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## EXPLORING THE VALUATION PROCESS OF INTELLECTUAL PROPERTY ASSETS: THE CASE OF THE MEDICAL DEVICE PATENT

*Vittorio Chiesa, Politecnico di Milano, Milan, Italy*

*Elena Gilardoni, Politecnico di Milano, Milan, Italy*

*Raffaella Manzini, Università Carlo Cattaneo – LIUC, Castellanza (VA), Italy*

*Emanuele Pizzurno, Università Carlo Cattaneo – LIUC, Castellanza (VA), Italy*

### ABSTRACT

It is widely recognised that intellectual property assets (IPs) nowadays create the crucial base for business development (Gosh, 2003; Gotro, 2002; Osborne, 1998). As a consequence, companies are often required to value them (Anson, 2004; Rabe and Reilly, 1996). Few contributions have been written on the theoretical and practical problems of the complex process that leads to the valuation of IPs (Harvey and Lusch, 1997). From this point of view, some contributions come from the consulting literature that draws guidelines by the practical experience of companies (Reilly and Schweih, 1999). But few works present a systematic view of the whole process and, furthermore, analyse the appraisal process with specific reference to empirical examples and cases, able to point into evidence the managerial and organisational problems arising during the process (Chiesa *et al.*, 2005).

With respect to the state of the art, the paper aims at (i) identifying the critical problems emerging from the application of valuation process frameworks; (ii) verifying whether the adoption of a specific valuation process framework affects the result of valuation.

The aims of the paper emerged from an empirical application of some available appraisal process frameworks through a case study. The empirical application permits to verify in a real context the influence of the valuation process frameworks on their output and their usefulness.

The case study concerns a medical device patent pending able to improve the muscular strength and to allow rehabilitating the muscular hypotrophy.

## 1. INTRODUCTION

Over the years, the relevance of intangible assets (IAs) is greatly increased. There are several definitions of what IAs are. For example, an IA could be defined as a resource which does not have a physical embodiment and whose industrial and economic exploitation gives a claim to future benefits (Boutellier, 2000; Holzmann, 2001; Khoury, 2002; Lev, 2001; Smith and Parr, 2000).<sup>1</sup> Other authors define the IAs as the core competencies of firms (Harvey and Lusch, 1997). These are factors of growing importance in boosting corporate competitiveness and economic performance. At the beginning of the twentieth century the largest industrial companies in the world were US Steel, Exxon, J&P Coats and Pullman. The equivalent list today includes Merck, Coca-Cola, Intel and Microsoft. This simple comparison exemplifies an important and continuous change; the competitive advantage of these new largest companies rests in the brand, control of standards, innovations and patents protection. Consequently the foundations of the economy have shifted away from the traditional industries, e.g. cars and steel, to the high technology and information-based industries.

Among the wide range of resources called IAs, a subset of them is called intellectual property assets (IPs); these assets are covered by legal protections. Examples of IPs are patents, trade secrets, trademarks and copyrights. IPs are increasingly recognized as the “key value drivers” of companies (Ghosh, 2003) and are playing a greater role in the economy than they have ever done.

About the growing relevance of IPs (Chatterji, 1996; Chiesa, 2001; Roberts, 2001), it has been observed that (i) the cross licensing agreements, (ii) the number of patents issued to the industry (table 1), (iii) the patent infringement lawsuits, (iv) the interest in external sources of innovations and technologies such as acquisitions, licensing, outsourcing (table 2) are improving.

Table 1: Number of patent applications registered in 2003, 2002, 2001 and 2000. (European Patent Office, Japan Patent Office, U.S. Patent and Trademark Office).

	2000	2001	2002	2003
<b>European Patent Office</b>	27,523	34,704	47,384	59,992
<b>Japan Patent Office</b>	125,880	121,742	120,018	n.a.
<b>U.S. Patent and Trademark Office</b>	175,980	183,972	184,378	187,017
<b>Total</b>	329,383	340,418	351,780	n.a.

Table 2: Percentage of companies relied upon external sources of technology. (Roberts, 2001).

	1992	1995	1998	2001
<b>Europe</b>	22	47	77	86
<b>Japan</b>	35	47	72	84
<b>North America</b>	10	30	75	85

<sup>1</sup> Examples of intangible assets are: customer base, trained work force, distribution channels, supplier contracts and employment contracts.

