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Tesi di Dottorato

INTERACTIVE DIGITAL MEDIA AND TECHNOLOGY TRANSFER

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List of Figures:

List of Tables:

1. Introduction

1. Aim

The following work aims to give an overview of the state related to the technology transfer of the interactive digital media and to develop a business model based on the main important factor on which the commercialization of these technologies should be based. Starting with understanding what means a successful innovation through the development process, analyzing how new technology unable firms to gain economic advantage, and going through their acquisition and management. The research focused on the Interactive digital media, and after deepening a technology used to develop several digital tools related to virtual and augmented reality applications. This PhD work includes within several and important issues such as the management of the intellectual property rights, in two of the major regions of the world, USA and Europe, the different strategies related to the licensing of IDM, and the policies used worldwide to protect them. Further different ways on how to evaluate these technologies, the ICT projects have been investigated. Several models related have been analyzed, and a conceptual model of technology transfer has been developed. The research has been conducted in different research centres and technology transfers offices, and in the end an experimental research approach has been utilized: beginning with an observation period, through a qualitative and quantitative stages allowed this work to furnish a business model adaptable to the various interactive digital media, and, within this work, to a rendering engine based on open source philosophy named the OpenSG. One of the peculiarities of this model is based on the fact that to commercialize an open source technology, used within the development of virtual reality and augmented reality matters, has not been easy, hence the work aimed first to investigate on which were the relevant factor needed to its commercialization, and after to their validation through a quantitative research sent to people all working in inherent field such as Digital Media, Business and Management, and Marketing. The reason why the research focuses on the Interactive Digital Media relies in their exponential use into everyday life and the potentiality they are gaining in most of fields. Furthermore, in the globalization, the IDM production represents a standard issue to work with and a new and trendy way to mediate communication. The programming languages do not differs from country to country as instead social and behavioural matters do. The work has been carried out during my work period in University of Calabria, in Singapore where I get the opportunity to study in depth topics as the transfer of the technology implemented in this research centre to the outstanding market, and furthermore the possibility to get knowledge about the rights and the patent aimed to be developed in the field above mentioned, and in Chapman University where I had the opportunity to get in touch with people working in the analyzed field. The revolution brought about by the Internet provided a platform for large scale knowledge sharing. The world-wide-web (WWW), powered by indexing and search technologies, provided a backbone service for linking up documents. The learning experience had changed, knowledge enhanced and well spread, resulting in huge numbers of new applications that change the way we live. Such phenomenon is not merely a result of capabilities in efficient search and linking of documents. It is more due to the fusion and mutation of varied and wide sources of information and ideas resulted from searches in the WWW. The Digital Media, and more the Interactive Digital Media represent a powerful tool to communicate and to be used among the most of fields, starting from the business planning, through the communication and advertisement sector, and to, but not least, to the cultural heritage preservation and dissemination (Feraco, 2008). Furthermore, whatever is captured in the documents will still have to be uncovered. The use of corpus for text statistical analysis, the use of facial action units for human expression video analysis, the appreciation of sight, sound, touch, taste and smell from written poems are just a few examples. Contemporary to the development of the technology, to the increasing of the computer use due to the low price trend the digital media gathered an enormous importance in everyday activities.

2. Theoretical Background

With the widespread of technology, the Internet and the World Wide Web, Interactive Digital Media become a tool used among many fields. Most of companies refer to their use in order to optimize their own activities, through the simulation of their processes that allows them to asset risks they have to consider in each specific step of their process. From (Heshmati, Sohn, & Kim, 2007) manufacture sector, to goods production, until the advertisements and edutainment sector, interactive digital media play a basilar role, in order to design and to simulate the desired processes into a virtual world. This enables them to analyse the whole activities among all its aspects, to simulate all adverse happening that may be possible, hence to be ready if tragically happens. This works also underlines the importance taken by the research and development (R&D) that most of times is undertaken in high-income countries. In fact most of developing economies must rely largely on imported technologies as sources of new productive knowledge (Hoeckman & Javorcik, 2006). Human knowledge, experience and emotion were expressed and communicated in words and pictures for recording on bamboo, papyrus, paper, and relatively recently, in digital form. Techniques such as Virtual Reality (VR) and Augmented Reality (AR) are becoming always more and more popular in many areas of application, including entertainment and urban planning, within manufacturing industries and military bodies (Burdea & Coiffet, 2003). In the learning sector the 3D graphics and, hence, 3D models are very useful to familiarize students with features of different shapes and objects. Many games have been developed using 3D images that the user must interact with in order to learn a certain lesson (Monahan et al., 2006) Interactive models increase a users' interest and make learning more fun and, thus, easy to acquire. In fact a new category of games is born, the serious game. They are not produced for the entertainment market itself, but being part of the Interactive Digital Media, they are aimed also to train and to form person in many fields (Feraco, 2009).

3. Research Project

During the first two year the work an observation research has been carries out through the participation to several events all based on the Digital Media, such as the Emerging Technology Conference in San Diego, the Game Development Conference in San Francisco, some European Meeting hold in Bruxelles based on the Technology Transfer and the Project Implementation in the ICT sector. This work developed a business model for the technology transfer of an open source rendering engine and for its commercialization. This technology will be studied as a product to be transferred to the market, and this process has been done after having gathered data and opinions from deep interviews to key persons working within the Interactive Digital Media. After this phase different factors belonging to three different categories were found and after investigated through several statistical analysis. Since the technology is an open source technology, key factors will be individuated and, hence, studied in order to check their importance through the process of commercialization. As mentioned before the project lasted three years that have been spent as the following table shows:

<table>
<tr><th>PHASE</th><th colspan="2">OBSERVATION</th><th>STATE OF THE ART</th><th>QUALITATIVE RESEARCH</th><th>QUANTITATIVE RESEARCH</th></tr>
<tr><td rowspan="2">PLACE</td><td rowspan="2">UNIVERSITY OF CALABRIA</td><td rowspan="2">NANYANG TECHNOLOGICAL UNIVERSITY - SINGAPORE</td><td rowspan="2">UNIVERSITY OF CALABRIA</td><td rowspan="2">CHAPMAN UNIVERSITY, ORANGE, LOS ANGELES, USA</td><td>CHAPMAN UNIVERSITY, ORANGE, LOS ANGELES, USA</td></tr>
<tr><td>UNIVERSITY OF CALABRIA</td></tr>
<tr><td>PERIOD</td><td>2007</td><td>2008</td><td colspan="3">2009</td></tr>
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Table 1: Phases, places and periods of the research project

4. Thesis Organisation

The following PhD dissertation is organized in nine chapters developed during the entire PhD course and organized as reported in this figure:

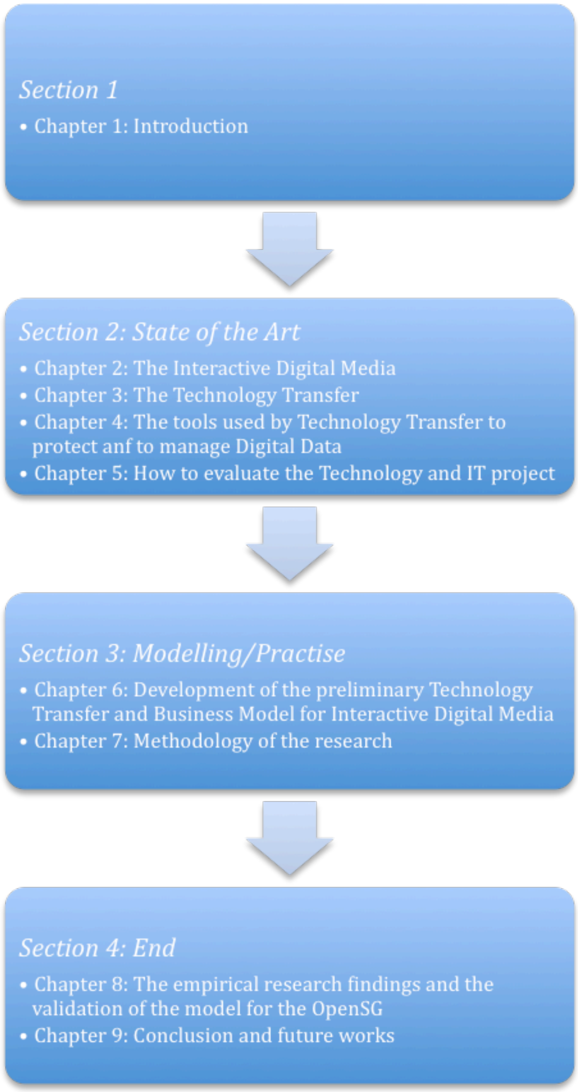

Figure 1: PhD thesis organization

The chapter one, the only of the first introductory section, briefly describes, a part of the theoretical background, the purpose of the undertaken research.

In the second section composed by chapter two, three, four and five, the related state of the art is described analysing the various aspects of this research work.

The second chapter introduces the digital media seen from a theoretical background trying to understand the core entities among them such as their development, their use even in the business sector, and other topic related to them such as: the Human Computer Interaction, Multimodal user interfaces, and their interactivity.

The third chapter focuses on the state of the art related to the technology transfer, determining conceptual issues all related to the various process of the transfer of technology. It analysis several issues related such as the public framework conditions, the relationship between industries and universities. The chapter even gives an overview to the business related to the strategies of technology transfers and ends with the description of some methods and measures for the technology transfer.

The fourth chapter is completely focused on the tools developed and used for the protection and the management of the Digital Data. In deep the chapter will focus on the Intellectual Property Rights, and furthermore will go in deep giving an overlook to the Digital Millennium Copyright Act, a US directive to protect IPR, and the European Copyright Directive. Some issues related to the licensing of technology, and patenting are described. The example of the Fraunhofer Institute and its policy to protect and manage Intellectual Property Rights is reported.

Chapter five gives and overview about the various methodologies used in by worldwide organizations to evaluate technology itself, and, because the most of the project inherent the interactive digital media, are related to the Information and Communication Technologies, some metrics adopted to evaluate projects are deeply analysed. The metrics described are the financial metric, the customer metric and the comparative metric.

The third section is dedicated to the modelling and to the description of the research methodologies utilized during this work.

Chapter six consists in the definition of issues related to the modelling for the technology transfer and business for interactive digital media. It develops a preliminary technology transfer model, and assumed it working, it focuses on the business approach to lead the thesis to the development of a business model for a technology used to develop interactive digital media. This technology is a rendering engine named OpenSG that will be described later in chapter 8.

Chapter seven consists of the methodological approach utilized in the research for testing and further developing the model. The research stages and the relevant research methods and techniques are discussed.

The chapter eight is dedicated to the testing of the results of the empirical research. Before the data analysis, it gives a briefly description of the technology, the OpenSG, for which the model wants to be implemented. After it focuses on the development of a preliminary model developed through a qualitative stage of the research, conducted in Chapman University, LA, California, and its validation through quantitative research developed with on-line questionnaire sent to experts working or teaching Computer science, Business and management, and marketing. All data are described and all results are reported. In the end the final business model, its influencing factors and its adaption to the OpenSG are reported.

In the ninth chapter a critical summary, generalisation, suggestions for further research as well as recommendations and implication for technology transfer and business operators working with digital data are provided. The final business model for the OpenSG is reported and described and the benefits of the model are provided. This PhD thesis ends with a paragraph dedicated to the future works.

2. The Interactive digital Media

The term Digital Media does not refer only to data storage product types such as Compact Disks, DVDs, USB drivers, memory stick and Personal Digital Assistants or Personal Media Players but also to all the other new means of dissemination of content through the new various digital technologies. According to the definition of the Communication Department of the University of Washington, Digital Media can be defined as any medium that uses digital interactive technologies as the engine for communication, i.e. video on demand services, interactive television, digital broadcasting systems and internet based content distribution network[1]. Digital Media hence are a new form of communication emerging from the ongoing technological change and do not require a physical carrier. Samuelson (Samuelson, 2001) defines digital media as "intellectual products made available in digital electronic form, whether operational in computers or other machines capable of reading works in digital forms". Furthermore Interactive media refers to media that allows for active participation by the recipient, hence interactivity. Traditional information theory would describe interactive media as those media that establish two-way communication. In media theory, interactive media are discussed along their cultural implications. The field of Human Computer Interaction deals with aspects of interactivity and design in digital media. Other areas that deal with interactive media are new media art, interactive advertising and video game production. Wong (Wong et al., 2004) defines digital media, from a computer science point of view, as the study of image, sound, and video processing; interactive multimedia development; and advanced web programming. By this definition, this study aims towards a working knowledge of the related programming

[1] http://www.com.washington.edu/Program/index.html, last visited on November 19th 2008.

languages, development platforms, and communication environments. Digital media has other definitions in other contexts, however, and it is instructive to consider what goes by this name outside of computer science. Existing programs in colleges and universities around the world align digital media with art, communications, architecture, or computer science. Degree programs can exist in any of these departments, or the courses can be offered from a separate department or as interdisciplinary endeavors (Wong et al, 2004). Most of times. Digital media courses in universities are offered around computer science, computer engineering, architecture, art, music, English and communication departments. Digital media courses within art departments generally focus on graphic design; 2D and 3D imaging, modeling, and animation; interactive multimedia programming; digital photography; and digital video.

2.1 The Development of Digital Media

Internet allows reaching an unlimited number of people simultaneously, with an exponential reduction of costs, and with no restrictions in terms of time and geographical limits (Castellis, 2001). Thanks to the environment developed by the ubiquitous networking and the low costs, the products that were once distributed as physical goods – i.e. music, video, tourist services – can now be delivered completely in digital form; this new virtual world has extensive implications for cost structures and strategies of content intermediaries. Shapiro and Varian (Shapiro & Varian, 1999) state that the digitalization of content and the increasing adoption of broadband distribution technologies, represent a revolution and a challenge that may be the greatest opportunity for the growth of new business and the transformation of the traditional business models. Today's digital media discussions focus less on the technologies required to make digital and streaming media work, and more on the business models required to make it successful. In corporations, digital media conversations focus on "cost avoidance", "cost containment", "per-user communication cost", and other business oriented justifications (Rayburn & Hoch, 2005). Digital media have a relevant importance among many fields, one is the Service Business, i.e. the main objective for a company operating in the digital media industry is to create a substantial benefit for its clients with the help of new technologies, e.g. Internet technologies. The benefits are created by:

1. adding more efficiency into company organisation and working processes ;
2. creating additional sales/revenues and/or
3. increasing corporate brand recognition.

These three activities can be seen as having a similar four-stage value creation process: strategic planning, creative planning, implementation and distribution of the actual service/production. In order to provide added value to its customers, digital media companies create “content products”, which are sold either via intermediary or directly to customers (Pelkonen, 2007). This content production process has a special value creation model as indicated in the following figure:

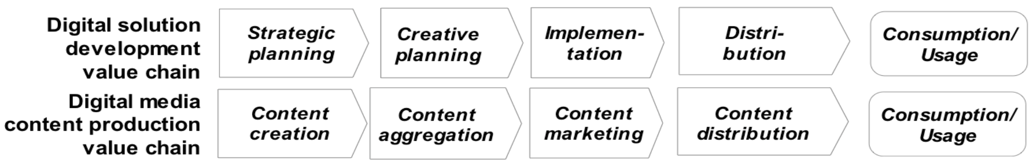

Figure 2: Digital solution and content production creation value chains. Source Pelkonen 2003.

Digital media company creates value for its customers by forming solutions that operate in one of this the following roles: Content Products, Marketing communications, Efficiency creation for business and operations, sales channels; thus creating an interactivity between the Marketer/Advertiser/Brand/Manufacturer on one side and the Consumer/ End-user of the digital service.

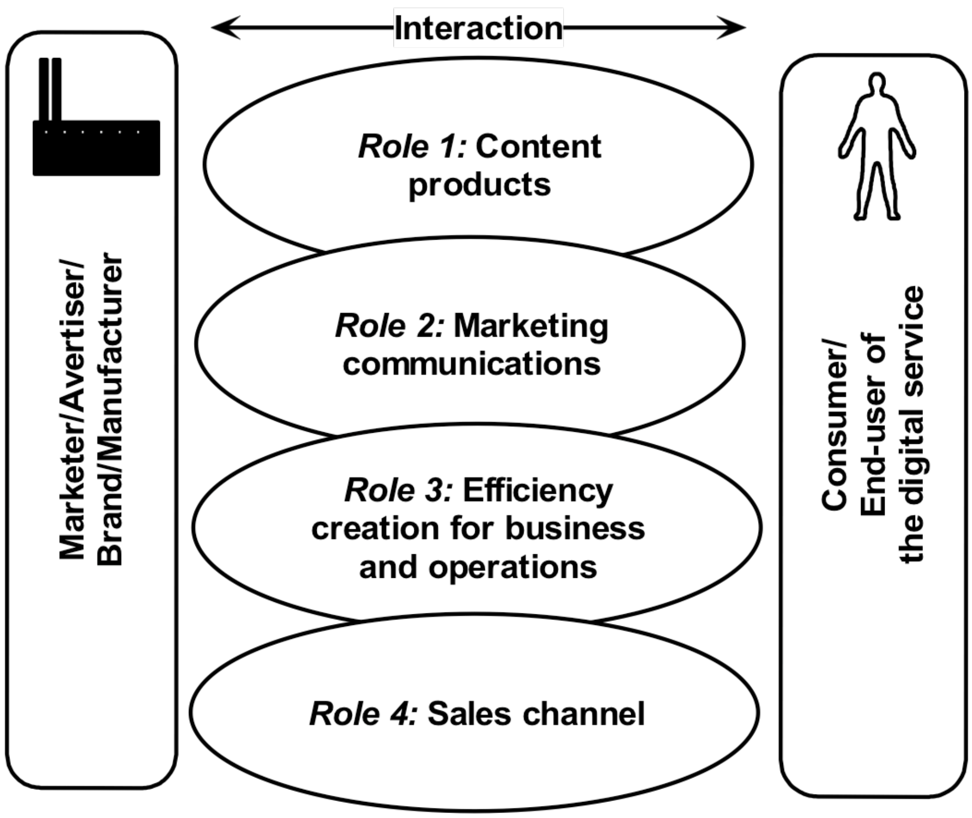

Figure 3: Different roles of digital media companies. Source: Pelkonen 2003.

In the evolving field of digital communication, it is more common to discuss a specific technology solution or delivery platform than to really understand the relations of this solution/platform to other similar activities. Pelkonen (2003) developed a two-fold matrix to assist in defining digital media activities in industries. He putted on the horizontal axis the four delivery platforms and on the vertical axis the eight solutions areas:

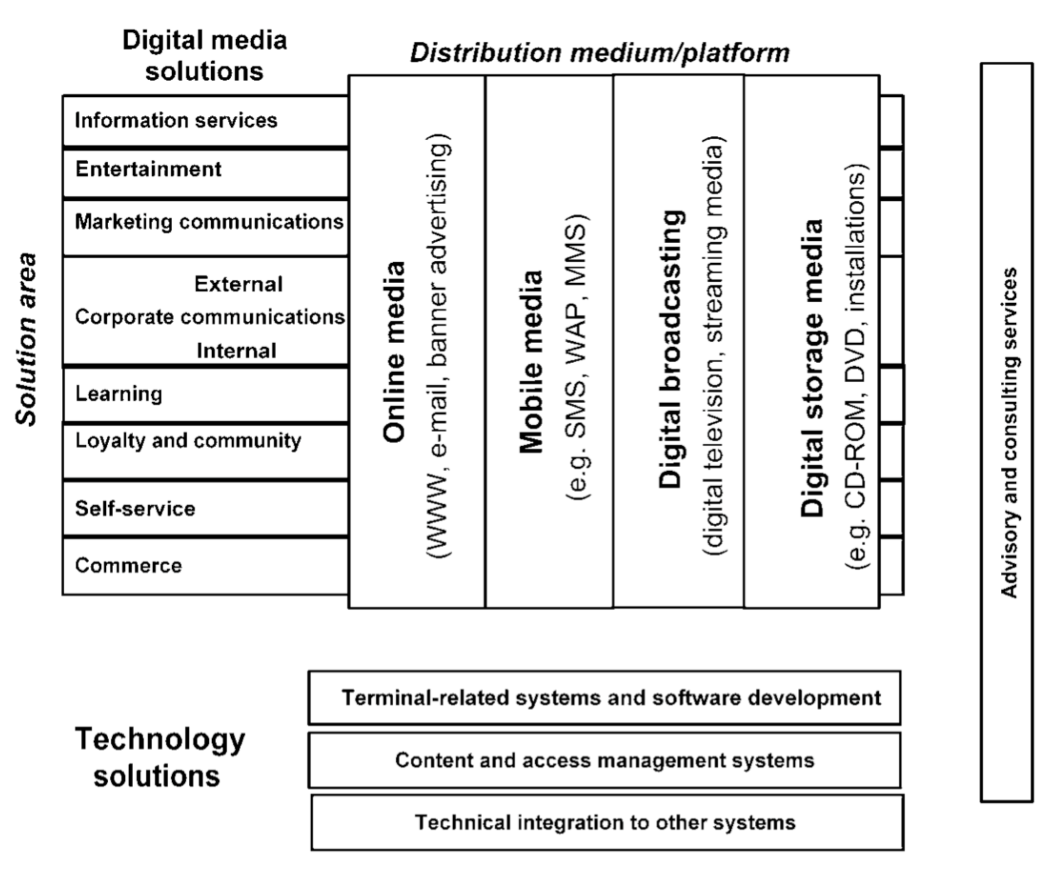

Figure 4: Digital Media Activities. Source: Pelkonen et al 2003

2.2 The Human Computer Interaction

To better understand about the interactive digital media, is worth to define, analyse and study important issues related as the Human Computer Interaction (HCI). To define the HCI is not a simple task because of the applicative nature that this subject has. Simply we can assert that Human Computer Interaction try to analyse the relation between man and computer, where the element computer changed its nature drastically in the last decades following a very rapid dynamic of change (Soro, 2008). Twenty-five years ago few people would have anticipated the tremendous processing speed of contemporary computer systems. Even though major improvements have been made in many areas regarding human–computer interaction (HCI), important issues still remain (Szameitat et al., 2009). The HCI studies objects very heterogeneous such as Personal Computers (PC), Personal Digital Assistant (PDA), Mobile Phones, but even simpler objects such as watch or electrical furniture, or the technologies related to Internet or even more complex technological issues such as the control panel of a chemical plant, or the plane cabin, and so on. According to the Association for Computing Machinery (ACM) the definition of Human Computer Interaction is:

“Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them”.

There are other disciplinary points of view that would place the focus of HCI differently than does computer science, just as the focus for a definition of the databases area would be different from a computer science vs. a business perspective. HCI in the large is an interdisciplinary area. It is emerging as a specialty concern within several disciplines, each with different emphases: computer science (application design and engineering of human interfaces), psychology (the application of theories of cognitive processes and the empirical analysis of user behaviour), sociology and anthropology (interactions between technology, work, and organization), and industrial design (interactive products). From a computer science perspective, other disciplines serve as supporting disciplines, much as physics serves as a supporting discipline for civil engineering, or as mechanical engineering serves as a supporting discipline for robotics. A lesson learned repeatedly by engineering disciplines is that design problems have a context, and that the overly narrow optimization of one part of a design can be rendered invalid by the broader context of the problem. Even from a direct computer science perspective, therefore, it is advantageous to frame the problem of human-computer interaction broadly enough so as to help practitioners avoid the classic pitfall of design divorced from the context of the problem. Human-computer interaction arose as a field from intertwined roots in computer graphics, operating systems, human factors, ergonomics, industrial engineering, cognitive psychology, and the systems part of computer science. Computer graphics was born from the use of Cathode Ray Tube (CRT) and pen devices very early in the history of computers. This led to the development of several human-computer interaction techniques. Many techniques date from Sutherland's Sketchpad Ph.D. thesis (1963) that essentially marked the beginning of computer graphics as a discipline. Work in computer graphics has continued to develop algorithms and hardware that allows the display and manipulation of ever more realistic-looking objects (e.g., CAD/CAM machine parts or medical images of body parts). Computer graphics has a natural interest in HCI as "interactive graphics" (e.g., how to manipulate solid models in a CAD/CAM system), furthermore it is a ubiquitous and indispensable tool for industrial design, being the primary means for modelling and communicating product design proposal (Sener et al, 2008). Many disciplines flow together in HCI, all of them will to study a common issue; this issue is the digital interactive systems placing HCI in the cross road among all these disciplines. Between these disciplines we can name the computer graphics, the cognitive psychology, the design, the economical studies and the economical processes management. In real this multi-disciplinary nature derives from the ergonomics both for the physics aspects and the cognitive aspects. The International Ergonomics Association defines ergonomics as:

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

The difference between HCI and ergonomics is given by the different emphasis on the various aspects of the interaction human-system. We could think about the HCI as a studying the relationship existing between users and computer systems. A great deal of specifically directed work has taken place over the years, but there are excellent introductory books to HCI (Baecker, Grudin, Buxton, & Greenberg, 1995; Helander, 1997) and also to the more specific study of *user-interfaces* (Bilotta, 1996). In HCI there are a great number of approaches used in analysing computer systems. Of particular importance from early in the discipline's history is the use of cognitive psychological models of user's action and planning to discuss how they interact with computers. Theoretical framework such as the GOMS (Goals, Operators, Methods, Selection rules) approach or Donald Norman's seven-stage action cycle in *the Design of everyday things* is representative of this tradition. HCI has traditionally used a methodology of building software and user-interfaces, testing them on users, measuring and analyzing the results, improving the software, and so on. In recent times, the popularity of ethnographic techniques such as interviews, observation in workplaces, and so on, has been growing as researchers become more concerned with the context of use. Jakob Nielsen has popularly defined usability as focusing on five main properties for emphasis in software: learnability, efficiency, memorability, error prevention, and user satisfaction. According to ISO 9241-11 (1998), usability is concerned with the effectiveness, efficiency and satisfaction with which user can achieve specified goals in specified context of use. According to Preece, Rogers and Sharp (Preece, Rogers and Sharp 2002, p. 14) the terms effectiveness means "how good a system is at doing what it is supposed to do". That is, effectiveness suggests that specified goals are to be achieved with accuracy and completeness (ISO 9241-11). Effectiveness is thus related to a system's desired functionality, what users are supposed the system for. Some of the interrelationships among these topics are represented in Figure 1. Computer systems exist within a larger social, organizational and work milieu (U1). Within this context there are applications for which we wish to employ computer systems (U2). But the process of putting computers to work means that the human, technical, and work aspects of the application situation must be brought into fit with each other through human learning, system tailorability, or other strategies (U3). In addition to the use and social context of computers, on the human side we must also take into account the human information processing (H1), communication (H2), and physical (H3) characteristics of users. On the computer side, a variety of technologies have been developed for supporting interaction with humans: Input and output devices connect the human and the machine (C1). These are used in a number of techniques for organizing a dialogue (C2). These techniques are used in turn to implement larger design elements, such as the metaphor of the interface (C3). Getting deeper into the machine substrata supporting the dialogue, the dialogue may make extensive use of computer graphics techniques (C4).

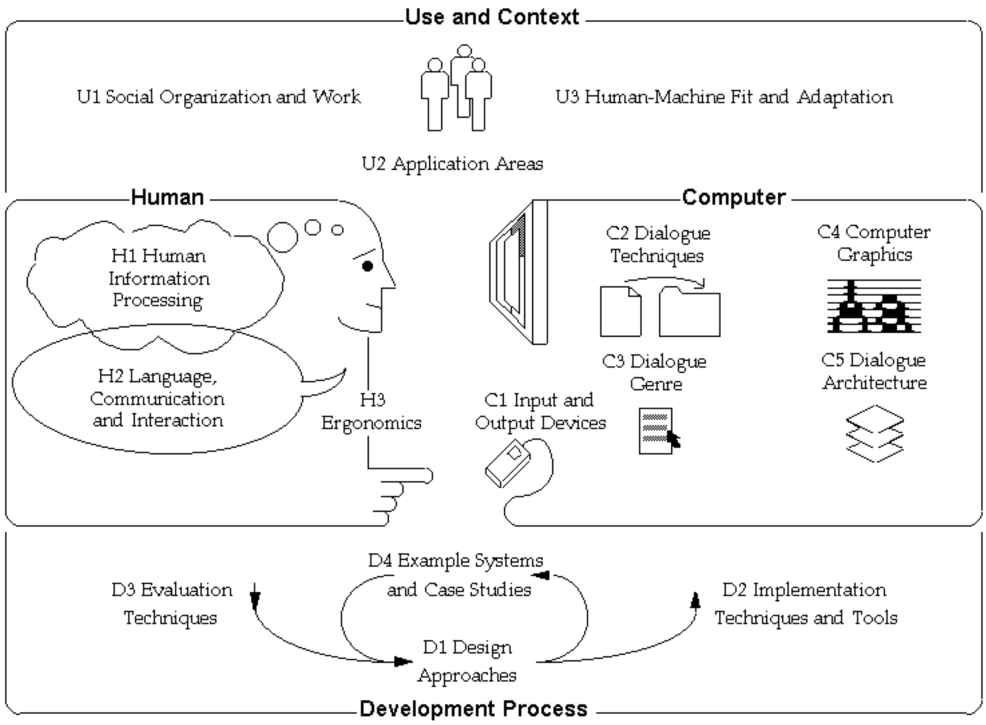

Figure 5: Context and use of Human Computer Interaction (Preece et al. 1994)

Following it is worth to give a detailed categorization of the HCI:

- *Nature of Human-Computer Interaction (N).* It embeds different point of view, and precisely: HCI as communication, as agent paradigm, as tool paradigm. It analyzes the objectives of the HCI; its history and intellectual roots, and even it sees the HCI as an academic topic, in fact it includes journals, literature, relation to other fields, science vs. engineering vs. design aspects.

- *Use and Context of Computers (U)*. The uses to which computers are put are spoken of as 'applications' in the computer world. These uses and the extent to which the interface (and the application logic in the rest of the system) fits them can have a profound impact on every part of the interface and its success. Moreover, the general social, work, and business context may be important. In addition to technical requirements, an interface may have to satisfy quality-of-work-life goals of a labour union or meet legal constraints on "look and feel" or position the image of a company in a certain market. The following topics are concerned with general problems of fitting computers, uses, and context of use together:

- U1. Social Organization and Work

This heading relates to the human as an interacting social being. It includes a concern with the nature of work, and with the notion that human systems and technical systems mutually adapt to each other and must be considered as a whole.

- U2. Application Areas

The focus of this section is on classes of application domains and particular application areas where characteristic interfaces have developed.

- U3. Human-Machine Fit and Adaptation

Part of the purpose of design is to arrange a fit between the designed object and its use. There are several dimensions to this fit and it is possible to place the burden of adjustment in different places: Adjustments can be made (1) either at design time or at time of use (2) by either changing the system or the user and (3) the changes can be made by either the users themselves or, sometimes, by the system. Topics under this heading all relate to changing some component of a socio-technical system so as to improve its fit.

- *Human Characteristics (H)*

It is important to understand something about human information-processing characteristics, how human action is structured, the nature of human communication, and human physical and physiological requirements.

- H1. Human Information Processing

  Characteristics of the human as a processor of information.

- H2. Language, Communication and Interaction

  Language as a communication and interface medium. Communication phenomena.

- H3. Ergonomics

  It defines and includes all the anthropometric and physiological characteristics of people and their relationship to workspace and environmental parameters.

- *Computer System and Interface Architecture (C)*

Machines have specialized components for interacting with humans. Some of these components are basically transducers for moving information physically between human and machine. Other components have to do with the control structure and representation of aspects of the interaction. These specialized components are covered in the following topics.

- C1. Input and Output Devices

  The technical construction of devices for mediating between humans and machines.

- C2. Dialogue Techniques

  The basic software architecture and techniques for interacting with humans.

- C3. Dialogue Genre

The conceptual uses to which the technical means are put. Such concepts arise in any media discipline (e.g., film, graphic design, etc.).

  - C4. Computer Graphics

    Basic concepts from computer graphics that are especially useful to know for HCI.

  - C5. Dialogue Architecture

    Software architectures and standards for user interfaces.

- *Development Process*

  The construction of human interfaces is both a matter of design and engineering. These topics are concerned with the methodology and practice of interface design. Other aspects of the development process include the relationship of interface development to the engineering (both software and hardware) of the rest of the system.

  - D1. Design Approaches

    It includes the process of design and other relevant topics from other design disciplines.

  - D2. Implementation Techniques and Tools

    Here are included tactics and tools for implementation.

  - D3. Evaluation Techniques

    Here are included all the philosophies and specific methods needed to evaluate.

  - D4. Example Systems and Case Studies

    Classic designs to serve as extended examples of human interface design.

After this wide overview about the HCI it is indeed that the field of application this area covers are in a wide range. To give an idea the following picture can summarize many of them.

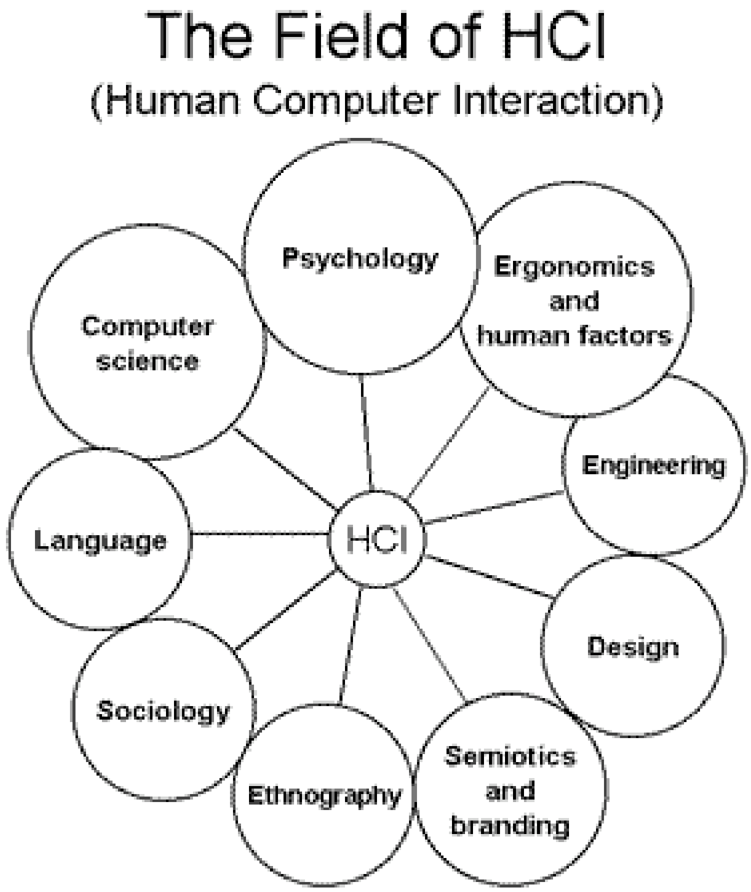

Figure 6: The field that are covered by Human Computer Interaction

2.3 The multimodal user interfaces

Among the HCI, one of the main aim of the research has been to humanize the interfaces. Humanization of interfaces has two aspects: to simplify interfaces in order to make them more easier and pleaser to be used (Shneiderman, 1992; Norman and Draper, 1986) and to make the interfaces the more possible it was similar to human being. According to Charwat (1992) the way, among communication human-computer, can be defined as a perceptive process through one of the three channel of human perception. To design effective multi modal interfaces it is good to follow some suggestions given by the W3C organizations; these suggestions are based on four major principles:

1. Satisfy real-world constraints

2. Communicate clearly, concisely and consistently with users
3. Help users recover quickly and efficiently from errors
4. Make users comfortable.

What the user is willing to achieve through the application is limited by the real-world constraints. These limitations may be due to the nature of the task the user intend to perform, other activities the user is performing, physical limitations of the user, and condition of the environment in which the user is performing the task. The user interface should be designed to compensate for these limitations. The tasks mostly performed by the users are indicated in the following table, and those tasks are mostly achieved through the use of the new mobile devices that will enable to enter data by speaking into a microphone, writing with a stylus, and pressing keys on a small keypad.

Content Manipulation Task	*Voice Mode*	*Pen Mode*	*Keyboard/keypad*	*Mouse/Joystick*
Select objects	(3) Speak the name of the object	(1) Point to or circle the object	(4) Press keys to position the cursor on the object and press the select key	(2) Point to and click on the object or drag to select text
Enter text	(2) Speak the words in the text	(3) Write the text	(1) Press keys to spell the words in the text	(4) Spell the text by selecting letters from a soft keyboard
Enter symbols	(3) Say the name of the symbol and where it should be placed.	(1) Draw the symbol where it should be placed	(4) Enter one or more characters that together represent the symbol	(2) Select the symbol from a menu and indicate where it should be placed
Enter sketches or illustrations	(2) Verbally describe the sketch or illustration	(1) Draw the sketch or illustration	(4) Impossible	(3) Create the sketch by moving the mouse so it leaves a trail (similar to an Etch-a-Sketch™)

Table 2: Performing the four basic manipulation tasks using four popular input modes, ranked from the easiest (1) to most difficult (4). Source: W3C Group Note.

It is needed to take in account even the physical suggestion thus physical devices exhibit different usability characteristics. The size, the shape and the weight of the device affect how it may be used. Most important, the placement of a microphone and speaker, the size of the display and writing surface, and the size of keys in a keypad affect the ease with which a user can enter information by speaking, writing or pressing keys. The following table summarizes the three modes of respect to physical usability issues.

Device Usability Issues	*Voice Mode*	*Pen Mode*	*Keystrokes Mode*	*Mouse/joystick Mode*
Required number of user hands	None (plus possibly one to hold the device)	One (plus possibly one to hold the device)	One or two	One
Required use of eyes	No	Yes	Frequently, but some users can operate familiar keyboards without looking at them	Yes
Portable	Yes, especially when walking	Yes, but difficult while walking	Yes, but difficult while walking	Yes, but difficult while walking

Table 3: Physical Usability issues for the four most popular modes of information entry. Source: W3C Working Group Note.

