Knowledge & Technology Transfer of Emerging Materials & Technologies through a Design-Driven Approach

4.2 GUIDEBOOK: definition of training contents and exercises production addressed to companies

Author: **P5 – Tecnun – Universidad de Navarra**

@datematseu #datematseu
www.datemats.eu

Datemats
Knowledge & Technology Transfer of Emerging Materials
& Technologies through a Design-Driven Approach
www.datemats.eu

@datematseu
#datematseu

Deliverable	**4.2**
Deliverable title	**Definition of training contents and exercises production addressed to companies**

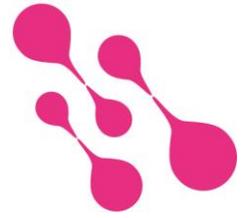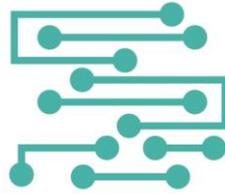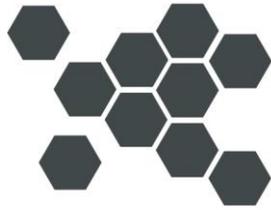| Work package	**WP4**
WP Leader	**Barcelona Design Center**
Date of submission	**2020-04-30**
Number of pages	**17 pages**
D. lead beneficiary	**TECNUN - Universidad de Navarra**
Partners involved	**ALL**
Type	**Electronic version published on-line**
Type speficiation, if needed	**Manual / Guidebook**
Dissemination level	**PU = Public**

Knowledge & Technology Transfer of Emerging Materials & Technologies through a Design-Driven Approach
Agreement Number: 600777-EPP-1-2018-1-IT-EPPKA2-KA.
Start Date: 2019-01-01

EXECUTIVE SUMMARY

This document collects, first, a review of published articles that reflect the different practices that are being carried out for the transfer of knowledge between Academia and companies. Despite the effort made to successfully carry out this transfer, there is still work to be done, since the literature shows that current methods used by Academia are not working. After this literature screening and after surveys carried out with the help of both companies and professors and researchers, explained in the deliverable of task T4.1, it is necessary to radically modify how things are working now and to propose a novel guide to facilitate this transfer. Therefore, the second part of this document includes a guide that suggests the methodology to follow in order to facilitate this unidirectional transfer of EM&T from Academia to Industry. At the end of this guide, a series of indications are given on how this guide should be implemented in terms of time and facilities.

INDEX

1 INTRODUCTION

1.1 CONTEXT

Based on the results coming from task 4.1 the Organization of Industries will define the proper contents and exercises to be used for the cooperation between Academia and Industries when it comes to the EM&Ts areas.

1.2 AIM

Result: A guidance with recommendations related to the contents, objective and fit on purpose methods (creative and hands-on session with materials) to be used for the cooperation between Academia and Industries when it comes to the EM&Ts areas.

1.3 SUMMARY

 This document collects, first, a review of published articles that reflect the different practices that are being carried out for the transfer of knowledge between Academia and companies. Despite the effort made to successfully carry out this transfer, there is still work to be done, since the literature shows that current methods used by Academia are not working. After this literature screening and after surveys carried out with the help of both companies and professors and researchers, explained in the deliverable of task T4.1, it is necessary to radically modify how things are working now and to propose a novel guide to facilitate this transfer. Therefore, the second part of this document includes a guide that suggests the methodology to follow in order to facilitate this unidirectional transfer of EM&T from Academia to Industry. At the end of this guide, a series of indications are given on how this guide should be implemented in terms of time and facilities.

2 CURRENT STATUS: LITERATURE REVIEW

2.1 ABSTRACT

Collaboration between universities and industry is necessary to improve innovation through the exchange of knowledge. There are numerous studies that have paid attention to this topic from different perspectives. The most important papers were collected, analyzed and summarized in order to understand the current procedures for transferring knowledge from Academia to Industries, as well as the main channels used, and the barriers identified. Although both parties show an interest, to a limited extent, to collaborate with each other, differences in goals and timing are found as barriers for knowledge transfer. Many researchers and professionals have written about the challenges, success patterns, and anti-patterns for collaboration between industry and academia.

