

TECHNOLOGY TRANSFER: EXPLORATORY RESEARCH INTO THE DESIGN PROCESS IN COMPANIES AND RESEARCH CENTERS

Washington Luiz da Silva Martins, wluizmartins@gmail.com
André Ogliari, ogliari@emc.ufsc.br
Acires Dias, acires@emc.ufsc.br
Federal University of Santa Catarina

Abstract. *Technology transfer has been the subject of constant impact in academia and industry. Given this effect, we sought, through this work, an exploratory research in large companies and research centers reference in the south of Brazil, aimed at understanding, clarification and confirmation of a concept of transfer of technology developed through a review literary inquiry. In this concept, it is considered that to be effective in the process of technology transfer, there should be planning process technologies at an earlier stage. Definition of performance as the problem of this research, we defined the phase of the design process of companies and research centers, because in this phase, product development, in which technologies will be considered. The results of this work, requirements were achieved, confirmed the need to develop a model to assist the design team in solving problems, using technology transfer, and represented a conceptual view of the planning model proposed.*

Keywords: *technology transfer, technology planning, design process of product.*

1. INTRODUCTION

Technology transfer! The principle seems simple, just the definition of technology, then attempt to cause a shift of that term from one point to another and then, yes, promote the transfer process.

However, this process is extremely difficult because there is a need for technology planning at an earlier stage for an effective transfer.

This article accepts the premise that it should: define a concept of technology transfer, based on the study of several authors, do some exploratory research into companies and research centers of reference in the region, aiming to raise requirements to confirm this concept and get other and, lastly, to show by means of a general illustration of a conceptual view of the planning model for technology transfer in the design process of product.

2. CONCEPT OF TECHNOLOGY TRANSFER

Technology transfer comes in many different concepts.

For the INPI (National Institute of Intellectual Property), it is the process by which a body of knowledge, skills and procedures applicable to problems of production is transferred by an economic transaction, from one organization to another, increasing the innovation capacity of the receiving organization (INPI, 2009).

According to Wikipedia (2009), "is the transfer of technical or scientific knowledge (eg research results and scientific research) in combination with factors of production". This reference is not considered a reliable scientific source. However, it was adopted for presenting a most appropriate concept for this work.

As for Montanha Jr. (2004, p. 27), It can happen in two ways: through professional training, along with educational institutions and research needs identified appropriate technologies (needed) to promote the domestic development of the company's technology, or by acquiring foreign technology.

Based on the above and considering the context of this work, the "technology transfer is the acquisition of physical resources and/or professionals training in certain skills in the design process of products." (MARTINS, 2009, p. 17).

Figure 1, which follows, represents that concept.

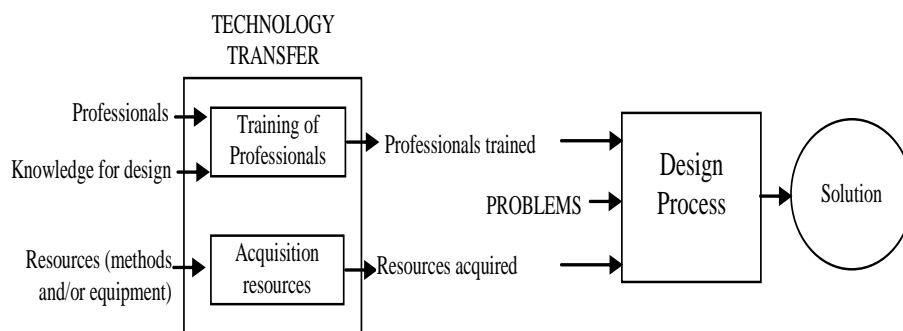


Figure 1. Conceptual view of technology transfer to the design process (MARTINS, 2009, p. 17)

Thus, for the technologies available at the time appropriate to the design process, it is necessary to develop activities prior to the process to prepare professionals and acquire the resources necessary to solve the problems that will arise during the project.

