Evaluation and Adoption of University Technologies by the Enterprises

Fernando Barbosa, Fernando Romero
Department of Production and Systems Engineering, University of Minho, Guimarães, Portugal
fbarbosa@dps.uminho.pt
fromero@dps.uminho.pt

Abstract: The relationships between university and industry have become increasingly important. On the one hand, investment in new technologies, as a response to the rapid and constant changes in the competitive environment, is vital to firms, and on the other hand, the universities have been call upon to have a more intervening stance in the enterprise context, reinforcing their so-called "third mission" in terms of a direct intervention in the economic circuit. Policy directives have led to an almost generalized adoption of specific measures by the part of the higher education sector, including the implementation of organizational structures that deal with technology transfer (technology transfer offices, science parks and start-up incubators near the university premises'), the implementation or reinforcement of new regulatory structures concerning intellectual property (the possibility to protect research findings by university staff through the patent mechanism) and stimulus for greater interaction with society at large (alterations in the requirements for career progression).

In this work we propose to look at the perspective of the enterprise, and explore the motives, the mechanisms, and the practice of firms that interact with universities. We privilege an integrated view of the phenomenon, focusing on the process of evaluation and adoption of technologies generated in the universities, and licensed or acquired by firms. Research on this theme is scattered and difficult to integrate, or to extract definite conclusions from it. The main research questions are: what are the main benefits, barriers and outputs perceived by firms in their interaction with universities? what are the main tools, methodologies, criteria, and relative weights with which firm evaluate their investment in new technologies?

The research was based on a quantitative approach and on an intentional non-probabilistic sampling strategy. The sample includes thirty three Portuguese firms, from different sectors. The selection criteria was based on the innovative performance of the firm, and on the concomitant presumption that innovative activities are well structured inside the firm. The sample includes micro, small, medium and large firms. A proportion of the sample includes conglomerates, and in fact, the sample represents approximately one hundred and twenty two firms.

A quantitative structured questionnaire was the main instrument of data collection, but some interviews with selected firms were also realized, in order to substantiate or consolidate some of the data that was obtained through the questionnaire.

In this paper we present the preliminary results of the analysis of that data. One of the main results was the realization that the criteria, tools and methodologies that are adopted by firms are not uniform throughout the process of evaluation and adoption of the technologies. It depends on the stage of the process. Accordingly, we propose a division of the process in specified stages and we identify which criteria, tools and methodologies firms' values most at each one.

Keywords: Technology Evaluation and Licensing, Innovation, University Industry Relations, Technology Adoption and Transfer.

1. Introduction

Research on the specific tools, methodologies and criteria that firms use in their process of evaluation and adoption of technologies from the universities is scattered and inconclusive. This paper presents an integrated perspective on the issue, backed by relevant empirical data. The main research questions are: what are the main benefits, barriers and outputs perceived by firms in their interaction with universities? What are the main tools, methodologies, criteria, and relative weights with which firm evaluate their investment in new technologies? The research questions developed out of the perception that the process of technology transfer between university and industry was hampered by difficulties related to the process of technology evaluation. We begin this work with a critical review of the existing literature about the concepts related to the interaction university-industry, focusing on the process of evaluation and adoption of technologies generated in the universities. Then we identify the methodology adopted in this work and finally the results are analyzed under the light of the research questions.