Another important issue to consider is the one related to the environment. People may work in environment that may not be ideal for some modes of user interfaces. The environment might be noisy or quiet, hot or cold, light or dark, or moving or stationary with a variety of distractions and possible dangers. Multimodal user interfaces must be designed to work in the environments where they will be used. The following table summarizes the environmental usability issues with respect to four popular input modes.

Device Usability Issues	Voice Mode	Pen Mode	Keystroke Mode	Mouse/joystick mode
Noisy environment	Works poorly in a noisy environment	Works well in a noisy environment	Works well in a noisy environment	Works well in a noisy environment
Other environmental concerns	Works well independently of gloves	Does not work well when users must wear thick gloves	Does not work well when users must wear thick gloves	Does not work well when users must wear thick gloves

Table 4: Environmental usability issues for the four popular modes of information entry.

Source: W3C Working Group Note.

The second principle on which these suggestions are based is the clear, concise and consistent communication with the user. Effective communication between the user and the device is necessary for achieving the user's goals. The MUI (Multimodal User Interface) is the conduit for all communication between the user and the device. Communication has to be clear and concise, avoiding ambiguities and confusion. Communication styles should be consistent and systematic so users know what to expect and can leverage the patterns and rhythms in the dialog. This can be achieved through consistency suggestions that will enable users to leverage conversational patterns to accelerate their interaction, through organizational suggestions thus organizing information and transition between topics will improve the users' comprehension of and performance with the multimodal interface; information should be structured and organized as in ways that are familiar to the user. The third principle is to help users recover quickly and efficiently from errors, in fact all users, especially novice users, will occasionally fail to respond to a prompt appropriately. The UI must be designed to detect such errors and assist user to recover naturally, furthermore the multimodal interface should help users learn how to use the user interface to achieve the desired results quickly and efficiently. This could be achieved through the conversational inputs, in fact the principle of conversational discourse suggest that the suggestions for the nature, content, and format of information exchanged between two humans may be applied to information exchanged between a human and a computer; through reliability, that is a lot frustrating for the user having a device at hand and not being able to use it. The last principle is to make users feel comfortable; users often judge a computer application by its user interface. If they will not like the user interface, the application will not be used. If the user interface is not easy to learn and not easy to use, the application cannot be used successfully[2].

Three different way can be chosen: visible, listenable and touchable. With the advances in ubiquitous computing the quest for natural interaction is of utmost importance. This includes interaction with different devices and modalities that are optimally suited to support the user's tasks, ideally without requiring the user to select and configure such devices. A multimodal/multi-device media player application is sketched by Schafer and Mueller (2008) and summarized in the following figure:

[2] These suggestions were developed by the W3C Working Group. The W3C is the World Wide Web Consortium, it develops interoperable technologies (specifications, guidelines, software and tools) to lead the web to its full potential. W3C is a forum for information, commerce, communication, and collective understanding (http://www.w3.org/).

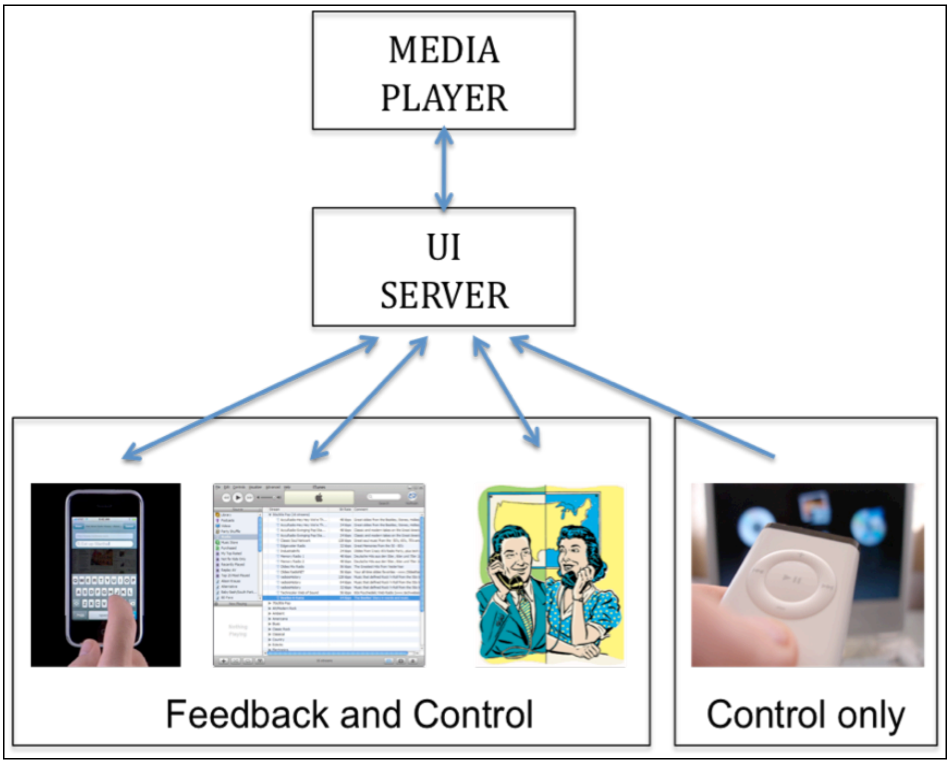

Figure 6: A multimodal-multi-device player. Source Schaefer and Mueller 2008

A user can employ different devices to control the media player such as a mobile phone, the media-playing device itself, a microphone for voice control or a wireless multisensory for gesture interaction. When we consider the Interactive Digital media, we have to care about the ubiquitous computing environments. In this environment an increasing number of services are delivered to users through various devices including cellular phones and PDAs (Portable Digital Assistant). Then, it is important to facilitate interoperability among services on these heterogeneous and autonomic environments. Web services (Ferris and Fareel, 2003; Chung et al., 2003) based on Internet standards such as SOAP (Simple Object Access Protocol) (Mitra and Lafon, 2007) and WSDL (Web Service Description Language) (Chinnici et al., 2007) are gaining momentum as a standard interface for the interoperability between software applications. This led literature to deepening studies related to the understanding individuals' motivation and involvement. It is of a central concern in media uses and effects research, because it is more illuminating to reveal why and how people use media rather than just to focus on what people do with media (Sun, 2008; Rubin, 2002).

2.4 The interactivity in Digital Media

Most of digital media are based on the principle of interactive structures. User should be able to relocate and to challenge them-selves to the interactive observation of a work. All projects and/or development related to digital media should excite not only the visitors' bodies, but also should bring their thoughts into motion. Becoming part of an interactive work, for the user, "Touching" an interactive work is not only allowed, but becomes necessary; whether with mouse, trackball, touch screen, tangible objects, video camera, responsive workbench, virtual balance, the touch less Point-Screen or other interfaces; the observer should be conducted to bring the process into motion (Fleischmann and Strauss, 2008). In the field of arts, digital media, and even more interactive digital media, represents a milestone of the new challenges. Many researches tried to define interactivity, underlining its importance and focusing it on differences existing in perception. According to Penny the difference in perception is differentiate as follow: "A painting is an instance of representation. A film is a sequence of representation. Interactive artworks are not an instance of representation, they are virtual machines which themselves produce instances of representation based on real time inputs" (Penny, 2005). According to Valli (2008) interaction design is the art of instigating and guiding behaviours (or interaction design) by means of proper static or dynamic stimuli. It is defined in terms of experiences: people naturally communicate through gestures, expressions, movements, and discover the world by looking around and manipulating physical stuff. Valli also states that the key assumption here is that they should be allowed to interact with technology as they are used to interact with the real world in everyday life, as evolution and education taught them to do. Because of this assumption today's designers face a great challenge: the creation of new interaction paradigms and new media conventions, that exploit the new machines' sensing capabilities offered by technology and to take care of human spontaneous ways to discover the real world. On the other side, interactive technology, in terms of sensors, actuators and narrative intelligence, is still matter of research for engineers and scientists. As even stated by Fleischmann and Strauss (2008) interactive structures remain the basic principle of digital media. Users of digital media will be in a position to relocate and to challenge themselves to the interactive projects to make an experience that moves over and beyond the usual contemplative observation.

3. *The technology transfer*

Technology Transfer – the processes and consequences of moving technological ideas, skills, processes, hardware, and system across a variety of boundaries – national, geographic, social and cultural, or organizational and institutional – is not a new topic (Seely, 2003).

"*Technological catching up will only be achieved through acquiring the capacity for creating and improving as opposed to the simple 'use' of technology. This means being able at some stage to enter either as imitators or as innovators of new products or processes."* (Freeman and Soete, 2004, p.352).

The transfer of technologies takes place among various kinds of players, takes on various kinds of modalities and is done for various motivations (Reisman 2005). To transfer a technology it implies that the technology is an innovation and that from these innovations occurs a technological change. With technological change, I mean, any variation of the technical and organizational knowledge, either a change in technology owned by an organization. This definition doesn't precise if this variation has to be considered positive or negative. In 1995 Lowe stated that the motivations that push an organization to affront a technological change could be of two different types:

- The hope and the will to improve own business, in order to have success and, hence, augment profits;
- The need for innovation as a consequence of external pressures from the environment (i.e. modification of the demand, growing of concurrent, etc.)

According to Mansfield (1961), the probability that an enterprise introduces a new technology is in direct function with the proportion of the enterprises that have already adopted it and of the profits of the innovation and in inverse function of the investment amount. This was the thinking of decades ago, nowadays the innovation became a continuous exigency and need for all the enterprises that want to have a future. According to Rogers (1983), one of the main exponent of the sociological theory of the innovation diffusion, the characteristics that determinate the eventually adoption of a new technology are:

- The relative advantage, measurable by economics terms and social prestige and satisfaction;
- The compatibility with the values of the belonging group;
- The complexity of innovation;
- The experimental possibility
- The innovation visibility.

Technology transfer is a topic discussed since decades, but last years saw an exponential growth of companies and public entities that dedicate lot of their attention to it. From a holistic point of view, Lundquist (2003) analysed the technology transfer and defined it as the movement of a specific set of capabilities, such as persons, team, business, organization, from one entity to another. Thus technology transfer is fundamental to the growth and maturity of most types of social institution, including business, government, military, academia, and arts. Without technology transfer none of these institution would be able to keep up with the pace of change (Lundquist, 2003). It relies on novel ideas; ideas can only come from individual scientists or engineers, or small groups of those individuals. But to have effect on industry, ideas should usually move through institutional frameworks that offer many of the needed resources; hence there are two major players: individuals, who are the core of the transfer of ideas and who effect interpersonal knowledge transfer, and institutions, which offer the framework for inter-organizational technology transfer (Lockemann, 2004). For a better understanding of what technology transfer is about it is due to give some core definition related to all matter belonging to this process. Lundquist and Thomson (1999) define:

Technology: the ability to produce a functional design, based in science and engineering that meets specific performance criteria. A functional design is the commonly understood result, such as prototype, of a step in product development.

Technology ownership: The ability to produce and/or use a technology in a specific environment, to a specific, set of standards, and to a particular level of performance.

Technology Transfer: Movement of the ability to realize a technology from one person or a group to another, as confirmed by demonstration of performance against agreed requirements.

It is always worth to consider that technology can be used in different ways and the way technology is applied specifically depends on both economic and political factors (Falch, 2006). Another important issue to be considered is the *Absorptive Capacity*, that will be later analysed in deep, related to the technology receiver. This concept has been introduced by Cohen and Levinthal (1990) and is the firm's ability to recognize the value of new and external information and its ability to assimilate and exploit it. Furthermore the inter-organizational absorptive capacity is of crucial importance to the relationship among organizational learning, knowledge management, and above all, the innovation creation and diffusion (Weeks and Davis, 2007). According to Thursby and Thursby (2004) the absorptive capacity is related to the firm's own level of research and to their level of involvement and monitoring of university research. The following figure represent a research model applied to inter-organizational innovations and underlines the importance of the absorptive capacity.

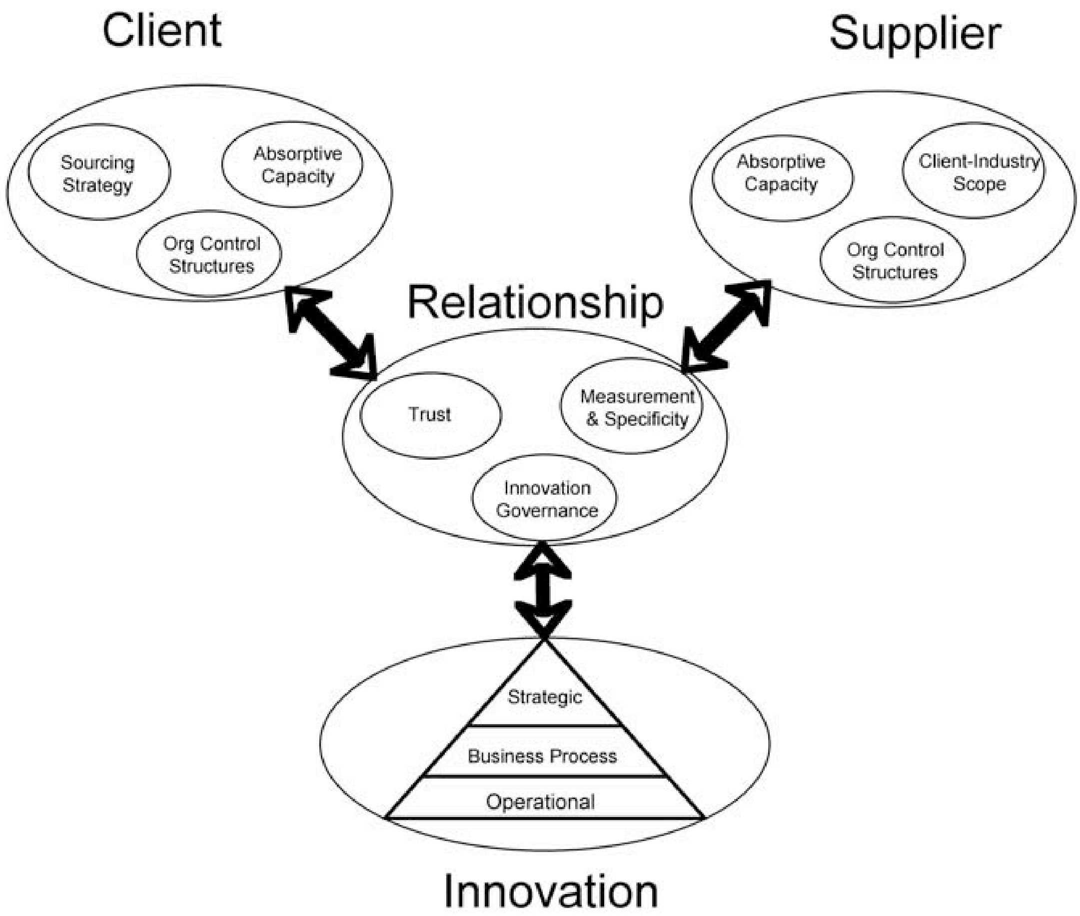

Figure 7: Research Model of inter-organizational innovation. Source: Weeks and Davis, 2007.

The research model focuses on three components: the client, the supplier, and the relationship. A fourth component, innovation outcomes, results from the interrelationships of the internal elements or processes extant within each of these three component areas. The figure also depicts each of the arrows linking the components as bi-directional; the three components influence and receive feedback from one another.

There are several types of technology transfer; some are listed in the following table:

Transition: movement along a value chain within an organization. This is the evolution of a technology into a product within a company or the evolution of a technology into, say, a defence system within the Department of Defence.
Internal Transfer: in industry, movement to direct use in-house including: Delivery of internally developed systems or equipment to manufacturing, technical services within a company, and acquired products that are customized before being put to use in the company. In government, movement to direct use within the agency or department of government.
External transfer: Movement into or out other organization, including acquisition of technologies from outside sources, licensing of technologies out to others, and alliances at many levels, including cooperative development and industry consortia. This is the typical concept of technology transfer.
Division-to-Division transfer: In industry, movement of technology into distinctly separate parts of the company. In government, movement into other agencies or departments. This has many of the aspects of external transfer.
Mergers and acquisition: Purchase of both technologies and technical capabilities by acquiring whole companies or business.
Dissemination: Movement of technology directly to technical communities. In-house reports within the company, university, or government lab. Technical papers and presentations sent directly to the public.

Table 5: Types of Technology Transfer. Source: Lundquist, 2003.

To have a broad idea on how technology transfer is used, it is good to underline differences existing between Corporation entities and Governmental ones. The different motives that lead such entities to adopt technology transfer are described by Kremic (2003) and reported in the following table:

GOVERNMENT		CORPORATION	
Primary Motive	LEGAL	Primary Motive	PROFIT
Secondary Motives			
Agency	Maintaining Public Relations Evaluating agency performance Sharing Costs	Corporate	Preempting and/or deterring competition Lowering costs Increasing growth Networking Training Employees Following customers Responding to content laws and/or legal requirements
Employee	Achieving self-satisfaction Completing job element Benefiting research	Local Transfer Source (field office)	Complying with corporate directives Achieving better quality and/or cost of supplies Educating customers and increasing sales

Table 6: Technology Transfer Motives. Source: Kremic, 2003.

There are three major differences between technology transfer in Government and Corporation; the first is related to their motives: government's is to share benefits domestically while corporation's is to seek profit in a competitive world market. The second difference is that motives are different across organizational levels: in a Government agency, the researcher may be seeking self-satisfaction, whereas the agency may be implementing legal requirements; in a corporation the corporate level is looking at global profit performance, whereas the local plant may be seeking better supplies and final products. The third difference is that the technology transfer methods used, and the way they are implemented, relate to the degree of control desired. Because Government seeks widespread benefit, it selects methods that reach many people through web sites, publications, and open collaboration; in contrast corporation wants to control access to its technology, thus preferring licences, joint ventures, direct investment, and other methods that can control access. These three differences lead to recognize that the person-to-person communication is the key to successful technology transfer (Kremic, 2003).

3.1 Conceptual Issues of Technology Transfer

Policy-makers today focus on the effectiveness of technology transfer bridging the gap between academic research and activities of the commercial market (Jones-Evans et al., 1999). Therefore, the transfer of technology from the science base to industry has increasingly become subject of scientific attention over the last years. As a result, numerous scientific studies and publications are concerned with increasing the effectiveness of technology transfer, the proper dissemination of scientific research, the assessment of framework conditions for industry-science collaboration, etc. (Van Looy et al., 2003; Ciesa & Piccaluga, 2000; OECD, 2002a; Schibany, Jörg and Polt, 1999; Hutschenreiter & Kaniovki, 1999; Mansfield & Lee, 1996). The definition of technology and subsequently of technology transfer is not a straightforward task. The literature provides numerous different definitions depending on the specific focus taken in the respective studies. Furthermore, concepts like knowledge transfer and industry-science relationships are heavily discussed in literature whenever the utilization of higher education research is subject of scientific attention. Also some authors do not differentiate between technology transfer and knowledge transfer. For instance Gibbons et al. (1994, p. 168) define ‘knowledge transfer’ similarly to technology transfer, i.e. as “the transmission of knowledge from higher education institutions to industry”. At least to some extent this approach might be valid. However, it can be shown that the two concepts are neither identical nor intrinsically different. Therefore, this chapter first provides a definition of technology transfer based on the mainstream literature. Furthermore, this chapter provides a discussion of relevant concepts of technology transfer including a definition of the transfer object, a discussion of the transfer mechanisms that are in place today as well as the introduction of concepts like the proper handling of intellectual property rights, that will be more in deep analysed in next chapter, the absorptive capacity, etc.

3.1.1 Technology

In general, technology has more than one definition depending on the specific context. According to the online encyclopaedia ‘*laborlawtalk*’ technology (Gr. τεχνολογια < τεχνη "craftsmanship" + λογος "word, reckoning" + the suffix ια) is the development and application of tools, machines, materials and processes that help to solve some human problem. Another definition which can be found in the same source defines technology – from an economic point of view – as the current state of our knowledge of how to combine resources to produce desired products (and our knowledge of what can be produced). Thus, we can see technological change when our technical knowledge increases (Labourlawtalk, 2005). Therefore, technical or scientific knowledge and technology might not be completely independent concepts and the question arises what the relationship between knowledge and technology is. Burgelman et al. (1996, p.2) define technology as “the theoretical and practical knowledge, skills, and artefacts that can be used to develop products and services as well as their production and delivery systems”. Also according to Schibany, Jörg and Polt (1999) technology can range from abstract scientific knowledge (codified and widely available) through engineering expertise to operative skills. Thus, for the purpose of this study, technology is defined as a tool or an entity that might be used to accomplish some task or to solve some problem and the origin of technology is the codification of (scientific) knowledge in some entity. Subsequently, tacit knowledge[3] on its own being embedded in individuals (e.g. ideas) is not regarded as technology. However, tacit knowledge is of special importance in handling technology. Therefore, from a system perspective (or more specifically 'from a tool's perspective') technology comprises codified knowledge like artefacts, techniques (e.g. machines, tools, and equipment), etc. and embodied knowledge (on how to handle technology) in combination (Schibany, Jörg and Polt, 1999). For the purpose of this study technology is defined as a tool or an entity to accomplish some task or to solve some human problem. Technology not only comprises codified knowledge but also a portion of tacit knowledge on how to handle the codified knowledge (representing some kind of combination). However, tacit knowledge on its own is not regarded as technology.

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[3] Knowledge occurs in tacit and codified form. According to Gibbons *et al.* (1994, p. 168) "tacit knowledge is knowledge that is not available as text and which may conveniently be regarded as residing in the heads of those working on a particular transformation process, or to be embodied in a particular organizational context." Therefore, tacit knowledge is personal and context dependent (Doloreux, 2002). "Codified knowledge, on the contrary, is defined as knowledge which need not be exclusively theoretical but needs to be systematic enough to be written down and stored to anyone who knows where to look" (Gibbons *et al.*, 1994, p. 167). Codified knowledge comprises blueprints, machines or materials (Lin, 2003). A similar distinction between codified and tacit knowledge can be found in Conceição and Heitor (1999) defining codified knowledge as 'ideas' being stored outside the human brain, for example, in books, compact discs, etc., whereas tacit knowledge is defined as 'skills' like convictions, abilities, talents, etc. representing knowledge which can not be separated from the individual. The distinction between codified and tacit knowledge is common sense in today's mainstream literature (e.g. Lin, 2003; OECD, 2000a; Conceição and Heitor, 1999; Saviotti, 1998).

3.1.2 Technology Transfer

As mentioned before, Technology transfer is defined in many different ways depending on the discipline of research and the purpose of the research (Bozeman, 2000). The term has been used to explain very different concepts regarding organizational and institutional interaction between academia and business. Due to the specific focus taken in this study, the transfer of a technology developed among a research centre and developed with an Open Source philosophy, a narrow definition of technology transfer will be pursued. “Technology transfer is the process of developing practical applications for the results of scientific research. While conceptually the activity has been practised for many years (in ancient times, Archimedes was notable for applying science to practical problems), the present-day volume of research has led to a focus on the process itself”. According to Amessea and Cohendet (2001) technology transfer relates to the intentional interaction of two or more persons, groups or organizations targeted at the exchange of technology by different mechanisms. Similarly, Bozeman (2000) defines technology transfer as the movement of know how, technical knowledge or technology from one organizational setting to another. Nevertheless, successful technology transfer does not end with handing over the technology to the industry, but requires the successful utilization of the technology in new products, processes, or organizational changes. In this context Rogers, Takegami et al. (2001) notes that technology transfer usually involves moving a technological innovation from an organization of the science base to a receptor organization and that the transfer is complete when the technological innovation is commercialized. Thus, for the purpose of this study technology transfer is defined as the process of moving technology from an institution of the science base (e.g. a higher education institution, a university) to an industrial organization, which successfully commercializes the technology through the implementation of new processes, the development and launch of new products or the facilitation of a successful and innovative organizational change.

The emphasis of this study is put on the technology transfer between the science base (or more specifically spoken between universities) and the industry. Technology transfer has been heavily discussed in literature (Buono, 1997; Lin, 2003; Bozeman, 2000; Lee, 1996). Additionally, the concept of knowledge transfer (Tidd & Trewhalla, 1997; Knoll, 2001; Schartinger et al., 2002) and the concept of industry-science relationships (Van Looy, Debackere & Andries, 2003; OECD, 2002a; European Commission, 2001g; Polt *et al.*, 2001) – representing concepts very close to technology transfer – have gained attention during the last years. Although these concepts are not intrinsically different compared to the concept of technology transfer, they are not identical as all of these concepts take a slightly different perspective on explaining the interaction between university and the industry. Technology transfer focuses on the transaction of technology from a process point of view and, therefore, covers process related concepts and is targeted at the successful utilization of technology for the sake of economic growth. Knowledge transfer[4] – on the contrary – is concerned with understanding and assimilating of knowledge and with learning and related cognitive effects that are crucial when exchanging knowledge. Knowledge transfer is therefore focussed on the accumulation of knowledge in the receiving institution or department (as knowledge transfer is also often discussed from the viewpoint of intra-company knowledge sharing and knowledge management). The growing amount of literature on knowledge transfer is based on the basic interest of scientists in the transfer of 'tacit

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[4] Knowledge is a term with many meanings depending on context, but is as a rule closely related to such concepts as meaning, information, instruction, communication, representation, learning and mental stimulus. Thus, knowledge can be defined as the awareness and understanding of facts, truths or information gained in the form of experience or learning. Knowledge transfer can be defined as the process through which an organizational unit is affected by the expertise of another (Argote and Ingram, 2000).

knowledge', a concept not explicitly covered when discussing technology transfer (Bozeman, 2000). The concept of industry-science-relationships is used whenever it is required to grasp all types of interactions between higher education institutions and industry including informal meeting, the flow of graduates to the industry (Schartinger et al., 2002). Thus, industry-science-relationships cover all types of higher education interaction including technology transfer and knowledge transfer. As a result, for the establishment of a comprehensive technology transfer model, concepts stemming from the discussion of knowledge transfer and industry-science-relationships have to be taken into account where appropriate. These concepts might give useful insights into the complex process of technology transfer and help developing a deeper understanding. Additionally, according to Bozeman (2000) it is not sufficient to focus on the object when pursuing technology transfer, as besides the object (i.e. the technology) knowledge of its use and application is also transferred.

3.1.3 Transfer Object

The transfer object from the perspective of technology transfer relates to the entity transferred (i.e. the content and form of what is transferred). The literature defines different transfer objects in various forms depending on the context discussed. According to the definition of technology which is in use for the purpose of this study (i.e. technology being a tool to accomplish some task) the identification of the transfer object results in the specification of what is meant by the term 'tool'. According to Bozeman (2000) the object (i.e. the tool) is represented by scientific knowledge, a technological device (i.e. physical technology), a technological design, a process, craft or know-how in general.

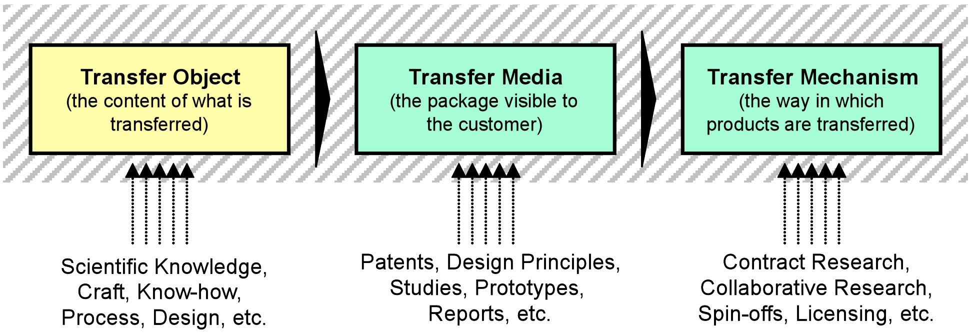

Figure 8: Transfer object, transfer media, and transfer mechanism

However, according to the focus and definition taken in this study some portion of the object must be of codified nature in any of the above cases. This codification of the transfer objects may happen in various forms (e.g. scientific knowledge might be available as a patent, a prototype, etc.). Therefore, apart from the definition of the transfer object the transfer media (i.e. the form of codification of the transfer object) is highly relevant for technology transfer. One might refer to the transfer media as the package visible to the technology recipient (like a transfer product). The transfer media comprises for instance patents, studies, documented design principles, specifications, workflows, prototypes, certificates, reports, etc. (*cf.* ARCS, 2005). As a result, the transfer object must not be mixed up with the transfer media and – consequently – the transfer media must not be mixed up with the transfer mechanism (i.e. the way in which the transfer product is moved over to the transfer recipient). A detailed discussion of the different transfer mechanisms can be found in the next section.

3.1.4 Transfer Mechanisms

Technology transfer mechanisms are frequently discussed in literature (*cf.* Van Looy, Debackere and Andries, 2003; Ciesa and Piccaluga, 2000; OECD, 2002a; Schibany, Jörg and Polt, 1999; Hutschenreiter and Kaniovki, 1999; Mansfield and Lee, 1996). However, the list of technology transfer mechanisms varies according to the specific purpose, focus and the perspective taken in these studies. For example, according to the (OECD, 2002a) these mechanisms comprise joint labs between academia and business, spin-offs, licensing of intellectual property, research contracts, mobility of researchers, co-publications, conferences, expos and special media, informal contact within professional networks and the flow of graduates to the industry. Similar, but still slightly different approaches can be found (e.g. OECD, 1999c; OECD, 1999b; European Commission, 2000a; Pyka, 2002; Polt *et al.*, 2001; Lin and Win, 2004). For the purpose of this study a categorization of technology transfer mechanisms is derived from multiple literature sources (*cf.* Lee and Win, 2004; Liu and Jiang, 2001; Amessea and Cohendet, 2001; Phillips, 2002; Rogers, Takegami and Yin, 2001; Debackere and Veugelers, 2005; Polt *et al.*, 2001; Schartinger *et al.*, 2002) comprising, spin-offs, licensing of patents, collaborative research, contract research, mobility schemes and monitoring of scientific activities (e.g. studying of publications).

"Licensing is the transfer of less-than-ownership rights in intellectual property to a third party, to permit the third party to use intellectual property"(Lee and Win, 2004, p.435). The third party (in most cases industry) has to present a plan to commercialize the invention, as royalties are calculated as a portion of the economic commercialization success (e.g. a portion of the annual turn over of a new product based on a licensing agreement). Licensing royalties may represent a considerable income for universities and R&D laboratories (Rogers, Takegami and Yin, 2001). Thus, patents facilitate – besides the protection of inventions – the transfer of scientific inventions (i.e. technology) to industry by allowing firms to licence patents (i.e. to commercialize inventions) held by the science system (*cf.* BMBWK, 2003b). Licensing can be exclusive or non-exclusive, i.e. being restricted to a specific market or a specific industry sector (Lee and Win, 2004). One major advantage of pursuing technology transfer by licensing of patents is the fact that this mechanism is geographically not restricted. Once a patent has been filed (including the application in the US, Japan and Europe) companies around the world might seek access to licensing if the invention is of economic

benefit. Thus, the mechanism of patent offices around the world can be seen as quasi-international sales channel.

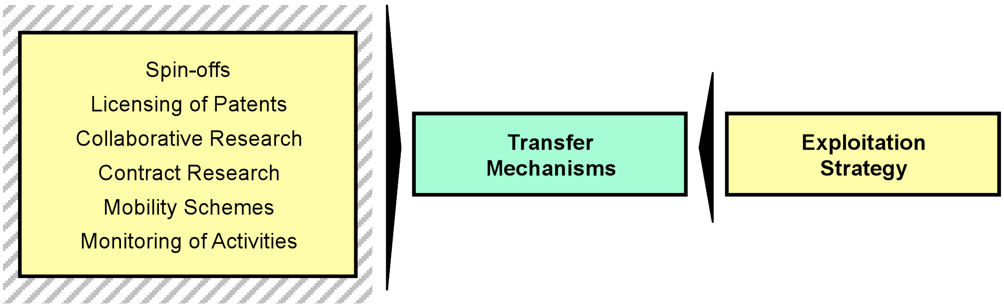

Figure 9: Transfer mechanisms in technology transfer

Spin-offs[5] facilitate the technology transfer by the means of founding a new company based on a technological innovation (Rogers et al., 2001). More specifically, spin-offs from higher education institutions are the formation of new companies by higher education institution members. The formation of spin-offs has gained attention during the last years in the mainstream literature (European Commission, 2000a; European Commission, 2002c; OECD, 2002a; Polt *et al.*, 2001). However, a spin-off does not necessarily represent a technology transfer mechanism, only if technology from the parent organization, an invention or a technology is utilized. Or like Rogers et al. (2001) put it: “A spin-off is a technology transfer mechanism because it is usually formed in order to commercialize a technology that originated in a government R&D laboratory, a university research centre or a private R&D organization”. Spin-offs are an appropriate means for transferring complex technologies as besides the transfer of the specific technology the knowledge on how to handle, adapt and industrialize the technology is transferred

[5] A *spin-off* is a new company that is formed by individuals who were former employees of a parent organization, and with a core technology that is transferred from a parent organization (Rogers and Steffensen, 1999).

simultaneously (‘tacit’ knowledge is also transferred). Nevertheless, focussing on spin-offs for facilitating technology transfer often requires additional support structures like incubators or science parks within or at least close to the higher education institution (Lee & Win, 2004). Similarly, Phillips (2002) argues that since technology business incubators are an appropriate mechanism for commercializing R&D, universities and other research organizations are the major developers of incubation centres. Incubators provide a bundle of services for spin-off companies including direct and indirect financial support (e.g. early stage financing, grants, loan and equity guarantees) as well as enabling measures (consultancy service and intermediation services). The long term effect of forcing spin-offs as technology transfer strategy might lead to an agglomeration of high-tech companies, eventually resulting in a technopolis like Austin Texas (Rogers et al. 2001).

Joint venture of R&D is a formalized co-operation between a university research centre and a contactor, in which costs associated with the work are shared as specified in the contract and in which the two parties work together from the R&D stage to the commercialization. More generally spoken the ‘joint venture of R&D’ belongs to the group of collaborative research mechanisms (Lee and Win, 2004). *Collaborative research* comprises the participation of academia and industry in networks and clusters (European Commission, 2000a), the execution of joints research projects (Polt et al., 2001), and scientific and technical co-publication (OECD, 2002a) and industry funded PhDs (European Commission, 2002c). In all of the collaborative R&D efforts both parties, i.e. academia and business, provide personnel, facilities and other resources for accomplishing some task in a research project. Collaborative research is defined by Debackere and Veugelers (2005) stating that it is defining and conducting joint R&D projects by enterprises and institutions of the science system either on a bi-lateral basis or on a consortium basis. According to Amessea and Cohendet (2001) contractual arrangements in the sense of pure contract research (see below) is increasingly replaced by relational arrangements. The reason is provided by Amessea & Cohendet (2001) that define joint projects as the ideal technology transfer mechanisms, as the place where facilities and expertise of research centre and industry are complemented. Additionally, collaborative research requires more interaction among the parties involved and, therefore, stimulates the exchange of tacit knowledge and the collaborative scientific knowledge generation in the teams. As a result, companies might develop a better understanding of the scientific world and scientists might develop application awareness. This phenomenon has been analyzed by Gibbons et al. (1994) discussing the new production of knowledge[6] in which one of the characteristics of *Mode-2* knowledge production is that the production takes place within the interaction of different institutions including universities and colleges, research centres, government agencies, industrial laboratories, think-tanks, consultancies, etc. Therefore, *Mode-2* knowledge production relies on heterogeneity and organisational diversity. Though, the disadvantage of collaborative research is that it requires proximity and, thus, limits the geographic market dimension for technology transfer from the perspective of the higher education institution or the research centre.

In contrast to collaborative research, in *contract research* a contract between the university and the company defines R&D efforts to be

[6] It has been observed that over the last decade there has been a shift in the way in which knowledge is produced and disseminated. This has been described as a shift from *Mode-1* to *Mode-2* knowledge production (Gibbons *et al.*, 1994). According to this concept *Mode-1* knowledge production reflects the way in which knowledge has been traditionally produced: homogeneous, disciplinary and hierarchical, produced in autonomous and distinct scientific disciplines (OECD, 1999c). According to Schibany, Jörg and Polt, (1999) *Mode-1* knowledge production is executed mainly through basic research. Therefore, the basic interest in a specific scientific field is in the centre of research in *Mode-1* knowledge production. On the contrary, *Mode-2* knowledge production is carried out in the context of applications. By this, *Mode-2* knowledge production is closely related to applied research (Schibany, Jörg and Polt, 1999).

performed by the university or the research centre for the sake of gaining access to unique capabilities for commercial benefit (Lee and Win, 2004). However, contractual arrangements do not only cover research projects but also (technology-related) consultancy performed by the research centre or the higher education institution (Van Looy et al., 2003; Polt et al., 2001). The contract research comprehends fundamental research, feasibility and prototype studies, experiments and the use of equipment (Debackere & Veugelers, 2005). The use of higher education facilities by the industry relates to the provision of new equipment and machinery for the industry (OECD, 1999c) and the access of the industry to specific and unique instruments located in the science base (Hagen et al., 2003). This represents a special type of contracting. According to Tidd and Trewhalla (1997) discussing technology acquisition strategies from the perspective of the industry contract research is most important for using technology to create new options (i.e. to open up technological opportunities). Additionally, other motives might be relevant as the lack of in-house resources to perform research (e.g. which is often the case for SME) or the need for technology in areas outside the core competencies of the specific company. From the perspective of scientific institutions contract research contributes to the market approach affecting the research function and builds closer ties to the industry (OECD, 1999c). Thereby, academia becomes entrepreneurial in its inner dynamic (Etzkowitz, 2003). Especially in times with decreasing public funding contract research contributes to fulfilling one of the core missions of higher education institutions (i.e. conducting economic useful research) by providing an additional income. The funding aspect of contract research has been discussed by the OECD (1999c). However, in contract research most often full IPR – or at least a remarkable portion – is assigned to the firm (European Commission, 2000a). Companies pay for the research expenses, which might represent less income from the perspective of the scientific institution compared to a technology licensing model. Additionally, contract research is not an easy and straightforward task for higher education institutions as due to different planning cycles (e.g. academic year versus financial year in the industry) there are still problems regarding delivery times for results contracted (OECD, 1999c). In fact, contract research requires an entrepreneurial transformation resulting in new organizational structures like research centres and processes implemented in the science system in order to deliver expected results to the industry (e.g. dedicated staff being responsible for executing contract research). Furthermore, with contract research – and collaboration with the industry in general – new skills like negotiating contracts, knowledge of grants and subsidies, marketing and business planning, networking, etc. are required (Jones-Evans *et al.*, 1999). For supporting scientists in this respect higher education institutions increasingly implement (centralized) support structures like technology transfer offices or industry liaison offices (Cooke, 2001). An advantage of contracting compared to collaborative research efforts is the fact that geographical proximity is less important (due to lower interaction) with the effect of the potential market being larger from the perspective of the scientific institution.