Keywords: EM&T, Knowledge Transfer Channels, Academy-Industry Collaboration, Guide for Knowledge Transfer, EM&T Kit, Design Thinking

2.2 REVIEW

According to Lockett et al., (2009), the definition of knowledge transfer is controversial beginning from the own denomination since many different names are used: 'knowledge exchange' (Schartinger et al., 2002; Swart and Henneberg, 2007), 'knowledge dialogue' (Ruddle, 2000), and 'knowledge translation' (Czarniawska and Sevon, 1996; Savory, 2006).

Polanyi (1966) distinguishes two types of knowledge that are directly related to the way to transfer that knowledge. On the one hand, there is the tacit knowledge, which is more related to skills and

experiences, while on the other hand, there is the explicit knowledge, which is recognized or scientific knowledge that is codified and formulated. Grant (1996) states that tacit knowledge is "knowing-how" and explicit knowledge "knowing-about".

The existence of these two groups lead to a diversity of potential knowledge channels through which knowledge is transferred. Landry et al. (2010) and Brennenraedts et al. (2006) summarized a variety of channels and activities that academic researchers use to transfer research-generated knowledge to industry (Table 1).

Knowledge Transfer Activity	Description
Scientific publications	Publication of scientific knowledge transferred in the pool of open science (Journal or Conference articles)
Practitioner-oriented publications	Books, magazines, online/social media, blogs, etc.
Teaching	Knowledge transfer achieved when students graduate and are hired by companies and other types of employers
Continuous cooperation in education	Contract education and training of professionals, Re-training of employees, influencing curriculum of university programs, providing scholarships, Sponsoring of education
Collaborative in R&D	Collaborative arrangements to conduct research undertaken by both academic and non-academic organizations
Sharing of facilities	Shared laboratories, Sharing of facilities (i.e.common use of machines), Common location or building (Science parks)
Informal knowledge transfer	Presentation to practitioners at events (e.g. seminars) or to specific organizations, interpersonal communications with practitioners, etc.
Spin-off formation	Development and commercialization of technologies undertaken by academic inventors through the creation of a spin-off company they own at least in part
Granted patents	Rights to anyone who invents or discovers any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement thereof
New product development	Knowledge transfer through new product development in which knowledge becomes embedded in a product
Mobility of people	Temporarily exchange of personnel of mobility from public knowledge institutes to industry or vice versa from industry to public knowledge institutes.

Table. 1. Knowledge transfer activities.

In general, explicit knowledge tends to be transferred by means of published research findings, and less media-rich activities like shared facilities and licensing patents. Controversially, tacit knowledge related to skills and experiences are better obtained by face-to-face contact meaning that internships, joint supervision, collaborative research and the creation of joint ventures are the most suitable for transferring this tacit knowledge (Karnani, 2012; Alexander & Childe 2013). When asking Academia how frequently they use the above-mentioned channels, the response is wide. In the medical field, for instance, Brennenraedts et al. (2006) discovered that academics feel more comfortable with scientific papers and conferences while they do not work with in site training with companies (Table2).

These results are in consonance with the answers obtained from Task 4.1 where knowledge transfer is mainly done through (1st) the publication of articles, followed, in the following order, by (2nd) patents, (3rd) books publication and (4th) product samples elaborated specifically to get company's interest.

When moving to a more dynamic (less academic) way of transfer, HEI's usually perform (1st) practical applications together with the company (2nd) developing case studies and (3rd) organizing workshops. Nevertheless, they found that the academic language vs industry language is too distant. Although

creating a trust relationship is important for both parts, Academia finds it difficult to get the appropriate person within the company to transfer that knowledge.