2. Conceptual framework

Firms face increasing and difficult challenges regarding the dynamics of technological change, and struggle to understand the factors behind them and to develop appropriate response strategies (Tidd, Bessant and Pavit 2008). As a result, companies are urged to seek new ways of acquiring external innovation through, for example, universities (Salas 2009). The establishment of cooperative relationships with universities is increasingly becoming an important source of business innovation. However, University Industry Relations (UIR) are difficult to establish, and both firms and universities have different motivations to enter a relationship (Salter 2009), although it seems that the acquisition and transfer of technology is beneficial for both parties (Ramos-Vielba, Fernández-Esquinas and Espinosa-de-los-Monteros, 2010). The motivation for firms to enter a UIR is related to access to scientific breakthroughs, to the possibility of increasing the applied power of science, to the delegation of selected development activities and getting access to technological resources (Bonnacorsi and Piccaluga, 1994). The high costs of some projects and the complexity and multidisciplinary of knowledge involved, advances in information technology and communication are some of the causes that explain the increase on UIR (Romero 2007). The motivations for universities to enter UIR are related to access to knowledge developed elsewhere, to financial motivations and the need to obtain additional funds for research, and, last but not least, to policies that have been set up to encourage scientific collaboration, motivated by the belief that collaboration maximizes public investment in research funding. The widespread notion in the literature is still that UIR are unidirectional relations, where industry is seeking knowledge from university, but research shows that bidirectional relations are in fact, the norm (Meyer-Krahmer and Schmoch, 1998). That would explain why UIR are less intense in regions where industry is less developed (Sanchez and Tejedor, 1995), and why size of firm seems to be an important determinant of university-industry interaction (Fontana, Geuna and Matt, 2006).

Technology evaluation is a fundamental aspect in the process of decision making and technology transfer. This term is often used in the literature to identify the whole process, which ranges from opportunity identification to the decision of adoption or transfer (Wang 2006). Many methodologies and critical aspects of this process have been identified, and is now generally accepted a segmentation of the process in several stages (Daim & Kocaoglu, 2008). However, most approaches still suggest that the evaluation methods are predominantly quantitative, independently of the stage of the process, and derive from traditional financial evaluation techniques such as NPV (Schilling and Hill 1998; Floyd 1997; Milis, Snoeck and Haesen 2009), Payback Period (Sohal et al. 1999; Twiss 1990; Milis, Snoeck and Haesen 2009), ROI (Daim and Kocaoglu 2008; Twiss 1990), DCF (Twiss 1990; Yan, Hong and Lucheng 2010; Dissel et al. 2005), among others. However, the evaluation of new technologies, ideas and business concepts, which constitute the main objects of technology transfer between university and industry, seems not to be adequately covered by these techniques, since in most instances of UIR, characterized by early stages of technology development, there is not a tangible commercial product (Damodaran 2001). Traditional financial techniques find it extremely difficult to include non-quantitative factors (intangibles, both in terms of benefits, or in terms of costs or risks) that may be fundamental in terms of the evaluation and adoption of technologies originated in the universities, and which seem to be essential in the context of UIR (Ordoobadi, 2010). This makes it difficult to establish an objective system for evaluating intangible factors, since it is not possible to design and apply appropriate quantitative indicators (Chiesa and Frattini 2010). Many other models adopt an approach based on checklists and scoring to overcome the mentioned difficulties. However, the criteria definition seems to be vague and the number of variables is generally quite restricted

(Linton et al, 2002). Small firms, due to less elaborated evaluation techniques and/or lack of resources to apply them, are the ones that face greater difficulties in overcoming this absence of relevant indicators when dealing with new technologies in the context of UIR, and, very often, they are guided by intuition and experience (See and Clemen 2005; Ordoobadi, 2006). Technology transfer from universities to firms, according to many models proposed in the literature, follow a linear model (Siegel et al. 2004). Although it may be an oversimplification, a linear perspective may be useful for the identification of crucial steps on the complex process of transfer and commercialization of new technology. Several models for evaluating investments in new technologies, and which could be applied in the context of technologies originating from university labs that are in a early stage of development, have been proposed, based on the idea that the process of technology evaluation can be separated in stages (Jolly, 2012). However, specific techniques and valuation metrics are not associated with those stages. In this paper, we propose a step further in that direction.