Mobility schemes facilitate the knowledge transfer portion (i.e. the transfer of embodied scientific knowledge) within the technology transfer process. Mobility schemes are crucially important for the transfer of tacit knowledge (Hutschenreiter and Kaniovki, 1999) and comprise the mobility of researchers (e.g. sabbaticals), the flow of graduates to the industry, temporary staff exchange as well as summer jobs and internships of students (European Commission, 2000a; Cooke, 2001). Besides the knowledge transfer facilitated, one major benefit of mobility schemes is the establishment of mutual trust and personal networks (Polt et al., 2001). “Mobility schemes, which aim at the transfer of knowledge through the movement of personnel, through recruitment and secondment, enable host or recruiting organisations to benefit from the expertise of qualified, and in some cases, experienced, researchers. These are evident across a number of member states, with the principal emphasis on the mobility of university based researchers, mainly postgraduates, towards industry" (European Commission, 2000a, p.11). Due to the increasing complexity, technology often cannot be adequately described as the handling and utilization requires deep understanding which is embodied in scientists (Schibany, Jörg and Polt, 1999). For that reason technology transfer might fail in the commercialization phase. Mobility schemes help to build the capabilities in the industry and, therefore, contribute to the successful technology transfer. This is outlined by the European Commission (2000a) stating that the mobility of students, research workers, engineers or scientists from one country or industrial sector to another, and from education or research to industry encourages technology transfer. As a result, mobility schemes are required as a pre-condition for technology transfer and, thus, might be regarded as facilitating measure as "investments in advanced technology must be matched by '*adoption capability'* which is largely determined by the qualifications, overall tacit knowledge and mobility of the labour force" (OECD, 1999b). Due to the crucial importance of mobility schemes there are numerous policy measures in place targeted at the stimulation of mobility schemes by the means of incentives and new legal framework conditions (Polt et al., 2001). The *monitoring of activities of the science base* comprises reading or studying of publications and patents, participation of the industry in research conferences or similar events, etc. Thus, monitoring activities relate to the observation of the presentation of scientific results by industry. According to Lee and Win (2004) this free and informal exchange of information including technical conferences and publications in scientific magazines represents the first step in establishing ties between academia and business. However, from the perspective of the higher education institutions (i.e. the technology transferring institution) this represents a technology transfer mechanism that can hardly be influenced. Rather, the indirect enhancement of these activities like the raising of awareness in the industry might be a strategy for enhancing monitoring activities. Within these monitoring activities publications are of special importance as this form of technology transfer can reach the largest number of individuals with the least effort per individual researcher (Liu & Jiang, 2001). Additionally, publications enlarge the technological opportunity set of enterprises (Jacobsson, 2002). Furthermore, publications and citation indexes are often used by economists as a proxy for measuring the innovation performance of economies (Jacobsson, 2002; OECD, 1999b). Nevertheless, publications are not an efficient technology transfer mechanism as publications are – at least in the first respect – written for and targeted at the science base (e.g. other scientists). Personal advancement from the perspective of scientific careers is gained by patents and publications (Heydebreck, et al., 2000). According to Rogers et al. (1999 cited in Liu and Jiang, 2001) scientific journals are written for fellow scientists and these articles are ineffective in reaching partioneers. Therefore, monitoring activities regarding publications being a scientific instrument addressing the scientific community might reach high-tech companies and huge enterprises (that have got dedicated staff like technology scouts), but often fails to reach small and medium sized companies for with the input of the science base would be crucial for facilitating innovation. Additionally, increasingly problems regarding the combination of efficient IPR handling and publications in joint industry-science-project are reported (European Commission, 2000a).

To sum up, a list of technology transfer mechanisms suitable for the context of this study has been established in this section representing the basis for further analysis. The categorization comprises

- spin-offs from institutions of the science system,
- licensing of patents of the sciences system by the industry,
- collaborative research,
- contract research,

- mobility schemes and
- monitoring of the activities of the science base.

3.1.5 Absorptive Capacity

Knowledge and technology belonging to the prime production factors in today's knowledge-based economies cannot exclusively be produced within the company. According to Tidd and Trewhalla (1997) almost all R&D managers believe that no company can survive as a technological island. Therefore, knowledge and technology from external sources plays an ever-increasing role in today's business environment representing a window on emerging areas of sciences (Olleros and MacDonald, 1988). Similarly, according to Pyka (2002) firms mention – among other motivations – that the acquisition of technology from external sources supports the company in monitoring the evolution of technologies and holds opportunities for commercial success. These observations on micro level go in line with findings on macro level. According to Gibbons et al. (2001) the basic value of research is that it generates options. On the contrary, Schibany et al. (1999) argue that in an uncertain and complex world research does not directly generate options but builds capabilities that eventually contribute to the generation and realization of options. By this, research generates capabilities which, from a society's perspective, represent a set of technological opportunities. Therefore, in order to generate technological opportunities the establishment of knowledge flows by opening external technology sources is crucial for the sustainable competitiveness in a competitive business environment. "However, the importance of the adoption of technological opportunities depends on an important variable – the capacities of firms to adapt scientific knowledge stemming from academic research. Hence, the degree to which firms use findings of academic research correlates with the firms' ability to adapt and to implement external generated technology for their own purposes" (Schibany et al., 1999).

In general, technological change can lead to significant productivity gains, if organizational change, training and upgrading skills is pursued simultaneously (OECD, 2000a). Most often, this technological change is based on the acquisition of external technology stemming from institutions of the science base. In order to have the necessary access to external sources, firms have to provide the capacity to absorb the external knowledge and technology for accessing an additional broad technology base (Cohen and Levinthal, 1989). This requires scientific and technological competencies within the company that allows locating new scientific ideas and transforms them into the output demanded by tomorrow's market (European Commission, 2000a). The ability of a firm to effectively use external knowledge, ranging from basic research and reverse engineering to the implementation of new production equipment, is called its absorptive capacity (Schibany et al., 1999).

Cohen and Levinthal in their work in 1989 founded a sound basis for the concept of absorptive capacity arguing that "R&D not only produces new information, but it provides, at the same time, to the firm or the individual who have produced it, a specific ability to identify, assimilate and exploit other existing external information in a related area" (Niosi & Bellon, 2002). Zahra and George (2002) revisited the concept of absorptive capacity by focussing on the dynamic capability that influences the nature and the sustainability of a firm's competitive advantage. Todorova and Durisin (2003) suggest a re-conceptualization of the model provided by Zahra and George (2002) enhancing some of its components and relationships. The model that is favoured for the purpose of this study follows the adjusted model of absorptive capacity provided by Todorova and Durisin (2003).

The model of absorptive capacity comprises the acquisition, the assimilation or transformation and subsequently the exploitation of scientific knowledge leading to competitive advantage from a company's perspective (Figure 10). According to Niosi and Bellon (2002) the acquisition relates to acquiring relevant new and pertinent knowledge, which is potential capacity from a company's perspective. This represents the first step associated with absorptive capacity. Due to the fact that this potential has not yet been realized in the model of Todorova and Durisin (2003) this step is called 'recognizing the value'. This first step within the process of absorptive capacity requires – as already mentioned before – scientific and technological skills, as the external knowledge has to be evaluated regarding its relevance for the specific company and its technology base and product or service portfolio. Whereas the focus of Todorova and Durisin (2003) is placed on the intensity, speed and effort to gather external knowledge, the emphasis of Niosi and Bellon (2002) is placed on the ability to 'see' and 'understand' it. Therefore, the first step in the process of absorptive capacity, initiated by an activation trigger, comprises the ability to continuously access and gather relevant information sources and subsequently understand and evaluate the gathered information regarding their significance for the specific company.

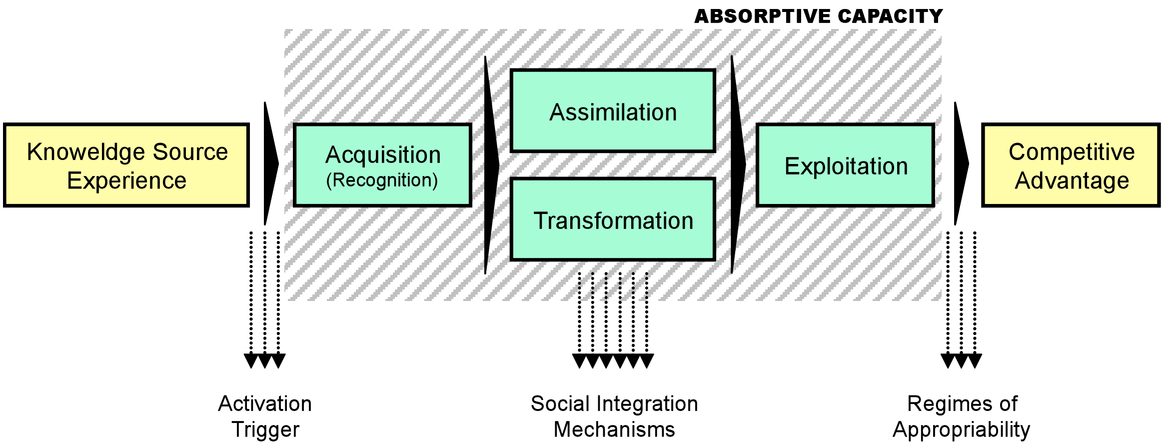

Figure 10: A model describing absorptive capacity

In order to exploit the potential capacity the next logical step is to realize the potential within the company. This realization of the potential relates to learning, i.e. the development of new cognitive structures. According to Marshall (1995) two alternative processes facilitate learning, namely assimilation and transformation. Assimilation means that the new idea can be absorbed with the existing cognitive structures of the company (Todorova & Durisin, 2003). Similarly, Niosi and Bellon (2002) explain that the 'assimilation capacity' refers to the ability of a company to absorb knowledge that an organization can interpret and comprehend with the old cognitive structures. On the contrary, 'transformation' occurs if the new ideas are not compatible with the existing knowledge structures of the company. For the transformation the cognitive structures of the individuals themselves have to be transformed in order to absorb the new (incompatible) knowledge (Todorova & Durisin, 2003). Thus, within the transformation process, in which new and to some extend incompatible knowledge is assimilated or absorbed, new cognitive structures are built within the company. For thoroughly learning and absorbing new knowledge social integration mechanisms are required. Social integration mechanisms facilitate the sharing of knowledge among organizational members in an organization (Spender, 1996). Social integration mechanisms depending on communication patterns and internal networks, for instance, influence the whole process (all components) of absorptive capacity (Todorova and Durisin, 2003). The last step in the process of absorptive capacity is the exploitation of external knowledge as organizational capability. According to Niosi and Bellon (2002) this last step is a matching of newly imported competencies with the internal ones (that have been refined and extended) targeted at the creation of new products, processes and knowledge in general. The result of the whole process might be that a new or extended organizational capability is created through the use of external knowledge, i.e. the cumulated stock of knowledge existing within the company is enlarged.

The concept of absorptive capacity gives insights to the knowledge generation process and capacity building within companies through the facilitation of assimilation and transformation of external knowledge. The consequences of this concept for an institution seeking technology transfer are summarized the following way:

- If the capacity to absorb new knowledge is influenced by the existing knowledge (e.g. basic skills, shared language, technological acumen) and expertise within a company (Buono, 1997), the capability is enlarged after every technology transfer project. Therefore, if the absorptive capacity of a company is poorly developed, it can be enhanced systematically through technology transfer mechanisms (i.e. the technology transfer might increasingly rest on complex technologies).
- If the absorptive capacity of a company is poorly developed, it is hardly possible to transfer technology (especially advanced or high technology) as companies might not be aware of the value of the external technology. For that reason, different policy mechanisms on EU level are promoted, like the stimulation of awareness creation for the importance of technology.
- Technology adopters going through a technological learning process are capable of building their own core competences which might be different from those of the technology provider (i.e. the transfer agent) (Lin, 2003).
- Although some technical information is freely available to all firms, even freely available information is not completely free due to the effort of absorbing it. “At the level of the firm, the costs of receiving information are significant, requiring complementary investments to absorb and utilise information flows” (Schibany, Jörg and Polt, 1999, p.16). Additionally, as already mentioned before, knowledge is becoming increasingly protected through various IPR regimes in today’s knowledge-based economies and might therefore not be freely available.
- The internal R&D capabilities for a company are crucial for facilitating innovation, as this capacity does not only generate new knowledge but also contributes to the firm’s absorptive capacity

(Schibany et al., 1999). This is especially true for SME, which often do not have internal R&D departments.

To sum up, successful technology transfer does not only include handling over a technology to a recipient, but includes also its commercialization by the means of new products, processes, or organizational structures. However, for successfully commercializing a technology knowledge about the handling of the technology is required (especially if we talk about complex technologies). Therefore, the absorptive capacity of a company crucially influences the technology transfer success. Furthermore, besides the intention of successfully launching a new product, for instance, technology transfer success also includes the enhancement of the internal capabilities of a company.

3.1.6 Support Structures

A number of competencies are required by the higher education staff being engaged in technology transfer, like the proper management of IPR issues (patenting, licensing, contracting), network development skills, marketing and business planning, application for grants and subsidies, etc. (Jones-Evans et al., 1999). For supporting researchers in the complicated technology transfer process most institutions of the science base have implemented support structures providing value-added services for staff being engaged in technology transfer. Therefore, support structures need to build complementary assets needed within the research group in order to cope with the challenges of technology transfer (Debackere & Veugelers, 2005). According to Hagen et al. (2003) these competencies have to be implemented in a central organizational unit which provides the required services for the higher education researchers facilitating successful technology transfer. This goes in line with numerous publications suggesting the implementation of structures for supporting technology transfer activities within the higher education institution (Jones-Evans et al., 1999; OECD, 1999c; Cooke, 2001). For instance, according to Debackere and Veugelers (2005) a technology transfer office is designed to provide administrative support (such as legal arrangements, financial issues) for researchers in technology transfer which allows the researcher to concentrate on R&D efforts. However, those structures do not only provide services for the scientists but are more intermediary service providers, i.e. they also provide services for the industry. According to Etzkowitz (2003) an important function of such offices is to improve the quality of information associated with nascent technologies for companies resulting in a reduction of uncertainty. Thus, these structures are designed for facilitating the technology transfer between academia and business by providing services and infrastructure for both, the higher education researchers and the industry.

Depending on the type of transfer mechanism, different services are required for effectively and efficiently facilitating the process of technology transfer. The services provided can be categorized in business incubation services (Etzkowitz, 2002; European Commission, 2001f; Heydebreck, Klofsten and Maier, 2000) and technology transfer related services (Cooke, 2001; Jones-Evans *et al.*, 1999). For structures providing technology transfer related services different concepts can be found in the literature: industrial liaison offices (Cooke, 2001; Gering, 1990), technology transfer offices (Cooke, 2001), regional office (OECD, 1999c), etc. Despite the different naming, the overall purpose of the structures is similar acting as formal function of the university in managing the interface between academia and various external institutions, including industry, government, and other research organizations (Schaettgen and Werp, 1996). A useful categorization of support structures can be found in Etzkowitz (2002) discussing the concept of the entrepreneurial university. In this concept besides the research group acting as quasi firm support structures are classified in technology transfer offices, industry liaison offices and incubators (Figure 11).

In general, a technology transfer office can be seen as mechanisms for reducing information asymmetries encountered in the scientific knowledge market (Debackere and Veugelers, 2005) by bridging the gap between the scientific world and the commercial market. The role of the technology transfer office is to facilitate commercial technology transfer through the licensing of inventions or other types of intellectual property to the industry resulting from university research (Cummings & Teng, 2003). The technology transfer office encourages faculty scientists to think of research in term of its commercial application. Thus, the technology transfer office operates as dual search mechanisms identifying technology within the university and, simultaneously, finding a place for it in industry (Etzkowitz, 2002). The services provided by technology transfer offices include the handling of industrial research contracts, the general management of intellectual property, the identification of technology transfer opportunities, the commercialization of inventions, assistance in monitoring and applying for research grants and subsidies, the establishment of information flows between academia and business, etc. (Cooke, 2001).

The industrial liaison office acting as a formal function of the university in managing the interface between academia and the outside world can be seen as a switchboard for services demanded by the industry (Jones-Evans et al., 1999). According to Cooke (2001) the primary functions of the industry liaison office comprises marketing the university and the industrial liaison function, both internally within the university and externally to companies and other interested partners; responding to outside enquiries and acting as information point (representing a single point of contact for the outside world); building information systems, databases for partner search, directories of technological expertise of the university; and additional non-research activities including continuing education, distance learning, cooperative education and work placements, etc. Therefore, in contrast to technology transfer offices searching for opportunities to exploit research results, industry liaison offices are more targeted at the management of the interface and the provision of useful information for value-added industry-science-relationships. The industry liaison office can be seen as a intermediary information hub for managing the university-industry interface.

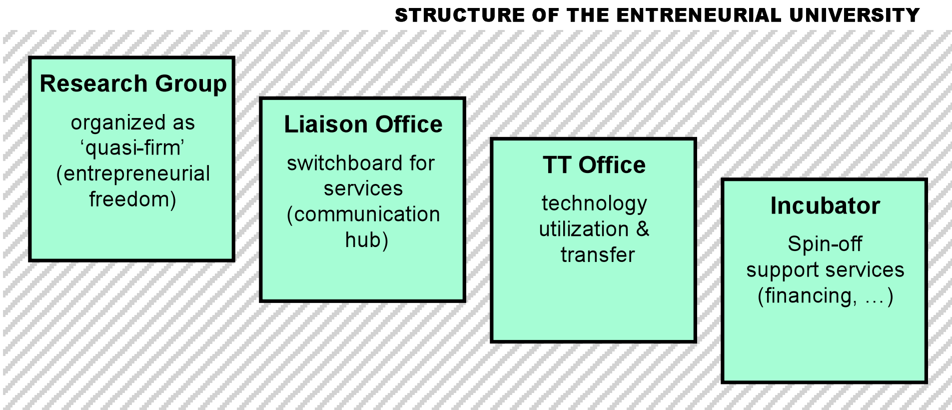

Figure 11: Multi-linearity of university-industry relations

Business incubation services provided by incubation units are targeted at the commercialization of research results by supporting the establishment of spin-offs from the higher education sector. According to Heydebreck et al. (2000) the services comprise technology-related services (e.g. technological consulting, support for efficient R&D management, etc.), market-related services (e.g. assistance with marketing of products and technologies, provision of a customer and supplier network, etc.), finance-related services (e.g. direct financial support, support in accessing external financing sources like venture capital funds, etc.) and soft services (e.g. education and training, information events, etc.). However, the commercialization of research results by spin-off companies (and the subsequent provision of the business incubation services), has to be matched against licensing of technology which represents an alternative route for exploitation (Davenport et al., 2002). Thus, the provision of business incubation services depends on the research exploitation strategy pursued by the higher education institution.

To sum up, incubation units, technology transfer offices, and industry liaison offices provide useful services for facilitating technology transfer. However, most often there is the issue of scale, as smaller universities often lack the resources and the technical skills to effectively implement a technology transfer office (Debackere and Veugelers, 2005). This has been identified by Polt et al. (2001) stating that most intermediary organizations (i.e. support structures) in the European Union are below the necessary critical mass to stimulate industry-science-relationships efficiently. In addition, the deal-flow might not be worth establishing support structures with a full range of services. One strategy to escape this problem is to seek co-operation with external intermediary structures like patent offices or regional public intermediary structures (e.g. innovation agencies). Another strategy is pooling together small higher education institutions to establish sufficient deal flow for the establishment of a joint support structure.

3.2 Public Framework Conditions

The process of technology transfer is crucially dependent on the public framework conditions, which are designed to act as enabling mechanisms in today's industrialized economies. Thus, besides factors directly influencing the interaction between industry and the science base and factors relating to the characteristics of the actors involved technology transfer is also influenced by public framework conditions (Bozeman, 2000). Public framework conditions comprise promotion programmes, intermediary structures, legislation and regulation as well as the institutional setting (Polt et al., 2001). First, promotion programmes relate to funding of innovation in the industry and the science base as well as programmes targeted at awareness rising for the growing importance of research and technological innovation. Second, intermediary structures are targeted at reducing information asymmetries and, therefore, transaction costs. Third, legislation and regulation represent the rules of the game in technology transfer. Fourth, the institutional setting in the higher education sector determines internal incentives and barriers for technology transfer (i.e. the awareness or attitude towards collaboration within the technology donating institution). Similar mechanisms influencing technology transfer are identified by the European Commission (2000a) discussing structural support modalities targeted at the enhancement of the technology transfer between academia and business.

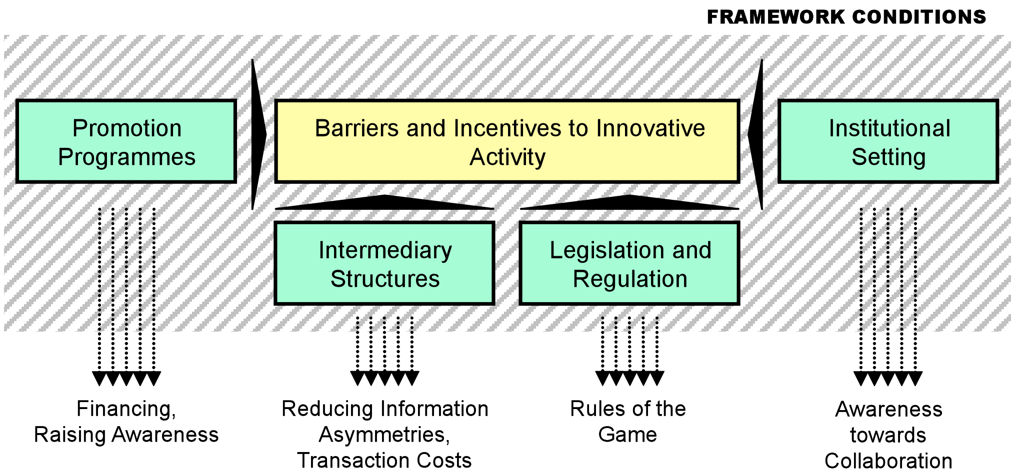

Figure 12: Public framework conditions

Public framework conditions are policy interventions targeted at removing barriers and providing incentives for industry-science collaboration (Figure 12). In the following sections the overall context of framework conditions (the reason for targeted policy intervention in the technology transfer process), promotion programmes, legislation and regulation, intermediary structures as well as the institutional setting will be discussed providing a sound basis which will be taking into account for the establishment of a generic technology transfer model.

3.2.1 The Overall Context of Framework Conditions

Technology transfer can be conceptualized as a market transaction in a knowledge market (Polt et al., 2001). For this conceptualization the specifics of the market have to be characterized in order to derive mechanisms to sustainably enhance the amount of technology transactions. According to Polt et al. (2001) the following characteristics of this specific market can be observed: high information asymmetries and low market transparency; high transaction costs because of the need for transfer and absorption capacities; high spill-overs and relative low level of private return from knowledge acquisition; restrictions on investment in knowledge production and exchange due to risk averseness; invisibilities and the existence of joint products and sometimes a need for reciprocal interaction and collaborative knowledge production. From a market transaction perspective all of these characteristics represent barriers for technology transfer. Similar statements regarding barriers for technology transfer can be found in the literature. For instance, according to the OECD (2000a) investors are reluctant to finance innovative activity and innovative firms as the costs and risks of innovation have increased. Additionally, Link and Scott (2001) argue – on a more general basis – that due to the specifics of the market (i.e. the existing barriers) the private rate of return does not overcome a certain hurdle rate of return required for doing the innovation investment from a micro perspective. However, from a macro perspective investments in innovation (and R&D) generate high social returns (i.e. spillovers), from which the society on the aggregate level benefits. To economists, this divergence between the private and social returns on R&D signifies the existence of what Martin and Scott (2000) refer to as an ‘innovation market failure’. The concept of market failure can be found in various literature sources (Polt et al., 2001; Siegel and Zervos, 2002; OECD, 2000a). Therefore, from a market perspective an ‘innovation market failure’ results in barriers for technology transfer.

From the perspective of the neo-classical economic theory the assumption can be derived that a purely market relation produces an optimal situation, which is desired for undistorted competition in free markets. Policy intervention is required where market failures have developed (Salter & Martin, 2001). The knowledge market, as shown above, is characterized by a ‘market failure in innovation’ (Martin and Scott, 2000). The reasons for the market failure in innovation are based on the specifics of the market already mentioned. According to Siegel and Zervos (2002) “there is a strong consensus that, in the absence of government intervention, there will be underinvestment in R&D (and therefore in innovative activity) in free market economies. The failure of market forces to generate optimal levels of R&D through direct financial support from government agencies for R&D projects, the relaxation of antitrust statutes to promote collaborative R&D, and other modifications in technology policy stimulate the formation of research partnerships”. Government intervention, therefore, from a research policy perspective has to correct the ‘market failure’ (Salter and Martin, 2001). These interventions significantly shape the establishment of public framework conditions conducive to innovation, which compensate for market failure and stimulate technology transfer by the provision of incentive structures (Polt et al., 2001). Policy intervention by the provision of incentives is of major concern of research policy on EU-level as well as on national level. Concisely, although the innovation performance of a region, a country or the European Union as whole depends on a large extent on decisions made by individual entrepreneurs, company managers and investors, based on their perception of costs, benefits and risks, removing barriers by providing incentives, support mechanisms, etc. plays a crucial enabling and catalytic role in the innovation process (European Commission, 2002c).

However, the public framework conditions in this model are not only targeted at the compensation of the ‘market failure in innovation’ in the industry, but also at the provision of incentives for higher education institutions and research centres to enhance industry collaboration on a larger scale, the provision of a regulatory framework conducive to collaboration and innovation, and the enhancement of the information flow between business and academia. Inappropriate framework conditions, therefore, represent general barriers in technology transfer. Thus, all four types of framework conditions have to be designed properly for the successful stimulation of technology transactions.

3.2.2 Institutional Setting

As already mentioned before, besides the barriers stemming from the market failure technology transfer additionally faces barriers which arise from within higher education institutions. According to Jacob et al. (2000)

a variety of collaboration barriers can be identified within the higher education sector. These barriers comprise a lack of entrepreneurship, a concern of academics that industrial collaboration is against the central ethics of universities being centred on fundamental research and the education of students, a bad efficiency of the existing system of collaboration, a lack of incentives for working with industry compared with incentives for research or teaching activities, a concern that the future direction of higher education research could be controlled directly by industry diminishing the ethos of a free-thinking academia and a clash of culture in general. All of these barriers relate to the attitude towards technology transfer of the institution which – in this context – is called the institutional setting favourable to technology transfer (Polt et al., 2001). Therefore, the framework conditions in this respect are targeted at the provision of incentives to the science base for enhancing the awareness of the importance of industry collaboration in order to overcome internal collaboration barriers. The barriers mentioned before indicate that higher education institutions which face these types of barriers have not undergone the 2nd academic revolution (Etzkowitz, 2002). A complete transformation according to the 2nd academic revolution does not only require the mission of the higher education institution to be changed in order to provide socio-economic impact in the industry, but also a change of the attitude of every individual employee towards the necessity of collaboration (a change in the mind-set). According to Polt et al. (2001) the institutional setting of the higher education sector is influenced by evaluation criteria and procedures, individual incentives, financing sources, institutional missions, organisational cultures, recruitment policies, administrative support and so on. The institutional setting, i.e. the attitude towards technology transfer, can partly be influenced by policy intervention. These interventions take the form of financial restrictions and awareness programmes. Financial restrictions shift funding from general funds for higher education (block-grant funding) to direct government funding structures favouring funding of collaborative initiatives (Van der Wende, 2001).

3.2.3 Legislation and Regulation

Legislation and regulation represent enablers on the one hand and simultaneously barriers for technology transfer on the other hand. Enabling factors relate to regulation and legislation that favours technology transfer by, for instance, providing incentives and support structures for the proper exploitation of intellectual property for higher education institutions. On the other hand, regulation and legislation represent barriers to technology transfer by, for example, hindering personnel mobility through the complicated civil servant law which is in use in most Austrian higher education institutions. A best-practice example of an enabling measure in Austria is the administrative simplification for start-ups which related to the abolishment of all inscription fees for start-ups by the Chamber of Commerce (European Commission, 2001c). This significantly reduced the costs associated with the establishment of new enterprises in Austria. However, in general, legislation and regulation play only a minor role regarding the technology transfer performance with the exception of regulation and legislation for the exploitation of IPR by higher education institutions and for allowing greater interaction between public sector research and businesses (Polt et al., 2001; European Commission, 2000a). Regarding the framework conditions for the exploitation of intellectual property rights different ownership regimes are in use in Europe, depending on whether the individual researcher, the research institute or the government owns the intellectual property rights from public research (European Commission, 2002c). However, for the proper exploitation of intellectual property rights the type of ownership regime makes a big difference, as the motivation of the individual researcher significantly depends on whether he/she, the institution or the government owns the intellectual property. Furthermore, according to European Commission (2002c) there is a trend to grant intellectual property rights to research institutions, based on the perception that ministries are too bureaucratic to protect and exploit intellectual property rights effectively, while often individual researchers lack the time and motivation to do so.

3.2.4 Promotion Programmes

Public promotion programmes are designed for compensating market failure in the knowledge market by providing financial resources and creating awareness of the importance of technology transfer (Polt *el. at*, 2001). The provision of financial resources is one of the most important instruments of research and innovation policy as public funding of innovative activity is designed to compensate for under-investment in this specific field. This is proofed by the fact that whenever policy discussions concern issues of competitiveness and economic growth, the topic of the public spending on research and innovative activity is coming up. For instance, at the Lisbon meeting in March 2000 the European Union formulated the goal of becoming the most competitive economy in the world by the time of 2010. Among other measures – like the implementation of a European Research Area – the increase of the R&D spending up to the level of 3% of GDP was found to be an appropriate means for reaching the ambitious goal (European Commission, 2002e).

Financial support programmes for enterprises may be divided into three basic categories, namely direct financial support to firms, indirect support to firms and support to enablers. First, direct financial support programmes comprise grants for R&D and innovation projects, loans for investments or the costs of research projects (usually at preferential interest rates), taking equity in companies (government-backed provision of capital to companies undertaking innovative activities) and subsidies for capital goods investment, projects, etc. Second, indirect support to firms and to enablers are the provision of loan and equity guarantees for lenders or investors (making it economically profitable for the financiers to provide loans or equity to innovative firms), the provision of tax incentives for innovation and interest rate subsidies on loans to firms from financial institutions. Third, tax relief for investors in innovative companies, equity investment in financial organisations, measures aimed at improving the financial environment (e.g. the development of stock markets adapted to innovative/high technology projects), intermediation services (bridging barriers between investors and entrepreneurs) and measures which have a stronger focus on the creation and support of new technology-based firms (e.g. consultancy and incubation services) belong to the support measures for enablers (*cf.* European Commission, 2001e). There are plenty of scientific publications discussing the advantages and disadvantages of the different funding measures, like those evaluation the benefits of indirect support versus direct support for innovative activity (e.g. Hutschenreiter and Aiginger, 2001; Leo *et al.*, 2002). However, as the type of public funding depends on the national and regional idiosyncrasies of the innovation systems to be enhanced (i.e. the strength and weaknesses), there might be no single best way on the aggregate level that works for all countries.

Besides the financial support mechanisms for enterprises public funding is also granted for building innovation capacities (i.e. the higher education institutions and the public research sector are target of public funding). As already discussed before, higher education funding relates to general higher education funding and direct government funds (*cf.* OECD, 1999c). Therefore, funding industrial innovative activity and funding of capacity building are common in today's innovation and research policy. However, not only the production of scientific knowledge and the subsequent utilization of technology have to be forced by public policy, but also mechanisms to transfer technology from the production agents to the utilization agents (e.g. by the means of technology transfer) has to be target of policy intervention. According to Polt *et al.* (2001) – in their benchmarking study on framework conditions – positive impacts of funding schemes targeted at an increased collaboration between industry and academia can be found in Finland, Ireland and the United Kingdom.

3.2.5 Intermediary Structures

Intermediary structures are designed for reducing information asymmetries and transaction costs for the technology transfer process between the industry and the science base. Furthermore, intermediary structures support the awareness creation in the industry. A variety of intermediary structures are existing covering physical and organisational infrastructure like technology transfer offices, industry liaison offices, technology centres, incubators, consulting networks and databases (*cf.* Polt *et al.*, 2001). Intermediary structures might exist as stand-alone solutions or within the organisational setting of the science base (e.g. implemented as department of a higher education institution). In most European countries both types of intermediary structures can be found. Stand-alone intermediary structures in Europe operate at the level of the European Union, at country level and at regional level. On EU level the Innovation Relay Centre (IRC) being a best-practise example represents a network designed for the stimulation of technology transfer within the member states[7]. Functioning as a single trans-national organisation, over 1.000 expert consultants in innovation and technology transfer in 250 networked local offices have already helped to bring to completion more than 1.000 licensing or technical co-operation deals between partners in different European countries. The services provided by the IRC network comprise the execution of technology audits in companies, the identification of technology profiles (technology needs and demands), the matching of demand and supply as well as assistance in the establishment of co-operations. By this the IRC networks help to minimize information asymmetries and reduces transaction costs on the aggregate level.

In Italy the APRE is an example-representing intermediary structures designed to enhance the international co-operation of the national actors concerned (i.e. companies, non-profit organisations, universities, etc.). The most important services of APRE are the creation of awareness for international research and technology activities, coaching for writing proposals for international research projects, information on legal and administrative issues in international co-operation and searching for international partners for collaboration. Thereby, the APRE supports the Italian science system to become part of the European Research Area by

[7] Source: The Innovation Relay Centre Network (http://irc.cordis.lu, 15.07.2009)

the provision of services and removing the barriers to international research collaboration. The intermediary services comprise the exploitation of intellectual property rights by searching for licensing partners for patents and funding of filing patents. Additionally, services relating to market and technology recherché as well as to a business angels network are provided. From the Italian samples discussed, it can be derived that intermediary structures provide value added services for facilitating technology transfer.

3.3 Technology Transfer and Universities

The capacity of a nation to produce wealth depends increasingly on the investment it undertakes in strengthening the so-called “triangle of knowledge”, which is composed of research, education and innovation (Abramo et al, 2009).

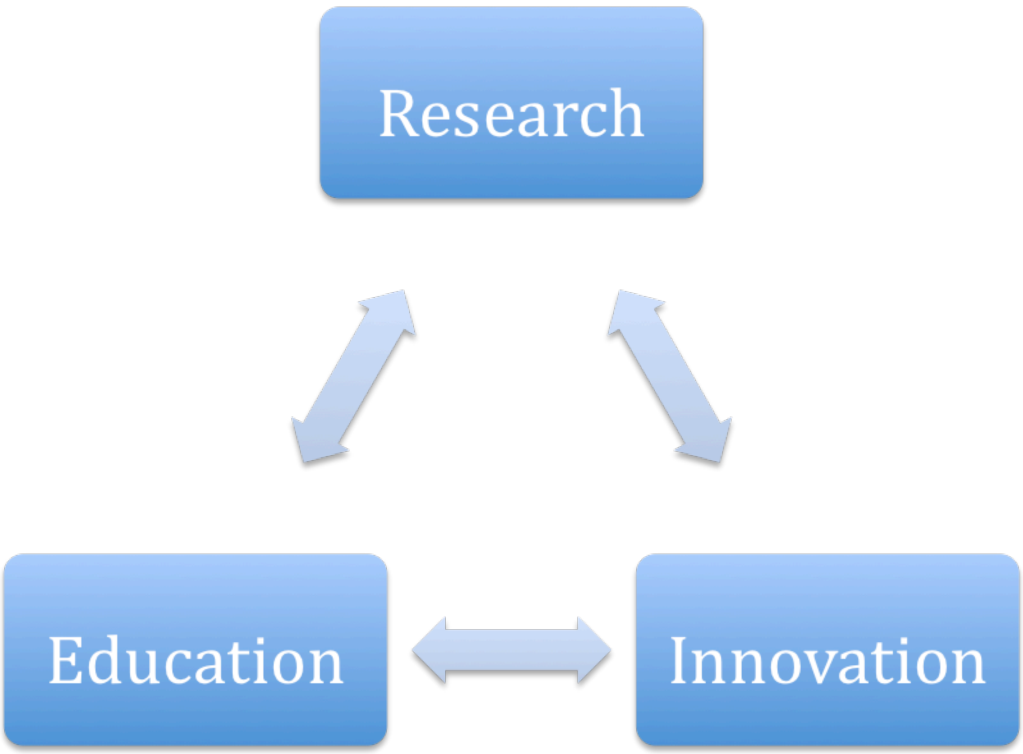

Figure 13: The triangle of knowledge.