Consequently it is important to appraise these emerging assets even if the task of assessing their value is particularly difficult (Harhoff *et al.*, 2003). But despite this growing importance and the relevance of IPs valuation, a small number of studies presents a methodical examination of the whole valuation process, a limited number of empirical examples and cases is available (Park and Park, 2004) and little contributions underline the real need to have a valuation process framework for guiding the appraiser during the valuation activity (Chiesa *et al.*, 2005). So, to make a further step into this field - through from an empirical application of appraisal process frameworks to a case study - the paper aims to:

- identify the critical problems emerging from the application of valuation process frameworks;
- verify whether the adoption of a specific valuation process framework affects the result of valuation.

The case study concerns a medical device patent pending able to improve the muscular strength and to allow rehabilitating the muscular hypotrophy.

To achieve the defined objectives, the paper is organized as follows.

In the next section, two themes are presented. First the major accepted valuation methods are explained and then, an overview of the major contributions on the valuation process is laid out. These contributions analyse and discuss not only the application of the valuation methods, but also present an overview of the basic concept related to the valuation of intangible assets.

Section 3 presents the empirical analysis; the application of three valuation process frameworks to the case study is described, in order to identify the critical problems emerging from their application, and verify the impact of different valuation process frameworks on the IP value.

Section 4 discusses some managerial implications and further research developments.

## **2. THE IP VALUATION STATE OF THE ART**

The academic literature as well as corporate practice posed great attention to the valorisation of IPs.

With respect to the aims of the paper, among the literature contributions are relevant the issues about (i) the methods for valuing IPs, and (ii) the valuation processes of IPs.

### **2.1 Methods for valuing the intellectual property assets**

According to the literature, the valuation methods have been classified into three groups: the cost, market and income methods.

The methods are well documented in an extensive bibliography: Anson, 1996; Anson, 2001; Anson and Serrano, 2001; Hoffman and Smith, 2002; Khoury *et al.*, 2001; Mard *et al.*, 2000; Mard, 2001; Park and Park, 2004; Razgaitis, 1999; Reilly and Schweihs, 1999; Smith and Parr, 2000; Spadea and Donohue, 2001; Stiroh and Rapp, 1998; Tenenbaum, 2002; WIPO. In this paper, the methods are presented for an illustrative purpose and are not intended to reflect a comprehensive review of this issue; table 3 presents a comparison of the three methods, while the required data and information of each valuation method are reported in table 4.

Table 3: Comparison of three valuation methods (adapted by Park and Park, 2004)

Method	Cost	Market	Income
<b>Definition</b>	Valuing based on cost required to reproduce or replace the IP	Valuing based on the price of IPs in market	Valuing based on the present worth of future income flow
<b>Advantages</b>	Easy to calculate if cost data is available	Possible to calculate the most rational value if market data is available	Possible to capture present worth based on profit generating capability
<b>Disadvantages</b>	Ignorance of future potential of IP	Lack of market data on comparable IPs	Change of error due to subjective estimation

Table 4: Data and information required by each valuation method

Method	Necessary data
<b>Cost</b>	<u>Material</u> : tangible elements used during the intangible asset development process <u>Labour</u> : human capital efforts associated with intangible asset development process <u>Overhead</u> : it includes for example taxes, legal fees, management and supervisor expenditures <u>Developer's profit</u> : it is the amount of profit expected by developer as a return <u>Entrepreneurial incentive</u> : it is the amount of expenditures required to motivate the owner of the intangible asset to enter into the development process <u>Capitalization rate</u> the past cash flows will be capitalized <u>Obsolescence</u> , i.e. the reduction in the value of the intangible asset due to improvements in technology
<b>Market</b>	<u>Similar transactions</u> : transactions involving similar assets that have occurred recently in similar markets
<b>Income</b>	<u>Future net cash flows</u> : incremental revenues; decremental expenses; additional investments <u>Time horizon</u> : the period during which the intangible is expected to generate net cash flows <u>Actualisation rate</u> : the future net cash flows will be actualised

## 2.2 The valuation process frameworks

The literature on IPs valuation process is quite wide; the contributions can be classified into two groups; the former focuses on and analyses several aspects of this issue, focusing on (i) the most important principles of the valuation process (King, 2001; Reilly and Schweihs, 1999), (ii) why the valuation is begin performed and who is expected to rely on the appraisal (Anson, 2002; Smith and Parr, 2000), (iii) the choice of valuation methods (Anson, 2001; Mard *et al.*, 2002; PWC, 1999), (iv) the coherence between: the techniques and the type of asset (Smith and Parr, 2000), the techniques and the objective of leveraging technology (Contractor, 2001; Khoury, 1998), (v) the linkage between the appraisal method and a specific form of transaction (e.g. licensing

agreement) (Berkman, 2002), (vi) the identification of intangible resources (Carmell, 2004).