This preparation is called the previous system of planning for technology transfer in the design process of product, which is presented in the conceptual vision of a model at the end of this article.

3. INTRODUCTION TO RESEARCH

There are several research strategies, such as experiments, survey research, data, data analysis and case study (YIN, 2001).

Figure 2 shows the method adopted, adapted from Yin (2001), to conduct this research. The steps include: planning, execution and analysis and conclusions. Each step is detailed in the following topics.

According to Figure 2, the planning stage is the early lifting of what will be done throughout the implementation process, that is, defines the issues to be addressed, are selected organizations and is elaborate the research protocol.

The execution phase consists of collecting data, ie, conducting the interviews themselves.

Finally, the stage of analysis and conclusions is the compilation of results for each subject studied, revising, when necessary, to prepare the final report.

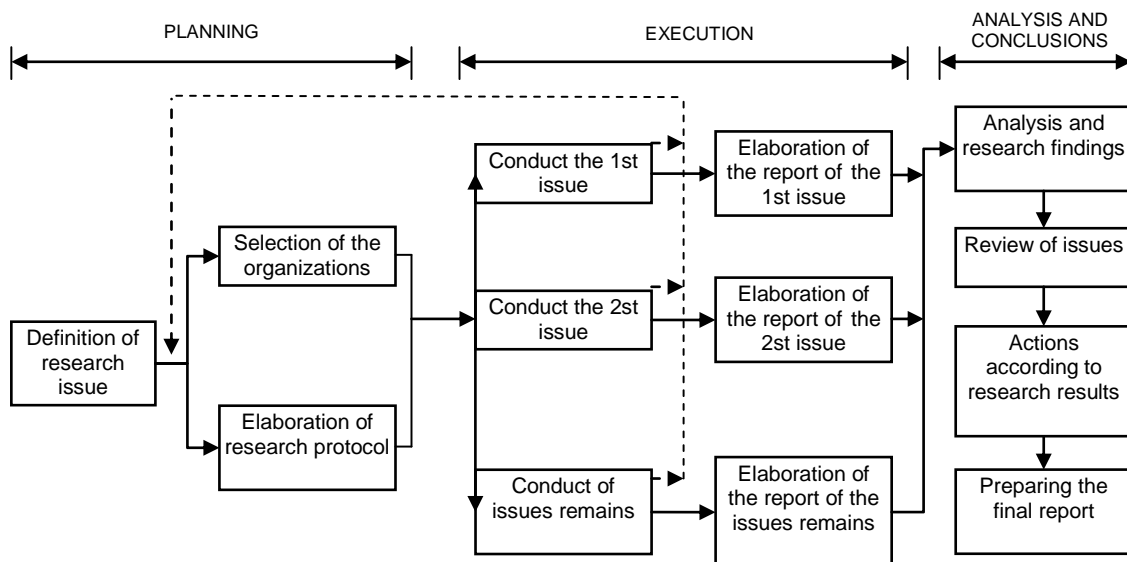


Figure 2. Method of preparation of research (adapted from YIN, 2001)

4. RESEARCH PLANNING

The purpose of this exploratory research is to raise the requirements for a proposed planning model for technology transfer, which will be derived from experience of the organizations that participated in the interviews.

As a result, there has been an aid to organizations in the decisions of the best stocks in shipments during the development of their products.

Returning to Figure 2, we observe that the planning stage is divided into three sub-steps: definition of research issue, selection of the organizations and elaboration of research protocol.

4.1 Definition of research issues

The Figure 3 represents the issues to be addressed in the research, serving as a guide for designing the protocol for data collection, last substep of planning.

In the central part, there are organizations that will target research. Around that target, to represent the relevant issues:

- General aspects: This is the introduction to this work and deal with general information and comprehensive organizations, for example, organization name, the respondent data, number of employees, among others.