Universities as part of the knowledge-generating infrastructure are ever more involved in the development of global economy and many recent innovations could have only been achieved through interdisciplinary teams of industrial and university researchers. Both Universities and companies take advantage from each part involved in the process of technology transfer. Acquiring and commercializing new university technologies can be an important means of staying current with technological advances in an environment of rapid technological change (van den Berghe 2008; Dosi 1982; Tushman and Anderson 1986; Granstrand et al. 1997). Universities profit through additional financial means, feedback regarding their competencies and research performance and input to identify new research areas. Companies profit by getting access to external knowledge for the development of new products and processes or support to build up specific competencies with the help of universities (Hofer, 2007), even if still difficulties arise from the nature of R&D and from *moral hazard* problems (Howels, 2004). University to business technology transfer is classed as “vertical transfer” where the technology passes from research through development and to production in the course of transfer. It means that the development stage could take place in either the supplier, i.e. the university, the acquirer, i.e. the SME, or preferably a combination of both. From this another emerging key theme is the location and nature of the interface between the supplier and the receiver of the technology (Decter, Bennett, & Leseure, 2006). Siegel and Phan state that University are increasingly being viewed by policymakers as engines of economic growth via the commercialization of intellectual property through technology transfer. The primary commercial mechanism for technology transfer are licensing agreements, research joint ventures, and university based start-ups. The greatest spin that pushed universities towards a powerful productivity of technology, at least in United States, is the Bayh-Dole Act that allowed licensing their intellectual property and retaining subsequent royalties. Obviously, depending on the choice of licensing path, the financial benefits from these activities may remain in the region or flow out entirely. For what concerns geographical issues, regional collaborations are supposed to be better suited for companies without previous experience in technology transfer. Face-to-face meetings, which facilitate the transfer of knowledge, are easier to realize because of short geographic distance. The ability to collaborate with partners located more distantly seems to be influenced by various characteristics like the technology transfer experience, size, R&D capabilities, and export quotes. Literatures show an evolution pattern of technology transfer with companies firstly collaborating regionally and then start to integrate knowledge from distant sources to increase their competitiveness further. Obviously technology transfer is also likely to be influenced by the type of products and services offered by companies. On the other hand, it is very important to understand which are the barriers that both firms and universities face when approaching technology transfer processes. On a research conducted in 2001 by Hall et al (Hall, Link, & Scott, 2001) they demonstrated that Intellectual Property issues between firms and universities do exist, and in some cases those issues represent an insurmountable barriers, which prevents the sought-after research partnership from ever coming about. Such situations have a greater likelihood of occurring when the research is expected to lead to less appropriable results that thus have a relatively greater degree of publicness and when the expected duration of the research is relatively short term and is thus more certain in terms of the characteristics of the research findings. The probability that insurmountable IP barriers will arise between a firm and a university in terms of partnering are greatest when the intellectual property characteristics of the research are certain and the ability of the firm to appropriate such result is least. Further, the probability of barriers is least when the IP is appropriable yet uncertain. The appropriability of the IP implies less publicness, and then less tension between the “two worlds”.

In an economy based on the knowledge, an institution as the university becomes a relevant economic resource that will play a key role not only in the production, but even in the following diffusion and application of the knowledge in order of innovation, further to this even the labor mobility has been recognized as a key mechanism for transferring tacit knowledge (Hoisl 2008). On the other hand University is relevant and responsabilized from the political and economics environment, both in regional and national level, in order to favorite the development of the technology transfer to the industry. Some universities are not touched by this process, others, more active, use some forms of technology transfer even superior to the one foreseen, developing in some cases collaboration such as spin off, incubators or joint venture. According to Zhang (2009) a spin-off is defined as a firm founded by university employees and usually we refer to their founders as academic entrepreneurs; on the other hand there are the technology business incubators that are entities mostly born from universities with the scope to transfer the technology produced (Phillips, 2002).

3.4 Business processes for Technology Transfer

According to McAdam et al. the existing literature on business and management in technology transfer, which include incidental business and management add-ons in economics and technology-based studies, can be divided into that dealing with key activities in the discourse and that which covers key stakeholders (Blaydon et al. 1999). Some of the key activities referred to the technology transfer are:

1. Technological idea generation
2. Technology appraisal
3. Venture capital funding and funding in general;
4. Spin outs;

5. Spin ins;
6. Technology licensing;
7. Joint ventures and business building;
8. Growth.

Evans et al. (Evans et al. 2001) discuss about the stakeholders of the TT process, they focus on the need to balance the “differing objectives of the various stakeholders” and refer to the stakeholders as including University, Councils and Government agencies, from a sponsoring perspective. These groups may have different need based on local, national and international needs. Other key stakeholders from a more operational perspective are identified as technology based academics who originated the ideas, management teams to enable growth and technology assessors to add credibility to funding applications. Literature refers even (McAdam, Keogh, Galbraith, & Laurie, 2005) to a range of supportive bodies such as knowledge clubs and Inter Organizational Relationship in which New Technology Based Firms can also act as brokers of knowledge for each other in spreading knowledge (Hargadon & Sutton, 1997). The development of this literature suggests that a stage where some forms of integration in relation to both activities and stakeholders can be achieved. This integration is needed to facilitate ‘best practice” benchmarking studies.

3.5 Business Models for Technology Transfer

From the desk research conducted, many different models were found according to the different places, technologies developed and receiver of the same. As mentioned before, technology transfer is applicable to all fields, and this allows several business model implementations. Successful technology transfer begins with the identification of appropriate candidate technologies for transfer. Technology transfer managers have few reliable tools to guide the process of determining when and which technologies are likely to be successful in the commercialization process. Indeed great technology alone is not sufficient to ensure a winning product. Obviously the commercialization process differs between private and public sector organizations (universities and government facilities) due to the differences in organizational structures, missions, and culture. In the public sector technology is pursued for its inherent scientific value and it is investigator – driven. Public sector research focuses mainly on long-term radical innovation processes. Commercial success and market needs have traditionally been of little or no concern. Among the private sector technology development, the criteria for success are explicit, and the technology is periodically benchmarked and evaluated against them. Often the major criteria for considering a technology are fit, fit, fit – with the company's current market, distribution channels and manufacturing capabilities (AUTM, 1994). Market research is carried out at every stage of technology development, reducing the risk in management decisions (Robertson and Weijo, 1988). It is generally agreed that the process of commercialization of a new product comprises a series of steps that include the idea generation and product definition, concept screening and prototype development, concept testing and diagnostic evaluation, preliminary marketing and financial analysis, product development, product testing, and simulated or actual test marketing. Failure to carry out one or more of these steps has been correlated to product failure.

4. The tools used by the Technology Transfer to protect and to manage the Digital Data

Knowledge can be defined as intellectual capital originating from intellectual activity in the industrial, scientific, literary, and artistic fields. Intellectual capital comprises human capital, structural capital and relational capital, whereby human capital is defined as explicit and tacit knowledge of the organisation's personnel that is of value to an organization (cf. Warden, 2003). Therefore, scientific knowledge can be regarded as intellectual capital. The term intellectual property[8] reflects the idea that intellectual capital is treated by courts like a tangible property. Thus, in common law jurisdictions intellectual property is a form of legal entitlement which allows its holder to control the use of certain intangible ideas and expressions (cf. Labourlawtalk, 2005). For the protection of intellectual property different mechanisms are in place depending on the intellectual activity, from which intellectual capital is arising. These mechanisms comprise statutory rights like, for instance, patents, utility models, trademarks, copyrights and non-statutory rights like trade secrets and know how (cf. Apke, 1998; WIPO, 2001). Each type of intellectual property rights provides its own ‘bundle of rights’. Intellectual activities and intellectual capital, for which intellectual property rights may be

[8] Intellectual property covers two main areas: industrial property, covering inventions, trade marks, industrial designs, and protected designations of origin; copyright, represented by literary, musical, artistic, photographic, and audio-visual works. Intellectual property makes use of the following instruments: patents, utility models, industrial design, trademarks, semiconductor chip protection, plant variety protection and copyright (IPR Helpdesk, 2004).

gained, comprise: literacy, artistic and scientific works, performance, phonograms and broadcasts, inventions in all fields of human endeavour, scientific discoveries, industrial designs, trademarks, service marks and commercial names and designations (WIPO, 2001). The protection of intellectual property (i.e. the definition of intellectual property rights) from a country's perspective has two main reasons, namely to give the moral and economic rights concerning intellectual capital to the creator (to prevent the creator from unfair commercialization by third parties not being involved in the generation of the intellectual capital) and to give the public the possibility to access these creations. The second reason relates to the promotion of the dissemination of results under fair conditions targeted at economic and social development (cf. WIPO, 2001). Therefore, in almost all legal frameworks intellectual property belongs to the creator except if the creator is an employee being in charge of the knowledge generation. In the latter case the intellectual property belongs to the employer (WIPO, 2001).

In technology transfer, a factor that has reached remarkable attention in literature is the presence of transparent and well-articulated intellectual property rights regimes. For instance, the European Commission (2001b) notes that the field of intellectual property followed a rapid movement from the backstage to the forefront of attention of strategic importance and the need to protect IPR will probably continue to grow in the coming years. This trend seems quite reasonable given the fact that industry-science-linkages are increasing and more formal collaboration mechanisms like collaborative research or contract research are coming up, all of which are centred on the IPR topic. This goes in line with observations of the European Commission (2002e) arguing that intellectual property rights, especially patents, copyrights, designs and trade secrets play a crucial role for the establishment of the rules of the game in research collaboration and technology transfer. The call for a more active use of intellectual property rights (IPR) by the European Community will lead to an increasing need to protect IPR in the future, as there is an increasing awareness that IPR are essential in an innovative and competitive environment (European Commission, 2001b).

Additionally, in Europe different types of ownership regimes exist depending on whether the individual researcher, the research institute or the government owns the IPR from public research (European Commission, 2002c). The decision upon this ownership regime is influenced by issues like incentives for researchers.

On the institutional level, however, one has to be aware that through the multitude of legal protection, IPR regimes have become complex and difficult to handle in Europe. For example, the proper management of IPR in a higher education institution covers a large list of activities (European Commission, 2000a):

- monitoring of inventive activity generated by the higher education institution to gain comprehensive disclosure across the institution,
- accurate identification and selection of inventions which might be worth for protection in terms of future income through licensing,
- negotiation with the research team for the protection and defence of the research results involving incentives and exploitation schemes,
- selection and establishment of the of the appropriate legal IPR defence mechanisms for the invention and
- decision on the length and extent of the protection as well as the exploitation and development route for the invention.

Furthermore, proper IPR handling includes monitoring of patent violations, decision on alternative routes of research commercialization (like spin-offs), negotiations with industry partners in collaborative research efforts regarding the ownerships of intellectual capital created, etc. Therefore, it is obvious that for small higher education institutions the full potential of intellectual property right management can hardly be exploited, as small higher education institutions cannot afford to run an IPR office. This has been observed by the European Commission (2000a) arguing that adequate monitoring and management of the IPR is especially difficult for small and/or new universities who are not able to lever the full value out of the intellectual property generated from research in the university. In addition, the deal flow of small higher education institutions might not be worth running an IPR office in an economic sense, as the cost of the IPR office might be higher than the income from the licensing of patents. A possible strategy for escaping this problem is provided by the European Commission (2000a) suggesting to pool together the resources of small higher education institutions to gain sufficient size (and deal flow). Another strategy could be to enhance the involvement of National Patent Offices in the dissemination of IPR (European Commission, 2001b). Therefore, due to the complexity and efforts related to the proper IPR management small higher education institutions might increasingly rely on external IPR services. In any case, higher education institutions require intermediary services for handling the complexity of IPR management for fully exploiting the potential of IPR. Large universities have set up support structures for managing IPR handling with dedicated staff.

Digital media that is readily and illegally distributed over the Internet and related digital networks has posed major problems for the members of the digital media value chain. Ubiquitous mobile communication devices such as media capable handsets and PDAs have made the problem even larger. Technical approaches to controlling illegal distribution – commonly known as Digital Rights Management (DRM) – have been varied and inconsistent since the shift from analogue media to digital media, but in recent year many advances have been made in this topic (Smith 2004). The current rules that define the management of the Intellectual Property Rights are still based on principles consolidates in a different technological context, hence right holders and content providers are not prepared to revise, in the virtual world, the order that, in the real world, has been shaped for a long time[9]. When it comes to intellectual

[9] See John Perry Barlow, Intellectual Property, Information Age, in Copy Fights: The future of Intellectual Property in the Information Age 37, 39, 2002

property rights, legal remedies are promptly invoked and prepared at record speed. The legal remedies have been introduced to deal specially with the new problems connected with the virtual world and digitization of contents. The technological protection measures are able to operate autonomously. Nevertheless they are avoidable using circumstances techniques (or brute force). For this reasons the new intellectual property rules have included extraordinary legal protection especially for the technological protection measures, in a double reinforcement, one for the copyrighted content and one for the technological measures that protect it. The theoretical literature does not give us a precise answer about the effect of a reduction (increase) in the enforcement of IPR (Pons and Garcia, 2008) Technological protection measures, in fact, require appropriate legislative and legal support to ensure that these measures are respected, and to prevent their circumvention by parties that might otherwise violate the right. As a consequence there is a complete and structured new legal tool able to prevent, check, and repress harmful actions against intellectual property rights. The most important decision in that direction has been made with the WIPO (World Intellectual Property Organization) treaties. Before speaking about it, it is useful to remember that there are at least two other main international treaties that are intended to harmonize copyright law among nations. The first one is the Berne Convention for the Protection of Literary and Artistic Works, adopted in 1886,and the other one is the 1994 Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs Agreement). In the 1996 the World Intellectual Property Organization (WIPO) adopted the Copyright Treaty. In the article 11 it states that contracting parties have to “provide adequate legal protection and effective legal remedies against the circumvention of effective technological measures that are used by authors in connection with the exercise of their rights”, and “to restrict acts, in respect of their performances or phonograms, which are not authorized by the performers or the producers of phonograms concerned or permitted by law"[10]. The article provides the adoption of a legal framework to protect technological men's of control over use. Similarly the article 18 of the WIPO Performances and Programs Treaty declares the same provision. To comply with the WIPO Treaty both Europe and United States enacted very similar anti – circumvention provisions. In 1998, the United States implemented the Digital Millennium Copyright Act (hereinafter DMCA) that introduced new anti-circumvention provisions, while, some years later, Europe enacted Directive 2001/29/EC on the Harmonization of Certain Aspects of Copyright and Related Rights in the Information Society (hereinafter EUCD) (Lucchi 2006). It is good at this point of the description to better get into each of the document described above, in order to get, from a legal point of view, which are the characteristics that distinguish each country for the digital media protections.

4.1 The Digital Millennium Copyright Act

The Digital Millennium Copyright Act represents the most significant digital media legislation. This act was signed into law by the President Clinton on October 28th 1998 and its main purpose was to implement the United States' treaty obligation under the two 1996 WIPO treaties: the WIPO copyright treaty and the WIPO Performances and Phonograms Treaty. The DMCA is divided into five titles:

- Title I, the "WIPO Copyright and Performances and Phonograms Treaties Implementation Act of 1998" implements the WIPO treaties

[10] World Intellectual Property Organization: Copyright Treaty, Dec. 20, 1996, 36 I.L.M. 65 (1997), art. 11

- Title II, the “On-line Copyright Infringement Liability Limitation Act”, creates limitations on the liability of on-line service providers for copyright infringement when engaging in certain types of activities.
- Title III, the “Computer Maintenance Competition Assurance Act” creates an exemption for making a copy of a computer program activating a computer for purposes of maintenance or repair.
- Title IV contains six miscellaneous provisions, relating to the functions of the Copyright Office, distance education, the exceptions in the Copyright Act for libraries and for making ephemeral recordings, “web-casting of sound recordings on the Internet, and the applicability of collective bargaining agreement obligations in the case of transfers of rights in motion pictures.
- Title V, the “Vessel Hull Design Protection Act” creates a new form of protection for the design of vessel hulls.

The general approach taken by the DMCA is to make circumvention of technological protection measures illegal except under certain condition. Briefly the DMCA:

a. makes it a crime to circumvent anti-piracy measures incorporated into most commercial software;

b. does permit the cracking of copyright protection devices, however, to conduct encryption research, assess product interoperability, and test computer security systems;

c. provides exemptions from anti-circumvention provisions for non-profit libraries, archives, and educational institutions under particular conditions;

d. prohibits the manufacture, sale, or distribution of code-cracking devices used to illegally copy software;

e. protects Internet service provider from copyright infringement liability for simply transmitting information;

f. obliges Internet service providers to remove material from users' web sites that appears to constitute copyright infringement;

g. limits the liability of non profit institutions of higher education – when they serve as on-line service providers and under certain circumstances – for copyright infringement by faculty members or graduate students;

h. requires that "webcasters" pay licensing fees to record companies preventing misappropriation of content and determining royalties to be paid to artists for their works.

The important part of the treaty, the one focused on the technological protection measures and the copyright management system is related to the Title I. In this section, three are the new important infringement disposition introduced by the DMCA: the first one is related to circumvention of technological protection measures that control access to copyrighted works; the second one is associated to the manufacturing, distribution or offering of products services and devices, that circumvent access controls; the third is related to the manufacturing, distribution, or offering of products, services or devices that circumvent a technological measure that "effectively protects a right of the copyright owner". In the chapter 12 the first section starts with "Circumvention of Copyright Protection Systems" and identifies three categories of anti-circumvention violations: a basic provision, a ban on trafficking and additional violation. The first provision states that no person shall circumvent a technological measure that effectively control access to a work protected under this title. To circumvent a technological measure implies "to descramble a scrambled work, to decrypt an encrypted work, or otherwise to avoid, to bypass, remove, deactivate, or impair a technological measures, without the authority of the copyright owner. The circumventions of technological measures are even defined as "the electronic equivalent of breaking into a locked room in order to obtain a copy of a book" (Melville et al., 2003). The prohibition of trafficking and the "additional violations" represents two different types of anti-trafficking provisions; the first one refers to the devices and services that circumvent access controls, the second one refers to the devices and services that circumvent rights controls. The DMCA has receipt many critiques for its anti-circumvention provisions, and particularly for their wide-ranging scope and the consequent possibility to impede consumers from engaging in fair uses of copyrighted work. In answer to the unfairness of the provisions of the DMCA, in early October 2002, two bills to amend the DMCA were introduced in the House of Representative. According to the sponsors of these bills. The DMCA has disrupted the “historical balance” in the US copyright law and has undermined the long-established fair use rights of lawful consumers (Bagner et al., 2003). The first bill was introduced by Representative Zoe Loefgren and was entitled “Digital choice of Freedom Act” on October 2, 2002. This bill would expressly extend fair use rights “to analogue and digital transmission”, and add a new section on the DMCA that would authorize consumers, who have lawfully obtained a digital work, to make archival copies of the work and to use the work on preferred digital media devices. The other bill proposed on October 3, 2002 is the Digital Media Consumer’s Rights Act (DMCRA)[11]. This bill attempts to restore the historical balance in copyright law; in particular it attempts to restore consumers’ fair use rights by amending the DMCA so as to permit circumvention of copy protection for non-infringing uses of digital copyrighted material. This bill ensures that consumers are fully aware of the limitations and restrictions they may discover when purchasing copy-protected digital media because manufactures are not currently obligated to place these kinds of notices on packaging. Furthermore it introduces an amendment to the first section of the chapter 12 of the DMCA, stipulating the permission to manufacture, distribute, or make non-infringing use of an hardware or software product that enables significant

[11] See Digital Media Consumer Copyrights Act of 2005, HR 1201, 109th Cong. 1st Sess. (available at http://thomas.loc.gov/cgi-bin/query/z?c109:H.R.1201:).

non-infringing use of copyrighted work, as in making back-up copies of legally purchased digital media (Lucchi, 2006).

4.2 The European Copyright Directive

As the DMCA, the European Copyright Directive (EUCD) is modelled on, and designed to implement the WIPO 1996 World Copyright Treaty and the World Performance Treaty. Its main aim is to adapt legislation on copyright and related rights to technological developments and particularly to the information society. The objective is to transpose at a Community level the main international obligations deriving from the two Treaties concerning copyrights and related rights adopted in the 1996 WIPO framework. The directive applies without prejudice to existing provisions relating to: the legal protection of computer programs; rental and landing rights and certain rights related to the copyright in the field of intellectual property; copyright and related rights applicable to broad-casting of programmes by satellite and cable retransmission; the term of protection of copyright and certain related rights; the legal protection of databases. Summarizing the Directive deals with the harmonization of the three main exclusive rights: reproduction rights, the right of communication and distribution rights. With regards to the reproduction rights, EU member states are to provide for the exclusive right to authorize or prohibit direct or indirect, temporary or permanent reproduction by any means and in any form, in whole or in part:

a. for authors, for the original and copies of their works;
b. for performers, of fixations of their performances;
c. for phonograms producers, of their phonograms;
d. for the producers of the first fixation of films, in respect of the original and copies of their films;
e. for broadcasting organizations, of fixations of their broadcast, whether their broadcast are transmitted by wire or over the air, including by cable or satellite.

For what concerns the right of communication, Member states are to provide authors with the exclusive right to authorize or exclude any communication to the public of the original or copies of their works, including the making available to the public of their works in such a way that members of the public may access them from a place and at a time individually chosen by them. In the same way for the making available of protected works in such a way that public can access them wherever and whenever they like: for performers, of fixations of their performances; for phonogram producers, of their phonograms; for the producers of their first fixation of films, in respect of the original and copies of their film; for broadcasting organizations, of fixations of their broadcasts. With regards to the distribution rights, the EUCD harmonizes for the authors the exclusive right of distribution to the public of their works or copies thereof. It is specified in the Directive that the distribution right is exhausted where the first sale or other transfer of ownership in the Community of a copy is made by the right-holder or with his consent[12]. But, according to the WIPO Treaty, the Directive states that, in the context of on-line distribution, the exhaustion concept is totally eliminated. Thus, for on-line distribution, as not for the tangible goods, a new basis of the exhaustion principle is introduced and this new kind of distribution is regulated through the right of communication to the public and it is considered as a service. The result is a restriction to resell digital content, because the application of the principle of exhaustion to digital works is restricted by license agreements. Hence the primary intent of these licenses is to

[12] The U.S. “first sale” Doctrine, and the equivalent European concept of “exhaustion” determine that the exclusive right of distribution cease after a copyright holder authorizes the first disposal of a copy of the work. A possessor can dispose of it without seeking any authorization of the copyright holder; hence, under the doctrine of the “first sale” once the copyright owner transfers title to a copy of a copyrighted work to a third party, the third party is entitled to sell or dispose of it without acquiring the copyright owner’s consent. Barret M., Intellectual Property – Patents, Trademarks & Copyrights 227 (2000).

characterize the “purchase” of digital content as a grant of a license instead of a sale that transfer ownership. The Directive establishes a number of exceptions to the right of reproduction and the right of communication. All these exception are optional; the only mandatory to the right of reproduction is introduced in respect of certain temporary acts of reproduction which are integral and essential to a technological process, the sole purpose of which is to enable the lawful use or trasmission in a network between third parties by an intermediary of a work or other subject matter and which has no separate economic significance. The Directive also formulates provision for other non-mandatory exceptions to the right of reproduction and communication, those are:

a. use for teaching or scientific research;
b. uses for the benefit of people with disabilities;
c. reproduction by the press;
d. quotations for criticism or review purposes;
e. use for the purpose of public security;
f. use of political speeches as well as extracts of public lectures or similar works;
g. use during religious ceremonies;
h. use of works, such as works of architecture or sculpture, made to be located permanently in public places;
i. incidental inclusion of a work or other subject matter in other material;
j. use for the purpose of advertising the public exhibition or sale of artistic works;
k. use for the purpose of caricature, parody or pastiche;
l. use in connection with demonstration or repair of equipment;

m. use of an artistic work in the form of a building or a drawing for the purposes of reconstructing the building;

n. use by communication or making available, for the purpose of research or private study;

o. use in certain other cases of minor importance where exceptions or limitations already exist under national law, provided that they only concern analogue uses.

In these cases, exceptions are accorder at national level by the Member State concerned[13]. The statutory copyright exemptions are different in each member state because the Article 5 of the Directive stipulates that Member State are free to choose from an exhaustive list those copyright exemption they want to implement in their national laws. The Directive was designed to be implemented by December 22, 2002, but only two Memebr States (Greece and Denmark) managed to meet that deadline. By now, eight of the original Member States have implemented the act: Greece (10th October 2002), Denmark (22nd December 2002), Italy (9th April 2003), Austria (1st July 2003), Germany (13th September 2003), Luxembourg (29th April 2004), UK (31st October 2003), Ireland (19th January 2004), Netherlands (1st September 2004). Among the new Memebr States, just Hungary, Malta, Lithuania, Poland, the Czech Republic, and Estonia have transposed it into national legislation. Recently European Commision has launched infringement proceedings against France, Finland, Spain and Czech Republic for non-implementation of the European Copyright Directive. In Italy the Copyrights Directive was transposed by Legislative Decree 68/2003 and explicitly recognizes an author’s exclusive right to authorize or prohibit any kind of public communication of his or her original works or copies. Further to this rules on the distribution of works have been harmonized and it also recognizes the principle of fair compensation to authors where

[13] Lucchi N., Intellectual Property in Digital Age: Regulation through Law, pp. 56

copies are made, and reinforces the protection of reproduction, public communication and distribution rights[14].

4.3 Licensing

When the inventor or the company does not have financial or technical resources to develop the invention, the business potential can still be exploited with a licensing agreement. This agreement gives the licensee a right to produce and sell a certain product or method protected by a patent or other intellectual property rights. Typically the license does not give the licensee the right to deposit the patent or sell the rights to commercially exploit the patent to a third part. The license agreement specifies rights and obligations of a company to exploit a patent or other intellectual property rights, such as design patent, a trademark, a utility model or technical know-how, that is not within its possession. Therefore the licensor, who is selling the license, can secure cash flow from a licensee with a license agreement. The agreement gives the licensor also the opportunity to follow business development of the invention at the license's end and hence to monitor its commercialization. The licensee wants perhaps to launch new product, or to expand contact network to enter in a new market, or to improve product's position in old market. The licensing way of acting has been proved to be one of the most fruitful and successful methods by which both large cooperation and small start-ups bring new invention to the market. The agreement to be drawn demands both highly developed legal and commercial expertise. A good agreement satisfies both parties – from a technical, functional and legal point of view. The basic information to be considered in licensing negotiations include:

1. parties and their background

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[14] See Italian Minister of Innovation and Technologies: Department for Innovation and Technology, Report of the Interministerial Committee on Digital Content in the Internet Age, 32 (2005), at http://www.mininnovazione.it/eng/intervento/allegati/rap_cont_dig.pdf.

2. who has applied for the patent, who maintains the rights?
3. Exclusive, non exclusive or sole license?
4. Scope of the license in terms of:
    a. The whole invention, or a part thereof
    b. Production, marketing. And/or selling
    c. Territory
    d. The time frame
5. Payments like down payments, royalties and minimum royalties
6. Further co-operation, technical assistance
7. Validity of the agreement.

A satisfactory agreement demands flexibility from both parts: the licensee will often be most ready to pay the licensor's money based only on the cash flow obtained from the sales of the licensed product or methods; on the other hand the licensor will desire a down payment to make sure that the he will cover investment in product development and patenting. Obviously this way of behaving is driven by how the sales of the invention go on the market, usually to avoid this, an agreement of royalties between the two parts is made of about 2-8% of the revenue generated by the sales, not including the value added tax (Kuosmanen et al., 2003). Royalties in some sectors such as chemical and process technology are typically below the 2 percent. The agreement can be exclusive so that the licensee has the exclusive rights for exploitation, while the licensor loses those rights or retains those rights. The agreement can also be non-exclusive so that there are more licensees than one, as well as possible commercial utilization by the licensor.

4.4 Licensing and Technology

The first intellectual property-related difficulty to transfer technology or to license intellectual property abroad involves the fact that IPRs generally have no “extraterritorial” force, it means that they have no applications outside the countries in which they have been enacted (Beck & Pan, 2006). In the United States they have U.S. patents, trademarks, copyrights, and other forms of IPR protection, but all of those do not protect such rights outside of the country, even on other countries they generally have no force outside where they are promulgated. To avoid this situation there has been the promulgation of a series of multilateral, intellectual property-specific international conventions, called *treaties*, which try to provide a modicum of intellectual property protection to the owners outside their home countries and to facilitate the registration and recording of such rights. Among the most important of these international treaties we find the *Paris Convention for the Protection of Industrial Property,* the *Berne Convention for the Protection of Literary and Artistic Works,* the *Universal Copyright Convention,* the *Madrid Agreement for the International Registration of Trademarks*, the *Protocol to the Madrid Agreement*, and the *Patent Cooperation Treaty*; all these treaties and agreements are managed by an U.S. organization: the *World Intellectual Property Organization* (WIPO). Furthermore there is the supervision of the World Trade Organization (WTO) that under its Trade-elated Aspects of Intellectual Property Rights requires of each signatories the setting of a minimum standards of IPR protection and enforcement of such rights in civil, criminal, administrative and customs actions. TRIPS, i.e., requires the protection of the intellectual property rights of its fellow signatories by the setting of minimum standards of protection for copyrights and neighbouring rights, trademarks, geographical indications, industrial design, patents, integrated-circuits layout designs, and undisclosed information’s. TRIPS even established minimum standards for the enforcement of IPRs in administrative and civil actions and, in regards to copyrights piracy and trademark counterfeiting, in criminal actions and actions at the border. Hence TRIPS requires WTO members to provide "national" and "most favoured nation" treatment to the nationals of other WTO members with respect to the protection and enforcement of their IPRs.

4.5 Patenting and Intellectual Property Rights

Patents represent another important tool among the Intellectual Property Rights used to protect inventors against unfair exploitation of their invention by imitators and competitors. A patent is an exclusive right to exploit an innovation commercially (Kuosmanen et al, 2003) and in particular university patents, jointly with exclusive licensing, could create the right incentives to develop products and could be a source of extra funds for universities and research centres (Bacchiocchi and Montobbio, 2009). By patenting, product and service developers obtain exclusive rights for their work, furthermore the patent can help to gain a foothold in a marketplace or to maintain a commercial advantage, during meanwhile the company can continue to develop its product, and it can even serve to the company to enhance its reputation and image, especially when the patent is internationally granted. What is really important about patenting is to know ho to apply for patents, what is patentable, and how to appropriate a patent. The universal practice is that the statutory patent rights are granted to the designated inventor; the government grants the patent rights to the applicant who can be the inventor or his assignee, typically a company, but that can be even a research institute or a team of researcher. The patent right in order to be granted by the government to the applicant have to meet three terms stipulated by the patent law (the Patenting Criteria):

- the inventive step: it means that the invention is not obvious for a person skilled in that field, like a professional or/and an expert. New combination of existing components constitutes an innovation only when there is a truly new creative insight hoe the components are fitted together.

- The Industrial applicability: the invention must be reproducible, hence whoever has the necessary means or equipment must be able to reproduce the invention according to the technical description of the patent.
- The Novelty: the invention has not been publicly available or that it has not been published outside the definitions specified in the patent laws. The inventive solution must be a novel combination in comparison to the existing technology and new in comparison to what has been publicly available before the application date.

To have a good invention, according to the Foundation of Finnish Inventions, a new product or service has to meet the following criteria:

- the product is market driven; it is in demand and there is a market pull.
- the product is inventive, novel and patentable,
- the product is significant to the business and to the employment
- the product is functional, capable of being produced and economical
- the product can be launched quickly
- there is organizational commitment behind the development project and the product
- investors are interested in the venture.

Further to this, the European practice has defined some basic properties of un-patentable and patentable inventions; these properties are listed in the following table:

Patentable	Un-patentable
• Industrial applicability • Inventive Step • Novelty	• Discoveries, scientific theories and mathematical methods • Artist's creation of a decorative product • Rules of game, business plane, computer programs (accounting systems, advertising methods)

Table 7: European focus on patentable and un-patentable iventions. Source: Korhonen, 2003.

In order to have a global view about patenting it is important to give a look to the main differences that occurs between two of the most industrialized region of the world, North America and Europe. The patenting procedures in these two regions differ in many important aspects. In Europe, in the most of cases, developers will apply for the patent in the name of their company or for the institution they work for, hence they will only receive a share of the economic returns; beside the American Patent System emphasizes the personal rights of the inventor, in fact in the US the firm or the Institution only appears as the assignee and the patent must always be official applied for a person-inventor or the related work-group. An important feature of the US patent law is that all the US patent applications become public only when they are granted. In Europe and in Japan they become public after 18 months of their filing date, making them potentially an excellent source of technical information. The US way to manage patent lead to an important limitation for the international competition, cause it will be kept secret until the patent will be granted. Another radical difference is given by what constitutes an “inventor”: in Europe, there is the critical definition of *First-to-File*, while in the US the critical definition is given by *First-to-Invent*; that means that in Europe the patent will be granted to the inventor or the entity that was first to file the application in the patent office, beside in the US the date of invention plays a crucial role. This means that the inventor is the person who has made the invention and is able to show an earlier date of invention. Another important feature, existing only in the US, is the *Continuation Practice*; this practice allows patent released years before to be renewed with all the oncoming relevant technology and can be repeated as many times it is desired. Another big issue is related to the differences about what is patentable and what is not. European patent Law stipulate this quite clearly, as mentioned before, while, in contrast to this, in the US almost *Anything Under the Sun* can be patented. Many computer programs and business plans have been patented in the US. For the nowadays world a national patent is not enough to compete with the globalized world, hence it is insufficient in the scope of international marketing and competitive advantages. Patent protection is required especially in countries where there are significant competitors in order to self protect the invention with suspending or blocking actions. Three are the different ways to check for a patent protection abroad:

1. File a national application separately for each target country
2. Use the international patenting system (Patent Cooperation Treaty)
3. Exploit the European patenting system (European Patent Convention).

In order to approach to the above-mentioned ways a patent must be, as a rule, granted, registered and maintained in force in each of the target countries separately. From a university research point of view, the process of patenting, starting from the idea, could be summarized in the following diagram that shows the various stages of the development process until the commercialization of the invention.

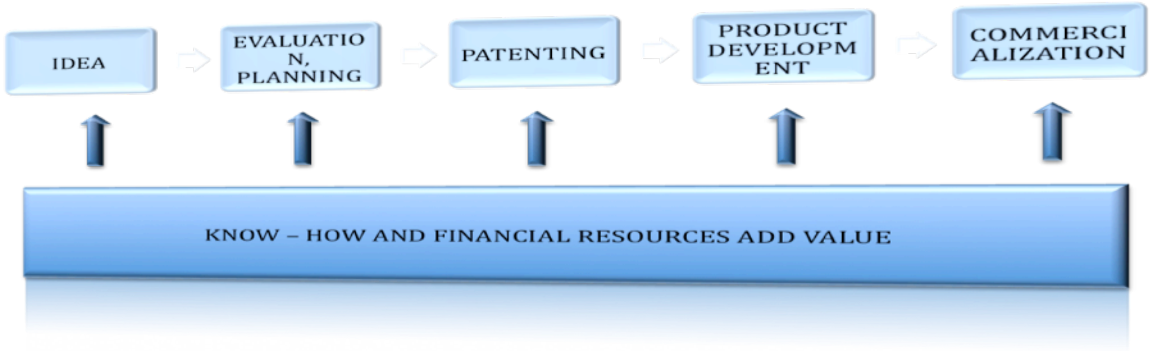

Figure 14: Stage of a Development Process of an idea into a product. Source: Patent Application Guide, 1998.

When considering applying for a patent, after or in the meanwhile of the transferring agreement of the Intellectual Property Rights, and when evaluating the invention and reference patent and developing the business case, pertinent questions to be analysed are:

- Is the life cycle of the potential technology, invention or market sufficient to enable a payback of the investment?
- Are the challenges of patents in nearby areas easy to treat?
- Will the goal be just to produce products and software for sale to customers, or can the patented technology or solutions be also sub-licensed to third parties?
- Is the development rate sufficiently slow so that patenting will not become obsolete or unnecessary before commercialization?

If the answer to this questions and to others related to the budget costs, is yes, hence the patenting process may be initiated by contacting a patent attorney.

4.5.1 The case of Fraunhofer-Gesellschaft for patenting of software inventions.

The Fraunhofer-Gesellschaft carries out applied research with the aim of contributing to technological innovation in industry and society. Innovation is the most important driver of economic growth, and matters relating to intellectual property rights therefore represent key issues for all modern national economies.

Based on its experience in contract research for industry, the Fraunhofer-Gesellschaft knows that the availability of patent protection plays a major role in encouraging companies to invest in research and development (R&D). Public authorities, too, are keen to secure legal protection for any intellectual property arising from the R&D activities that they support and, to this end, have incorporated intellectual property clauses into their sponsorship conditions. For these reasons, the Fraunhofer-Gesellschaft exploits all patent opportunities across the entire breadth of its technical research, and is one of the most active patent applicants in Germany. In utilizing its patents, the Fraunhofer-Gesellschaft is aware that intellectual property rights should not only serve the interests of the intellectual property owner, but must also take into consideration the concerns of the general public. Only a patent system that balances the preconditions for intellectual property rights with their effects and restricts patent protection to purely technical inventions can help to drive forward technical progress and thus benefit society in general. In the traditional fields of technology, the Fraunhofer-Gesellschaft believes that this balance is maintained – at least in Germany and by the European Patent Office. This opinion is to a great extent shared by the affected groups. However, any increase in the economic importance of new technological fields, such as biotechnology or computer implemented inventions, will give rise to uncertainty as to whether, and to what extent, the patent system needs to be modified. In this context, the Fraunhofer-Gesellschaft maintains that, where proven principles have been developed in practice over many years to achieve a balance of interests, changes should be made only to the extent that they are deemed unavoidable due to the special nature of the new technologies.