Channel	Score (1-5)
Emitting licenses on university patents	1.17
Participation in fairs	1.35
Own double appointment	1.52
Temporarily exchange of personnel with industry	1.52
Teaching employees of the industry	1.52
University patents	1.61
Spin-offs	1.68
Contract advisement	1.73
Participation in boards of organizations	1.78
Participation in professional organizations	1.83
Contract research	2.02
Sharing facilities with industry	2.18
Not refereed publications	2.23
Supervision of a Ph.D. student	2.42
Colleagues who get (or have) job in industry	2.48
Graduates who get job in industry	2.48
Presentation of research at the industry	2.52
Networks based on friendship	2.91
Joint R&D projects with	2.98
Refereed scientific journals or books	3.2
Conferences and workshops	3.28

Table. 2. Preferred channel

Nevertheless, it is obvious that the collaboration between Academia and Industry is necessary and that both parties must obtain some kind of benefits from it: Industry normally looks for a problem solution, while Academia usually wants to publish and increase the education quality of students. Both parties work to different timescales, objectives, reward systems, and perceptions, and they understand each other's practice differently (Garousi et al., 2016). In the Academy, there is a low introduction and presence of the entrepreneurial culture, which makes it difficult to undertake the objectives of transfer and participation in innovation processes in a more natural and agile way. Public-private collaboration needs to be strengthened to drive innovation.

Boosting the creation of academic spin-offs (companies generated to exploit the results of university research) may probably help to shorten distances between Academia and Industry. In principle, spin-offs constitute not only a very effective mechanism for transferring knowledge, but also an attractive formula for these institutions for contributing to the renewal of the local productive fabric with activities of global projection and high added value, in addition to retaining talent and intellectual capital, frequently from the same universities.

That does not mean that Academia develops a completely appropriate knowledge transfer process. There are various studies that point out that some individual factors like demographics, career trajectory, productivity and the effect of scientific disciplines are also some other factors that affect the engagement undertaken by academic researchers in this knowledge transfer (Perkmann et al., 2013). Among these "other" factors, motivation could be the most important one. Chen et al. (2006) published that Academia has two main motivational factors that drive academic research: 1) extrinsic rewards (e.g. tenure, promotion, income increase), and 2) intrinsic rewards (e.g., an individual's satisfaction to achieve peer recognition and contribute to the discipline). Independently of what kind of motivation factors Academia staff follows, it seems that the selection of the proper professor is critical. An academics that engage with industry due to their personal willingness to make their knowledge base available to industry (Iorio et al., 2014) or because they sense the necessity of

providing service to the practitioner community and promoting innovation through this acknowledge/technology transfer is of utterly importance (Ankrah et al., 2013).

2.3 CONCLUSIONS

Once presented a brief state of the art and analyzed the report from task 4,1, these are the conclusions obtained:

- General:
    1. For this collaborative research, a common goal definition is mandatory for both parties.
    2. Motivated staff from both parties is necessary.
    3. Sharing facilities with people from both parties working in the same space is enriching.
    4. It is very important to dedicate enough time, human resources and financial support for developing specific activities for improving knowledge transfer, such as incorporating peer-based training in situ, generating support libraries about the knowledge for industries so employees can access it, etc.
- From the Academia:
    1. Academia tends to use traditional transfer channels for this knowledge transfer because the quality of researchers' CV is normally marked based on those traditional channels (journal, papers, conferences, etc.).
    2. They feel more comfortable with writing papers and conferences than organizing a more practical/dynamic channel.
    3. Academia staff plays several roles in the institution aside from generating knowledge (for example: preparing classes, lecturing, students' advisors, university management, etc.) which leads to a reduced time to dedicate to the setting of those alternative methods.
- From industry:
    1. Getting dedicated R&D people within the company to work together with Academia in order to facilitate the transmission of the generated knowledge.

3 GUIDE OVERVIEW

The literature review together with the findings of the let to the definition of a fit-on purpose guide for the knowledge transfer process of EM&Ts. Although most of the research in the literature confirm that all of the transfer activities undertaken are capable of transferring knowledge effectively, the channel to diffuse these results cannot be adequate to both Academia and Industries. One clear example is with journal papers: Academia write down and publish research, so knowledge becomes public and accessible for many people; but companies argue that they have to hire personnel able to 'translate' that publication to an actual application. As traditional channels are no longer effective, Academia usually establishes activities that show practical applications of research results together with the companies (Question 4 of T4.1) along with activities to maintain companies interest to maintain long term relationships and facilitate trust. These initiatives are done by means of workshops to make research methods and possible outcomes understandable, but here, there is not a consensus about what should happen in those workshops.