- Technology Transfer: the object of the present study, which deals with specific information for effective implementation of the process of technology transfer in organizations.
- Design process: application context of this work, and includes specific information concerning the mapping of the sequence of the design process of product organizations.
- Planning: stage of this research activity. This information referring to the main content of the model, including the difficulties and facilities for its implementation in organizations.

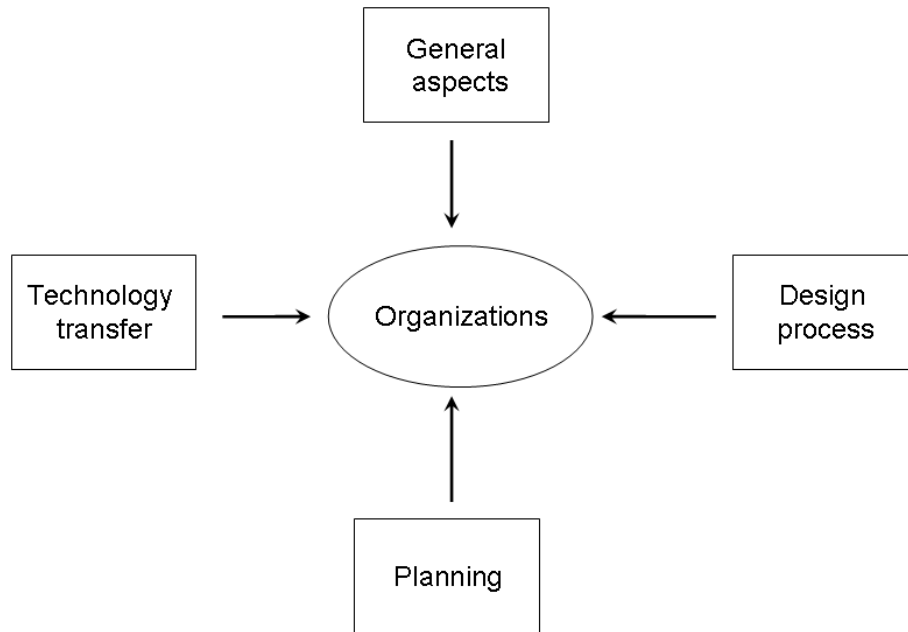


Figure 3. Definition of research issues (MARTINS, 2009, p. 54)

4.2 Selection of the organizations

The selection of the organizations varies according to the research purpose (STAKE, 1994).

The consultation of more than one organization has the advantage compared to a single query. Therefore, the results of consultation with more than one organization are considered more convincing, and the overall study is seen as being more robust (HERRIOTT; FIRESTONE, 1983).

From this consultation, we need to decide the number of organizations supposedly necessary or sufficient for research. The recommended number of organizations to be interviewed may be four to ten (GIL, 2002). Therefore, we chose in this research for four different organizations and interviewed two experts from each organization, to increase the sample size.

It is known, however, that this paper does not deal with statistical data, or obtain large amounts of data, but obtaining internal information of the organizations are not always exploitable in academic research conventional as in journals, books, internet, database, among others.

These four organizations selected were the two research centers and two large companies. This decision was made, since organizations like structures may allow better comparisons. Took into account also the geographical proximity, which facilitated data collection by this researcher.

The organizations are called: Research Centers: A and B and the Companies: C and D.

Moreover, there was an effort to convince organizations to participate in this survey process and requirements for further evaluation. And the choice of the profile of experts, prioritized to those with more training and experience, with a view to obtaining greater contributions to the development of the proposed model.

4.3 Elaboration of research protocol

Holding the definition of issues and selection of organizations, was conducted the research protocol, as the last stage of planning.

The research protocol is the document that contains not only the collection instrument, but also determines the approach to be adopted for its implementation. The Protocol is therefore one of the best ways to increase the reliability of the research (GIL, 2002).

The management is planning the interview, which consists of:

- 1 - In marking the first contact with the interviewees.

- 2 - The details of the objectives and content of research.
- 3 - In estimating the approximate time for the interview.
- 4 - In checking the resources allowed for the interview.
- 5 - In the definition of the place, date and interviewees.