3. Methodology

The data on which this study relies consists of primary data collected from the Portuguese business sector. The research was based on a quantitative approach and on an intentional non-probabilistic sampling strategy. The sample includes thirty three Portuguese firms, from different sectors. The selection criteria was based on the innovative performance of the firm, and on the concomitant presumption that innovative activities are well structured inside the firm. Thirty three answers were received (16.5% response rate) and the sample includes five microenterprises, six small companies, twelve medium companies and ten large companies. A proportion of the sample includes conglomerates, and in fact, the sample represents approximately one hundred and twenty two firms. Although being a non-probabilistic sample, its scope and creditworthiness is important**,** since, according to official Portuguese R&D statistics (GPEARI, 2011), it represents 22.34% of total Portuguese investment in business R&D. A quantitative structured questionnaire was developed based on key concepts extracted from the scientific literature, on exploratory interviews conducted with some companies, and on the business experience of the researchers, and it was the main instrument of data collection. Some interviews with selected firms were also realized, in order to substantiate or consolidate some of the data that was obtained through the questionnaire. The extent and depth of the questionnaire limited the number of responses, but it provided a rich set of data. A total of 642 variables were collected. This paper presents only some preliminary results that support our arguments. Work is in progress regarding a detailed statistical analysis, and the formulation of additional explanatory models.

4. The process of university-industry collaboration

The process of university-industry collaboration is a complex one, which involves key decisions on the part of the intervenient players. From the perspective of the firm, which is the privileged perspective on this paper, it necessarily starts with the decision to engage or not in such a relation. The decision not to engage is explained by the obstacles that firms face when confronted with that particular partner. The decision to engage in a relation involves expectations of results. If there is an engagement then the process of evaluation and selection of which technologies or which relations to establish follows, having in mind the expected benefits. Thus, the process of university-industry collaboration evolves within this integrated context. As such, the data we collected addressed this issue. The two extremes of the process, engagement and expected benefits or outcomes, provide indications on the very rationale of this relationship.

The aggregated results are presented in a series of tables. All tables present only the five most valued and the five least valued factors. For each table and question there were many more factors whose importance was asked to the respondents.

The three following tables present the results concerning the UIR engagement problem. Tables 1 and 2 indicate the responses to factors concerning the decision to engage or not in UIR. Table 3 indicates the outcomes of those relations.

Table 1: Expected benefits with the collaboration

Type of benefits	Mean (n=28)
Access to qualified human resources	4,14
Generation of new products	4,04
Generation of new processes	3,96
Sales increase	3,93
Obtain technical support for solving problems	3,71
Access to laboratories and equipment	3,25
Access to the tacit knowledge of the partner	3,11
Research costs reduction	3,07
Patents	2,96
Maintaining Technology Ownership	2,75

Five point Likert scale: 1= Unimportant; 2= Of little importance; 3=Moderately important;4= Important;5=Very important

Table 1 presented the expected benefits, which are analysed below, in conjunction with table 2 and 3. Concerning engagement, the reverse of the coin is the difficulties that firms experience when trying to relate to universities. It s important to understand those constrains, as they may prove a decisive factor not to engage in UIR. The following table presents the results on this topic.

The main barrier that firms face when they interact with universities is the short-term orientation of the industry research and different research time horizons. Another main barrier is the different missions and goals of each institution. The inadequacy of the nature of academic research to the interests of the industry is also an important barrier.

Table 2: Frequency of barriers to university-industry collaboration

Type of barriers	Mean (n=28)
Short-term orientation of the industry research / different time horizons	3,61
Different missions and goals	3,54
Inadequate nature of academic research to the interests of the industry	3,32
Lack of suitable governmental funding for UI joint research	3,11
Unrealistic expectations of universities about the value of their technologies	3,04
Lack of acceptance of the results generated by the partner	2,43
Poor rewards for university researchers	2,21
Potential conflict of interests regarding confidentiality	2,21
Potential conflicts about industrial property rights	2,21
Geographical distance between universities and industry	2,07

Five point Likert scale: 1=Never; 2= Rarely; 3=Usually; 4= Very frequently;5= Always

These are somehow familiar results that have showed up in the literature, and they are coherent with the expected benefits and main outputs of UIR signalled by firms. Firms' objectives are clearly very well defined, and address essentially short terms benefits in terms of product and process development (with the exception of the need to access qualified human resources, which may include

a short or a medium term perspective), which is eventually at odds with the objectives pursued by universities.