In the field of computer implemented inventions, the draft European directive aimed at harmonizing the different practices in the EU member states in respect of patent granting and jurisdiction for computer-implemented inventions has triggered a lively debate about how best to adapt the patent system.

Opponents of patent protection for software inventions argue that patents, particularly in the field of software:

- enable large companies to achieve a monopoly (example: PC operating systems), stunt the development of young companies, and reinforce the supremacy of certain countries (example: the supremacy of the USA over European countries);
- impede beneficial standardization efforts;
- torpedo the attractive "Open Source" business model;
- monopolize obvious ideas (trivial patents), and
- extend protection to non-technical solutions (patenting of business methods).

According to the findings of the Fraunhofer-Gesellschaft, most of these fears have no factual basis. For example: it is a verifiable fact that Microsoft's position as market leader did not come about through the use of patents. Indeed, this market position had already been established before the company had built up a significant patent position. There are as yet no known examples to indicate that established industry has used patents to impede small companies' growth or even force them out of the market. In fact, Microsoft has recently been ordered to pay a total of several billion dollars to a wide range of small companies on the grounds of patent infringement. And the claim that European companies would catch up with US companies if the existing protection for computer implemented

inventions were lifted turns the argument on its head; the global market dominance of American software companies speaks for rather than against the thesis, proven many times over, that strong patent protection in a company's home country provides a sound basis for international success.

It is true that the field of software is subject to intensive standardization. Norms, standards and quasi-standards are not, however, software-specific phenomena (example: UMTS standards for third-generation mobile communications). In the past, standardization committees have always found a solution for dealing with patents, for the simple reason that any company wishing to push through a particular standard usually offers relatively favorable conditions. It is also important to consider that standardized solutions are the result of R&D investments that would probably not have been made at all without patent protection.

The fear that the patentability of computer-implemented inventions would prevent the "Open Source" model from succeeding is unfounded. In fact, this model has been developed with great success in precisely the kind of patent environment that already exists in the USA and the EU.

The argument that, particularly in the field of computer-implemented inventions, "trivial" patents are being granted time and again in cases where a consideration of the state of the art as a whole would have shown this to be unjustified, has a certain degree of validity. Errors in the application of a system, however, do not imply that the system itself is at fault; with time, these errors can be reduced to a tolerable level – for example by completing the state-of-the-art documentation – within the existing system framework.

This brings us to the remaining argument that software can also be used to solve nontechnical problems. This is without doubt correct. For this reason, the patent laws of the EU member states stipulate that the patenting of data processing programs "as such" is excluded. However, a negative restriction of this kind does not support the clarification of the technical criteria to be met, as has been shown in practice in the individual EU member states.

All these arguments lead us to conclude that the field of software does not have any particular characteristics that require computer-implemented inventions to be treated differently than other technical inventions under patent law. However, the very fact that software can be used to solve problems outside the technological environment makes it advisable to clarify the situation by drawing up a positive specification of the technical criteria to be met. Such a specification must, however – as before – provide the courts with sufficient flexibility to adapt the required "technical character" to the dynamic development of the technology.

Examined from this perspective, we can see that the draft directive, agreed by the Council of Ministers on May 18, 2004, is essentially in line with the requirements. Its provision that a computer-implemented invention is patentable only if it makes a "technical contribution" – i.e. the invention contributes to the state of the art in a given technological field – clarifies the only remaining uncertainty and thus provides the required flexibility in terms of jurisdiction. Furthermore, this provision defines a sharp contrast with the liberal patenting practice in other countries such as the USA where, for example, it is possible to patent pure business methods. The draft directive permits exceptions to patent infringement for the purposes of interoperability between different computer programs, and the clauses limiting competition and prohibiting the misuse of market power take precedence over patent protection. Taking these points into account, as well as the fact that the Commission is investigating the effects of the guideline specifically on small and medium-sized enterprises and the Open Source model and must respond as appropriate, the Fraunhofer-Gesellschaft cannot identify any serious arguments against the abovementioned compromise.

The imposition of even further restrictions on the patentability of computer-implemented inventions can ultimately be justified only by an objection in principle to the patenting of technical inventions. The Fraunhofer-Gesellschaft believes that such a position would significantly impede innovation and be extremely damaging to Germany's economic position.

Should the European Parliament be unable to accept the compromise proposed on May 18, 2004, it would be better to abandon the initiative in its entirety. There is reason to assume that pressure in practice will lead to harmonization even without the directive – it may take longer, but a similar outcome will be achieved.

5. How to evaluate the Technology and IT projects for their transfer to the market.

It is appropriate at this point of the research to give a look to some important technology evaluation guidelines that allow us to understand if a project or a technology has the potentiality to be carried out. The development and the commercialization of advanced technologies will depend increasingly on efficient technology transfer and technology trading system. This requires the development of technology markets, exchanges and hence a reliable technology valuation methodology. Further to this it is very important that a business model tailored on the characteristics of the technology is developed.

5.1 The technology evaluation methods

Basing main contents about the fact that what market needs is the worth of technology as a product to be traded in it, lead to the independence from any firm is proposing technology. The systems that encourage technology transfer can be classified into two in general: a simple one that just builds and offers data on the information about the technology to transfer and the one that encourages technology transfer by making evaluations of technologies in various perspectives (Baek, Sul, Hong, & Kim, 2007). An example of the former is given by the Tech-Net run by the SBA (Small Business Administration) and the latter by the Value-Based Modelling of Defence diversification Agency in Britain and the TOP-index system of National Technology Transfer Center in USA. There are two main different concepts about technologies: one is narrow technology and the other in the broad technology. The narrow concept refers to the intellectual property including patent, utility model patent, and trademarks in addition to disparate technology such as knowhow, trade secret and computer software; the broad concept is not limited to the individual technology, but refers to the firm’s total capability as well. Technology is valued as an asset and it is identified as an intangible asset. It is basilar to underline the importance of the intellectual property, that alludes to all those whose possession is recognized by the law. Technologies that are not defined as intellectual properties are mostly those that are difficult to assess their value independent of the owner (company, individual, research centre, etc.) and, hence, it is rare for such technologies to become the object of the valuation. From a business point of view the value of technology can be measured using four different methods:

- the cost approach method
- the market approach method
- the income approach method
- the method of real options

5.1.1 The cost approach

The cost approach method estimates the cost of recreating the future utility of the technology being valuated, and assumes this value to be the future returns from the technology (Smith & Parr, 2000). Technology assessment is done calculating the reproduction cost of acquiring the same technology or the substitute cost of acquiring a similar asset, and then reflecting depreciation.

5.1.2 The market approach

The market approach method estimates the market price of a similar technology that has already been traded on the market and applies it to their assessment (Reilly and Schweihs, 1998). In general, if there exists a comparative market where assets are being actively traded, and if information on the transaction costs is readily available, it can become a practical method. Anyway, it is effective when concerning and assessing real estate, vehicles, general purpose computer software, but it is not effective for assessing the cases like most intangible assets or intellectual property, where similar instances of transaction are infrequent or the details of the transaction are not revealed.

5.1.3 The Income approach

The income approach method considers the sum of the present values of future cash flows of the technology as the value of the technology. According to Boer (1999) this concept, disregarding the costs of technology development, determines the value of the technology according to its feasibility to expected profits. This approach is currently being subdivided into different branches according to its various facets surrounding the assessment of the future expected profit. These facts include the estimation of the income generation period, the estimation of future income, the risks of no profit, and the conversion of future earnings into present value. Between these facets the most used results to be the discounted cash flow method is the most widely used. The discounted cash flow, analogous to the *net present value* in finance, first subtracts expenses from the cash flow received from the usage of assets, and then this net cash flow is adjusted at a proper discount rate. This method, suitable for patents, registered trademarks, copyright and other intellectually properties that can create a future profit, has the disadvantage of being unable to accurately reflect the value of technology that does not create a direct profit but bring value to the company, or technologies where future profits are hard to estimate.

5.1.4 The method of real options

The method of real options incorporaetes the financial concept of option in technology valuation, and as options are not considered as an obligation but a right, the investors have the opportunity to correct their decision according to future enviornment (Copeland and Antikarov, 2001). Using real options in investment decisions sucha s research and development projects and technology transfer can guarantee flexibility against future uncertainty in decision making. Heo (2000) stated that the real options method is not simply a model that expresses the value of an option attached to an investment alternative, but that by itself is a complete valuation model for an investment alternative. This model does not need to rely on a subjective assessment of expected returns, and while its benefits id that it recognizes uncertainity as an opportunity , its downside is the difficulty of applying the model to a real situation because of complexity of calculating important variables and the tacit acceptance of the rationality assumption (Hong et al., 2002). A monetary economic model to value the technology value. The method outlined by Baek et al. (2007) is based on three different steps:

Step 1. The expected return aalysis: it utilizes product market and cost structure analysis according to different technology types in order to calculate the amount of profit that can be created during a specific period. The amount of profit is then converted into present value based on the cashflow based model.

Step 2. The technology contribution analysis: it calculates the technology's degree of contribution (the technology contribution coefficient) to expected returns by tking into account the technology's level of innovation and the characteristics of the industry it belongs.

Step 3. The technology evaluation from a buyer's perspective considers aaditional development costs, adjustment perdio and cost for commercialization, and dynamics of profit to assess the value of the technology from the buyer's position.

5.2 IT Technology evaluation

Another important field to be investiaget is related to the evaluation of the Information Technology projects, hence from an IT enterprise point of view, state that decisions made regarding IT can influence a company's competitive position and often dictate its ability to exploit market opportunities (Haag, Baltzan and Philips, 2006). Indeed an IT metrics is needed to evaluate the technology. Two of the primary types of IT metrics are the *efficiency* and the *effectiveness metrics*. Efficiency metrics measure the performance of the IT system including throughput, speed, availibility, ecc. Effectiveness IT metrics measure the impact IT has on a business processes and activities including customer satisfaction, conversion rates, sell-through increases, ecc. Hence metrics provide a vital feedback to the firm, quickly confirming success or immediately identifying corrective actions needed such as changes in process, strategy , or product offering. Furthermore, the act of specifying concrete goals with precise measurements can help senior managers clarify their strategic priorities and set clear direcgtions, strategies, and goals throughout the organization. In order to monitorize a firm's performance three different metrics have been developed:

- the financial metrics
- the customer metrics, and
- the comparative metrics.

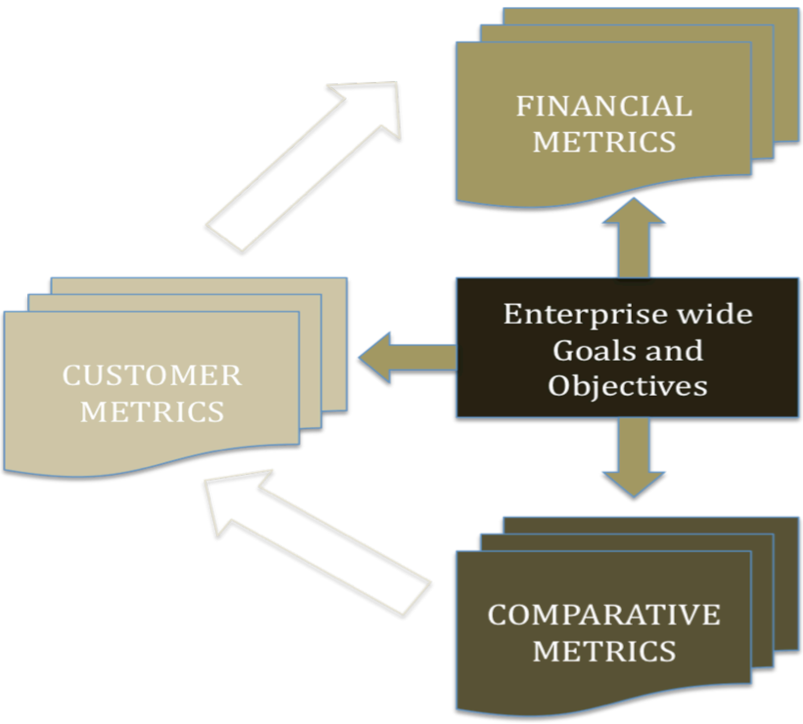

Figure 15: Business Metrics Framework. Source: Haag, Baltzan and Philips, 2006

5.2.1 The Financial Metrics

Financial metrics assess the financial performance of a company. Typical financial metrics include revenue growth, gross margins, operating income, earning per share, and cash flow. Organizations can use five different financial metrics to measure the business value of its Information Technology investments:

1. Net Present Value (NPV)
2. Internal rate of return (IRR)
3. Return on investment (ROI)
4. Payback period (PB)
5. Total cost of ownership (TCO).

Present Value is the value of cash to be received in the future expressed in today's dollars, euros, ecc. *Net Present Value* of a capital expenditure project is the present value of the stream of net (operating) cash flows from the project minus the project's net investment. Essentially the NPV makes a comparison between the cost of an investment and the present value of uncertain future cash flows generated by the project. In theory, an IT project should be accepted if its NPV is greater than or equal to zero and rejected if its NPV is less than zero.

The *Internal Rate of Return* is the rate at which at which the NPV of an investment equals zero. This is often referred to as the *discounted cash flow rate of returns*. Essentially the IRR is the interest rate, when applied to the cost and benefits of a project, which discounts the cash flow to zero. Usually the IRR is often compared aginst the *hurdle rate*, that is the minimu ROI percantage a project must meet to be considered for management approval. Hence a project with an IRR in excess of the hurdle rate is worth pursuing; when the internal rate of return of a project is greater or equal to the firm's cost of capital the project should be accepted, when it is lower it should be rejected.

The *Return On Investment (ROI)* indicates the earning power of a project and is measured by dividing the benefits of the project by the investments. The tangible benefits include cost reductions and revenue increases. The ROI equations is as follows:

$$ROI = \frac{Increased\mathrm{Re}venuesOrCostSavings}{Investment}$$

In the case that the analysis period exceeds one year then the interest ratefactor needs to be applied which can include inflation expectations, interest rate assumptions, and even a risk profile. In this case the formula is:

$$ROI = \frac{\frac{IRCS^1}{IRF^1} + \frac{IRCS^2}{IRF^1 * IRF^2} + ...+ \frac{IRCS^n}{IRF^1 * IRF^2 * \cdots * IRF^{n-1} * IRF^n}}{Investment}$$

where $IRCS^{1...n}$ indicates the increased revenues or cost savings per year and *IRF* indicates the interest rate factor. In general when the expected ROI is greater than or equal to the required return, an organizatoinal will find the investment attractive. Even if a ROI is an easy tool to be adopted in business development plan, it is needed to underline that it is not a simple task when it comes measuring ROI on a technological project.

The reciprocal of ROI is the *Payback Period* of an investmentor the period of time required for the cumulative cash inflows (net cash flows) from a project to equal the initial cash outlay (net investment). It essentially determines the amount of time required for a project to pay for itself. Usually this metrics is used as an initial screen for project priorization, which means that the longer prejects are usually not even considered. PB is taking a dominationg role in industry as the initial yardstick for project approval. The formula to determine the PB is:

$$PB = \frac{NetInvestment}{AnnualNetCashInflows}$$

this method does not take in account the time value of money and gives equal weight to all cash inflows, it even ignores all cash flows occurring after the payback period, thus it shouldn't be used in determining the acceptance or the rejection of a project.

The final financial metrics is the *Total Cost of Ownership (TCO)*. It consists of the costs, direct and indirect, occurred throughout the life cycle of an asset, including acquisition, deployment, operation, support and retirement. TCO attempts to properly state the cost of an IT investment. It is calculated by compiling all indirect and direct costs, computed on an annual basis, and then totaling them to provide the total cost of the ownership. Direct costs include the hardware, software, operations and administrations. Indirect costs include such things as end users operations and downtime. This financial methods, that the most of times requires the hiring of consultants, is very important because an organization can drasticallty understimate the cost of an IT investment if it fails to consider the totl cost of ownership. There are no fixed rules for a TCO and generally they are analyzed on a project-to-project basis.

The best measurement to use when assessing the value of information technology is the one that is correctly scaled to the size of the project.

- *Net Present Value (NPV)* and *internal rate of return (IRR)* are primarily used for large projects where the time value for money is a big factor, or when the corporation requires projects to exceed its forecasted expectations.

- *Return on Investment (ROI)* is most valuable when used to decide between different projects or competing priorities.

- *Payback period (PB)* is typically applied to project of short duration.

- *Total cost of ownership (TCO)* is used on projects of varying sizes because it provides a framework for good financial analysis of IT investments.

5.2.2 The Customer Metrics

Customer metrics assess the management of customer relationships by the organization. These metrics typically focus on a set of core measurements including the market share, the customer acquisition, customer satisfaction, and customer profitability. Customers are always concerned with the quality of the service they receive from an organization. Above all now that the internet has become part of everyday life one of the biggest problem users face with is congestion caused by capacity too small to handle large amounts of traffic. Corporations are continually benchmarking and monitoring their systems in order to ensure high quality of service. The most common quality of service metrics that are benchmarked and monitored include *throughput*, *speed*, and *availability*.

- *Throughput* equals the amount of information that can travel through the system at any point in time.
- *Speed* establishes the amount of time allowed for the system to perform a transaction.
- *Availability* denotes the numbers of hours that the system must be available for use by customers and employees. In today's world many systems needs to be available 24x7x365 in order to meet global customers and employee needs.

Nowadays companies can observe through *click-stream data* the exact pattern of a customer's navigation through a site. *Click-stream data* is a virtual trail that a web user leaves behind while using the Internet. It can reveal a number of basic data points on how consumers interact with the Web sites. Metrics based on *click-stream data* include:

- The number of page-views
- The pattern of Web site visited, including most frequent exit page and most frequent prior Web site
- Dates and times of visits
- Number of registrations filled out per 100 visitors
- Number of abandoned registrations
- Demographics of registered visitors
- Number of customers with shopping carts
- Number of abandoned shopping carts.

Following is reported a table that summarizes the main important web Site metrics according to Haag et al. (2006) and that are divided in four main characteristics: visitor, exposure, visit, and hit.

Visitor	*Visitor Metrics*
Unidentified Visitor	A visitor is an individual who visits a Web Site. An "unidentified visitor" means that no information about that visitor is available
Unique Visitor	A unique visitor is one who can be recognized and counted only once within a given period of time. An accurate count of unique visitors is not possible without some form of identification, registration, or authentication.
Session Visitor	A session ID is available (e.g., cookie) or inferred by incoming address plus browser type, which allows a visitor's responses to be tracked within a given visit to a Web site.
Tracked visitor	An ID (e.g., cookie) is available which allows a user to be tracked across multiple visits to a Web site. No information. Other than unique identifier, is available for tracker visitor.
Identified visitor	An ID is available (e.g., cookie or voluntary registration), which allows a user to be tracked across multiple visits to a Web site. Other information can be linked to this ID (name, demographics, ecc.).
Exposure	*Exposure Metrics*
Page exposures (page views)	The number of time a particular Web page has been viewed by visitors in a given time period, without regard to duplication.
Site exposures	The number of visitor session at a Web site in a given time period, without regard to visitor duplication.
Visit	*Visit metrics*
Stickiness (visit duration time)	The length of time a visitor spends on a Web site. Can be reported as an average in a given time period, without regard to visitor duplication.
Raw visit depth (total web pages exposure per session)	The total number of pages a visitor is exposed to during a single visit to a Web site. Can be reported as an average or distribution in a given time period, without regard to visitor duplication.
Visit depth (total unique Web pages exposure per session)	The total number of unique pages a visitor is exposed to during a single visit to a Web site. Can be reported as an average or distribution in a given time period, without regard to visitor duplication.
Hit	*Hit metrics*
Hits	When visitors reach a Web site, their computer sends a request to the site's computer server to begin displaying pages. Each element of a requested page (including graphics, text, interactive items) is recorded by the Web site's server log file as a "hit".
Qualified hits	Exclude less important information recorded in a log file (such as error messages, etc.)

Table 8: Web Site Metrics. Source: Haag et al., 2006.

5.2.3 The Comparative Metrics

Comparative metrics assess how the organization is performing compared to the other organizations, industries, and markets. One of the best ways to demonstrate business value is by tracking costs and contributions over time. An organization can develop cost breakdowns and compare them to industry standards to help determine if its information technology costs are in line with other industries. Different are the comparative metrics used:

- IT spending by activity and resource
- IT spending as a percentage of revenue
- IT budget allocated per employee
- The value of the hep desk

The first method, the *IT spending by activity and resource* allows management to easily compare spending among departments and even compare other organizations' spending against its own. Understanding if an organization's IT spending is in line with other similar organizations can provide a great amount of comfort to sceptical business managers. It comes very helpful when managers are preparing budgets for the following year.

IT spending as a percentage of revenue is one indicator that the company is or is not spending the right amount on information technology, since industries have various technologies needs and therefore spend differing amounts of money on technology. It is the total level of IT spending, measured as a percentage of the revenue of the organization. If a company is underspending on technology relative to its industry peers, it maybe missing a competitive advantage that its competition is enjoying. On the other hand, if a company is overspending on technology relative to its industry peers, it may be hurting its cost structure only to realize a diminishing marginal benefit.

The *IT budget allocated per employee* is generated by the IT budget divided by the number of employees. If the business is currently satisfied with the quality of services from the IT department then it can determine the amount per employee that the business is paying for this service. This method allows managers to make educated decisions about the amount of money they spend for the services they obtain.

The *value of the help desk* represents one of the easiest measurements of an IT organization's effectiveness. Since most help desks track detailed trouble tickets, it is easy to apply metrics to determine the value provided by the help desk. Each trouble ticket typically tracks the department origin, time to complete, and IT employee assigned.

6. Development of the preliminary Technology Transfer and Business Model for the Interactive Digital Media, and for the OpenSG.

This chapter of the work focuses on the development of the propositions and conceptualisation of a new model, explaining factors, which would influence the process of commercialization towards the Interactive Digital Media, and in deep towards an open source tool used to develop them, that is the rendering engine named OpenSG. This is done in order to understand the important factors that are essential to the development of a right and useful strategy for the commercialization and the transfer of this technology. This will contribute to the existing knowledge introducing factors, or better to underline how the good management of these factors, will address to a better development of the commercialization and to the technology transfer of such technological tool developed among an open source philosophy. There is no doubt that the process would have differs if actualized in different context such as the open source and not open source one. But being the aim of this work the development of a business model for the OpenSG, we will focus on the philosophy of the Open source underlining the importance reached by the Interactive Digital Media. Industry's product innovation, choice of marketing and communication strategy and maintenance of competitive advantage are dependent on a clear understanding of the factors that determine consumers' perception (Nielsen, 1998; Jongen and Meulenberg, 1998; Verbeke, 2000). This is mostly valid even among the process of transferring a technology to the market. A preliminary technology transfer model is assumed as the basis model for the business model after developed for the Open SG.

6.1 Establishing an Initial Technology Transfer Model

In this sub-chapter, an initial technology transfer model is defined based on the findings of the background chapter and the previous chapters of the literature review. The model is of general nature, i.e. no specific institutions or products of the science base or specific industry branches have been taken into account. For that reason, this model works as a template for further analysis. However, the model needs to be verified and enhanced during the qualitative and quantitative research for being used as template for evaluating the basilar factors on the commercialization of a tool used to develop interactive digital media. The initial model is based on findings that arise from related models in mainstream literature. These are a contingency effectiveness model of technology transfer introduced by Bozeman (2000), an industry-science-relationship model established by Polt et al. (2001) and a knowledge transfer model discussed by Cummings and Teng (2003). Through analysis of the literature three groups of influential factors can be identified, i.e. factors arising from the characteristics of the transfer agent, the characteristics of the transfer recipient and transaction related and environmental factors. Furthermore, the model describes the output effects of technology transfer and provides indicators for the definition of technology transfer performance, which will be required for qualitative analysis (as a matter of a clear definition of the research subject for interviewees).

6.1.1 Conceptual Basis of the Model

In the scientific theory for empirical sciences a model represents a well-founded part of the reality. In the research process the establishment of such a model starts with creation or adaptation of a theoretical model based on existing literature. Such a theoretical model is a system of consistent statements regarding the specific research subject (Mayer, 2002). The model established in this sub-chapter comprises the factor which is supposed to be explained (i.e. the technology transfer performance), influential factors as well as statements defining the nature of the relationship between the influential factors and the factor to be explained. The subject represents the phenomenon which is supposed to be explained (in this study the research subject is the 'technology transfer and a business model for the Interactive Digital Media'). Influential factors derived from the relevant mainstream literature are those components which define, explain or influence the behaviour of the subject (e.g. the demand for technology from a company's perspective). Statements are used for modelling the relationships between the research subject and the influential factors. Influential factors can be conceptualized through the dimensional analysis, i.e. specifying the key dimensions of the influential factors (e.g. the organizational design of the scientific institution can be conceptualized as the availability of developers, processes and the organizational structure like the organization of the research teams as quasi firms, the level of technology innovation of the IDM).

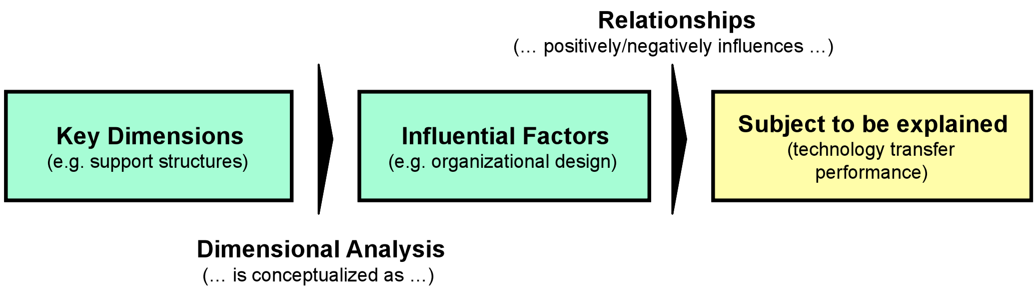

Figure 16: The conceptual basis of the model

The mutual relationships between the influential factors and the factor to be explained as well as their specific nature will not be taken into account in this conceptualization of a generic technology transfer and business model. The reason is that some of those relationships might depend on the idiosyncrasies of the specific scientific institution under consideration. Therefore, in this model the influential factors are merely defined to somehow influence the research subject. Additionally, the dependencies among the influential factors are not taken into account. Such dependencies relate, for instance, to the transfer object and the transfer mechanisms: if a technology is complex requiring a high portion of tacit knowledge to be commercialized mobility schemes might be the best way of transferring the technology to the industry. An initial model is reported later for the commercialization of the OpenSG. As a result, the initial model conceptualized in this sub-chapter represents a taxonometric classification of factors influencing the technology transfer performance for further analysis, i.e. the model will be (after additional verification) the basis for additional research leading to a conceptualization of a commercialization model for technology transfer in the context of the interactive digital media.

6.1.2 Conceptualization

The generic technology transfer model is designed to explain the factors influencing the technology transfer performance (representing the very base for analysing the research subject in this study) targeted at the stimulation of innovation performance and economic growth. The model established in this section represents (after additional verification and enhancement) the starting point for further analysis (i.e. the analysis of the commercialization of the OpenSG).

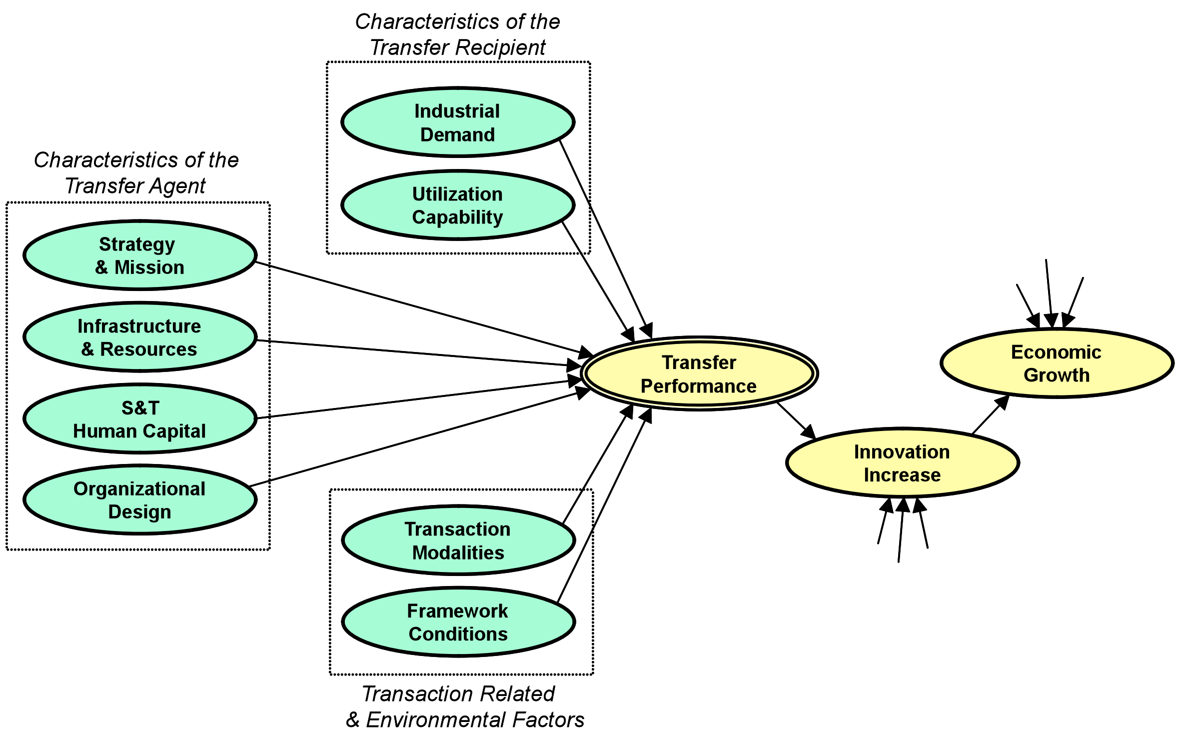

Figure 17: Categorization of influential factors of technology transfer

The model is derived from an analysis conducted by Bozeman (2000) discussing the body of literature regarding technology transfer. In this analysis a contingency effectiveness model for technology transfer is presented. This model provides a useful categorization of factors influencing technology transfer identifying five broad dimensions (i.e. five groups of factors). These dimensions include the specifics of the technology transfer agent (e.g. the organizational design), the specifics of the technology transfer recipient (e.g. the absorption capacity of new technology), the demand environment, the transfer object and the transfer media. However, for the purpose of this study the three latter groups are summarized. The overall category is named ‘transaction related and environmental factors’. This goes in line with other models in literature like the industry-science-relationship model introduced by Polt et al. (2001) or the knowledge transfer model by Cummings and Teng (2003) wherein factors are classified in those originating from the donating institution, the receiving institution and intermediate factors.

Successful technology transfer brings forth innovation in the industry in terms of new products or lean processes, and innovation increase on the aggregate level contributes to endogenous economic growth.

6.1.3 Technology Transfer Performance

The technology transfer performance for interactive digital media is conceptualized as the technology transfer quality and the technology transfer quantity. The transfer quality relates to the economic impact of the technology in the receiving institution (i.e. the market impact). In this context Bozeman (2000), discussing the effectiveness of technology transfer, applied the market impact of the transferred technology to the effectiveness dimension. He introduces five dimensions describing successful technology transfer including the market impact, the impact on the economic development of an economic system (e.g. a region) on the aggregate, the political reward most often measured in terms of increased funding, the effects on other missions than technology transfer on the agent or the recipient and advances in the scientific and technical skills of human capital. However, as a narrow definition of technology transfer is pursued in this study, only the market impact dimension will be taken into account. As a result, the economic usefulness of the transferred technology represents the quality dimension of technology transfer. This aspect of economic usefulness is emphasised by several authors in the literature (e.g. Lundvall, 1992; OECD, 2002a; Knoll, 2001; Pavitt, 2000). As a result, technology transfer quality refers to the ability to deliver technology, which is subsequently successfully commercialized by industry in an economic sense. Transfer quantity relates to the amount of technology which is transferred to the industry on the aggregate level facilitated through various transfer channels. This quantitative approach can be found in various literature sources. For instance, Schartinger et al. (2002) list the number of collaborative research projects, the number of spin-offs, the number of jointly written scientific publications, etc. for measuring the performance of industry-science-relationships. Similarly, according to Hakanson and Nobel (1998) transfer success is defined as the number of transfers completed within a certain period. Concisely, the quality dimension of the technology transfer performance refers to the economic impact of the transferred knowledge (impact perspective), whereas the quantity dimension represents the amount of technology which is transferred from the technology donating institution (delivery perspective).

6.1.4 Characteristics of the Transfer Agent

The characteristics of the transfer agent comprising the factors strategy and mission, infrastructure and resources, scientific and technical of human capital and the organizational design significantly determine the technology transfer performance from the perspective of the technology donating institution.

Of crucial importance for the technology transfer performance is the scientific and technological human capital within the scientific institution seeking technology transfer. The skill base of the modern scientist being involved in technology transfer is not only restricted to scientific excellence but also involves – as supposed by Polt et al. (2001) – additional skills which are required for facilitating technology transfer.

These additional skills relate to new management skills like the ability to apply for research grants and the ability to manage projects properly (Braddocka and Neaveb, 2002). This goes in line with Ernø-Kjølhede et al. (2001) stating that the modern researcher is a highly skilled employee focused not only on his or her research agenda but also on the desires of stakeholders and who is an individualist and at the same time a team player. Furthermore, a positive attitude of the staff being supposed to perform technology transfer is required. However, this does not always go in line with the incentive structure in the scientific world, as scientists are often awarded according to their academic value of research (e.g. publications) rather than according to the successful conducted technology transfer projects. The scientific value of research not always matches the demand of the industry (Liu and Jiang, 2001). As a result, the factor ‘scientific and technical human capital’ is conceptualized as the scientific quality of the research staff, the management skills as well as the attitude towards technology transfer.

Another important factor influencing the overall technology transfer performance is the organizational design of the technology transfer agent. The organizational design is conceptualized as the organizational structure of research teams, the availability of support structures within the scientific institution, the working practises applied as well as the incentive schemes available for researchers. Due to the increasing complexity and inter-disciplinarily nature of technology research teams rather than individual researchers are required for conducting research within the science base (OECD, 2002a; Ernø-Kjølhede et al., 2001). Most often those research teams are of inter-disciplinary nature targeted at conducting Mode-2 knowledge production (Gibbons et al., 2006). Also Etzkowitz (2002) and the OECD (1999c) vote for the establishment of research teams or research centres set up as quasi firms for the successful facilitation of technology transfer. The effect of the implementation of dedicated research teams is a proper alignment of the focus towards the research mission (and often the utilization mission) in contrast to research that is conducted alongside lecturing duties (wherein lecturing is always in the fore). The organizational design also covers proper working processes, a factor closely related to the organizational structure of research teams. One of the major issues in this respect are different planning cycles between industry and the higher education sector, as the higher education sector planning is traditionally related to the academic year (OECD, 1999c). This most often results in different expectations regarding delivery times for services. Also, new management methods have to be implemented within the higher education system like a proper project management or project controlling being a result of the industry representing – at least to some extent – a new client base for higher education institutions (OECD, 1999c). Thus, research teams have to pick up the pace of development of industry in order to deliver the expected results by the means of the implementation of proper working practices, methods and processes. Another important factor in the context of organizational design is the availability of support structures providing value-added services for the research team and the industry. Support structures comprise industry-liaison offices, technology transfer offices and business incubators all of which are targeted at supporting technology transfer by the means of giving administrative support to researchers (Etzkowitz, 2002; Etzkowitz, 2003; Cooke, 2001; Jones-Evans et al., 1999). Support structures can also be seen as centralized services in a higher education institution providing services for research teams or individual researchers assisting in the complex process of technology transfer (e.g. handling of intellectual property rights, contracting, raising venture capital, etc.). In the analysis of the technology transfer performance of scientific institutions a number of barriers can be found. These barriers relate to – among other important factors – a lack of incentives for working with industry compared with incentives for research or teaching activities (cf. Jacob et al., 2000). In daily life, individuals at universities and publicly (co-) financed research institutes are judged by their research performance rather than by other parameters such as their contribution to regional development. Personal advancement is gained by patents and publications and not by the number of jobs created (Heydebreck et al., 2000). Therefore, shifts in paradigms regarding incentive schemes are required as a core element of organizational design. New incentive schemes have to find a proper balance between motivation for purely scientific activities and those relating to technology transfer.

Furthermore, a factor influencing the technology transfer performance is the availability of infrastructure and resources. The availability of infrastructure and resources is conceptualized as the availability of financial resources, technical infrastructure and the size of R&D representing the critical mass required for reaching ambitious research goals. Due to the trend of decreasing public funding for higher education research, industry funding and, therefore, technology transfer activities are becoming increasingly an important dimension of the overall higher education research funding. A high portion of block-grant-funding might thus be negatively associated with technology transfer activities leading to purely interest driven research activities within the higher education sector (as industry funding is not required for financing research). Technical infrastructure represents the environment needed for conducting research. Most often scientific instruments are very expensive and can therefore not be charged as a portion of the working costs in industry funded projects. However, according to Hagen et al. (2002) unique machinery or specific labs, which compensate for missing infrastructure in the industry, might cover a portion of the investments if access services for the industry are provided. Thus, without any public funding the establishment of an environment conducive to high level research (e.g. labs and unique machinery) might not be possible. Another factor established by Bozeman (2000) is the size of R&D, i.e. the critical mass of resources being engaged in the production, dissemination and utilization of scientific knowledge. Additionally, Polt et al. (2001) introduces the size of R&D as an important factor for facilitating industry-science-relationships.