Since the collection instrument itself is also known as semi-structured questionnaire (MONTANHA JR. Et al, 2005), showing open and closed questions to make flexible data collection. For the preparation of this document was used in Figure 4 as a reference.

The Figure 4 thus represents a guide for preparation of the questions as indicated. It shows the research issues outlined above. In each subject are identified sub-issues that present themselves organized by items, ranging from 2.1 to 5.4.

These items are questions that will be discussed in Section 6.

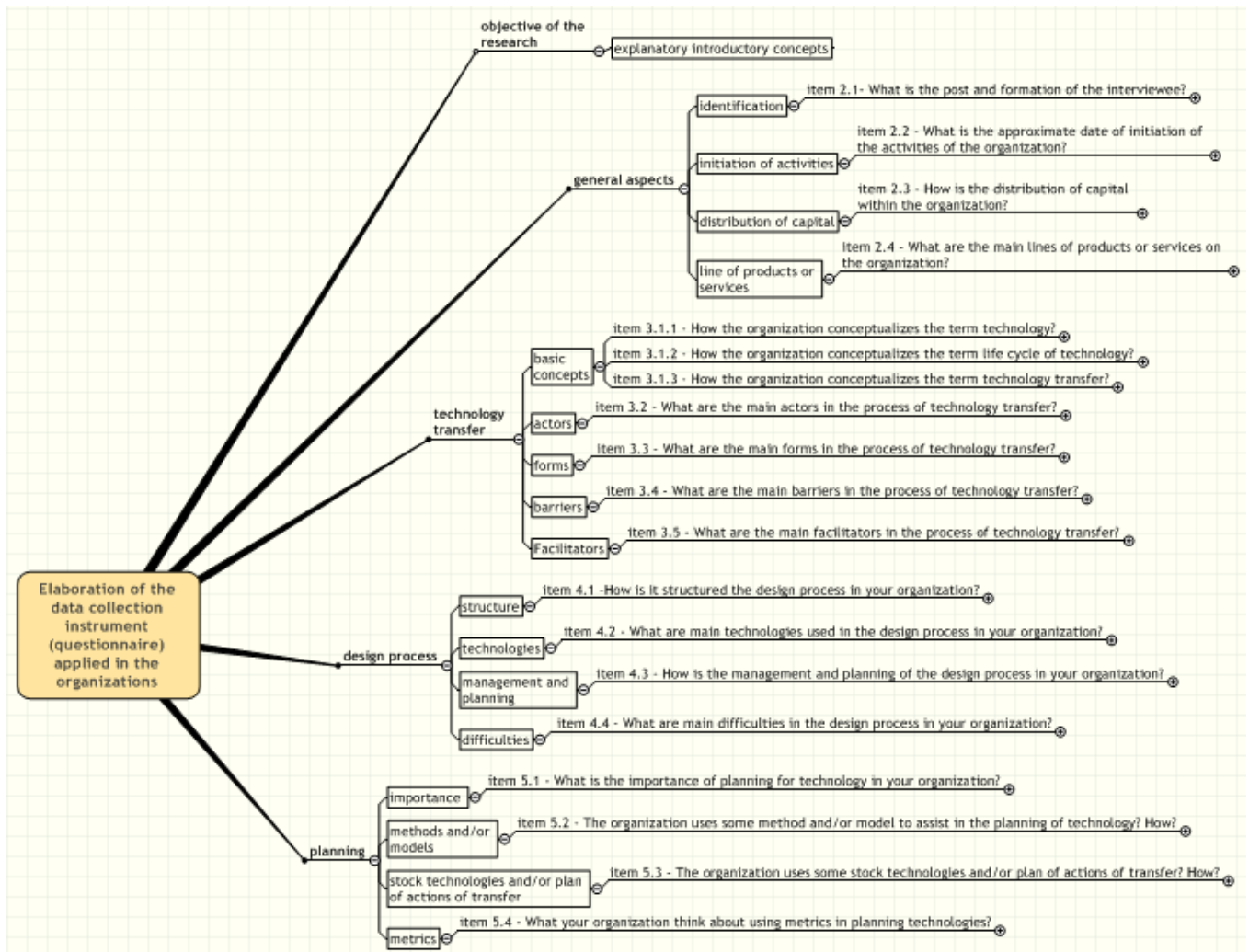


Figure 4. Tree guide for preparing the data collection instrument (questionnaire) (adapted from MARTINS, 2009, p. 56)