The proposed guide is divided into three main parts: First, it covers a recruiting phase to catch companies' interest about EM&Ts, so they feel the guide is going to be efficient in terms of time-investment. Then, a learning part is introduced to explain the basics about the EM&T they want to learn. Finally, a more practical strategy is applied to explain specific strategies of how to come up with ideas to find new challenges that link the EM&T and the company's core.

3.1 PROMOTIONAL PART EM&T

Before starting with the own knowledge transfer activity, it could be interesting to attract and catch the attention of potential companies interested in working with this EM&T. Hence, we can distinguish whose companies are really interested in this transfer and, in the end, which ones are going to be involved with all their efforts in the rest of the activities.

For this pre-stage, an advertisement or short promotional video -different for each EM&T- showing the goodness of the EM&T and the potential of the EM&T for companies must be prepared. This short video (less than 30 seconds) should be published in Academia homepage and distributed among companies with which Academia has contacts.

3.2 LEARNING PART EM&T

3.2.1 UNDERSTANDING 4EM&T

Like the pre-mobility approach (see deliverable 3.2), a theoretical vision is necessary to understand the EM&T. The structure here would be the same as the one though for the Pre-mobility with students, that is, a set of videos about the EM&T. At the end of these videos, some questions can be included to help consolidate the content of the videos or a moderator can start some Q&A regarding the contents of the video to verify that they have learned the most fundamental aspects or if they find it useful. The topics this media must cover should be the following:

1. What is the EM&T?
2. What is the current status of the EM&T (Technology Readiness Level – TRL)
3. What is it for? Possible applications at the current TRL.
4. Expected developments in coming years and future applications expected.

It is desirable that, at this first stage, people from companies work in pairs. They can belong or not to the same company, but it is desirable that their backgrounds and profiles are different (as an example, coming from different departments) so they can have different points of view over the same challenge.

3.2.2 EXPLORING 4EM&T

The theoretical part is followed by an exploring part aimed at making the company be aware of the full potentiality of the 4EM&Ts. The tool used to carry out this part is the so-called EM&Ts transfer toolkit (see deliverable 3.4). It is considered of paramount importance to have the 4EM&T materials kit, so that companies can interact with them and empathize with the material.

This phase will enclose a dynamic where people from companies can be working in groups of 4-5 people, trying not to mix people from the same company in the same group. If the knowledge transfer process is going to be done with people that belong to the same company, create the groups mixing people from different departments.

The idea is that a moderator with an extensive knowledge of the EM&T takes one material from the kit and explains examples of its applications while the group plays/touches it. Once the first material of the kit has been explained, (s)he takes the second material, explains it while the groups play with it. And so on.

These applications can include successful stories of companies that have implemented this EM&T in the company and, if possible, should be close to the products/services that companies work with. This approach implies that several copies of the EM&T transfer toolkit are needed. It is thought in one per

group. Perhaps It could be a good idea to have one toolkit for company, so, at the end of this collaboration, the company can get that toolkit to its facilities. This will be an excuse to find future collaborations/projects with it.

3.3 APPLYING PART EM&T

This dynamic part should be used to come up with the EM&T applications for every company. It is divided in two activities: 1) Design thinking (to learn how to discover/define/develop/deliver a challenge about an EM&T) and 2) Learn by doing (Workshop) (to put in practice the design thinking approach). The way of implementing this dynamic part is totally influenced by the state of development of each EM&T.

3.3.1 DESIGN THINKING

One of the most difficult parts of the knowledge transfer is the stage where companies try to think and solve possible applications of that EM&T in their companies. Here, a design thinking strategy -like the double diamond- is proposed to show them the logic steps that they should follow.

Design thinking is a process for creative problem solving to create a wide number of potential solutions and then narrow these down to a "best fit" solution. One of the most important aspects of this methodology is that it focuses on human values at every stage of the process and empathy for the people for whom you are designing is fundamental to this process.

Nowadays, Design Thinking (https://designthinking.ideo.com/) is spreading in companies all around the world, diminishing hierarchies, creating an environment that challenges the status quo, and encouraging innovation and smart risk-taking. With design thinking, organizations can accelerate emerging technologies' adoption process and reduce the resistance to change. When design thinking is deeply embedded in an organization's culture, it becomes easier to adapt to the new trends and changing market conditions.