Table 3: Main outputs for the process of technology transfer:

Outputs	**Mean (n=33)**
Product or service development	4,00
Economic development	3,55
Continuing training for the company	3,52
Informal transfer of know-how	3,39
Workshops and seminars	3,18
Sponsored research agreements	2,85
Affiliate programs	2,58
Joint publications	2,55
Serependity	2,45
Creation of joint labs	2,45

Five point Likert scale: 1=Never; 2=Rarely;3=Usually; 4= Very frequently; 5= Always

Table 3 presents the results of the questionnaire regarding the frequency of the main outputs of technology transfer, which can be confronted with the results in table 1.

Referring to table 1, we can see that the main benefit that firms expect when they interact with universities is the access to qualified human resources. This result is in line with several studies that highlight the importance of this factor. Referring to table 3, one can see that the main outputs of technology transfer are product or service development, economic development and continuing training for the company, which are in line with the other main benefits expected with the cooperation (Table 1), which is the generation of new products and the generation of new processes, and which are more related to the main preoccupation of this paper, since they imply an implicit process of evaluation and selection of technological options. The importance attributed to these expected benefits and outputs stresses the importance of understanding more fully the evaluation and selection processes that are implied in the process, in order to improve and better comprehend the articulation between the two actors involved in the process. It justifies the relevance of this work and the analysis of the results that we present in the next section regarding the process of evaluation.

5. Technology evaluation

This is the main section of this paper, whereby the analysis of the results highlight some important factors that have not been properly addressed in the literature. We assume that the process of technology evaluation and selection is divided in stages, similarly to the main literature on the subject, but, unlike this one, we find that the techniques, tools and decision criteria associated with each stage is different, and it varies accordingly. As mentioned in the review section above, most models assume that the most widely used methods are quantitative and derive from traditional financial evaluation techniques. Our results do not support that view. Although quantitative techniques are used, they are used, as a determinant decision tool, only in some stages of the process. We identified five stages in the evaluation process, which are: the idea generation stage, the screening stage, the idea evaluation stage, the opportunity stage and the feasibility stage. In the following tables, we present the tools and methodologies used in the first three stages, and then a table presenting the differential evaluation criteria that firms attribute to each stage, supporting our argument that tools, methodologies and criteria are not indiscriminately used throughout the evaluation and selection process. As mentioned before, only the five most valued and the five least valued factors are indicated in the tables. For each table and question there were many more factors that were asked to the respondents.

Table 4 presents the results of the questionnaire regarding the tools and techniques used in the stage of idea generation.

Table 4: Tools and techniques used in the stage of idea generation

Type of tools and techniques	Mean (n=33)
Meetings	3,67
Brainstorming	3,64
Check Lists	3,03
Flowcharts	2,94
Questionnaires	2,79
String diagram	1,64
Idefo diagram	1,61
Lotus flower	1,61
Edgar	1,55
Jb help me	1,52

1=Never; 2= Rarely; 3=Usually; 4= Very frequently; 5= Always.

The main tools and techniques used by firms in the stage of idea generation are the meetings. Another main tool and technique is the brainstorming. Checklists are also widely used tools in this stage. The results regarding the evaluation methods used in the screening stage are quite different from those used in the previous stage, and the results are shown in Table 5.

Table 5: Evaluation methods used in the screening stage

Evaluation methods	Mean (n=33)
Experience	4,09
Opinion and advice from companies and collaborative networks	3,03
Intuition	2,85
Check lists	2,79
Others	2,00
Rapidscreen	1,76
Strategy Canvas	1,58
COAP	1,45
Quick Outlook commercialization Assessment	1,39
TEC Algorithm	1,30

1=Never; 2= Rarely; 3=Usually; 4= Very frequently; 5= Always.

The main evaluation methods used in the screening stage are the experience, opinion and advice from companies and collaborative networks, and intuition. The least used are methodologies that are quite systematic and that involve a considerable amount of quantitative considerations. The degree of subjectivity involved in this stage is somewhat surprising, and it is not very often referred to in the literature, since at this stage it would be expected that the collection and analysis of some hard numbers would have a greater weight in terms of decision making. In fact, the importance of quantitative methods will only become visible in the next stage, and particularly, in the last stages of

the evaluation process. Table 6 presents the results of the questionnaire regarding the evaluation methods used in the screening stage.