Returning to the conduct (planning interview) for this study, it consisted of sending email to the likely respondents, whose intent was to mark the first contact.

Secondly, the objectives and content of the research were presented and detailed, and we estimated the maximum time of one hour per respondent and there was the possibility of using a notebook within organizations.

Finally, we defined the location, date, and the two experts to be interviewed for each organization.

5. RESEARCH EXECUTION

After the planning, has begun the implementation process of the research that has been the physical realization of the stages of behavior (previous section) and in the questionnaire in the research centers and enterprises as defined in subsection 4.2 (Selection of the organizations).

The questionnaires were applied in order to allow the interviewees were free to ask any questions to the interviewer to understand the questions and stay free to not respond, if not of interest or not considered appropriate.

The greatest difficulty in applying the questionnaires was due to lack of time respondents, due to them being generally occupying a managerial position, as shown in the next section, being, as it were overloaded in their respective functions.

6. RESEARCH ANALYSIS AND FINDINGS

The analysis and conclusions are summarized according to the research subjects:

I) General:

- Item 2.1: Identification of experts - experts were interviewed: four doctors, two teachers and two graduates with specializations. Everyone working in research centers and large enterprises.

- Item 2.2: Initiation of activities of the organization - the only company D between 1970 and 1979. Already the others before 1970.

- Item 2.3: Distribution of capital - The research center A is the state capital, the research center B and Company C are of national private capital, the company is D private foreign capital.

- Item 2.4: Line of products or services - Research centers surveyed perform services, divided into teaching, research and extension. The companies develop products surveyed: Company C, electric motors, and Company D, compressors.

Realized, until the time of this research, that research centers and companies surveyed are mature organizations with different distributions of capital and product lines or services. Respondents are also qualified professionals.

II) Technology Transfer:

- Item 3.1.1: Concept of technology - the concepts given by experts similar to the concepts studied in the academic literature, they present a set of common elements, such as knowledge, techniques, methods, and others. This justifies further the concept adopted in this paper: "A set of knowledge, methods or equipment used in design activities" (MARTINS, 2009, p. 12).

- Item 3.1.2: Concept of life cycle of technology - this concept coincides with that found in academic literature, but the company specialists D confused with the concept of product life cycle.

- Item 3.1.3: Concept of technology transfer - the concept adopted in this paper is: "Acquisition of physical and / or professional training in certain skills in the design process of product" (MARTINS, 2009, p. 17). This is similar to the concepts presented by the experts. However, it is questionable how successful this process of transfer? It is suggested, then the need for a model to assist this process.

- Item 3.2: Actors of technology transfer - the players who received more highlights for the experts were: universities, research centers and suppliers of machinery and equipment. It guides the work in the identification of partners, are key to technology transfer.

- Item 3.3: Forms of technology transfer - in companies, the emphasis of the forms of transfer is in training for technology development. This occurs specifically in the category of technology equipment. That is, if the company can not be trained on technology acquired some knowledge because of being protected, would not transfer it. Not so with the research centers that, according to experts, both can be trained to develop the technology, how to get the technology ready, without necessarily having to be trained on the technology acquired.

- Item 3.4: Barriers to technology transfer - The barriers identified in this study are consistent with those surveyed in the literature review, namely: personal, technical and regulatory. However, as a novelty, there was an emphasis on bureaucratic barriers, as reported by specialist company, and the financial barriers, as reported by specialist research center. All refer respectively to the financial and bureaucratic difficulties with government agencies.