The latter, instead, discusses the entire IP valuation process (i) suggesting a valuation framework, (among the other Andriessen *et al.*, 1999; Anson, 2002; Chiesa *et al.*, 2005; Hall, 1993; Harvey and Lusch, 1997; Park and Park, 2004; Reilly and Schweih, 1999; Venning, 2005), and (ii) discussing the theoretical and practical problems of the valuation process of intellectual property assets. Concerning this second aspect, few academic contributions are available (e.g. Chiesa *et al.*, 2005; Park and Park, 2004) even if some contributions come from the consulting literature that draws guidelines by the practical experience of companies (Reilly and Schweih, 1999).

The literature analysis highlighted the complexity of IPs valuation. It is composed by main steps, in fact, it consists not simply in the selection and application of a valuation method, but also in (i) the identification of the IPs to be valued, (ii) the description of the scope of analysis, (iii) the identification of limiting conditions such as the accuracy level of data used in the appraisal, (iv) the preliminary analysis, data selection and collection; (v) the application of the valuation methods; (vi) the reconciliation of values (when an analyst uses several valuation methods, different value indication can be obtained, thus a range of “significant” values has to be define).

Furthermore the need to have a valuation process framework supporting the appraiser has been confirmed.

Even if, each intellectual property asset valuation is unique (Reilly and Schweih, 1999), having a pattern (Smith and Parr, 2000), which can be used in any appraisal assignment to value an IP, help appraiser because (Chiesa, *et al.*, 2005; Reilly and Schweih, 1999):

- forces to perform a systematic and rational analysis;
- allows to synthesize and conclude a reasonable estimate of value;
- forces to solve some critical trade-offs and to deal with contrasting elements;
- gives a communication tool, people with different competencies are usually involved in the valuation process and a framework can make the valuation easier;
- allows people (even if not directly involved in the valuation process) to understand how the value of the asset has been determined and the validity, reliability and precision of the obtained results.

With respect of the aims of the paper several academic and consulting literature contributions have been considered. Some of the analysed academic contributions are: Chiesa *et al.*, 2005; Park and Park, 2004; Ratnatunga *et al.*, 2004; Anson, 2002; King and Henry, 1999; Harvey and Lush, 1997; Hall, 1993. In addition, some of the consulting contributions come from different international valuation firms, have been considered such as Appraisal, Economics, Inc., Inavisis, Inc., The Financial Valuation Group, The Patent & License Exchange Inc., Valutech Pty. Ltd., Willamette Management Associates.

Among these contributions, three valuation process frameworks have been selected and applied to a case study in order to reach the aims of the paper. The frameworks are the following:

- Reilly and Schweihs (1999, Willamette Management Associates);
- Park and Park (2004); and
- Chiesa, Gilardoni and Manzini (2005).

The Reilly and Schweihs' valuation process has been selected and applied to the case study, because:

- the authors have acquired practical experiences in valuing IPs because they work (i) as managing directors in a firm which provides independent valuation services to the business financial and legal communities, and (ii) as expert witnesses in many intellectual property disputes;
- their contribution seems to be one of the most complete frameworks suggested by international valuation firms, in fact the other contribution usually are limited to presenting and proposing a valuation process plan and do not debate it (e.g. The Financial Valuation Group and Valuetech Pty. Ltd.);

The Park and Park's valuation process has been selected and applied to the case study, because:

- it seems to be appropriate fitting the scope of the valuation, facing several aspects to gain a precise monetary value;
- it is one of the most recent and operative academic contributions;
- it presents a detailed procedure;
- it decomposes the complexity of valuation into several modules.

The Chiesa *et al.*'s valuation process has been selected and applied to the case study, because it is the valuation process framework proposed by the authors of the paper and they would like to discuss their proposal and to improve it.

### **2.2.1 Reilly and Schweihs (Willamette Management Associates)**

Reilly and Schweihs in their work "The appraisal process" (in "Valuing intangible assets", 1999) assert that the appraisal of intangibles is the culmination of the exploratory research into the predictable economic performance of an intangible asset.