Table 6: Evaluation methods used in the idea evaluation stage

Evaluation methods	Mean (n=33)
Experience	3,97
Competitive advantage	3,88
Business goals	3,88
Cost benefit analysis	3,88
Strategic Analysis Model	3,61
Delphi	1,48
Stochastic programming	1,39
Fuzzy logics	1,36
Stochastic differential equation	1,36
TEC Algorithm	1,36

1=Never; 2= Rarely; 3=Usually; 4= Very frequently; 5= Always

The main evaluation methods used in the idea evaluation stage are experience, competitive advantage and business goals. Curiously, subjective criteria (experience) still seems to dominates the picture, although more structured and quantitative methods acquire a substantial weight. Notice that the methods and the tools that are used in this stage are also quite different from those used in the previous stages, reflecting the different decision criteria that are used in the different stages. The decision criteria becomes gradually less subjective and more quantitative. The next section highlights this "evolution" in the process of decision making of firms, and it will include the final stages of the process.

6. Weighting of the different dimensions and criteria used in the evaluation process according to the specific stage of development

During the above presentation, discussion and analysis of the results, it became clear the validity of the assumption that evaluation and selection methodologies, tools and criteria are not uniform along the evaluation process. In Table 7, in which all identified stages of the evaluation process are included, we emphasize the decision criteria that are used in each stage, presenting the results from the questionnaire about the weighting of the different dimensions and criteria used in the evaluation process, according to the specific stage of development. The table summarizes the main results of this study, supporting our argument for the existence of a differential approach in terms of the tools, methodologies and decision criteria that are determinant in each stage. The data was obtained in the following way: respondents were asked to weight, in a scale ranging from 0 to 1000, the relative importance of each dimension, in each stage of the evaluation process. Responses to all dimensions were required, and the sums of the weights equalled, necessarily, 1000.

On the screening and idea evaluation stages, the main dimension is the market, followed by the technology and by a subjectivity factor. On the feasibility stage, it is the economic/financial dimension and on the opportunity stage, the main dimension is the financial analysis.

Table 7: Weighting of the different dimensions and criteria used in the evaluation process

Dimension	Stage			
	Screening stage	**Idea evaluation stage**	**Feasibility stage**	**Opportunity Stage**
Market	44,94%	27,91%	19,30%	-
Technology	38,20%	23,10%	-	-
Subjectivity	16,86%	9,06%	-	-
Product/Service	-	21,22%	-	-
Risk	-	18,71%	12,21%	-
Economic/Financial	-	-	20,43%	-
Technical	-	-	16,20%	-
Operational	-	-	12,26%	-
Legal	-	-	10,12%	-
Organizational	-	-	9,48%	9,87%
Financial analysis	-	-	-	16,91%
Financial plan	-	-	-	14,94%
Executive summary	-	-	-	14,09%
Project evaluation	-	-	-	12,73%
Marketing	-	-	-	11,99%
Entrepreneurs	-	-	-	11,68%
Social impact	-	-	-	7,79%
Total	100%	100%	100%	100%

We realize that, not only are the tools and methodologies different, so is the nature of the criteria that underlies the use of those tools. In the early stages, subjectivity and qualitative approaches dominate the decision process, whereas structured and quantitative approaches are gradually superimposed or determine later stages. This is also true in the last stages, present in the table along with the ones that have already been discussed.