- Item 3.5: Facilitators to technology transfer - research centers and companies surveyed had formal facilitators both informal as facilitators for the transfer.

In short, in the issue of technology transfer was found that some subjects such as basic concepts, actors, shapes and facilitators are in agreement with the understanding of this research. It is worth mentioning, however, the observations of financial and bureaucratic barriers reported by the interviewed experts (item 3.4).

III) Design Process:

- Item 4.1: Structure - this item reveals three important points. The first is that the design process from research centers is very much focused on education, not focusing on product development, unlike companies that focus on product development with little emphasis on teaching. The second point is that companies, by the responses, confuse the concept of the design process of product development. Finally, we highlight the diversity of training for professionals engaged in the design process from research centers and companies who rely on the technical level qualification doctorate.

- Item 4.2: Technology - They are considered according to the concept adopted in this paper explicitly in the form of methods and equipment, and implicitly in the form of knowledge.

- Item 4.3: Management and planning - In the centers of research is conducted in a non-formalized, and companies procedures are adopted, using some tools or software not detailed during the interview.

- Item 4.4: Difficulties - On The research center reported the difficulty in managing projects and, as warranted, verbally, by one expert: "It is because of the various nuances of the projects in general: to balance the needs of involvement with customers external and internal legal compliance and relationship with the foundations of support and stimulation body. "Research Center B, note the difficulty in the lack of knowledge of staff. Companies C and D match in the responses, highlighting the difficulty of setting priorities for the projects execution.

That said, perceive themselves in the subject design process presented some similarities in item 4.2. In contrast, proves that many differences in approaches from research centers and enterprises studied, as presented in items 4.1, 4.3 and 4.4.

IV) Planning:

- Item 5.1: Importance - the answers of the experts are unanimous, they consider the very important technology planning. However, it is worth noting the statement of the expert (Company C): "It is very important. However, it is unusual. The company here is very vertical, ie, does internally, in general, anything that uses it. "This means that if there is no field of technology, because of any protectionism in general, there is no transfer and, in turn, there is no planning.

- Item 5.2: Methods and/or models- in this item, did not obtain details of the methods and / or models to assist planning. Only superficially were reported some information on internal models, the PMBOK (PMI, 2000) and some examples of other companies. In the reports it found that even if they use methods and / or models.

- Item 5.3: Stock technologies and/or plan of actions of transfer - Research centers do not use or do not know Stock technologies. Since plan of actions of transfer following informality in the research center A. The company C also uses informal methods and Company D obeys the internal documentation.

- Item 5.4: Metrics - All experts considered important. Of particular note is the phrase expert (Company D): "It is important, especially to improve management decision making, because this is a lengthy process that delays in the projects too." It is understood, before this report that metrics and structured according to the information available that can speed the design process of product.

It can be seen in this last summary of responses, the planning of technology is important. However, were not detected methods, models, database technologies, action plan on transferring and metrics that could help the team in solving their design problems.

And soon it will be proposed as a model, which is presented in overview in section 8 of this article.

7. REQUIREMENTS FOR ESTABLISHING THE PLANNING MODEL FOR TECHNOLOGY TRANSFER IN THE DESIGN PROCESS OF PRODUCT

From the previous discussion of the topic, related to the following considerations:

General aspects - The research centers and companies studied have been useful to confirm and provide contributions to the literature review that supported this research.

Basic concepts - are in agreement with what is being considered in this work.

Technology Transfer - The news that topic refers to the emphasis on transfer barriers (financial and bureaucratic) mentioned respectively by the research center B and company C.

Design process - this topic, it was found confirmation of the requirements that must be addressed in the model (Section 8). For example, in item 4.1, the structure of the design process from research centers and companies passed on the proposed model, which should be flexible to meet different goals and visions that arise between the organizations surveyed.