In the context of these workshops, Design thinking principles and processes will inspire companies' representatives to discover new opportunities that can emerge from EM&T application in their companies and product/services portfolio. BCD mentions that some of the companies they have relations already know Design thinking.
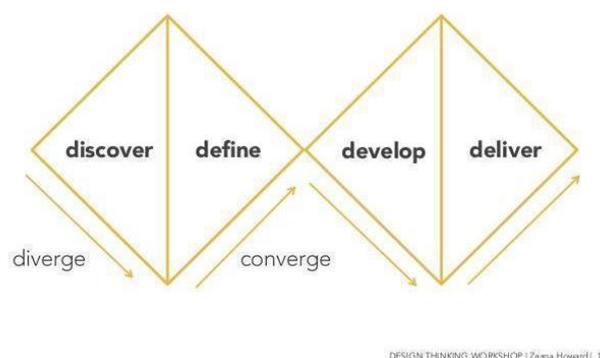

DESIGN THINKING WORKSHOP | Zaana Howard | 14

Fig. 1. Double diamond.

The four steps should be explained very, very briefly using multimedia formats:

1. Discover: What kind of opportunities can my company find for that EM&T?
2. Define: Among all those opportunities, what is going to be the project challenge for the developing phase?

datemats

3. Develop: Come up with solutions for that challenge
4. Deliver: Get a specific/individual solution.

It could be a good idea to employ success stories from any company where these four steps were implemented in the specific EM&T. Working in groups, they can read the case-study and then an open-discussion activity can be implemented regarding the following topics:

- Have the four steps been identified in the case-study?
- How cost-expensive/time-expensive is it?
- Do you follow these steps in your company? Do you face the same difficulties?
- Etc.

3.3.2   LEARND BY DOING

For this part, a challenge approach strategy is suggested so companies can start thinking in possible applications that EM&Ts can have in their companies. The main goal of this phase is not to find a real & specific project challenge for each company, but to learn the process of finding a project challenge for a new EM&T. (First diamond is covered). Possible NDA issues must be considered in this part.

The procedure will be the following working in team of two or more people but mixing different profiles:

1. Each team will select a material from the toolkit. People from the same team need to agree with the sample they are selecting. It should be a sample with potential application in their companies.
2. Necessary tools are explained for the "discover" phase.
3. (https://designthinkingforeducators.com/design-thinking/)
4. Teamwork#1: teams use these tools to come up with opportunities for that sample for EACH company.
5. Open discussion #1.
6. Necessary tools are explained for the define phase.
7. (https://designthinkingforeducators.com/design-thinking/)
8. Teamwork#2: teams use these tools to converge in a single opportunity for that sample for EACH company.
9. Open discussion #2.

The process can be repeated if a second sample of the toolkit wants to be studied.

4   TIME STRUCTURE

The suggested structure for the knowledge transfer activity with the companies and considering the above mentioned activities is the following. The duration of this transfer activity is estimated for 4-5 hours.

- PART 0 (45 minutes)
    - Introduction. Explain the goal of the activity and the organization? Schedule. Time. (10-15 min)
    - Introducing the participating companies (10 min).
    - Dynamics to obtain information about the companies. A warm-up exercise can be performed to break the ice and create a pleasant environment. (10-15 min)
- PART I (60 minutes)
    - Understanding 4EM&T (Section 3.2.1).
    - Exploring 4EM&T. Empathize with the materials, "touch" them (Section 3.2.2)

- BREAK (15 minutes)
- PART II (120 minutes)
  - o DESIGN THINKING (45 minutes)
    - ▪ Group formation.
    - ▪ Explain tools
  - o Learn by doing (75 minutes)
    - ▪ Selection of the EM&T from the toolkit for each group
    - ▪ Discovering
    - ▪ Ideation
- PART III (30 minutes)
  - o Final Presentation
  - o Conclusions
  - o Feed-back

5 GOOD PRACTICES

5.1 DATA COLLECTIONS

For the visibility and dissemination of the workshop, it is convenient to collect photos and videos that record the progress of the workshop, and then upload them to social media platforms with the prior consent of the participants and send it to each of the participants.