The technology transfer performance is crucially influenced by the overall strategy pursued and the mission established within the technology donating institution. According to Debackere and Veugelers (2005) efforts to improve industry-science-relationships are especially successful when they are embedded in the central mission of the institution. In case of higher education institutions this institutional mission also represents the expectations of the external stakeholders (i.e. the politicians) most often being concerned with the socio-economic impact on the society as a whole. The overall mission is also identified by Bozeman (2000) to play a crucial role in the effectiveness of technology transfer. Additionally, the overall strategy plays a crucial role in facilitating technology transfer defining, for instance, the overall mode of knowledge production (i.e. Mode-1 versus Mode-2 knowledge production relating somehow to basic versus applied research), the type of relationships between academia and business (e.g. long-term versus project based), the geographic market dimension (e.g. the regional engagement), the target customer (i.e. the type of preferred company), the utilization mechanisms in use, etc. (Gibbons et al., 1994; Debackere and Veugelers, 2005).

6.1.5 Characteristics of the Transfer Recipient

The characteristics of the transfer recipient comprise the capability of commercially utilizing technology and the industrial demand for technology. The utilization capability represents the capacity to successfully commercialize technology in terms of innovation increase and economic success. The utilization capability is conceptualized as absorptive capacity, the manufacturing experience, the marketing capabilities and the overall business strategy pursued (Polt et al., 2001; Bozeman, 2000). A detailed discussion of the utilization performance of the transfer recipient goes beyond the scope of this study, as the major concern deals with the effects of the idiosyncrasies of Universities of Applied Sciences on their technology transfer performance. These idiosyncrasies do not affect the transfer recipient's characteristics. Thus, the factor is listed for completeness reasons but will not be taken into account for the detail analysis within the empirical research.

The industrial demand in this model rests on an analysis conducted by Polt et al. (2001) regarding a conceptual model for analysing industry-science relationships. In this model the market demand – besides other important factors – is identified to play a crucial role in the collaboration between business and academia. In the same vein Bozeman (2000) identifies the demand for technology as one of five broad dimensions determining the effectiveness of technology transfer. The demand in this study is conceptualized as potential demand and existing demand. In his discussion of the demand environment for technology Bozeman identifies the market-push and the market-pull mechanism shaping the demand of industry. Market-pull represents demand that is articulated by the industry (i.e. existing demand). On the contrary, push mechanism are designed for satisfying demand which is hidden (i.e. potential demand that is not articulated by the industry). Detailed discussions regarding push and pull mechanisms can be found in the literature (Spoun, 1998; Moon & Bretschneider, 1997). Variables influencing the industrial demand for technology (independent if articulated or not) might comprise the pace of technological development, the complexity of technology to be dealt with, the collaboration culture, the specific industry sector, the size of business R&D, the overall R&D strategy, the competitive environment in the industry sector, the availability of alternative technology suppliers and the funding for collaborative research provided by the government. However, this detailed perspective on the demand environment goes beyond the scope of this study as it is assumed that the industrial demand for technology is not heavily influenced by the idiosyncrasies of Universities of Applied Sciences. Rather firms may not care about the specific type of the technology donating institution as long as their requirements are properly met. As a result, the total demand for technology of the industry accounts for the existing demand (articulated by the industry) plus the potential demand which has to be stimulated by market-push mechanisms (hidden demand).

6.1.6 Transaction Related and Environmental Factors

Besides factors arising from within the institutions involved in technology transfer (i.e. factor relating to the transfer agent and the transfer recipient) also market related factors crucially influence the technology transfer effectiveness. These market related factors originate in transaction related factors and environmental factors, i.e. the modalities of transaction and framework conditions. Transaction modalities can be conceptualized as the distance between technology donating and technology receiving institution, the modalities and handling of intellectual property including non-disclosure agreements, the monetary participation of the industry in the research project, the transfer object, and the transfer mechanisms. For instance, Mansfield and Lee (1996) investigate the effects of distance on technology transfer from academia to business. The study shows that while distance is very important for the collaboration between academia and business in applied research, in basic research distance only plays a minor role. Thus, in technology transfer distance is of crucial importance as face-to-face contacts especially count in collaborative research projects. The technology transfer mechanisms representing a set of options for transferring technology (e.g. spin-offs, licensing of patents, contract research, etc.) have been identified to be crucial for the overall technology transfer performance (cf. European Commission, 2000a). Thus, transaction mechanisms are conceptualized as the specific forms of technology transfer which are in place. Transfer mechanisms are conceptualized as spin-offs, licensing of patents, collaborative research efforts between academia and business, contract research, mobility schemes and monitoring of activities of the science base. Closely related to the transfer mechanisms is the transfer object, i.e. the entity which is transferred from the science base to industry. The transfer object can be categorized in scientific knowledge, technological devices, technological designs, processes, craft, and know-how in general.

Environmental factors influencing the technology transfer performance are public framework conditions, which shape the market in which the transaction takes place. According to Polt et al. (2001), framework conditions comprise promotion programmes, intermediary structures, legislation and regulation as well as the institutional setting.

A Taxonometric Classification

_ Group	_ Influential Factor	_ … is conceptualized as … (key dimensions)
_ Characteristics of the Agent	_ S&T Human Capital	▪ scientific excellence of staff ▪ management skills ▪ attitude towards technology transfer
	_ Organizational Design	▪ structure of research teams ▪ availability of support structures ▪ proper working practices ▪ proper incentives schemes
	_ Infrastructure & Resources	▪ financial resources ▪ technical infrastructure ▪ size of R&D (critical mass)
	_ Strategy & Mission	▪ technology transfer strategy ▪ overall institutional mission defined
_ Characteri stics of the Recipient	_ Utilization Capability	▪ absorptive capacity ▪ manufacturing experience ▪ marketing capabilities ▪ business strategy
	_ Industrial Demand	▪ existing technology demand ▪ potential technology demand
_ Transaction Related & Environmental Factors	_ Transaction Modalities	▪ transfer object ▪ transfer mechanisms ▪ costs ▪ distance ▪ IPR handling
	_ Framework Conditions	▪ intermediary structures ▪ funding programmes ▪ legislation & regulation

Table 9: Summary of the key dimension of the influential factors

It is well known, from literature and from the everyday life, that Interactivity is fascinating more than a normal technology, hence that

Interactive Digital Media are tools continuously growing (Papastergiou, 2009; Evans & Gibbons, 2007).

6.2 The Business Model

Before growing our business consciously, we need to have a clear definition of how the business is structured, this structure this will be called business model. There exist many schools of thought in defining a business model. In all the cases the business has to be viewed from many sides:

- rational and operational aspects of the business;
- economic or financials of the business;
- emotional or feelings about the business.

A definition of business model states that it describes the value and organization offers to various customers and portrays the capabilities and partners required for creating, marketing, and delivering this value and relationship capital with the goal of generating profitable and sustainable revenue streams. In the following picture is reported a business model framework:

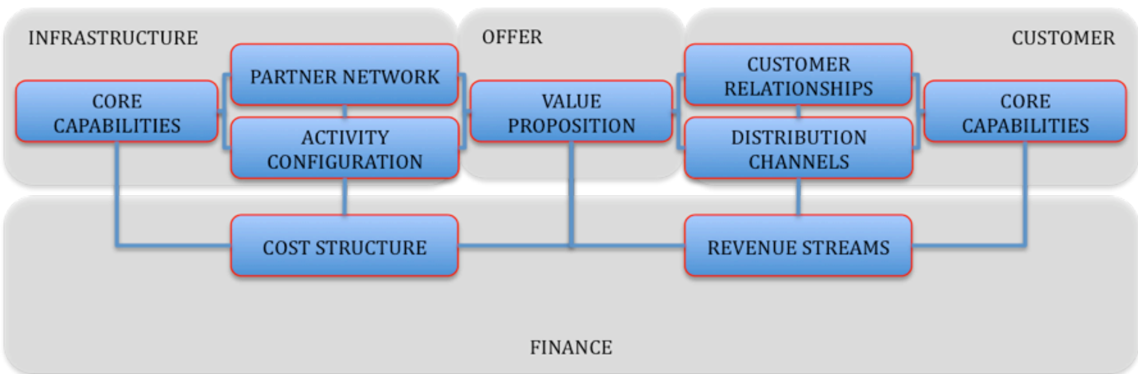

Figure 18: Business Model Framework

Above all in the software segment, and precisely in the case of interactive digital media, the important role of business process modelling will become even more crucial than it is now because these systems grow in scale and complexity (Barjis 2008). The importance of the business modelling process is confirmed by a survey conducted by the Standish Group (Standish 2004)…*da slide share*

With the introduction of the Internet of Things and Services, completely new business models are needed to identify and explain the much more dynamic value creation and to model the exchange of products, services, information and resulting values among dynamically emerging constellation of multiple stakeholders across the business system (Guarise et al, 2008). In this environment companies must continuously and constantly repositioning themselves. Developing a strong business model means, for a firm or for a product, in this case a digital media, to have a better foundation for understanding the challenges and communicating and sharing the understanding among stakeholders. The business model aims to answer to the generic and fundamental questions that are:

- what is that we offer to the customer?
- Who are our customers?
- How do we operate to deliver the product or the service so that we can create a profitable and sustainable business?

The answers have a base role in order to develop the further strategy for the business model implementation, and on the choice of modelling approach to be taken. Once the questions find the answers, it is easily to instantiate the model into a preferred Business Case. According to Pigneur (2005) the fundamental elements of a business model can be summarised in the following figure:

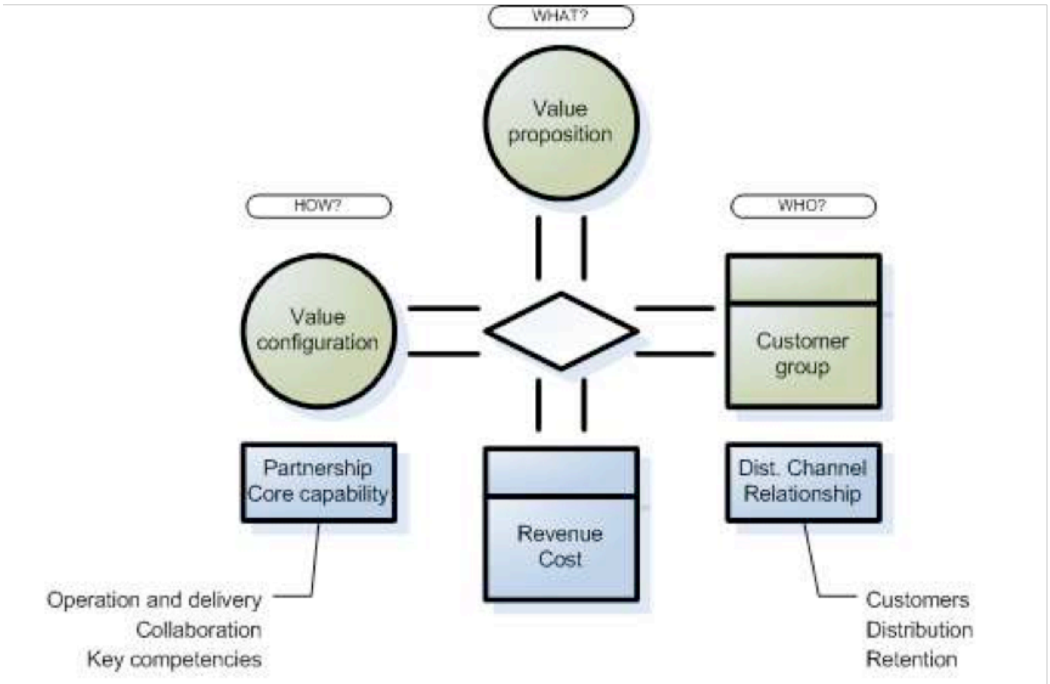

Figure 19: Fundamental elements of a business model. Source: Pigneur 2005.

For the open source software, and hence also and precisely for the OpenSG there are key factor in designing the model that results to be relevant for the business development. These key factors are the community, the partners, the developers and the customers. The community generate activities, feedback and specific contributions, the partners are needed to create the market, the customers to answer and to give the possibility to the software to be customized and the developers to asset it in order to satisfy the customers' needs.

All these considerations, and analysis allow me to develop a preliminary technology transfer and business model to adapt to the OpenSG.

7. Methodology of the research

The following chapter lists the relevant research stages of this PhD work. According to Wrught and Crimp (2000) using a mixture of qualitative and quantitative methods will lead to more significance and reliable conclusions. Further to this two methodology there has been the desk research and the observation research developed during the first two years of the work. Thus a combined approach can focus on the respective strenghts of each methodology (Armaratunga et al., 2002). Qualitative methods have an open and exploratory character, whereas quantitative methods have more potential for statistical usage. Counter positions on mixing research methods, claim that one should concentrate on one paradigm. Still, further support from research methodologists is eligible in order to support researcher (Johnson and Onwuegbuzie, 2004). The following picture gives an overview of the chosen research process:

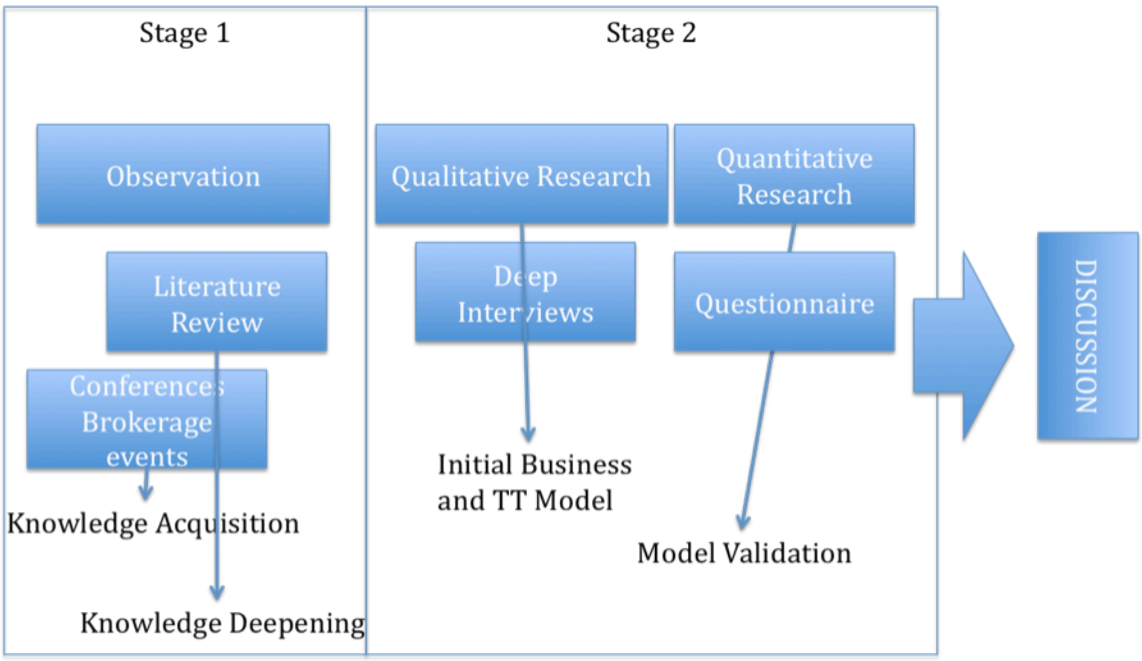

Figure 20: Research Stages of the PhD thesis

The research has lasted for three years, in which the first two have been dedicated to an observation phase where knowledge and information about the Interactive Digital Media has been gathered. This phase has been conducted during the first in the Evolutionary System Group of the Department of Linguistics in the University of Calabria and during the second year in the Centre for Advanced Media (CAMTech) in the Nanyang Technological University of Singapore. During both periods the observation research has been conducted through the participation in several and different conference and fairs all based on interactive media and on technology transfer. During the first year I took part in several meetings organized by the European Commission where I gathered information about the transfer of technology through the implementation of European Project in order to achieve founding for the research. During the second year, working in Singapore, I got a deep knowledge about interactive media such as virtual reality and augmented reality, joining the research that were conducted in the research centre I worked with. In Singapore they even developed a rendering engine, with an open source philosophy, that is the media through which many of this technologies are carried out. At this point of the research, because of my business background I started to think about the development of a model that could achieve some profit for this powerful and easy to use engine. Hence during my third year I spent half of it researching and trying to understand which model could better suite on the OpenSG, and in the mean time on the Interactive Digital Media. During the last year I conducted two different kind of researches: a desk research and a field research conducted in the Chapman University in Orange County, Los Angeles, California. The desk research gave to me the possibility to acquire enough knowledge on items such as:

- The basis of the Interactive Digital Media, deepening subject such as Human Computer Interaction, Multimodal User Interfaces, Digital Media, Interactivity;

- The core components of the technology transfer, analyzing all the aspects related to the transfer of technology and knowledge between the two different worlds: the academic one and the industrial one. Analyzing various business models, and strategies that allow universities to get in touch with industries and vice versa.
- The main tools developed in USA and in Europe for the protection of the interactive digital media developed; giving a deep look into the Digital Millennium Copyright ACT and European Copyright Directive.

After the desk research the stages of the research moved forward to the qualitative and quantitative research through the methods and in the places as following:

1. A qualitative research developed in California, and precisely in Orange at the Chapman University where interviews has been conducted in order to deepen and develop the business model;
2. A quantitative research made through a survey questionnaire custom made in the Chapman University and, after been validated by marketing and business experts, sent to more than 1.400 recipients through the web, using a web tool to submit questionnaires on-line.
3. In the end the model developed from the technology transfer and business models analysed, and from the qualitative research conducted through the in-deep interviews has been evaluated through a quantitative research made through questionnaire submitted to all person working with digital media and sent to a web community made by academics and industrial managers.

7.1 The desk research

As above stated the desk research has been conducted during the first two years of my PhD course, where I had the possibility to analyse several digital library, but furthermore to take part in several seminars and conferences where I had the opportunity to understand in deep the importance and the power that such tool as the interactive digital media possesses and manifest in many field of industries and academies. The desk research has been developed in the first year between Italy, at the University of Calabria, and the USA in the University of Chapman in Orange County, wherein even another part of the research, the qualitative one, have been conducted. The desk research and the participation to the conference, brokerage events, and other several meetings about the Digital Media, allowed me to even build the population of people that has been after the interviewed for the quantitative part of the research. Following is reported part of the events I participated during the first two years of my PhD courses:

- "Q.LIME – Quality in Licensing and IPR Management Education Proprietà intellettuale e Licensing Management: un'opportunità formativa", 23 gennaio 2007, Aula Caldora, Università della Calabria, Rende
- Convegno APRE, "7° Programma Quadro di Ricerca e Sviluppo Tecnologico dell'UE", 31 gennaio e 1 febbraio 2007, Osservatorio Nazionale di Capodimonte, INAF, Napoli
- Giornata Informativa sul VII PQ, 5 febbraio 2007, Aula Caldora, Università della Calabria, Rende
- IL 7° PROGRAMMA QUADRO PER LA RICERCA E LO SVILUPPO TECNOLOGICO - Giornata nazionale di lancio delle misure per le PMI", 6 febbraio 2007, Camera di Commercio di Milano, Palazzo Turati, Milano

- The Information Day and Brokerage Event, 8/9 of March 2007, Institute of Byo-cybernetics and Biomedical Engineering, Polish Academy of Sciences, Warsaw.
- IV CIRCLE - International Conference on “Consumer Behavior and Retailing Research”, 11 – 14 April 2007, Grand Hotel President, Locri – Siderno, Reggio Calabria, Italy
- NEST-Promise “Promoting Research on Optimal Methodology and Impacts”, Regione Calabria, 10th of July 2007, Bruxelles.
- XXIII Incontro ARETHUSE “Il Governo delle risorse locali”, 26/27-09/2007, Università del Molise, Termoli (CB)
- Game Developers Conference, San Francisco, 20-28 February 2008.
- Emerging Technologies 2008 O”Reilly, San Diego, 3-7 March 2008.
- Euro-Southeast Asia Cooperation Forum on ICT Research, Bruxelles, 6 – 7 October 2008
- CIRCLE VI Conference on Consumer Behavior – Voralberger University – Dronbirn, Austria
- II Digital Documentaion Conference, Old Fruit Market, Glasgow, United Kingdom, 22-24 April 2009.

Further to these conferences the research activities lead me to many other research travels where I had the chance to gather more contacts in order to build the population for the quantitative research. Some of these travels are shown here:

- Leeds, England, 2nd - 6th May 2007, Study period in the Leeds Metropolitan University for research related to the consumer behaviour with Prof. Vignali Claudio
- Darmstadt, Germania, Fraunhofer Institute e IniGraphicsNet, 18 - 23 of June 2007 on research focused on mobile communication,

virtual and augmented reality and technology transfer.

- Udine, HCI Lab, Dipartimento di Matematica e Computer Science, Università di Udine, mobile communication and real and augmented reality.
- EECS (Electronic Engineering and Computer Science Department) Berkeley, San Francisco, USA, 31st August – 10th September research on chaos and CNN.
- CAMTech (Centre for Advanced Media Technology), Nanyang Technological University, Singapore, March – December 2008
- University of Chapman, Orange County, CA, USA, February 2008 and September and October 2009, research on Digital Media.

This first stage of the research, as previously mentioned, allowed me even to design the following parts. In the picture is reported the various step of the entire PhD research:

7.2 The qualitative Research

The qualitative research stage of the study concentrates on testing and validating the proposed business model from an experts' point of view. Furthermore new perspectives were found and enrichment and refinement of the proposed model dimensions took place. According to Söderqvist (2001), the qualitative approach produces rich and deep data on the different aspects of the phenomenon. The benefits of qualitative approaches provides to the researcher the possibility to get an insider view on the research object, which is often not in the case in quantitative research. Therefore qualitative approaches facilitate understanding of behavioural aspects and the corresponding reasons (Burns 2000). The tool chosen to carry out the qualitative research has been the in deep interviews.

7.2.1 *Interviews*

Interviews are associated with both positivist and phenomenological methodologies. Collis and Hussey (2003) state that interviews are a method of collecting data in which selected participants are asked questions in order to find out what they do, think or feel. On the following table are reported advantages and disadvantages of using interviews as a way of primary research.

Advantages	Disadvantages
Used in a variety of context and situations	They are very time consuming
Face to face with interviewee, so can clear up any misunderstanding straight away	You need to take into account length of interview, travelling to and from interview
Interviews make it easy to compare answers	There are problems with bias, reliability and validity which must be addressed throughout the whole interview process

Table 10: Advantage and Disadvantage of Interviews. Source: Vignali et al., 2007.

The focus of the qualitative research has been chosen to be in Chapman University in Orange County, Los Angeles, California, USA. The reason of this choice stays in the fact that this university represent both a great reference point for the business with its Business School and a great point of reference for the Digital Media because very close to the Hollywood industries such as Disney, Pixar, Dreamworks, and many others. The interviews were developed on the basis of the desk research carried on, and it is reported in appendix A. The interviewed persons were chosen through an accurate research of their profile on the web pages of the Dodge College Film School of Film and Arts, where all professors' details were reported. After this a first mail contact has been sent in order to settle appointments for a one to one interviews. The mail was sent to more than 30 full and associate professors, and 14 of them, the 46,6% answered positively in manner that we could schedule the appointment for the interview. Each interview lasted from 30 to 45 minutes and notes were carefully taken in order to recognize if there were point of conjunction between the various subjects that could lead me through the finding out of the main important factors for the development of the model to be developed. Even if the most of them gave me the permission to name them in this work, for privacy reasons I prefer not to mention them, hence they will be numbered from Int.1 to Int.14. Their expertise, brief resume and their main activities are reported in the following tables.

N.	*Expertise*	Background
1	*Digital Media and Arts*	The Int. 1 is a full professor at the Dodge College of Film and Arts, Orange County, Los Angeles, California, USA. He produced corporate and non-profit videos and a wide range of award-winning public relations pieces. At Chapman, she also served a four-year stint as Director of Public Relations.
2	*Digital Media and Arts*	The Int. 2 is the Dean of the Lawrence and Cristina Dodge College of Film and Media Arts. He is a producer/director of educational and industrial films and the school's technology guru, and he put Visual Storytelling at the heart of the program.
3	*Digital Media and Arts*	The Int. 3 is the Associate Dean & Chief Technology Officer of the Lawrence and Cristina Dodge College of Film and Media Arts.
4	*Digital Media and Arts*	The Int. 4 is a screenwriter/director in Hollywood. He holds a MFA from Columbia University in New York. He has taught at University of Southern California, and currently teaches screenwriting and production at Chapman University's Dodge College of Film and Media Arts.
5	*Digital Media and Arts*	Full professor of animation and of Digital media at the Dodge College of Film and Arts. He worked on several films, including Cats & Dogs, Antz, A Simple Wish, South Park, and Doughboy commercials.
6	*Digital Media and Arts*	The In. 6 is a documentarian and a professor in Digital Media. He has a Masters in Visual Anthropology at USC, he use to teach documentary techniques at the Dodge College of Film and Arts. He cooperates with the Hollywood Industry too.
7	*Digital Media and Arts*	The Int. 7 is a full professor of Digital Processing at the Dodge College of Film and Arts. He as a degree from Harvard (with honours in English Literature), as well as an M.F.A. from UCLA. He directed a wide range of projects from feature films to music videos and corporate profiles.
8	*Digital Media and Arts*	The Int. 8 is an art director that works for Columbia Pictures. He was set designer, and after became an assistant art director and art director to production designer. He worked on such films as Bullit, True Grit, Little Fauss and Big Halsey, and Back to the Future.
9	*Digital Media and Arts*	A graduate of the Harvard Business School where he studied marketing. He has also worked for HBO, several Internet start-ups and the American Film Institute. Along the way, he launched Disney's American Teacher Awards, set up a national literacy promotion for The Disney Channel's 10th anniversary.
10	*Digital Media and Arts*	The Int. 10 is a Professor of Interactive Media, he is a lead artist for game giant Interplay Productions, he worked on projects such Star Fleet Academy. Today, he is creating top-secret games for Microsoft's new Xbox technology.
11	*Computer Science*	The Int. 11 is the Associate Dean of the Schmid College of Science, in the Department of Mathematics & Computer Science of the Chapman University.
12	*Computer Science*	The Int. 12 is the Canchelleros of the Chapman University and the advisor for the Dodge College of Film and Media. He worked in several important Universities around the world leading technology and digital media.
13	*Advenced Technology*	The Int. 13 is full professor of advanced technology in the University of Chapman dealing with Augmented and Virtual Reality.
14	*Advenced Technology*	The Int. 14 deals with the industry of Hollywood where he coordinate different project among animation and digital entertainment. He even teaches 3D media and environment development in the Dodge College of Film and Art.

Table 11: Brief Description of interviewees.

To what concern the sample size, in qualitative research no consistent guidelines was found. According to Cresswell (1998) the sample size for qualitative research has not to be less than eight to ten, while Lamnek (1995) and Merkens (2003) state that for qualitative studies the quality of the informants and the quality of the provided content is at the centre of interest rather that statistical representative for quantitative studies. The selected 14 interviewees fulfil the criterion of representativeness, due to the background illustrated in the previous table.

7.3 Data analysis: Content Analysis

The interviews were carried out during September 2009 in Chapman University, and precisely among the Lawrence and Kristina Dodge College of Film and Arts and the Business School and Computer Science School. Because of the previous organization in contacting this key-person not so much time has been needed for interviews, and even because the location chosen had all the necessary facilities and expertise needed to carry on the research. The overall qualitative research process for the focused interviews started with the development of a questionnaire based on an initial model derived from analysis of the explorative researches carried out during the first two years of my PhD course, through conference participations and meetings all related to the technology transfer and digital media and from the technology transfer conceptualization model developed previously in this work. Before conducting the interviews, it has been submitted to a several business and marketing professors and to a computer science professors, who addressed me towards improvements related to the syntax of questions and to the goals I wanted to achieve.

7.3.1 Content Analysis

Content analysis is defined as “a method of collecting data where text is systematically converted to numerical variables for quantitative data analysis” (Collis & Hussey 2003). Mostyn (1985) citied from Collis and Hussey (2003) refers to it “as the diagnostic tool of qualitative researchers, which they use when faced with a mass of open ended material to make sense of" (Collis and Hussey 2003).

Advantages	Disadvantages
Inexpensive method and pressure of time is not an issue	Silverman, (1993) cited from Collis and Hussey, (2003) stated that Its Theoretical basis in unclear and its conclusions can often be trite
You can choose to conduct your analysis when you wish	Process of data reduction at early stage of the research
The systems and procedures for carrying out content analysis are very clear	To record only the words or phases you consider are of particular interest, may mean that you discard large amounts of data that could help you understand the phenomenon you are studying.

Table 12: Advantage and Disadvantage of content analysis. Source: Vignali et al., 2007.

7.3.2 Procedure

The interviews were transcribed and collected data were analysed using a 6-step process of content analysis (Mayer, 2004; Mühlenfeld 1981). This technique was chosen as it is focusing on the evident and unstopped content of the communication content, which represented the overriding objective of the qualitative research. The particularity of this analysis procedure is the multiple revising of the given material in order to derive a theoretical and empirical description and interpretation of the results. The following are the steps needed to carry out such analysis:

1. Mark all relevant text parts, which are potential answers of the questions according to the interview guideline.
2. Coding of the text according to developed categories.
3. Build logical connection between single information.
4. Write text according to logical connection.
5. Add interview sections to text.

6. Report.

Content analysis is a method of codifying a text or a transcribed interview into various groups or categories based on selected criteria (Weber, 1988). The definition process of the categories used for coding the interview data is the most crucial one (Mayring, 2005). As stated in Bar Ilan & Groisman (2003), “most studies using content analysis are unable to use existing classifications and have to develop their special coding tool for analysing the data at hand in order to meaningfully characterise the dataset”. Kirppendorff (1980) supports this and highlights the difficulty in defining the appropriate categories.

For this reason an inductive approach for developing categories has been selected. The inductive approach means that the interview data is the point of departure and the categories need to be formulated very close to the collected material (Mayring, 2005). In the following figure the process of inductive category development is presented.

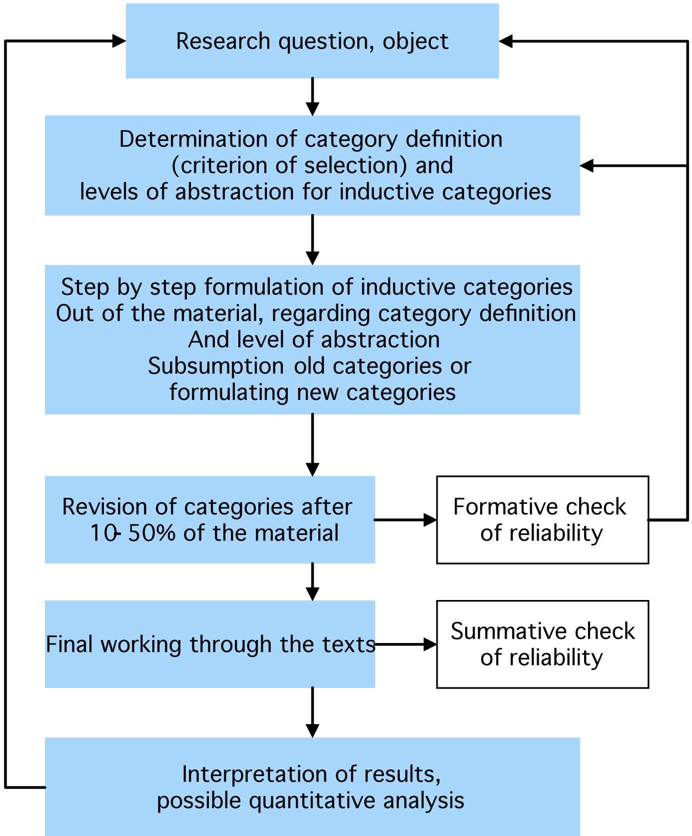

Figure 21: Process Inductive Category development. Source: Mayring 2005

This underpins the exploratory and open character of qualitatively oriented research approaches. After one third of text being coded the developed codes have been revised before coding all interview material. The major limitation in using content analysis is the subjectivity involved in coding the texts (Frost and Wilmshurst, 2000; Unerman, 1999). A permanent revision process as explained by Mayring (2005) was applied to address this issue. For the qualitative analysis the software tool MAXqda[15] was used to handle the more than one hundred pages of transcribed interviews and to process the data. It has to be emphasised that the qualitative research could not be substituted by software but it is a useful support tool (Kopp and Menez, 2005). The content analyzing

[15] Software to support text analysis http://www.maxqda.com/

process was carried out in English language and the results are all reported in the next chapter.

7.4 Quantitative Research

The last stage of the research, the quantitative research, lies in testing and validating the adapted initial business model, and hence the factors that influences the technology transfer and business model, by a quantitative potential shareholders and consumers research gathering significant statistical data. The focus is on researching the attitudes of this category of experts regarding the qualitatively researched business factors towards the interactive media technologies. Sanzo et al. (2003) state that consumer's perception and evaluation is notably influenced by the existence of positive and negative attitudes towards a product with reference to different dimensions. The reason why the choice of a quantitative additional method can be explained by Johnson and Onwuegbuzie (2004). According to the authors, "in a qualitative research study the researcher might want to qualitatively observe and interview, but supplement this with a closed-ended instrument to systematically measure certain factors". This is regarded to improve generalizability and, if findings correspond across different approaches then greater confidence can be won for the conclusions. In the case of conflicts the researcher has the possibility to adjust the conclusions for the provision of new knowledge.

7.4.1 Research Method: Survey

As argued by several authors in the research methodology field (Mayer, 2002; Diekmann, 2002; Denz, 2005; Kirchhoff et al., 2001) the perfect research design does not exist and it is in fact a balancing of advantages and disadvantages linked to certain research designs. As claimed by Diekmann (2002), the research method survey is indispensable for researching opinions and attitudes despite of several critics holding that research may neglect phenomena due to focusing on theory testing rather than theory generation. Although an experimental design as an alternative research method would have been theoretically feasible, the decision was taken for a survey design for the following reasons. Furthermore, the multiplicity of factors, which were researched in the previous qualitative part and which needed to be tested in the quantitative one, would be unrealisable in an experimental research design. Diekmann (2002) states that for researching influences of multiple variables, experimental designs are very difficult to realise due to the fact that complexity and expenditure are exploding.

7.4.2 Sampling

The sample group for the quantitative survey has been chosen from the various and worldwide conference I attended during this year, where I had the possibility to exchange contacts with many of the persons met during this happening. From the various meetings and travel I gathered more than 1000 business card that I used during my quantitative research stage to organize my on-line survey. Even if often criticized by research scientists is the lack of representativeness of online surveys due to certain attributes of the Internet population (male, upscale…) (Evan & Mathur, 2005). However, Fricker and Schonlau (2002) state it seems that gaps between online and off-line populations are quickly closing. Above all this is real for the population I choose because the majority of them are academics or working with computer graphics, hence the most percentage of them use internet as their main stream of communication. The population has been built, as mentioned before, through policy of public relations during these years. In particular the connection established took place through the participation to the conferences inherent to the various field of Interactive Digital Media, such as intellectual property rights and computer graphics, and to the analysis of consumer behaviour and business:

All these activities allowed me to develop a population of 1480 persons, whose contacts have been gathered through personal exchange and business cards. All these contacts have been reached through emails.

The emails were asking to compile an on-line questionnaire developed after the qualitative research and published on Internet through a server named Monkeysurvey.com[16]. From all sent mail a return rate of 483 has been gathered. A formula by Mayer (2002) was utilized for the sample size calculation. In the table 12 is illustrated the results of the sample size according to the population of 1480 recipients with a real probability error of 5%.

n = sample size *N = Population Size* *d = 5% probability of error*	
$\frac{N}{1+d^2*(N-1)}=n$	$\frac{1480}{1+0,0025*(1480-1)}=315$

Table 13:Calculation of the sample size according to 5% real probability error. Source: Mayer, 2002.

From this calculation, and because the return rate of this investigation has been of the 32,63% (483 out of 1480), that through the use of the formula above showed of Mayer (2002) and reported in the following table shows a real probability error of 3,735 %.

16 www.monkeysurvey.com

$\frac{N}{1+d^2*(N-1)}=n$	$\frac{1480}{1+d^2*(1480-1)}=483$
$\frac{N}{n}=1+d^2*(N-1)$	$\frac{1480}{483}=1+d^2*(1480-1)$
$\frac{N}{n}-1=d^2*(N-1)$	$\frac{1480}{483}-1=d^2*(1480-1)$
$d=\sqrt{\frac{\frac{N}{n}-1}{(N-1)}}$	$d=\sqrt{\frac{\frac{1480}{483}-1}{1480-1}}$
$d=3{,}735e-0{,}2$	

Table 14: Calculation of the real probability error with a sample size of 483 using the Formula of Mayer, 2002.

The procedure for the online survey started with an invitation mail sent to the sample population, described previously on this paragraph, wherein the mail was included a link for the protected website to access the online questionnaire and a figure representing the business model for the Interactive Digital Media. McDevitt and Small (2002) confirm this approach and explain that, it is necessary to compile a large selected group of persons and secondly a part of known Internet users should be chosen according to a randomize sample.