Technology planning - This is the basic subject of the proposed model should have metrics and action plan, assisting companies and research centers in their shipments of technology to solve design problems.

In the thesis MARTINS, 2009¹, which dealt with a review of the literature on technology transfer have been set some requirements for the preparation of a planning model for technology transfer in the design process of products such as:

- General requirements: be easy to implement, simple to be attractive, be integrated and flexible.

- Specific requirements: having Stock technologies, have capture mechanism Barriers/facilitators and have the method of evaluation/orientation.

Some of those requirements are confirmed in this article. However, the new requisites are identified in Table 1.

¹ It is recommended to read the thesis: **Systematization of planning for technology transfer in the process of product design**. Author: MARTINS, W. L. S. (2009).

Table 1 Relationship of the considerations of this paper versus the identification of new general and specific requirements

CONSIDERATIONS:	General aspects	Basic Concepts	Technology transfer	Design process	Technology Planning
REQUIREMENTS (general and specific):					
1) Being regarded as an activity planning technologies	X	X	X	X	X
2) Have methods to prioritize technologies				X	X
3) Have mechanisms to include financial and bureaucratic barriers.			X		X

The Table 1 shows an "X" the propositions of general and specific requirements (represented in the first column), which should compose the model. These requirements stem from considerations (represented on the first line) obtained in this article.

As new general requirements, the model should:

- To be considered as activity technology planning in the context of design process of product, featuring metrics and plan of actions of transfer.

With regard to new requirements, the model should:

- To have presented in support tools, sequence of prioritizing the technologies to help the design team to choose.
- To have provided the tools support, opportunities for integration of financial and bureaucratic barriers.

Therefore, it is presented in the next topic, the conceptual view model, which will form the basis for detailing the systematic planning for the technology transfer in the design process of product (the result of a future work).

8. CONCEPTUAL VIEW OF THE PLANNING MODEL FOR TECHNOLOGY TRANSFER IN THE DESIGN PROCESS OF PRODUCT

The model presented in this section (Figure 5) shows the main elements associated with the issue of technology transfer in the design process of product, as well as the phases of the system for the solution, and that your details will be made in a later article.

In Figure 5, which represents the model, there are two sides: 1 and 2. In one hand are the design problems that require technology transfer (training of professionals and/or acquisition of resources) to its solution. Between these two sides are the barriers (barriers to the transfer) and facilitators (practices for the transfer).

On the side are two technologies (knowledge, methods and equipment) and systematic (Phase 1 – Identification of technologies, Phase 2 - Evaluation of technologies and transfer and Phase 3 – technologies Planning).

Thus, the design team can, through this systematically identify, evaluate and guide the implementation of the identification of barriers and facilitators, in order to use technology in solving design problems.

The phases of the systematic use matrix, tools, rules, systems and contents, not detailed in this figure, which should be done in the context of another work.

However, there is, in general, that all requirements discussed in the thesis MARTINS, 2009², as well as those shown in Table 1 (Section 7), are included in the model depicted in Figure 5.

² It is recommended to read the thesis: **Systematization of planning for technology transfer in the process of product design**. Author: MARTINS, W. L. S. (2009).