*The Valuation Process.* The authors consider the valuation process a systematic approach to answering to specific questions about asset value. The process provides a pattern that can be used in any appraisal assignment to perform market research and data analysis, to apply appraisal methods and procedures, and to integrate the results of these analyses into an estimate of a specifically defined value.

The authors identified the basic steps of the valuation process and a synthetic description of the phases of the valuation process is presented below.

1) *Identification of the appraisal problem.* The appraisal problem is defined considering not only the intangible asset, but also the rights legally held (or rights that may legally held) and the market forces. All these elements, in fact, could affect the value of an intangible.

2) *Data collection.* In this step the appraiser develops an analytical work plan to gather, analyse and adjust data. Usually data should include the following:

- Characteristics of intangible asset (as ownership interest to be valued, right, privileges and factors affecting ownership or operational control)
- Historical financial information for the intangible asset
- Nature and conditions of the relevant industries that have an impact on the intangibles asset value
- Economic factors (such as the nature and conditions of the relevant industries that have an impact on the IP) affecting the intangible asset
- Prior transaction involving the intangible asset

3) *Three approaches to value.* The authors suggested for appraising the intangible asset to consider three distinct methods to value (cost, market and income method). In fact, value indications can serves as useful comparison for assessing the reasonableness of the results of the principal methods.

4) *Valuation conclusion.* Even within the same valuation approach different methods will typically result different indications of value. Consequently a process of reconciliation is required to obtain a final value. However the analyst should review the entire intangible appraisal for appropriateness and for accuracy.

To strengthen valuation, they suggest making a sensitivity analysis. In this manner, a reasonable range of values for the intangible may be established.

The authors recognised the value is strictly related not only to the intangible, but also to several factors characterising the particular place, time and circumstances the intangible is in. Nevertheless, they did not suggest which factors have to be considered, how to quantify them and how to use them in valuation. The authors recognised that some general assumptions have to be made in order to carry out an appraisal assignment in an efficient manner. Moreover they suggested to apply independent appraisers certify that the analyst has conducted the appraisal without personal interests and biases.

### **2.2.2 Park and Park**

Park and Park (2004) in their work “A new method for technology valuation in monetary value: procedure and application” applying their proposed valuation method to a case study, present the flowchart of the valuation process.

*The Valuation Process.* The authors explain that the whole valuation process is module-based where respective modules focus on specific functions<sup>2</sup>. The modules are:

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<sup>2</sup> See Park and Park (2004) for the overall flowchart of the valuation process.

VOT Module, VOM Module and Value Computation Module. First to portray the process, two concepts, interrelated each other, have to be introduced. The former is the “value of technology” (VOT) and it is referred to the potential value that is embedded in a technology itself, the latter is the “value of market” (VOM) and denotes the practical value of technology that is materialized in market or in business process.

In VOT evaluation module the assessment of factors reported in table 5 is carried out in the form of score, percentage, number or other, depending on the single factor. Then the “adjusting factor” and “discount rate” are computed.

Table 5: VOT factors and their input metric (Park and Park, 2004).

VOT factors	Definition	Input metric	Useful for
Proprietary position	Degree of protection	Score	adjusting factor / discount rate
Level of technology	Technical level of technology (compared to state of the art)	Score	adjusting factor / discount rate
Life of technology	Income-generating duration of technology	Year	VOM module
Degree of standardisation	Degree of standardisation	Score	adjusting factor / discount rate
Type of technology	Product, process	Classification	VOM module
Contribution ratio	Contribution ratio to expected income flow	Percentage	VOM module
Scope of application	Number of applications	Number	VOM module
Degree of completeness	Readiness for commercialization of technology	Score	adjusting factor / discount rate

In this case the term “technology” means IPs or the technology the IPs is based on

The adjusting factor serves as a weight for the amount of income in VOM and it is evaluated as follows:

- weights ( $w_i$ ) for each factor based on consultation with specialists are assigned;
- scores ( $s_i$ ) for each factor are assigned (the range is 0-1);
- the weighted sum is computed ( $\sum_{i=factors} w_i \times s_i$ );
- the adjusting factor is determined based on a pre-determined table (table 6).

Table 6: Calculating adjusted factor.

Weighted sum	Adjusting factor	Weighted sum	Adjusting factor
0-4	0.7	20-24	1.1
5-9	0.8	25-29	1.2
10-14	0.9	30-34	1.3
15-19	1		

The discount rate serves to determine the risk of income in VOM and the process is similar to the previous one.

In VOM module the income flow is estimated considering the profit generation and cost saving of IP. Then, in Value Computation module, the monetary value of subject IP is finalized.