The main point here is that the evaluation process is a complex one that involves several stages, whose characteristics imply the adoption of different decision criteria supported by different tools and methodologies. In the first stages of the process, the stages that deal with idea generation and screening, qualitative and subjective criteria dominate the process. This is explained by the fact that there are not definite or consolidated concepts that can be conducive to qualitative analysis or to structured processes of evaluation, generally based on a quantitative approach. There is not yet a “dominant design”, to make an analogy with Abernathy and Utterback (1978), or a well defined concept, and as such there is no sure way to collect data or to rely on specific patterns of data. The technology that is being evaluated, and whose origin is the university, is presumably of a new vintage, or it possesses characteristics that may not be totally familiar to the evaluator, so there may not be recorded or familiar references on which to rely a sound assessment. Qualitative assessments, experience and intuition become relevant factors on these stages. In later stages, as the product concept is consolidated, and the requisites for data collection become much more established, quantitative assessments take over, eventually dominating the later stages, whereby uncertainty is reduced and information retrieval is maximized.

7. Conclusion

One of the mains results of this research was the realization that the criteria, tools and methodologies that are adopted by firms are not uniform throughout the process of evaluation and adoption of the technologies. It depends on the stage of the process. Accordingly, we propose a division of the process in specified stages and we identify which criteria, tools and methodologies firms' values most at each one. This is particularly important in the context of transfer of technologies from universities, since these technologies may fit well within some stages and not so well in other stages.

Important implications for the practice of technology evaluation may result from this research, as we expect to develop a new evaluation model that assumes the division of specific process steps, identifying and considering the criteria for analysis of the potential of ideas appropriate to each stage. The first stage, the screening of ideas, analyzes the issues related to the market, technology and subjectivity. The second stage, the evaluation of ideas, analyzes the issues related to the market, technology, product/service, risk and subjectivity. The third stage, the viability of ideas, analyzes the economic and financial issues, market, technical, operational risk, legal and organizational. The fourth and final stage, the opportunities of ideas, analyzes the issues related to financial analysis, the executive summary, project appraisal, marketing, sponsors, organizational factors and social impact.

One of the main distinguishing feature of this evaluation model is the introduction of a variable on subjectivity in the analysis of innovative ideas, which, according to the results obtained in this research, is a methodology (including experience) often used in the selection of business opportunities in a context of uncertainty, especially in the early stages of development, typical of university technologies. The results of our research also pose some challenges to existing theoretic models proposed in the literature, which scarcely assume any differentiation in the stages of the process of technology evaluation. Our results show that such a perspective does not adequately models the process.

References

Abernathy, W.J., and Utterback, J.M. (1978) "Patterns of industrial innovation", *Technology Review*, Vol 80, No 7, pp 40–47.

Bonaccorsi, A., and Piccaluga, A. (1994) "A Theoretical Framework for the Evaluation of University-Industry Relationships", *R & D Management*, Vol 24, No. 3, pp 229-247.

Chiesa,V., and Frattini, F.(2009) "Evaluation and Performance Measurement of Research and development: Techniques and Perspectives for Multi-level Analysis", *R&D Management,* Vol 20, No. 5, pp 513-514.

Daim, T. U., and Kocaoglu, D.F. (2008) "How Do Engineering Managers Evaluate Technologies for Acquisition? A Review of the Electronics Industry", *Engineering Management Journal,* Vol 20*,* No*.* 3, pp 44 -52.

Damodaran, A (2001) *The Dark Side of Valuation: Valuing Old Tech, New Tech, and New Economy Companies,* Financial Times Prentice Hall, London.

Dissel, M, Farrukh, C, Probert, D, and Phaal, R. (2005) "Evaluating Early Stage Technology Valuation Methods: What is Available and What Really Matters", *Proceedings from 2005 IEEE International Engineering Management Conference*, St John's, Newfoundland, Canada, Vol 2,pp 302-306.

Floyd, C. (1997) *Managing Technology for Corporate Success*, Gower Publishing, Hampshire.

Fontana, R., Geuna, A., & Matt, M. (2006) "Factors Affecting University-Industry R&D Projects: The Importance of Searching, Screening and Signalling", *Research Policy*, Vol 35, No. 2, pp 309-323.

GPEARI, (2009) *As Empresas e Instituições Hospitalares com mais Despesa em I&D em 2008*, GPEARI - Ministério da Ciência, Tecnologia e Ensino Superior.