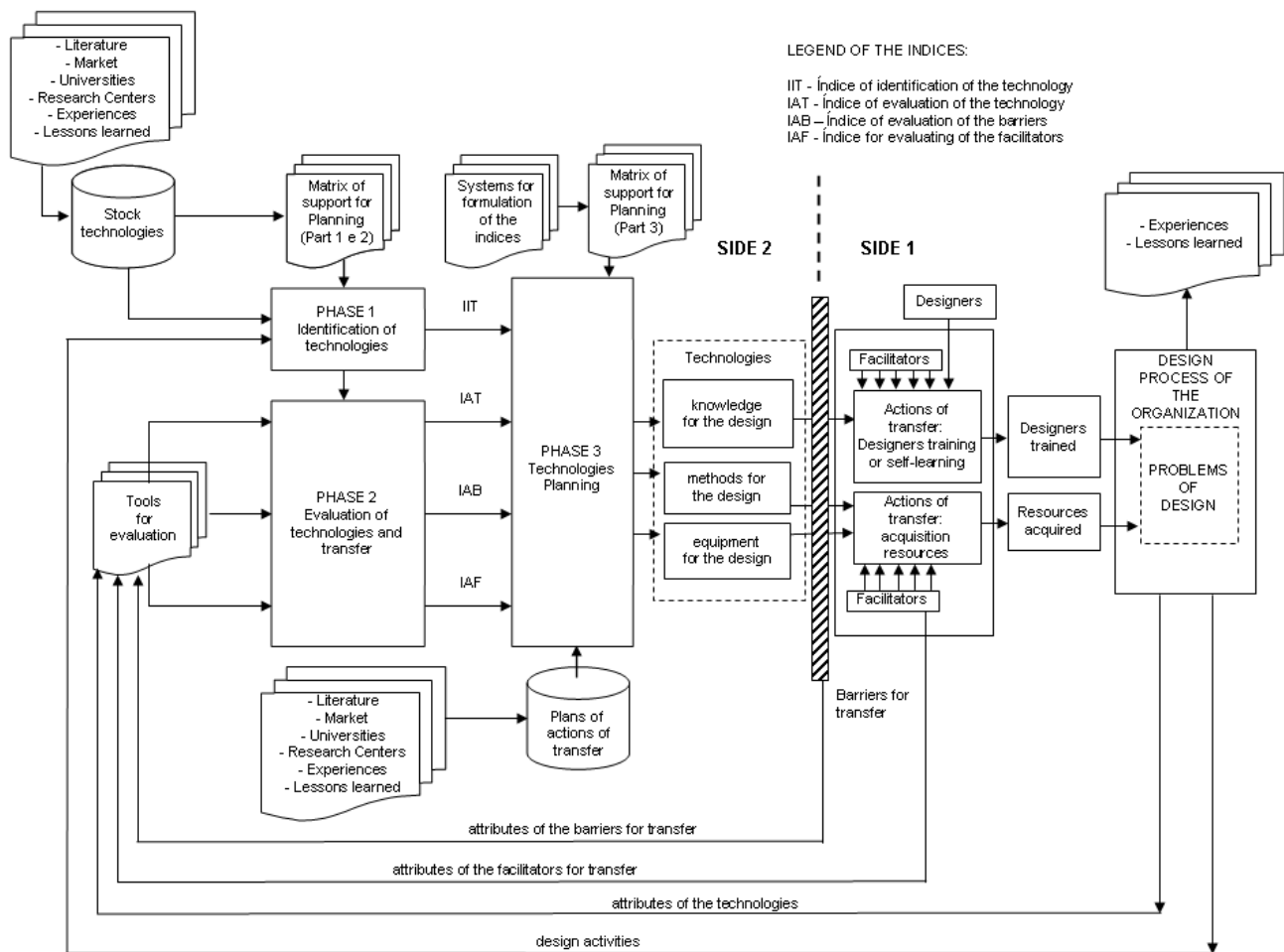


Figure 5 Conceptual model of planning for technology transfer in the design process of product (Martins, 2009, p.72)

9. FINAL THOUGHTS

This paper presented an original research in companies and research centers of reference in southern Brazil, allowing confirm previous studies on the subject and identify new requirements for proposing a model of planning for the transfer of technology in the design process products.

So, the development of this work in the affairs: general aspects, basic concepts, technology transfer, process design and technology planning in the research centers and companies, made a clarification should be obtained and better understanding in this area.

In addition, he encouraged the opening of opportunity, utilizing the work in question, for the development of new projects by companies and research centers studied, as well as encourage its use by other organizations.

Finally, in section 8, he represented the vision of a conceptual model, which serves as the basis for detailing the systematic planning for the technology transfer in the design process of products, a focus of future work.

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