7.4.3 Quality factors

As literature about research methodology highlights, the discussion regarding objectivity, reliability and validity of quantitative research is a very crucial one. Due to the standardized process of the chosen online survey format, where the researcher has no direct influence on the interviewee (Mayer, 2002), a high level of objectivity is given. Due to the standardized process of the chosen online survey format, where the researcher has no direct influence on the interviewee (Mayer, 2002), a high level of objectivity is given. As far as reliability is concerned, it is a degree of reproduction of measurement results. For determining reliability of a measuring instrument, three possible methods, such as parallel tests, test- retest and split- half reliability method could be utilized (Diekmann, 2002). Under the circumstances of this survey potential usable tests are the corrected item total correlation[17] and Cronbach's Alpha[18] which is also recommended by several methodologists (Diekmann, 2002, Friel, 2004, Arsham, 2006). As pointed out by Reynaldo and Santos (1999) Cronbach's Alpha is a common tool for assessing reliability of scales in a numeric value and therefore also a measure of its internal consistency. The central question of validity is if the measure instruments measure what they were intended to measure (Mayer 2002). External validity, which is strongly related to the chosen sampling method, concerns about the generalizability of the research results of the sample to the population. External validity can be achieved according to the chosen sampling methods explained within this chapter. Internal validity refers to the adequateness of the measure instruments to measure an attitude or attributes which the research is interested in (Mummendey, 1999). Content validity, as a type of internal validity, could be established by experts' opinion about the representativeness of items (Chong, 2006). Due the fact that a part of the items of the quantitative research were developed from expert data of the foregoing qualitative research, content validity can be stated for the given questionnaire.

7.4.4 Research Technique: Questionnaire

The utilized research process for the consumer questionnaires started with choosing the sample followed by a dimensional analysis and the development of the empirical model. In this study the empirical model,

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[17] Corrected item total correlation is the correlation of a item with the sum of the other items within the same scale (Barrett, Morgan and Leech, 2005).

[18] "Cronbach's alpha measures how well a set of items (or variables) measures a single unidimensional latent construct" (Academic Technology Services, 2006, p.1).

qualitatively researched within the first part, consisted of an assumption of coherences between new perceptions factors that are potentially influencing the commercialization of an interactive digital media. According to Mayer 2002 the quantitative process can be summarized in the following picture:

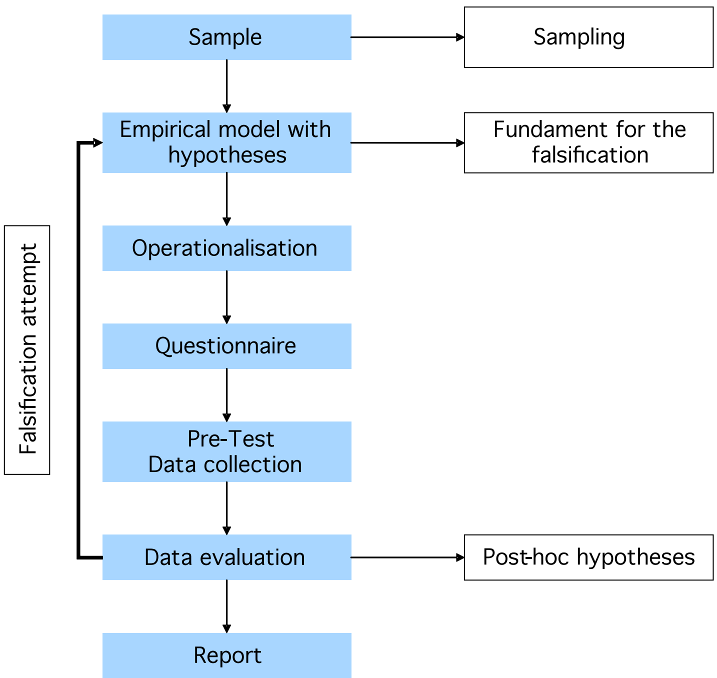

Figure 22: Quantitative research process. Source: Mayer, 2002.

Within the operationalisation process of the empirical model dimensions and items were chosen which describe the variables. Therefore items from known and approved scales were selected, and additional items needed to be constructed, as explained in Mayer (2002), using the qualitative expert data from the first research stage to provide results in accordance with the research criteria (Lamnek, 1995). Defining an index for the commercialization of an interactive digital media as a dependent variable was a crucial factor for questionnaire development. According to the operationalisation the questionnaire was developed. For investigating the importance of each factor about the IDM commercialization statements were presented to the interviewees. They were asked to rate their opinions towards the statements on a five point Likert-scale (Diekman, 2002). As Mayer recommended, multiple items within a question battery are used for measuring a dimension, where a dimension embeds two crucial factors. Before submitting the questionnaire to all the recipients, a pre-test was firstly conducted on ten key persons, all experts in Digital Media and in Marketing and Business strategies. After an adaptation according to the suggestions received by the first reviewer of the questionnaire the data collection and the data evaluation started. Because the questionnaire and the model have been adapted to the OpenSG technology, this technology and the results of questionnaires are presented in the following chapter. As pointed out by Svensson (2001) “the theories, the models, and the conceptual frameworks are supposed to reflect an empirical phenomenon. This is managed often through simplification, though it is not usually possible to describe real world complexity with understandable or interpretable theories, models and conceptual frameworks”. A brief summary of the research activities is shown in the following figure:

Figure 23: Research Activities for developing the questionnaire.

7.5 Data analysis methods

This paragraph explains in brief the conducted data analysis methods and justifies their appropriateness because of their selection. The results of will be given in the following chapter.

7.5.1 Cronbach's α

It is a coefficient used as a measure of the internal consistency reliability of a psychosometric instrument (Cronbach, 1951). Cronbach's α measures how well a set of variables or items measured as a single, uni-dimensional latent construct. It will generally increase when the correlation between the items increase; for this reason it is even called the internal consistency or the internal consistency reliability of the test. It can take values between negative infinity and 1.

7.5.2 Anova test and Post Hoc test:

The ANOVA test, analysis of variance, reports whether or not significant differences of one observed variable between different sub-groups exist (Backhaus et al., 2000). This test has been utilized for confirming differences of believes about the commercialization of interactive digital media, and precisely regarding the OpenSG tool. If significant differences for one variable between the different sub-groups are observed, Kappelhof (2007) recommends performing a Post Hoc test. The Post Hoc test shows exactly which groups (e.g. sex, education levels, field of expertise) are significantly different. This allows the researcher to provide a more detailed interpretation of the reported differences. As the ANOVA test and the Post Hoc test belong to parametric tests, the primary data should follow normal distribution. Variance homogeneity is not a necessary precondition as an ANOVA test with Tamhane's post hoc analysis was applied as recommended by Barrett, Morgan and Leech (2005).

7.5.3 Factor analysis

The factor analysis is a method of data reduction and aims to summarize a fairly large set of items, which correlate high with each other, into one factor. By computing a factor analysis it can be tested, if the variables used in the survey are indicators for a latent variable and if these single variables explain one or more dimensions of this latent variable (Mayer, 2002). The factor analysis is utilized for testing the one- dimensionality of the scales, which is necessary within an item and scales analysis as recommended by Diekmann (2002). By this procedure, not directly observable factors based on a set of observable variables can be identified (Bortz, 1993). To receive valid results, the examined scales needed to consist of at least 3 items and the data should follow normal distribution (Mayer, 2002).

7.5.4 Kolmogorov-Smirnov test

The Kolmogorov-Smirnov test can be used to answer the question whether or not the primary data follows normal distribution. As this is a key question for all parametric tests it was performed before selecting adequate statistical analysis (Engineering statistics handbook, 2007).

7.5.5 Multiple linear regression

A multiple regression analysis was conducted for further data analysis. The main purpose of the multiple linear regressions is to explore the potential influences of independent variables on a dependent variable. As stated by Statsoft (2007), “the general purpose of multiple regression (the term was first used by Pearson, 1908) is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable”. In the case of multiple regression analysis, the following assumptions need to be considered. The scale level of the dependent variable should usually have interval scale level or higher. The variables should be nearly normally distributed within the population and linearity between the factors should be given (Barrett et al., 2005). The scale levels of the independent variables should have interval level or higher, although in multiple regression also dichotomous variables are useable as so called dummy variables, which was not the case in the present consumer survey (Barrett, Morgan and Leech, 2005). The most important preconditions for the application of a multiple linear regression analysis are tested in the following chapter.

8. The empirical research findings and the validation of the model for the OpenSG rendering engine.

This chapter shows the findings of the PhD research in details through the analysis listed in the previous chapter. The results are divided along the timeline presented in the first chapter of the used qualitative and quantitative methods. First the result of the content analysis of the qualitative experts interviews are described; after this the preliminary model is adapted and improved and then it is adapted to the OpenSG. Secondly, the results of the quantitative analysis of the gathered data by the questionnaires is explained in detail and according to the findings the model is validated, and the influencing factors according to the experts are explained. Based on both, qualitative and quantitative research, a significant contribution to the technology transfer of Digital Media area is provided. Before describing the findings of the research it is worth to give an overview of the rendering engine focus of the technology transfer and business model developed.

8.1 The OpenSG

The OpenSG rendering engine represents an open source technology that is aimed to be the focus of the business model developed. It is appropriate at this point to give a description of this rendering engine. It belongs to the category of the Free Open Source software programs that are available on the Internet and are developed in voluntarily basis. According to Wheeler (2005) the free Open Source software are programs whose licenses give users the freedom to run the program for any purpose, to study and modify it, and to redistribute copies of either the original or modified program with any fee due to the previous developers. Main factors needed for a software to be classified as an Open Source Software (hereinafter OSS) are, as even determined by the Open Source Initiative: the availability of the source code, the availability to distribute the software freely, the right to create derived works through modifications and no discrimination to join the development. On the same side the free software foundation, FSF (GNU, 2006), states that the free software is a matter of users' freedom to run, copy, distribute, change and improve the software. More precisely it refers to four kind of freedom for the user of free software:

- The freedom to run the program for any purpose.
- The freedom to study how the program works, and adapt it to your needs. Access to the source code is a, hence, a precondition.
- The freedom to redistribute copies, so you can help your neighbour.
- The freedom to improve the program, and release your improvements to the public, so that the all community benefits

OpenSG is regarded as one of the leading general purpose rendering engines, especially with respect to its scalability, and widely used in international corporate and university based R&D environments. OpenSG is a freely available scene graph system for flexible and efficient real-time rendering for Virtual and Augmented reality applications that has been used in a number of projects and has proven that the concepts described here are viable and practically useful. These examples cover the range from simple applications that benefit from the simplicity of integrating extensions into the system, through medium-size systems that integrate external components to full-fledged Virtual Reality systems. The daily use of these systems demonstrates the viability of the concepts developed among the OpenSG. The OpenSG runs on a variety of platforms, from Windows, Linux and Mac, and to workstation from all large manufacturers like HP, SUN, and IBM up to million dollar or more multi-pipe systems from SGI (Silicon Graphics, Inc.). Some projects where this technology has been extensively used are:

- Arvika: Arvika is a German state-funded research project to explore Augmented Reality technology for the construction industry. This system uses a unified core that is used as an

Augmented Reality component inside a web browser like Internet Explorer or Mozilla, running on a laptop with a connected USB camera, up to an high-end SGI Onyx system for augmenting the images of crashed cars with their simulated equivalents. Arvika profits from the flexibility and openness of the OpenSG system that allows integration into a plug-in framework for Internet browser. The following figure indicates an example:

Figure 24: OpenSG

- Avalon: it is VRML-based VR system that has been developed by ZGDV over the last couple years has been ported over to OpenSG from its OpenGL-based low-level structure. In the process Avalon gained the ability to be used in arbitrary projection environments and obtain a significantly higher graphics throughput than before. The following figure is a reconstruction of the Cathedral of Siena:

Figure 25: The Siena Cathedral rendered using Avalon

Figure 26: Digital Prototyping rendered using the OpenSG

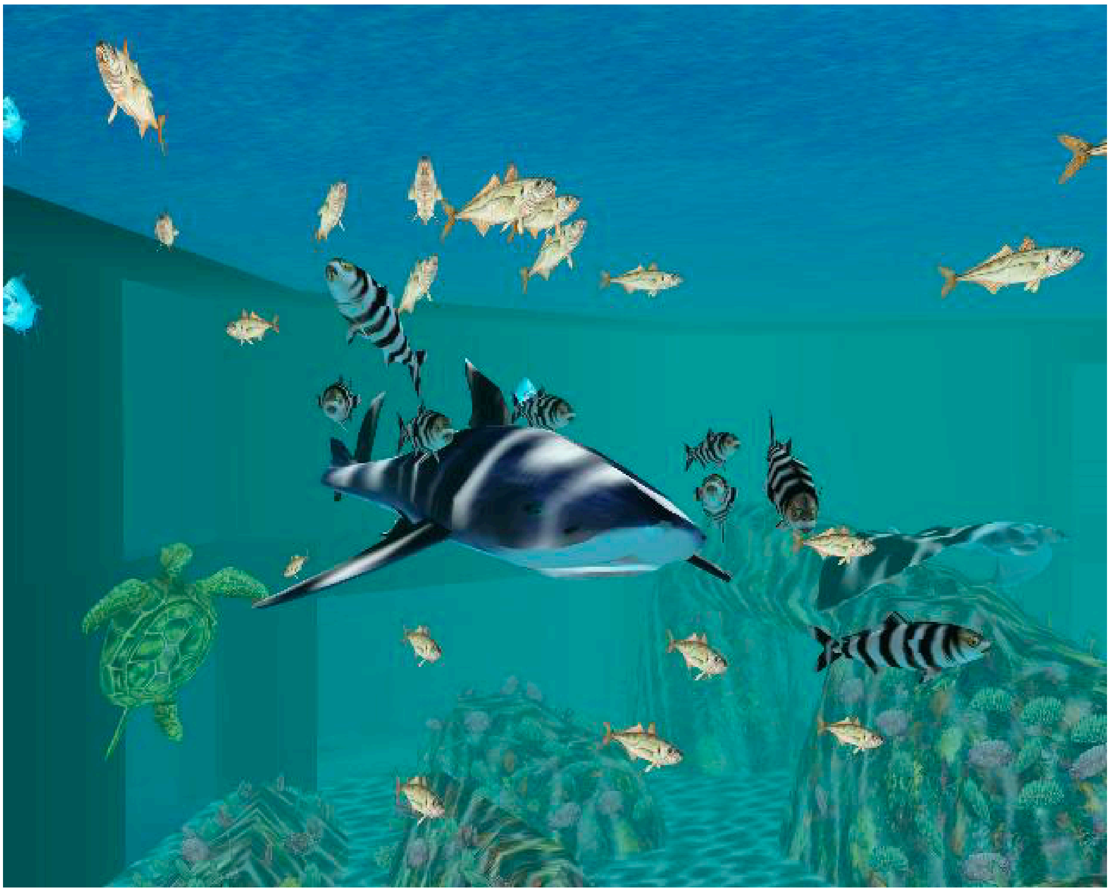

Figure 27: Virtual Acquarium developed through the use of the OpenSG

8.2 Qualitative research

The main objective of this chapter is the presentation of the qualitative research results and the development of the initial model. After the procedure of the chosen content analysis has been described the results are illustrated and the relevant determinants and factors are elaborated. These new findings have been utilized to develop the business preliminary model then tested through the quantitative approach.

8.2.1 Results

The emphasis of the in-depth interviews with Interactive Digital Media experts for the qualitative part of this PhD thesis was two-fold:

1. To validate and test the proposed influencing elements for the commercialization and the technology transfer of the OpenSG;
2. To collect various perspectives of the use of the Interactive Digital Media.

The results of the research provided a well defined model and added new factors then added to the business and technology transfer model preliminary developed. Following relevant determinants for the Interactive Digital Media and the various dimension related and analysed are illustrated. The qualitative research together with the desk research previously conducted during the first two years of the PhD course confirmed the hypothesis done and on which the interview has been developed. The interviewees were asked to express their knowledge and opinions regarding several questions all concerning the commercialization of the Interactive Digital Media, and after having them explained, to those who didn't know anything about the OpenSG, some of the relevant information of such technology

8.2.2 Determinants of relevant factors for the commercialization of Interactive Digital Media

The emphasis of the in-depth interviews with digital media and business experts made for the qualitative part of this PhD thesis was three fold:

1. to validate and test the proposed main factors influencing the commercialization of the OpenSG rendering engine for the Interactive Digital Media,
2. to collect various perspective of the commercialization process for the technology examined
3. to further refine and enrich the emerging components of the initial business model after validated through the online questionnaire.

From the content analysis 6 relevant factors resulted to be the more important in order to commercialize a software developed in an open source philosophy. The interviews were rewrite inside the software Maxqda, and some analysis to determine those factors were carried out. One of the more relevant for this determination is the word frequency. The results are reported in the following table:

Word frequency																
		Interviewees	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Word	Word length	Frequency														
Innovation	10	57	6	6	5	3	4	6	2	4	4	5	2	2	4	4
Customers	9	43	4	2	4	2	3	1	2	4	1	5	4	5	2	4
Partners	8	79	6	8	8	2	4	4	8	6	9	8	3	5	2	6
Technology	10	123	8	10	8	12	9	8	11	14	8	10	8	6	8	3
Community	9	124	8	8	13	11	14	8	6	9	6	8	12	7	6	8
Developers	10	145	8	9	14	12	8	8	16	4	18	12	10	8	12	6

Table 15: Word frequency table.

In the table above the more frequent terms used among the interviews are reported. It is evident that they represent the more important key factors emerged from the interviews done. These factors are: the developers, the community, the partners, the customers, the technology and the innovation – factor. Those factors have been divided into dimensions as indicated in the following paragraph.

8.3 Dimensions and factors influencing of the Business Model

After having defined which are the main factors that influences the commercialization of the Interactive Digital Media and defined the variables, of each single factor, that have been investigated through the questionnaire it is worth to recode and explain them in deep. The factors identified through the qualitative research made through the deep interview that influence the commercialization of an Interactive Digital Media, and in deep the tool that later will be deeply explained, are six and are embedded into three dimensions. The three dimensions and the factors are:

1. Production and Research & Development Dimension:
    a. Developers
    b. Community
2. Market and Commercialization Dimension:
    a. Partners
    b. Customers
3. Competitive Dimension
    a. Technology
    b. Innovation

An item scale analysis has been used to further the investigation. The purpose of the item-scale analysis was to test the questionnaire regarding its reliability. The statistical test has been done to assess the adapted scales based on the qualitatively research expert data. Following a description of each dimension and its factor analysis is reported. Additionally Cronbach's α has been calculated for each single factor to check its reliability. This analysis were suggested by Diekmann (2002) and Arsham (2006) who stated that as assessment of reliability of the used scale is necessary; this support the deision for applying these analyses within the quantitative research stage.

8.3.1 First Dimension: Production and Research & Development

Among the first dimension two main factors have been identified for the Interactive Digital Media in this investigation. It regards the commercialization of an Open Source rendering engine; that is why all questions were focused about which characteristics the commercialization process has to have and which factors need to be developed and better managed. In the first dimension two main factors have been individuated: the Developers and the Community, Because Open Source Software projects are seen as online epistemic communities (Cohendet et al., 2000; Preece, 2000) their members form a group of people connected together on the Internet with a common goal – to develop software – with the "met" – objective of producing and constructing knowledge about the artefact they develop for the benefit of all community (Barcellini et al., 2007). According to Mahendran (2002), Gacek and Arief (2004) major project based on OSS are highly hierarchical and meritocratic communities. Five different statuses are generally distinguished in these projects. Some participants can modify the source code and participate directly in the design process and in decisions regarding the software and/or the technology developed. These statuses are divided in *developers* and in the community. Apart from the project leader and the administrators, the *developers*, or contributors are those who participate in the evolution of the OSS and maintain some of its parts, usually the core parts. Other participants are called *users*, divided in active users and passive users, and both are embedded in the *community*. Active users are those who participate in mailing-list discussions as informants for newcomers, by reporting or correcting bugs with patches, and by proposing new modules. These *active users* in a particular OSS project may be developers. On the other hand there are the *passive users* that are those who use the software or lurk on the discussion and documentation spaces of the project (Preece et al., 2004). In the model it is investigated the importance and the influence that developers and the community assume through the questions developed among the first section of the questionnaire reported as a whole in the Annex 1 and in the following table:

FIRST DIMENSION: PRODUCTION AND R&D Based on the model adopted the first dimension embeds two key figures that are represented by the *Developers and the Community.*	
Question	Code
2. To what concerns the idea generation and the consequently production of the IDM, the developers, that represent the core of the OSS, have to continuously transfer their knowledge into the product.	P1
3. The existence of an active community in an Open Source point of view is fundamental in order to provide a continuous update of the OSS, suggesting improvements and bugs corrections based on their use of the product.	P2
4. The developers are part of the community, and the community is an active part of the project carried out. Hence a strong and communication has to be build and continuously maintained between these two parts.	P3
5. Most of the times, and in the case of the OpeSG rendering engine, the know-how is developed among universities and/or research centres. Do you think this know-how can be transferred from the cradle to the market (or industries) through:	
a. Training sessions for companies workforces	P4a
b. PhD Courses sponsored by the companies based on their specific projects	P4b
c. Committing specific projects for Universities or research centres	P4c
d. Consultations	P4d

Table 16: Questions coded and aimed to investigate the R&D and Production dimension of the business model.

All respondents were asked to express their level of agreement with the proposition made through the questionnaire. Near every question has been reported the code needed later to recode the variables. To validate if variables suite correctly in factors a *factor analysis* with a varimax rotation was computed and the results are reported in the following table where even the Kaiser Meyer Olkin (KMO) is reported.

Items	Factor Loadings	
	1	2
The Developers have to transfer continously their knowledge into the product	0,721	
The know-how developed among universities, as for the OpenSG, could be transferred to the market through training session for companies workforces	0,576	
The know-how developed among universities, as for the OpenSG, could be transferred to the market through PhD Courses sponsored by the companies	0,601	
The know-how developed among universities, as for the OpenSG, could be transferred to the market committing specific project to University/Research Centre	0,654	
The know-how developed among universities, as for the OpenSG, could be transferred to the market consultations	0,76	
An Active Community is foundamental for a continous update of the Open Source Software		0,72
Strong communication has to be build and maintained between the developers and the community		0,577
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,676
Bartlett's Test of Sphericity	Approx. Chi-Square	1142,7
Bartlett's Test of Significance	Sig.	0

Table 17: Factor analysis for R&D and Production Dimension.

The KMO value for sampling adequacy[19] is 0,676 that is nearby the recommended value of 0,6 (Tabachnik and Fidell 1996), while the

[19] “Kaiser-Meyer-Olkin Measure of Sampling Adequacy generally indicates whether or not the variables are able to be grouped into a smaller set of underlying factors.High values (close to 1.0) generally indicate that a factor analysis may be useful with the

Bartlett's test[20] reached statistical significance. This results support the following factorization of items:

FACTOR	VARIABLES EMBEDDED
DEVELOPERS	P1 – P4a – P4b – P4c – P4d
COMMUNITY	P2 – P3

Table 18: Variables and Factors of the first dimension.

8.3.2 Second Dimension: Market and Commercialization

The second dimension is related to the Market and to the commercialization of the OSS rendering engine, the OpenSG. From the qualitative research and from the factor analysis reported in the following table, two main factors arose from interviewees: the Partners and the Customers.

data. If the value is less than .50, the results of the factor analysis probably won't be very useful" (SPSS Online, 2007).

[20] "Bartlett's Test of Sphericity compares the correlation matrix to an identity matrix. An identity matrix is a correlation matrix with 1.0 on the principal diagonal and zeros in all other correlations. So clearly the Bartlett value should be significant, as it is expected that relationships between the variables exist" (SPSS Online, 2007).

Items	Factor Loadings	
	1	2
A technology developed among Open Source Phylosophy in University or Research Centre needs partners in order to be commercialized	0,887	
For an Open Source Software we do not have to commercialize the software itself but the knowledge build and developed around it	0,923	
Partners should take an active part in th e process of development of the OSS	0,757	
A continous presence of partners is mandatory in the project in order to make scheduled controls on the project development	0,612	
A continous presence of partners is mandatory in the project in order to continously exchange the know-how needed for the product customization	0,755	
A continous presence of partners is mandatory in the project in order to carry the sustainment, in terms of resources	0,898	
After commercialization customers have to be monitored and their feedback need to deeply analyzed		0,819
On a Business to Business basis partners represent a great portion of customers		0,873
Embedding the OSS Technology in another SW can lead to an easier commercialization, but contemporarily to problems related to IPR		0,928
A university/research centre needs complementary assets, thus they basilar for resources findings because provide various services, training and consulting		0,921
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,598
Bartlett's Test of Sphericity	Approx. Chi-Square	2344,505
Bartlett's Test of Significance	Sig.	0

Table 19: Factor analysis for the Market Dimension

As in the previous dimension, here too, the value of the KMO for sampling adequacy is very near to the recommended value of 0,6 as it is 0,598 and even the Bartlett's test reached a statistical significance.

To validate the importance of this factors and the dimension they belong in the questionnaire the following investigation were done:

SECOND DIMENSION: MARKET AND COMMERCIALIZATION In this section we try to analyze the importance of partners and customers in the process of commercialization and "to market" the OSS production	
6. A Technology developed among research centres and/or universities with an Opens Source philosophy needs partners (private and governmental) in order to be commercialized.	M1
7. For an Open Source Software, we do not have to commercialize the software itself but the knowledge build and developed around	M2
8. Partners should take an active part on the process of development of the OSS, through sponsoring the research and the development in order to customize the product basing on their needs	M3
9. A continuous presence of partners is mandatory among the development of the project in order to:	
a. Make scheduled controls on the project development	M4a
b. To continuous exchange the know-how needed for the product customization	M4b
c. Carry the sustainment, in terms of resources (people, equipments) to the project	M4c
10. Once the product is commercialized customers, both they are final or not, have to be monitored and their feedback need to be deeply analyzed	M5
11. On a B2B basis the partners represent a great portion of customers	M6
12. Embedding the OSS Technology in another SW can lead to an easier commercialization, but contemporarily to problem related to IPR	M7
13. A University or Research Centre, that bases its business on OSS ideology, needs complementary assets, thus they are more important and basilar for resources findings because provide various services, training and consulting	M8

Table 20: Questions coded and aimed to investigate the Market Dimension of the Business Model.

As for the previous dimension all questions have been coded and the relative variables have been embedded within the factors according to the results of the factor analysis previously reported. This encoding is reported in the following table:

FACTOR	VARIABLES EMBEDDED
PARTNERS	M1 – M2 – M3 – M4a – M4b – M4c
CUSTOMERS	M5 – M6 – M7 – M8

Table 21: Variables and factors of the Market Dimension.

8.3.3 Third Dimension: Competitive Dimension

The last dimension that overcome from the qualitative analysis and from the desk research studies and needed for the commercialization of any Interactive Digital Media, and for the OpenSG in this case is the one related to the level of innovation and to the added value for the technology. To validate the importance of this factors and the dimension they belong in the questionnaire the following investigation were done:

THIRD DIMENSION: COMPETITIVE DIMENSION This part is focused on the competitiveness and the innovativeness of the technology	
14. The continuous update of the IDM, or of the OSS technology leads to an always update factor of innovativeness	C1
15. The process of transferring the technology to the market, accompanied by a continuous R&D, and the continuous monitoring of the competitors will definitely leads to an high competitive factor	C2
16. The following strategies will lead to the achievement of added value for the technology to be transferred to the market:	
a. The fulfilment of customers' needs	C3a
b. the analysis of their feedback	C3b
c. process of knowledge-sharing between the actors of the community	C3c

Table 22: Question coded and aimed to investigate the factor of the Competitive Dimension.

The factor analysis done for the third dimension is reported as follows:

Items	Factor Loadings	
	1	2
The continuous update of the ODM leads to an always update factor of innovativeness	0,952	
The process of transferring the technology to the market with a continuous R&D will definitely leads to an high competitive factor	0,833	
The process of knowledge-sharing between the actors of the community will lead to an added value for the technology	0,574	
The fulfilment of customers' needs will lead to an added value for the technology		0,909
The deep analysis of customers' feedback will lead to an added value for the technology		0,802
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,583
Bartlett's Test of Sphericity	Approx. Chi-Square	1014,833
Bartlett's Test of Significance	Sig.	0

Table 23: Factor analysis for the Competitive Dimension.

The values are even here in the range of the specification given.

8.4 Quantitative research

The following paragraph is dedicated to the analysis of the data gathered; it will define the loading of the various variables adopted for the questionnaire in the corresponding factors and dimension, after the same factors and dimensions are analysed according to their reliability and their normality is checked in order to test them with parametric tests. Before going through the statistical testing and validation of data, it is worth to give a little description of the sample analyzed.

8.4.1 The sample description

As mentioned before the online questionnaire has been sent to 1.480 recipients, of whom 483 compiled it through an online link embedded in the mail sent. The main demographic demands done, because of the need of the research, were based only on 4 issues:

1. gender,
2. field of expertise,
3. industry or academic,
4. and level of education.

From the data gathered the respondents were for the 86,5% (418) male and for the 11,5% (56) female, while the 2% (9) didn't answer. To better understand their profile some cross tabulation are reported below. The first table following shows the numbers of people working in the industry or in the academy and their field of expertise:

Where do you work * Field of expertise Crosstabulation

		Field of expertise					
		Computer Science	Business	Management	Marketing	Other	Total
Where do you work	Academy	163	99	18	71	1	352
	Industry	49	44	21	1	1	116
	Both	5	0	0	1	0	6
	Total	217	143	39	73	2	474

Table 24: Cross Tabulation: Workplace and Field of expertise.

The results are even illustrated in the following graph:

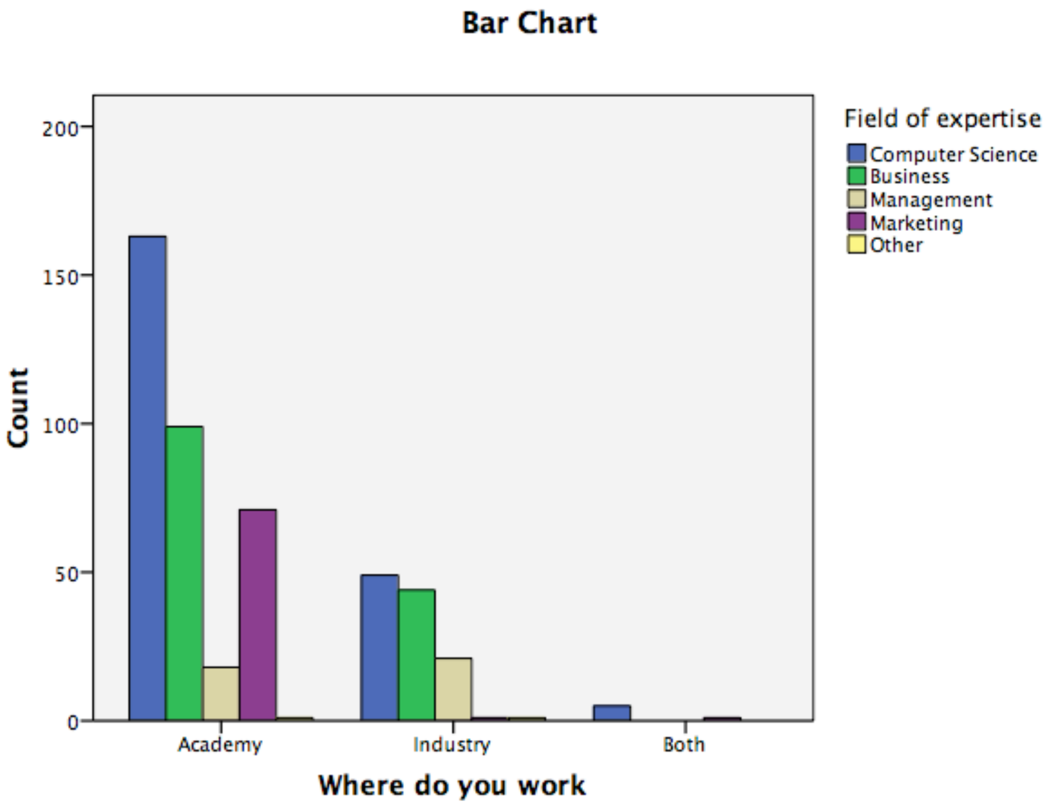

Figure 28: Sample Cross Tabulation between Work Place and Field of Expertise

the total people working in academies were the most respondent with a percentage of 74,2% while the people working in the industry were 24,4% while only 6 respondents, the 1,26%, works in both sector. Another interesting cross tabulation has been made between the Level of education of the respondents and their field of expertise. It is reported in the following table:

Which is your level of education * Field of expertise Crosstabulation

		Field of expertise					
		Computer Science	Business	Management	Marketing	Other	Total
Which is your level of education	Master Degree	166	44	24	33	2	269
	PhD	51	99	15	40	0	205
	Total	217	143	39	73	2	474

Table 25: Cross Tabulation. Level of education and Field of expertise.

And in the following graph:

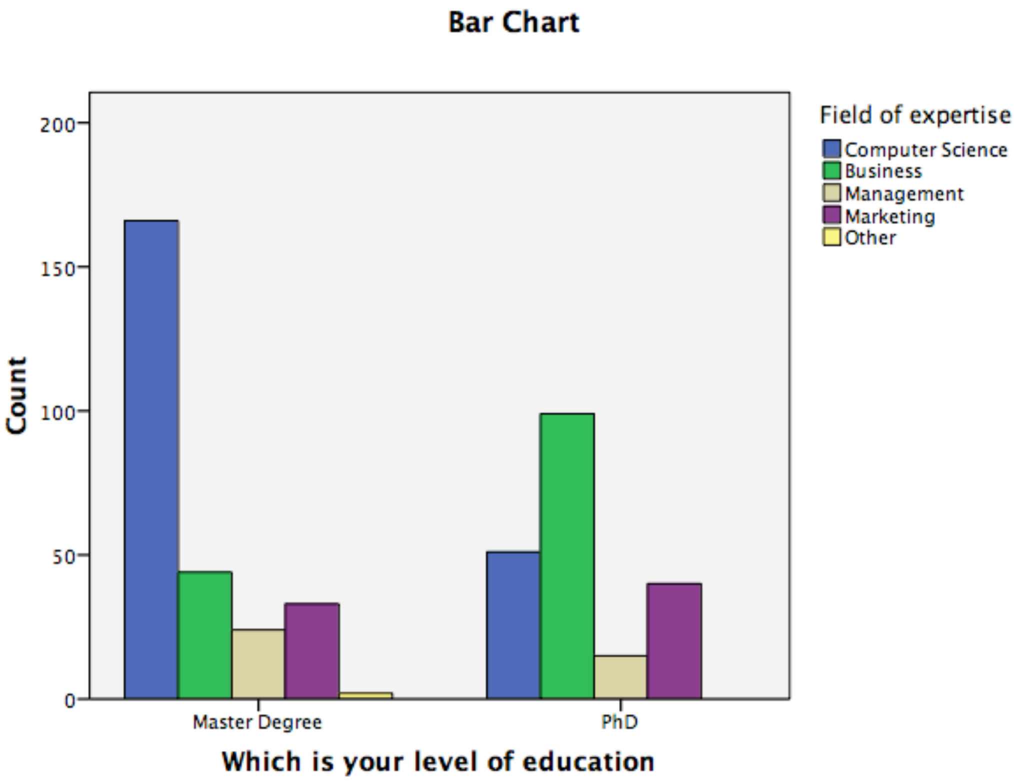

Figure 29: Sample Cross Tabulation between Level of Education and Field of Expertise

On the total sample the 56,7 % (269) owns a master degree, and within this group, the 61,7% in Computer Science, the 9,28% in Business Administration, the 8,9% in Management, the 12,2% in Marketing and the left 7,92% have specialization in other fields. On the other hand the respondents who possess a Doctorate in Philosophy (PhD) are the 43,3% (205), and within the 25% in Computer Science, the 48,2% in Business Administration, the 7% in Management and the 19,5% in Marketing. All the cases have been reported to show that the sample gathered even in the quantitative analysis is formed by people who have expertise in the field of interactive digital media, and hence that their opinions are really relevant for the aim of this study.

8.4.2 Questionnaire reliability

Before going to analyse the primary data in order to check if they can be investigated through parametric tests, it is worth to analyse the reliability of the questionnaire through the use of the Cronbach's α. The Cronbach's α is going to be calculated first for each single factor. All results have been reported in the following table:

FACTOR	Items Coded	N. of Items	α value
DEVELOPERS	P1, P4a, P4b, P4c, P4d	5	0,74
COMMUNITY	P2, P3	2	0,72
PARTNERS	M1, M2, M3, M4a, M4b, M4c	6	0,66
CUSTOMERS	M5, M6, M7, M8	4	0,7
TECHNOLOGY	C3a, C3b, C3c	3	0,68
INNOVATION	C1, C2	2	0,87

Table 26: Cronbach's alpha values for each factors.

The values needed from the Cronbach's α, as mentioned in the paragraph dedicated to the explanation of this parameter, in order to be acceptable, have to be in a range between 0,6 – strong enough to be accepted – and 1 very reliable; usually in social sciences a value that stays near 0,7 is more than acceptable. In this case all factors shows a good level of reliability. Once that the reliability of the questionnaire and of the factors has been demonstrated and validated, there is now the need to show that primary data are following a normal distribution, and a linearity. Hence, before conducting statistical tests it is fundamental to asses the condition of the primary data in order to decide which further tests are applicable or not. For testing if the primary data follows normal distribution, which is an important pre-condition for parametric tests[21], a Kolmogorov -Smirnov test is pursued (Bühl and Zöfel 2002). The results of the K-S test for the variables of each single dimension are illustrated in the following tables, one for each dimension, and for each single factor too:

[21] "Parametric statistics are those which assume a certain distribution of the data (usually the normal distribution)" (Garson, 2007, p.1).