Likewise, the facilitator or that person in whom (s)he delegates, should collect, as an observation diary, the key comments and responses of the participants, the use of the method followed, etc. in such a way that this information serves to improve the structure and the methodology followed in the workshop.

5.2 LEARNING PART EM&T

Prior to the explanation of this theoretical part and, in order to enrich this knowledge transfer, several pre-works need to be done by Academia. This works includes:

1. Regarding the selection of the proper media contents (videos):
   - A set of 2-3 videos for each topic should be selected.
   - The selection of the videos will be done according to the respective EM&T and the with the specific contents that want to be transferred
   - These videos must be:
   - Either found in open-access sources (Ex. YouTube and similar platforms)
   - Or can be created ad-hoc by Academia and later uploaded to YouTube and similar platforms. This option will allow the distribution of the contents to the companies really interested in the EM&T, giving only to them that exclusive knowledge.
   - created by tools like Panopto, Ocam or Camtasia, etc.
   - For those videos collected on the Internet, the intellectual property/copyrights must be noted to know if the video as it is can be modified (trimmed/ info augmented) if necessary, to improve the contents.
   - The duration of the videos should not be more than 5 minutes. After that time, the viewer can lose interest.
   - Each video will be described with a paragraph of 3-4 lines indicating the learning outcomes expected after its viewing. These learning outcomes will be evaluated at the end of the video using tools like kahoots.

datemats

- Each video will have markers identified with some keywords at specific key points (min: seconds), so the viewer can review and access specific aspects of the contents easily.
- The quality of the videos should be, at least, 720p
- Although the videos should preferably be in the local language of the company for a better understanding of the EM&T, this option is not always possible, so English should be the next option to follow.

2. Regarding the facilities:
- For the Understanding phase
  o It is advisable that this learning process is done in the Academia facilities or another independent space that meets the conditions required, since the supplies that the universities have, facilitate the realization of the workshop, either by spaces, technological resources, etc.
  o A dedicated computer lab with Internet connection will be enough.
- For the Exploring phase:
  o It is advisable that this learning process is done in the Academic facilities or another independent space that meets the conditions required.
  o It needs a lab with a media projector for PowerPoint/video presentations. The lab can have the necessary equipment in case the moderator wants to make some demonstration of any element of the material toolkit.
  o It will be convenient if the laboratory can have adequate work benches that facilitate group work in an active way.

3. Regarding the moderator/facilitator:
- Academia must select for this phase a person to control the times.
- This person should be an expert in the corresponding EM&T in order to briefly introduce that each video is about during the ongoing of the Understanding phase. Moreover, he will be leading the Exploring phase, so (s)he must know deep in the Toolkit.

4. Regarding people from companies:
- At least two people shall be selected to participate in the transfer process. The background of these people shall also be different. On the one hand, a person with a technical background more focused in the daily technical aspects of the company; and on the other hand, a CEO profile with a wider vision of the company whereabouts so as to detect future applications of the EM&T. They must have power decision making within the company.
- They should be people-person, dynamic, optimistic, etc.
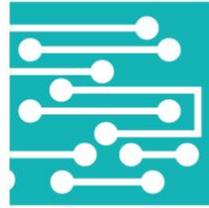
5.3 APPLYING PART EM&T

1. Regarding the selection of the tools for the Discover and Define phases:
- Easy understandable by the audience because its background can be very different.
- As the way of explaining them should be also attractive, the tool "methods cards from IDEO" (https://www.ideo.com/post/method-cards) is suggested.
2. Regarding the facilities:
- For the Design Thinking phase
  o It is advisable that this learning process is done in the Academia facilities.
  o It needs a lab with a media projector for PowerPoint/video presentations.
  o The lab will have working benches at a height of 90 cm, so people from companies are seated on stools.
- For the Learn by doing phase:
  o It is advisable that this learning process is done in the Academia facilities.

     o It needs a lab with a media projector for PowerPoint presentations for instance.

     o The lab will have workbenches at a height of 90 cm, so people from companies are seated on stools.

