a role to play in the "entrepreneurial" educational activities offered by the university.
43. CSF-8: in order to build an effective spin-off operation and depending on the local context where the TTO operates, the TTO may need a mandate to operate within its region as a networked incubator. This mandate includes the freedom to operate and participate in infrastructure projects (science parks and incubator facilities) and to participate in seed-funding schemes, etc. Moreover, a mandate to participate in cross-border regional knowledge transfer and development activities may gain importance in the years to come as cross-border collaborative research becomes more prominent at the level of European innovation programming.
44. CSF-9: in order for the TTO to successfully interact with the academic community through the transversal structure described above, it is advisable for the TTO staff to have a thorough, in-depth understanding and experience with the academic environment, its modus operandi, its norms and values, its intricacies and behaviours. At the same time, a profound understanding of the needs of industry and business is an absolute necessity. As a consequence, an effective TTO operation requires experts able to "see both sides"; who are capable of translating the needs and objectives of the one side into the language understood by the other side.

45. CSF-10: the professional development of the TTO function will comprise continuous benchmarking, positioning and comparing its own approaches against the “best available practices” in technology or knowledge transfer as they develop and grow. Therefore, a successful TTO should become part of the broader TTO community that has grown and developed over the last decade. Memberships of professional organizations such as AUTM in the US or ASTP in Europe are definitely relevant. In addition, professional TTO operations will take into account and learn from best practice frameworks such as the Responsible Partnering framework developed by a group of European research management associations¹⁴.

VI. CONCLUSION: MANAGING THE INCLUSIVE TTO

46. In the previous sections of this paper, the many intricacies and prerequisites of running a successful TTO operation have been highlighted. They are necessary conditions influencing and determining the entrepreneurial effectiveness of a university. Recent research¹⁵ has underlined the dimensions determining the entrepreneurial effectiveness of European universities. This research reveals a primary boundary condition for a TTO to succeed, namely a strong, highly significant and positive relationship between the scientific productivity of universities and their entrepreneurial performance. Universities with a strong scientific productivity find themselves in an advantageous position when developing technology transfer activities. Those findings do suggest that industry explicitly takes into account the scientific output of the university as a criterion for selecting its academic partners.

47. Observations like these support the complementary role of academia and industry in innovation systems, whereby universities’ specific role is and remains to focus on the more basic, curiosity-driven, longer-term part of the R&D spectrum. Industry-science links do and should respect that logic. In addition, strong associations between scientific productivity and patent activity exist, both at the level of the individual researcher and at the level of the institution. In the various studies reported in this paper, the more prolific scientists emerge as the

ones who are more likely to patent. A similar relation holds at the level of universities. Hence, there is little doubt that universities that engage in effective technology transfer can and do so on the basis of their excellence in science; while their excellence in science is further fed by the experience and insights their scientists gain through their interactions with industry. Industry-science links therefore are a matter of rigour and relevance – the rigour which is characteristic of excellent scientific work and the relevance that deep industry problems and challenges bring to the research agenda. Industry-science links are therefore also at the origin of deep intellectual, cognitive spillovers between academia and industry. This is a core contribution to the advancement of academic science. Such advancement will always be critically dependent on the scientist’s curiosity and fascination leading to the emergence of major, game changing advances.

48. Given these reflections and insights, it is clear that the evolution of the TTO towards a stage 3 mode of operation offers many challenges and opportunities. On the challenge side, managing the inclusive TTO first and foremost means focusing on scientific excellence throughout the academic institution. As successful technology transfer operations follow excellent science, the latter should be a primary focus of university leadership. However, scientific excellence will not lead to effective transfer if the TTO function is underdeveloped and not well positioned within the academic context. The previous sections have described how the TTO function can be successfully embedded within the academic context. Not only does the internal context matter, also the external context does have a significant impact on effective technology transfer operations. Governance, strategic flexibility and autonomy, operational and financial degrees of freedom together constitute major critical success dimensions of an effective TTO function. As this TTO function evolves from “merely” supportive to more “inclusive” the cross-fertilization between scientific rigour and relevance of academic enquiries will be stimulated and invigorated. The growth and development of the academic TTO function should therefore be taken seriously, professionally and diligently. Getting the right people together will enable this. Such an inclusive approach towards its TTO will enable the university to fully benefit from the research opportunities that emerge in today’s innovation eco-systems.

14 The Responsible Partnering Framework and report were developed by EIRMA, EARTO, EUA and PROTON

15 Van Looy, Bart, Landoni, Paolo, Callaert, Julie, van Pottelsberghe, Bruno, Sapsalis, Eleferios, Debackere, Koenraad, 2011, Entrepreneurial effectiveness of European universities: An empirical assessment of antecedents and trade-offs, *Research Policy*, Vol. 40: 553-564.

About LERU

LERU was founded in 2002 as an association of research-intensive universities sharing the values of high-quality teaching in an environment of internationally competitive research. The League is committed to: education through an awareness of the frontiers of human understanding; the creation of new knowledge through basic research, which is the ultimate source of innovation in society; the promotion of research across a broad front, which creates a unique capacity to reconfigure activities in response to new opportunities and problems. The purpose of the League is to advocate these values, to influence policy in Europe and to develop best practice through mutual exchange of experience.

LERU publications

LERU publishes its views on research and higher education in several types of publications, including position papers, advice papers, briefing papers and notes.

Advice papers provide targeted, practical and detailed analyses of research and higher education matters. They anticipate developing or respond to ongoing issues of concern across a broad area of policy matters or research topics. Advice papers usually provide concrete recommendations for action to certain stakeholders at European, national or other levels.

LERU publications are freely available in print and online at www.leru.org.

Universiteit van Amsterdam
Universitat de Barcelona
University of Cambridge
University of Edinburgh
Albert-Ludwigs-Universität Freiburg
Université de Genève
Ruprecht-Karls-Universität Heidelberg
Helsingin yliopisto (University of Helsinki)
Universiteit Leiden
Katholieke Universiteit Leuven
Imperial College London
University College London
Lunds universitet
Università degli Studi di Milano
Ludwig-Maximilians-Universität München
University of Oxford
Université Pierre et Marie Curie, Paris
Université Paris-Sud 11
Université de Strasbourg
Universiteit Utrecht
Universität Zürich



LERU Office

Huis Bethlehem tel +32 16 32 99 71 www.leru.org
Schapenstraat 34 fax +32 16 32 99 68 info@leru.org
B-3000 Leuven
Belgium