One-Sample Kolmogorov-Smirnov Test

		The Developers have to transfer continuously their knowledge into the product	An Active Community is fundamental for a continuous update of the Open Source Software	Strong communication has to be build and maintained between the developers and the community	The know-how developed among universities, as for the OpenSG, could be transferred to the market through training session for companies workforces	The know-how developed among universities, as for the OpenSG, could be transferred to the market through PhD Courses sponsored by the companies	The know-how developed among universities, as for the OpenSG, could be transferred to the market committing specific project to University/Research Centre	The know-how developed among universities, as for the OpenSG, could be transferred to the market consultations
N		483	483	483	483	483	483	483
Normal Parameters[a]	Mean	4,00	4,41	4,49	4,10	4,08	4,22	4,12
	Std. Deviation	,747	,648	,599	,868	,869	,709	,664
Most Extreme Differences	Absolute	,222	,316	,348	,306	,314	,268	,284
	Positive	,221	,238	,248	,206	,212	,264	,284
	Negative	-,222	-,316	-,348	-,306	-,314	-,268	-,260
Kolmogorov-Smirnov Z		4,870	6,952	7,652	6,714	6,895	5,884	6,249
Asymp. Sig. (2-tailed)		,000	,000	,000	,000	,000	,000	,000

a. Test distribution is Normal.

Table 27: Kolmogorov - Smirnov test for the variables of the R&D and Production Dimension.

One-Sample Kolmogorov-Smirnov Test

		A technology developed among Open Source Philosophy in University or Research Centre needs partners in order to be commercialized	For an Open Source Software we do not have to commercialize the software itself but the knowledge build and developed around it	Partners should take an active part in the process of development of the OSS	A continuous presence of partners is mandatory in the project in order to make scheduled controls on the project development	A continuous presence of partners is mandatory in the project in order to continuously exchange the know-how needed for the product customization	A continuous presence of partners is mandatory in the project in order to carry the sustainment, in terms of resources	After commercialization customers have to be monitored and their feedback need to deeply analyzed	On a Business to Business basis partners represent a great portion of customers	Embedding the OSS Technology in another SW can lead to an easier commercialization, but contemporarily to problems related to IPR	A university/research centre needs complementary assets, thus they basilar for resources findings because provide various services, training and consulting
N		483	483	483	483	483	483	483	483	483	483
Normal Parameters[a]	Mean	4,00	4,12	4,34	3,65	4,47	4,43	4,30	3,97	3,87	3,92
	Std. Deviation	,859	,949	,559	,971	,547	,495	,860	,975	,870	,758
Most Extreme Differences	Absolute	,376	,297	,344	,326	,322	,379	,294	,224	,266	,254
	Positive	,253	,176	,344	,198	,316	,379	,209	,147	,198	,233
	Negative	-,376	-,297	-,266	-,326	-,322	-,303	-,294	-,224	-,266	-,254
Kolmogorov-Smirnov Z		8,262	6,534	7,568	7,154	7,084	8,330	6,459	4,931	5,837	5,572
Asymp. Sig. (2-tailed)		,000	,000	,000	,000	,000	,000	,000	,000	,000	,000

Table 28: Kolmogorov - Smirnov test for the variables of the Market Dimension.

One-Sample Kolmogorov-Smirnov Test

		The continuous update of the ODM leads to an always update factor of innovativeness	The process of transferring the technology to the market with a continuous R&D will definitely leads to an high competitive factor	The fulfillment of customers' needs will lead to an added value for the technology	The deep analysis of customers' feedback will lead to an added value for the technology	The process of knowledge-sharing between the actors of the community will lead to an added value for the technology
N		483	483	483	483	483
Normal Parameters[a]	Mean	3,95	4,17	4,44	4,54	4,45
	Std. Deviation	,752	,772	,613	,499	,557
Most Extreme Differences	Absolute	,342	,309	,323	,363	,320
	Positive	,277	,252	,260	,319	,309
	Negative	-,342	-,309	-,323	-,363	-,320
Kolmogorov-Smirnov Z		7,521	6,801	7,103	7,978	7,034
Asymp. Sig. (2-tailed)		,000	,000	,000	,000	,000

a. Test distribution is Normal.

Table 29: Kolmogorov - Smirnov for the variables of the Competitive Dimension.

One-Sample Kolmogorov-Smirnov Test

		DEVELOPERS	COMMUNITY	Customers	Partners	Technology	Innovative factor
N		483	483	483	483	483	483
Normal Parameters[a]	Mean	4,2453	4,4503	4,3420	4,0820	3,9984	4,2218
	Std. Deviation	,57286	,55000	,48234	,40480	,49883	,37172
Most Extreme Differences	Absolute	,183	,261	,159	,168	,226	,170
	Positive	,183	,203	,086	,168	,110	,170
	Negative	-,161	-,261	-,159	-,101	-,226	-,114
Kolmogorov-Smirnov Z		4,030	5,747	3,486	3,699	4,964	3,737
Asymp. Sig. (2-tailed)		,000	,000	,000	,000	,000	,000

a. Test distribution is Normal.

Table 30: Kolmogorov - Smirnov test for the factors

From the table above it is possible to see that the significance values (p, or Asymp. Sig. (2-tailed)) are smaller than 0,05. In addition, the most extreme differences (absolute) between the expected and observed distribution are larger than the critical K-S values. Critical K-S values are drawn from the critical value table. The interpretation of the Kolmogorov-Smirnov test shows that the primary data are not significantly following perfect normal distribution as the p- values are smaller than 0.05 (Diehl, 2002). However, according to MRC (2006) the K- S test is "overly sensitive for large samples" (p.14). As Garson (2007) states, "when sample size is large, even unimportant deviations from normality may be technically significant by this and other tests. For this reason it is recommended to use other bases of judgement" (p.4). Hair, Black and Babin (1998) and MRC (2006) confirm this and use skewness[22] and kurtosis[23] values for evaluating normality of a distribution. Referring to Barret, Morgan and Leech (2005) and Garson (2007) the data follow an approximate normal distribution when skewness values are between -1 and 1 and kurtosis is within the range of +2 to -2. The following table presents tha values of Skewness and Kurtosis of the factors end for each dimension:

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[22] "Skewness is a measure of symmetry, or more precisely, the lack of symmetry" (Engineering statistics handbook, 2007).

[23] "Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution" (Engineering statistics handbook, 2007).

Statistics

		First Dimension Production and R&D		*Second Dimension* Market and Commercialization		*Third Dimension* Competitiveness	
		Developers	Community	Customers	Partners	Technology	Innovative factor
N	*Valid*	483	483	483	483	483	483
	Missing	0	0	0	0	0	0
	Mean	4,2453	4,4503	4,3420	4,0820	3,9984	4,2218
	Skewness	-0,135	-0,563	-0,641	-0,056	-0,854	0,0129
	Std. Error of Skewness	0,111	0,111	0,111	0,111	0,111	0,111
	Kurtosis	-1,017	-0,553	-0,272	0,489	0,405	-0,215
	Std. Error of Kurtosis	0,222	0,222	0,222	0,222	0,222	0,222

Table 31: Skewness and Kurtosis tests for each factors.

The table above reports that the skewness and kurtosis values of the primary data are within the recommended range, and even if there is no perfect normal distribution the skewness and kurtosis values are adequate for performing parametric tests as confirmed by Hair, Black and Babin (1998), MRC (2006), Barret, Morgan and Leech (2005) and Garson (2007). Statsoft (2007b) summarizes: “In a nutshell, when the samples become very large (> 100), then the sample means will follow the normal distribution even if the respective variable is not normally distributed in the population, or is not measured very well. Thus, parametric methods, which are usually much more sensitive (i.e., have more statistical power) are in most cases appropriate for large samples”. Concerning this research and as reported in the sampling paragraph the sample size is 483. This is supported by Garson (2007) who underlines “that moderate violations of parametric assumptions have little or no effect on substantive conclusions”. In the same vein, according to Vasu

(1979) and Steenkamp and van Trijp, (1991) factor analysis or linear multiple regression analysis are “even more robust against moderate departure from normality”. This is justified by Backhaus et al. (2000) and Wiseman (2005) who state that as long as the result of a multiple regression analysis is not conflicting due to professional reasons (wrong sign of a significant coefficient), there is no reason for abandon a well-reasoned proposition or hypothesis. Additionally, they state that the regression analysis is relatively insensitive of small inaccuracies of the mentioned pre-conditions and is a therefore a very flexible and multifunctional analysis tool. The results of the Anova test of linearity between the factor towards the OpenSG (the dependent variable), and the influencing factors (the independent variables) are shown in the following table:

Index OpenSG X		df	F- value	Significance
PRODUCTION and R&D DIMENSION				
Developers	Linearity	1,000	29,500	0,000
	Dev. Of Linearity	11,000	0,984	0,128
Community	Linearity	1,000	143,234	0,000
	Dev. Of Linearity	11,000	1,230	0,236
MARKET DIMENSION				
Partners	Linearity	1,000	43,987	0,000
	Dev. Of Linearity	14,000	1,399	0,076
Customers	Linearity	1,000	107,483	0,000
	Dev. Of Linearity	22,000	1,432	0,430
TECHNOLOGY DIMENSION				
Technology	Linearity	1,000	57,371	0,000
	Dev. Of Linearity	21,000	1,029	0,112
Innovativeness	Linearity	1,000	50,647	0,000
	Dev. Of Linearity	18,000	0,119	0.433

Table 32: Anova test of linearity for the investigated factors.

The results of ANOVA test of linearity shown in the previous table confirm the right to use parametric tests because the data follows an approximately normal distribution. In fact according to Kappelhof (2007) in case of significant linearity between the variables the significance value of deviation from linearity should be larger that ,05 and the significance value for linearity should be below ,05. In this case it can be reported that significance levels for deviation of linearity are not significant, and significance values for linearity are significant for relationship between the OpenSG and its influencing factors.

8.5 Multiple linear regression:

The following paragraph shows the results of the multiple linear regression. The precondition for the applicability of the multiple linear regression analysis were testes and fulfilled. Most of the statistical methodologist (Backhaus et al., 2000; Osborne, 2002; Barret, Morgan and Leech, 2005; Garson, 2007) state that the two most important preconditions for pursuing a multiple regression analysis are first, the normal distribution of variables and second, the linear relationship between the dependent and the independent factors. Both those pre-condition have been met and explained in the previous paragraphs where the primary data were tested. The multiple linear regression, as mentioned in the previous chapter is to explore the potential influences of independent variable, the factors in this case, on a dependent variable, the commercialization of the OpenSG and how the most influencing dimension affects the others. As far as multicollinearity is concerned, the variance inflation factors (VIF) are reported as follows:

PRODUCTION AND RESEARCH & DEVELOPMENT

Coefficients(a)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2,399	0,147		16,341	0
	DEVELOPERS	0,018	0,056	0,024	0,33	0,742
	COMMUNITY	0,366	0,058	0,455	6,336	0

a. Dependent Variable: OPENSG

Adjusted r^2 = 0,225

MARKET AND COMMERCIALIZATION

Coefficients(a)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1,513	0,166		9,12	0
	Customers	-0,178	0,033	0,194	-5,385	0
	Partners	0,825	0,039	0,754	20,916	0

a. Dependent Variable: OPENSG

Adjusted r^2 = 0,484

TECHNOLOGY AND INNOVATION

Coefficients(a)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	0,793	0,185		4,282	0
	Technology	0,098	0,035	0,111	2,83	0,005
	Innovative factor	0,692	0,047	0,581	14,811	0

a. Dependent Variable: OPENSG

Adjusted r^2 = 0,406

Table 33: Results of the Multiple Linear Regression of each factors.

As visible from the table above the factors that the more contribute and influence the OpenSG variable are the Community, Partners and the Innovative factors. The partners represent the strongest one and it is part of the determinants. The second important factor is the innovativeness with a beta weight of 0,581. The multiple regression analysis was conducted first for every single variable. The results obtained have been used to reduce the variables for each factors where needed, and then conducting in a second step a multiple linear regression with the OpenSG commercialization index. The same approach has been used in order to understand and to check in which weight one of the three dimensions developed can affect the others. Following is reported the study related to the influence that the first dimension has on the commercialization of the OpenSG. The factors individuated are the Developers and the Community already discussed previously. One per time their influence has been calculated and reported through the linear regression reported in the following table:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,401[a]	,161	,159	,40623

a. Predictors: (Constant), DEVELOPERS

Table 34: Linear Regression for the Developers.

As visible from the value of the R^2[24] the factor Developers influences the technology for a percentage of the 64,7% alone. The table following is for the Community:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,493	,166	,240	,38610

b. Dependent Variable: OPENSG

Table 35: Linear Regression for the Community.

[24] "R² is a measure of the proportion of the variation in the dependent variable explained by the several explanatory variables in a multiple regression" (Studer, 2007, p.6).

The factor Community influences the OpenSG for the 24,3%. If these two factors are studied together the influence they have on the dependent variable is reported in the following figure:

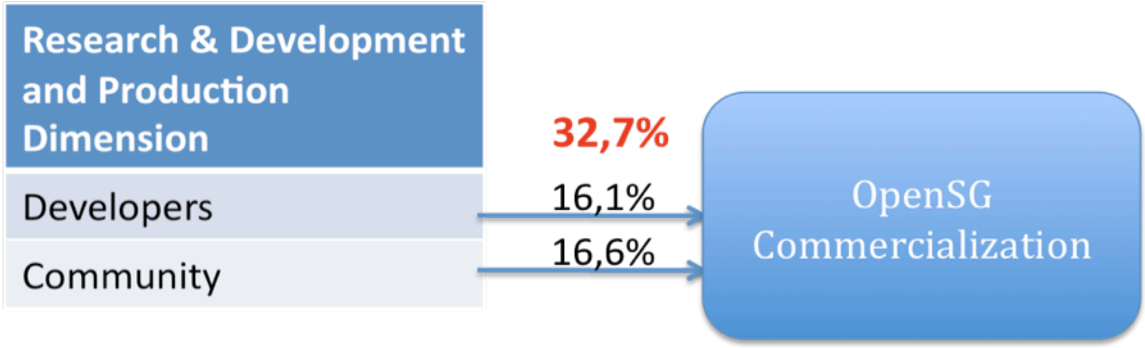

Figure 30: Factors' influence for the R&D and Production Dimension

Totally the management of these two factor is able to influence the Open SG Commercialization for a 38.7% on the total process.

The second dimension affects the commercialization of the OpenSG as follows:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,673[a]	,283	,452	,32789

a. Predictors: (Constant), Partners

Table 36: Linear Regression for the Partners.

For what concern the first factor of the second dimension, the Partners, and following the table of the second factor of the second dimension, the Customers.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,563	,014	,311	,36766

b. Dependent Variable: OPENSG

Table 37: Linear Regression for the Customers.

Graphically the entire influence of the second dimension is reported in the following figure:

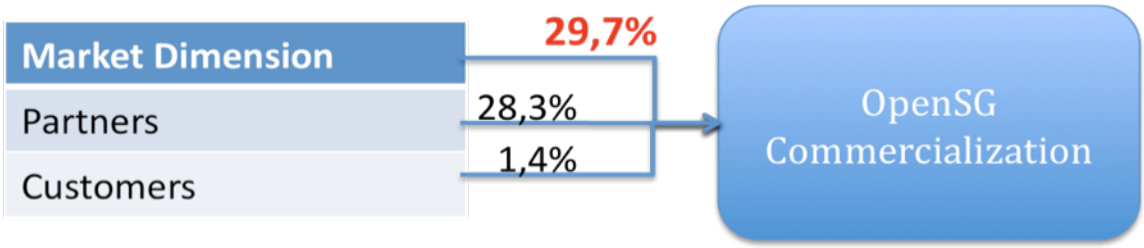

Figure 31: Factors' influence for the Market Dimension

The last dimension that has been investigated through the quantitative research is the technology and innovation one. The factors under examinations were the technology added value and innovation factor, their respective results are reported in the following tables:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,367[a]	,135	,135	,41249

a. Predictors: (Constant), Technology

Table 38: Linear Regression for the Technology.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,629[a]	,236	,395	,34457

a. Predictors: (Constant), Innovative factor

Table 39: Linear Regression for the Innovativeness.

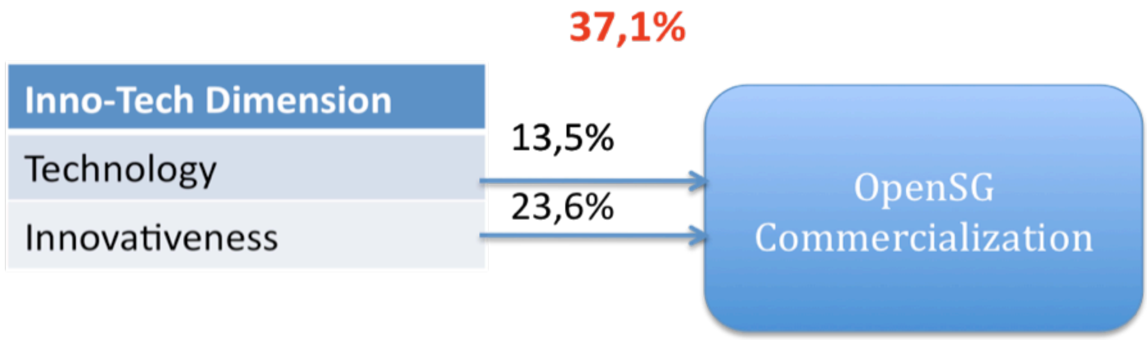

Figure 32: Factors' influence for the Innovation and Technology Dimension

The Final Business Model of the OpenSG

The total influence of the factors retrieved through the qualitative stage of the research and then evaluated by the quantitative stage through the questionnaire and affecting the commercialization process of the OpenSG result to be of the 99,5%. The left percentage is not under control of the project managers. In the following figure is reported the final business and technology transfer model with the respective factors embedded in their dimensions. Each factor is linked to the OpenSG with an arrow that indicate the respective activities that should be carried out during the entire process.

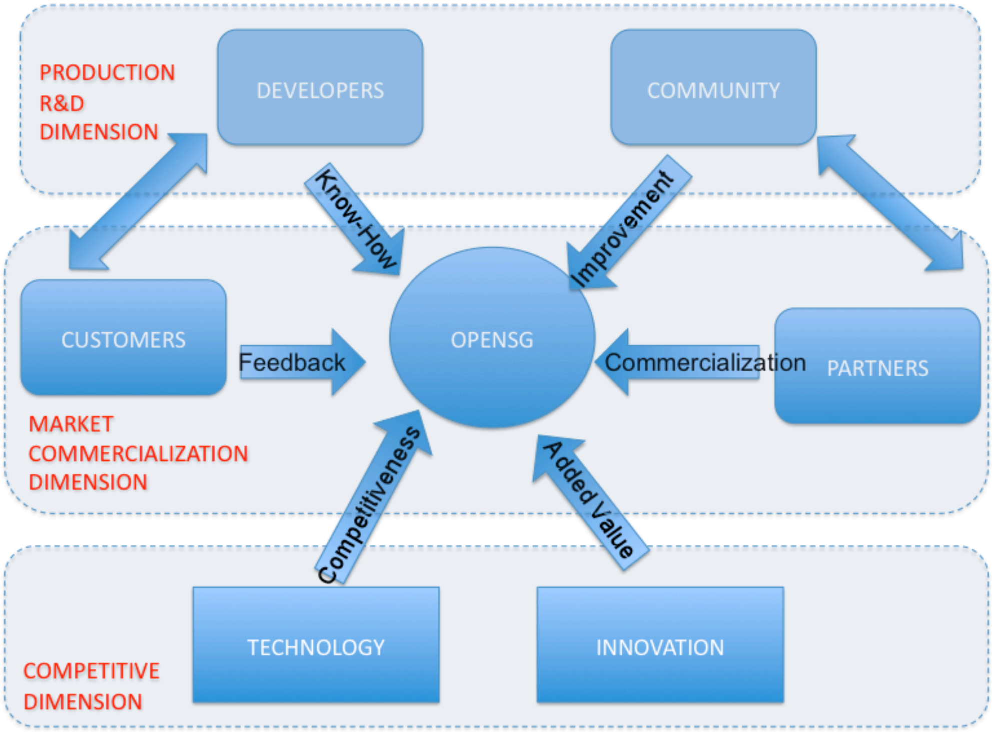

Figure 33: Business Model for the Commercialization of the OpenSG

The business model showed in the previous figure represents the development of the results of the qualitative research and the knowledge acquired through the stage of the desk research. The quantitative research, with the questionnaire sent to all experts in the field helped to understand in which percentage those factors influence the commercialization and the technology transfer of the OpenSG. The statistical methodology, after the data validation, used to understand the influences that the factors found has on the process of commercialization of the OpenSG.

9. Conclusion

The research investigated, apart the importance gained by the interactive digital media, on which are the factors that according to persons that operate among the Digital Media, the Business and management and the marketing that the most influence the commercialization of a technology used to develop Interactive Digital Media. The model has been developed following the directive of those experts and after has been validated through a quantitative research submitted to other experts all around the world. This work contributes to the actual state of the art from a technology transfer and business point of view, for what concerns both the importance of digital media, and the relevant factor influencing the commercialization. This chapter summarizes the final model itself and a critical evaluation. Furthermore implications for business and technology transfer of digital media are indicated.

9.1 Resume and final model

Fundamental changes in business environment for the digital media, and for the technologies adopted to develop them, such as for the rendering engines, can be identified around all the world. On any kind of field, consumers, industries and academics increase the demand for digital media, in order to improve the quality of trainings, learning, and for an easy to use procedure in any fields. Based on current literature and considering the results of the qualitative and quantitative research stages, the model of the commercialization of the OpenSG was finalized. The propositions, part of the survey, were defined during the development of the preliminary model, and after the deep interviews to the experts. Quantitative methods were used to testing the propositions. All three dimensions result to affect the process in a significant way.

As stated previously the first dimension, Production and R&D has been investigated through 8 different statements. These propositions' support is funded. The dimension is significantly related to the commercialization of the OpenSG and therefore affects the process. Indeed the developers and the community represent topics of a core importance when concerning Digital Media, and its development. The developers should put all their knowledge in order to keep the project always up to date, while the community is needed in order to develop more functionality in the project, to eventually fix bugs or complain about something wrong. Community will use the technology develop for more than only one aim, and this operation allows developers to make the project more flexible and extensible for more uses.

The Second dimension, the Market and Commercialization Dimension, has been investigated through eleven statements. Its support is funded. In fact from the results of the quantitative research this dimension affects the commercialization process for the 29,7%. That is why the technology that has been investigated belongs to the family of the Open Source Code Software, and it is utilized for developing important technologies related to the Interactive Digital Media, such as tools of Virtual and Augmented Reality. Hence the role of partners affect the process of commercialization with strong influence, in fact the 28,3% of the total dimension influence is provided by this factor, the last 1,4% by the customer that in this phase do not represent a relevant factor to be taken in account.

The last dimension, the Competitive Dimension, investigated such factor as the added value brought by the technology and the level of innovation that the technology should have. From quantitative results this dimension is the more affecting the entire process. Its support is funded. The level of innovation factor has been revealed as the more important factor leading to the success for the commercialization. Hence it is of an extremely importance that a benchmark activity is continuously coordinated by the project leaders, and even by the partners of the project.

Following is reported the overall model with factors that need to be managed in order to successfully commercialize technologies such as interactive digital media, and in this case the OpenSG rendering engine.

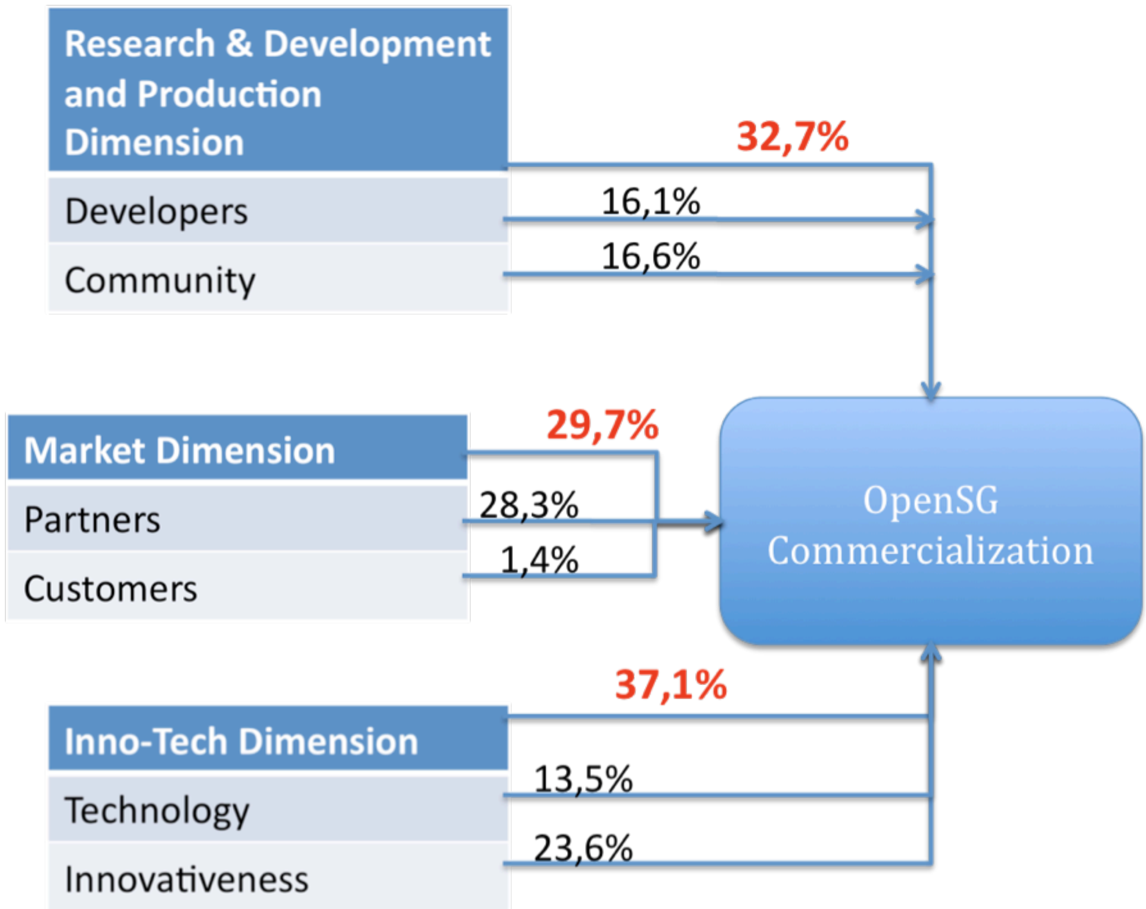

Figure 34: Final Business Model with the factors' influences.

The major contribution of this research is the development of the business and technology transfer model and its validation with experts working in the field of digital media, business and marketing. Following is reported a table of benefits of this research work:

• The influencing factor for the commercialization of a technology used for the development of Interactive Digital Media have been identified, confirmed and explained. • Customers are not a relevant factors inherent the commercialization of these technologies, that means that these technologies, such as OpenSG, are more suitable for a market Business to Business. • The strongest factors influencing the process of commercialization are represented by the Innovativeness embedded in the technology, by the partners that take part in the process and by the community that support the development • The success of the commercialization is dictated for the most by the coordination of activities between the developers, the community and the partners. • This model is applicable to any Open Source Software needed to develop Interactive Digital Media.

Table 40: Benefits of the Model.

9.2 Implications for business operators and technology transfer agents in the digital media field.

Due to the recent rise of the interactive digital media around the globalized world a necessity for research in this area became apparent. Producers of Digital Media, of technology utilized to produce such tools, industries, universities and research centres search for support in their strategic and operational marketing, business and technology transfer decision. Therefore one of the primary purpose of this dissertation was to provide these kind of operators with this research results to guide strategic and operational business implementations. By understanding the relevant factors of the process of commercialization of such technology, it is possible to manage these factors in a much more effective way. Exemplified by a concrete measure would mean to address, in example, the strong communication between developers and the community. Effective strategies could link these two elements of the process and manage their cooperation in a better way. Furthermore the presence of partners among the implementation of a open source technology has been revealed to be one of the most relevant factor when addressing the technology to the market. Market that is not referred to the final one, in fact customers do not affect the model so much, but to a business to business level. Hence industries can take advantage from cooperating with universities and research centre in order to achieve their objectives, such as digital prototyping, training session with new and effective model of learning. All these factors have been highlighted by the qualitative research and then validated by the quantitative stage. The above mentioned interaction improvements in the communication process of the factors of the first dimension could with any doubt lead to a better and efficient process management and development for the investigated technology.

9.3 Further Research

Based on the findings of this study additional research is required regarding the generic business and technology transfer model as to further international and cultural perspectives, the application of new approach in different contexts as well as detailed analysis concerning further technologies utilized for the development of interactive digital media. Additional research is required to expand the model to cover also other interactive digital media technologies. Furthermore the mutual dependencies of the factor influencing the commercialization has not been taken in account which in fact is a consequence of the specific focus of this study. The application of this model to other technologies could lead to a generalization of the same in order to adapt it basing on the cultures, markets' environment, level of innovation of the technology, absorptive capacity of the receiver, technology transfer agent characteristics, and other issues that have not been taken into account during this work.

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Appendix

A.1 INTERVIEW GUIDE FOR THE QUALITATIVE RESEARCH

1st PART INTERACTIVE DIGITAL MEDIA

1. What are your considerations about Interactive Digital Media?

2. In which field could they be applied? In any?

2nd PART DEVELOPMENT PROCESS AND FACTORS

3. Thinking about the development and the production of an Interactive Digital Media, i.e. a virtual reality system, what is the core entity according to you in charge of its design and its maintenance?

4. What are the key factors that should always be present during the development of the process of creation of IDM for the entity you mentioned before?

____

5. If the development of the project is based on an open source philosophy and it is developed among research centres and/or universities, how do you think that this know how could be transferred to the market? How could it be commercialized?

____

3rd PART TECHNOLOGY TRANSFER AND COMMERCIALIZATION

6. Relating to the commercialization of the technology, always based on an Open Source philosophy and developed among Universities and/or Research Centres, who plays a key role in the process?

____

7. If the project involves partners (we even assume that partners are those who pay for the realization of such technology), in which role they should take part in it?

____

____

8. What do you think about the strategy of using complementary assets? Where for complementary assets we mean that the technology is embedded in a bigger one?

4th PART COMPETITIVE DIMENSION

9. For the technology developed which are the most important actions for the owners in order to keep it innovative and competitive to the market?

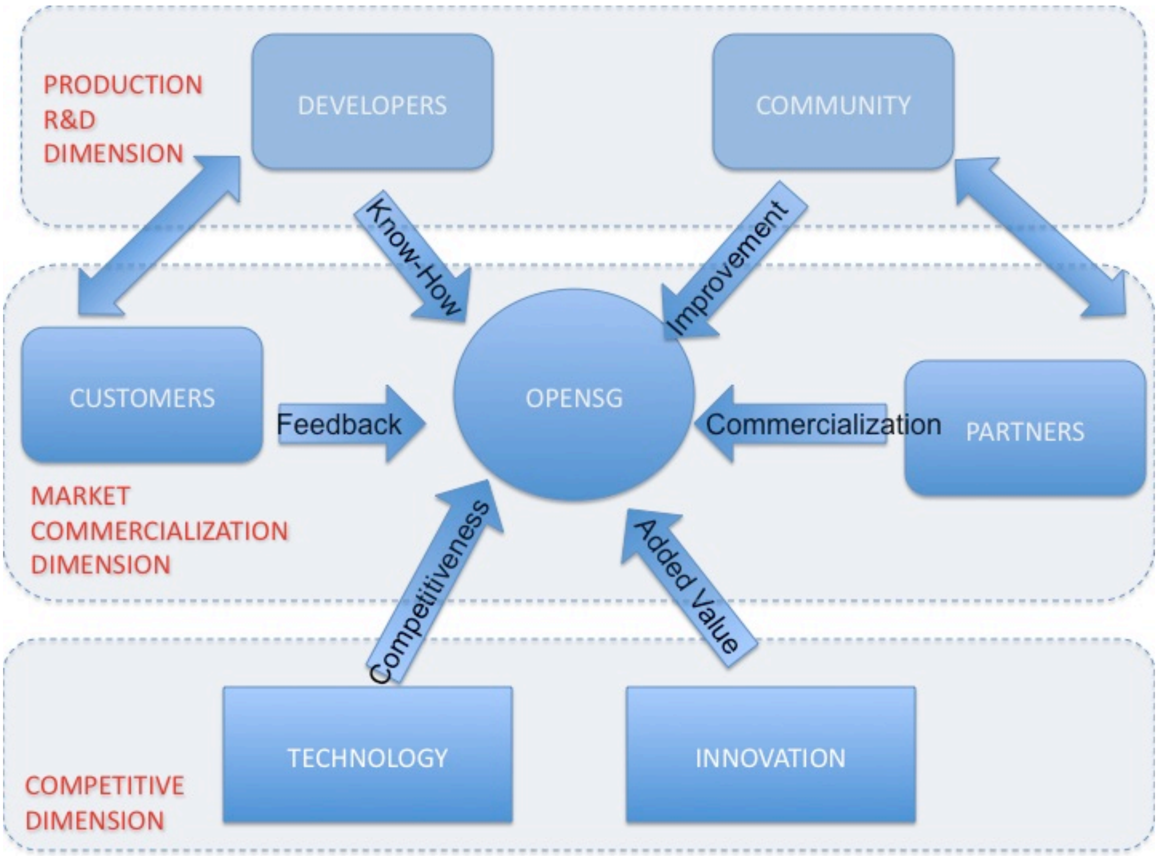
10. Which strategy would you recommend towards customers? And towards the competitors?

A.2 INTERVIEW GUIDE FOR THE QUANTITATIVE RESEARCH

Questionnaire:

We appreciate if you could spend 15 minutes of your precious time in order to answer to the following questions related to the use of the interactive Digital Media. This research is aimed to develop a business model adaptable to the IDM, and for the OpenSG rendering engine, a digital scene graph, Open Source developed between CAMTech in Singapore and Fraunhofer Institute. The questionnaire will be used in an aggregate way.

The following model is a figurative description of the business model developed for an OSS, and in this case for the OpenSG



Please state if you agree or disagree with the following affirmation

	Completely Disagree	Disagree	Don't know	Agree	Completely Agree
Consideration about the IDM					
1.1 Interactive Digital Media are an extremely powerful tool to be used in any kind of field	☐	☐	☐	☐	☐
1.2 IDM are being used in any kind of field	☐	☐	☐	☐	☐
1.3 IDM growth extremely with the use of Internet and the WWW	☐	☐	☐	☐	☐
FIRST DIMENSION: PRODUCTION AND R&D Based on the model adopted the first dimension embeds two key figures that are represented by the *Developers and the Community.*					
2. To what concerns the idea generation and the consequently production of the IDM, the developers, that represent the core of the OSS, have to continuously transfer their knowledge into the product.	☐	☐	☐	☐	☐
3. The existence of an active community in an Open Source point of view is fundamental in order to provide a continuous update of the OSS, suggesting improvements and bugs corrections based on their use of the product.	☐	☐	☐	☐	☐
4. The developers are part of the community, and the community is an active part of the project carried out. Hence a strong and communication has to be build and continuously maintained between these two parts.	☐	☐	☐	☐	☐
5. Most of the times, and in the case of the OpeSG rendering engine, the know-how is developed among universities and/or research centres. Do you think this know-how can					

be transferred from the cradle to the market (or industries) through:					
a. Training sessions for companies workforces	☐	☐	☐	☐	☐
b. PhD Courses sponsored by the companies based on their specific projects	☐	☐	☐	☐	☐
c. Committing specific projects for Universities or research centres	☐	☐	☐	☐	☐
d. Consultations	☐	☐	☐	☐	☐
Other (please specify your suggestions) ____ ____ ______________________________					

SECOND DIMENSION: MARKET AND COMMERCIALIZATION

In this section we try to analyze the importance of partners and customers in the process of commercialization and "to market" the OSS production

6. A Technology developed among research centres and/or universities with an Opens Source philosophy needs partners (private and governmental) in order to be commercialized.	☐	☐	☐	☐	☐
7. For an Open Source Software, we do not have to commercialize the software itself but the knowledge build and developed around	☐	☐	☐	☐	☐
8. Partners should take an active part on the process of development	☐	☐	☐	☐	☐

of the OSS, through sponsoring the research and the development in order to customize the product basing on their needs					
9. A continuous presence of partners is mandatory among the development of the project in order to:					
a. Make scheduled controls on the project development	☐	☐	☐	☐	☐
b. To continuous exchange the know-how needed for the product customization	☐	☐	☐	☐	☐
c. Carry the sustainment, in terms of resources (people, equipments) to the project	☐	☐	☐	☐	☐
10. Once the product is commercialized customers, both they are final or not, have to be monitored and their feedback need to be deeply analyzed	☐	☐	☐	☐	☐
11. On a B2B basis the partners represent a great portion of customers	☐	☐	☐	☐	☐
12. Embedding the OSS Technology in another SW can lead to an easier commercialization, but contemporarily to problem related to IPR	☐	☐	☐	☐	☐
13. A University or Research Centre, that bases its business on OSS ideology, needs complementary assets, thus they are more important and basilar for resources findings because provide various services, training and consulting	☐	☐	☐	☐	☐

THIRD DIMENSION: COMPETITIVE DIMENSION This part is focused on the competitiveness and the innovativeness of the technology					
14. The continuous update of the IDM, or of the OSS technology leads to an always update factor of innovativeness	☐	☐	☐	☐	☐
15. The process of transferring the technology to the market, accompanied by a continuous R&D, and the continuous monitoring of the competitors will definitely leads to an high competitive factor	☐	☐	☐	☐	☐
16. The following strategies will lead to the achievement of added value for the technology to be transferred to the market:					
a. The fulfilment of customers' needs	☐	☐	☐	☐	☐
b. the analysis of their feedback	☐	☐	☐	☐	☐
c. process of knowledge-sharing between the actors of the community	☐	☐	☐	☐	☐
Others (please specify your suggestions) ____________________ ____________________ ________					

If you have any comments please indicate it here:

____

____

____

____

____

Thanks for your collaboration