GPEARI, (2011) *IPCTN10: Resultados Provisórios*, GPEARI - Ministério da Ciência, Tecnologia e Ensino Superior.

Linton, J.D., Walsh, S.T. and Morabito, J. (2002) "Analysis, ranking and selection of R&D projects in a portfolio", *R&D Management*, Vol 32, No. 2, pp 139-148.

Meyer-Krahmer, F., and Schmoch, U. (1998) "Science-Based Technologies: University-Industry Interaction in Four Fields", *Research Policy*, Vol 27, No. 8, pp 835-851.

Milis, K, Snoeck,S and Haesen, R. (2009) "Evaluation of the Applicability of Investment Appraisal Techniques for Assessing the Business Value of IS Services", [online], FBE Research Report,KBI_0910,K.U.Leuven,BE.https://lirias.kuleuven.be/handle/123456789/247210.

Ordoobadi, S. (2006) “Development of a Tool for Managing Technological Innovations in Small Manufacturing Companies”, *Proceedings of the 7th Asia Pacific Industrial Engineering and Management Systems Conference*, Bangkok, Thailand.

Ordoobadi, S. (2011) “Inclusion of Risk in Evaluation of Advanced Technologies”, *The International Journal of Advanced Manufacturing Technology,* Vol 54, No.1-4, pp 413-420.

Ramos-Vielba, I, Fernández-Esquinas, M. and Espinosa-de-los-Monteros (2010) “Measuring University–industry Collaboration in a Regional Innovation System”, *Scientometrics,* Vol 84, No.3, pp 649–667.

Romero, F. (2007) “ University-Industry Relations and Technological Convergence”, *Proceedings from PICMET 2007*, Portland, Oregon, USA, pp 233-240.

Salas, J.A.P. (2009) “Best Practices for Industry-University Research Collaboration”, Master Dissertation, Massachusetts Institute of Technology, Cambridge.

Salter, A, Bruneel, J. and D´Este, P. (2010) “Investigating the factors that diminish the barriers to University-Industry Collaboration”, *Research Policy,* Vol 39, No.7, pp 858-868.

Sanchez, A. M., & Tejedor, A. C. P. (1995) “University-Industry Relationships in Peripheral Regions: The Case of Aragon in Spain”, *Technovation,* Vol 15, No. 10, 613-625.

Schilling, M.A. and Hill, C.W.L. (1998) “Managing the New Product Development Process: Strategic Imperatives”, *The Academy of Management Executive* **,**Vol 12, No.3, pp 67-81.

See, F.E., Clemen R.T. (2005) “Psychological and Organizational Factors Influencing Decision Process Innovation: The role of Perceived Threat to Managerial Power”, Working paper, Duke University, Durham, NC.

Siegel, S.S., Waldman, D.A., Atwater, L.E. and Link, A.N. (2004) “Toward a Model of the Effective Transfer of Scientific Knowledge from Academicians to Practitioners: Qualitative Evidence from the Commercialization of University Technologies”, *Journal of Engineering and Technology Management,* Vol 21*,* No*.*1-2, pp 115-142.

Sohal, A.S., Schroder, R., Uliana, E.O. and Maguire, W. (1998) “Adoption of AMT by South African Manufacturers”, *Integrated Manufacturing Systems,* Vol 12, No.1, pp 15 – 34.

Tidd, J., Bessant, J. and Pavitt, K. (2008) *Gestão da Inovação*, Bookman, Porto Alegre.

Twiss, B.C. (1990) *Business for Engineers,* Reprinted ed.1991, Peter Peregrinus, London.

Wang, Y.-T. (2006) *Information Technology Investment Decisions and Evaluation in Large Australian Companies*, Ph.D., Nathan, Griffith University. http://www4.gu.edu.au:8080/adt-root/public/adt-QGU20070716.175827/index.html

Yan, L., Hong, Z., and Lucheng, H. (2010) “Review on Methods of New Technology Valuation”, *Proceedings of 2010 International Conference on E-Business and E-Government,* Guangzhou, China, pp 1932-1935.