3. Regarding the moderator/facilitator:
- (S)he is a person that plans, guides, and manages a group event to ensure that the group's objectives are met effectively, with clear thinking, good participation and full buy-in from everyone who is involved.
- For this dynamic part, (s)he must not be an expert in the EM&Ts but must have a deep knowledge about design thinking. Nevertheless, depending on the EM&T an expert could also join him/her to solve doubts groups can have

6   REFERENCES

- Alexander, A. T. and Childe, S. J. 2013. Innovation: a knowledge transfer perspective. Production Planning Control, Vol. 24, No. 2-3, pp. 208–225.
- Ankrah, S.N., Burgess, T.F., Grimshaw, P., Shaw, N.E., 2013. Asking both university and industry actors about their engagement in knowledge transfer: what single group studies of motives omit. Technovation 33 (2–3), 50–65.
- Bosley, D. S. (1995). "Collaborative partnerships: academia and industry working together. (Symposium Part IV)," Technical Communication, 42(4), November 1, 1995, 611-619.
- Brennenraedts, R., R. Bekkers and B. Verspagen, 2006. "The different channels of university-industry knowledge transfer: Empirical evidence from Biomedical Engineering," Working Papers 06-04, Eindhoven Center for Innovation Studies, revised Feb 2006.
- Chen, Y., Gupta, A., Hoshower, L., 2006. Factors that motivate business faculty to conduct research: an expectancy theory analysis. J. Educ. Bus. 81 (4), 179–189.
- Czarniawska, B. and Sevón, G. (Eds.). 1996. Translating organizational change, Vol. 56. Walter de Gruyter.
- Garousi, V., Petersen, K., & Ozkan, B. 2016. Challenges and Best Practices in Industry-Academia Collaborations in Software Engineering: A Systematic Literature Review. Information and Software Technology, 79: 106–127.
- Grant, R.M.: Toward a knowledge-based theory of the firm. Strategic Management Journal 17, 109–122 (1996)
- Iorio, R., Labory, S., Rentocchini, F., 2014. Academics' motivations and depth and breadth of knowledge transfer activities, c. MET Working Papers, c. MET-05 – Centro Interuniversitario di Economia Applicata alle Politiche per L'industria, lo Sviluppo locale e l'Internazionalizzazione.
- Karnani, F. 2012. The university's unknown knowledge: tacit knowledge, technology transfer and university spin-off findings from an empirical study based on the theory of knowledge. The Journal of Technology Transfer, Vol. 38, No. 3, pp. 235–250.
- Landry, R., Saïhi, M., Amara, N., Ouimet, M., 2010. Evidence on how academics manage their portfolio of knowledge transfer activities. Res. Policy 39 (10), 1387–1403.
- Lockett, N., Cave, F., Kerr, R. and Robinson, S. 2009. The influence of co-location in higher education institutions on small firms' perspectives of knowledge transfer. Entrepreneurship & Regional Development, Vol. 21, No. 3, pp. 265–283.
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., Sobrero, M., 2013. Academic engagement and commercialization: a review of the literature on university–industry relations. Res. Policy 42 (2), 423–442.
- Polanyi, M.: The Tacit Dimension. Routledge, London (1966)
- Ruddle, K. 2000. Systems of knowledge: dialogue, relationships and process. Environment, Development and Sustainability, Vol. 2, No. 3-4, pp. 277-304.

- Savory, C. 2006. Translating knowledge to build technological competence. Management Decision, Vol. 44, No. 8, pp. 1052-1075.
- Schartinger, D., Rammer, C., Fischer, M. M. and Fröhlich, J. 2002. Knowledge interactions between universities and industry in Austria: sectoral patterns and determinants. Research Policy, Vol. 31, No. 3, pp. 303-328.
- Swart, J. and Henneberg, S. C. 2007. Dynamic knowledge nets-the 3C model: exploratory findings and conceptualization of entrepreneurial knowledge constellations. Journal of Knowledge Management, Vol. 11, No. 6, pp. 126-141.
- Esther de Wit-de Vries · Wilfred A. Dolfsma · Henny J. van der Windt · M. P. Gerkema (2019) Knowledge transfer in university–industry research partnerships: a review. J Technol Transf 44:1236–1255