### 2.2.3 Chiesa, Gilardoni and Manzini

Chiesa *et al.* (2005), in their work “The valuation of technology in buy-cooperate-sell decisions”, present a framework aimed to give a systematic vision of the appraisal process.

*The Valuation Process.* The authors within the framework<sup>3</sup> distinguished three different elements: activities, constraints and links.

#### 1) *Activities.*

- Identifying the unit of analysis. This activity focuses on the identification of intangible asset, the authors underline the relevance of considering if the intangible is an independent economic unit or if it is a part of a complex product/system.
- Identifying the aim and scope of analysis. The comprehension of the aim and scope of analysis allows describing the context in which the valuation takes place (e.g. licensing agreements, infringement damages, strategic alliances, etc.). Moreover this activity requires the identification of a set of actors potentially involved in the transaction agreement. Consequently the accuracy and quality of valuation should be increased.
- Identifying the most proper methods. The choice of most proper methods is not trivial, but it is strictly linked not only to the unit of analysis, and the context of analysis but also to the availability of time and resources.
- Comparing necessary and available data. This activity could require coming to a compromise. Sometimes the necessary data need greater resources and time than available ones. Consequently the appraiser could accept to obtain an appropriated value (in terms of accuracy, precision, overall coherence, etc.) rather than the best value.
- Collecting data. This activity expects to (i) identify data sources, (ii) identify the right data and information, (iii) establish the level of completeness and accuracy of gathered data.
- Determining the value asset.

2) *Constraints.* Some constraints have been identified, such as (i) the available data, time and allocated resources and (ii) the necessary data, time and resources required to apply a method.

3) *Links.* There are several links within the framework. They assure to carry out a careful management of valuation process and to make the various activities coherent among them.

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<sup>3</sup> See Chiesa *et al.* (2005) for the overall flowchart of the valuation process.

The authors contributed to highlight the complexity of the appraisal process and to analyze in detail the different activities the process is composed of. In addition, the authors explained how the activities are networked each other and how a different management of activities could have an effect on the accuracy of appraisal process finding. The authors made an effort to point into evidence the most critical elements that could lead to a misleading and/or biased valuation. The aim of Chiesa *et al.*'s work is to force the appraiser to solve the trade-off between the level of truthfulness of valuation and the amount of resources used to carry out the valuation.

### **3. THE CASE STUDY**

Through the case study the three valuation processes has been applied to a real IP valuation, in order to verify whether the adoption of a specific valuation process framework affects the result of valuation. This application has been developed in collaboration with the inventor and owner of the IP, who discloses all relevant information.

#### **3.1 The context**

The valuation processes have been applied to a medical device fated to improve the muscular strength and rehabilitate the muscular hypotrophy. The object of the case study is a patent for a new product, born from an intuition of a gymnast, graduated in medicine, who has worked as a mascot for an Italian volleyball team. This activity brought an increment on his muscular capacity and physical performances. These facts lead the creator to engineer a particular medical device that could be used in the post surgical treatment and in the treatment of osteoporosis, due to its proven benefits in improving muscular strength and rehabilitating the muscular hypotrophy.

Up to today, the medical device is a patent pending and the inventor is following the patent procedures for establishing a legal protection of his invention in Italy. The inventor needs to estimate the value of his invention, for licensing it to a producer for its exploitation. Thus the objective of the valuation process is the determination of the monetary value of the medical device patent (MDP). Due to the patent pending, some data and information reported in this paper are disguised for confidentiality reasons.

#### **3.2 Frameworks application to the case study**

This section consists in the application of the three aforementioned valuation processes to the specific MDP with the aim to obtain a monetary value of the asset itself.

### 3.2.1 Reilly and Schweih's (Willamette Management Associates)

Following the steps proposed by these authors, and applying them to the case study, the first phase encountered is the *identification of the appraisal problem*. More in details:

- Identification of the subject intangible asset: the MDP,
- Identification of the subject intangible asset property rights to be valued: in the first phase an Italian patent is establishing; an international patent will be required,
- Objective of the intangible asset appraisal assignment: to determine the monetary value of the intangible asset,
- Purpose of the intangible asset appraisal assignment: it has to be licensed,
- Definition of an appropriate standard of value: monetary,
- Date of the value estimate: during 2004,
- A listing of limiting conditions, if any: none (as intended in this process).

The second step is the *data collection*. In this step the appraiser develops an analytical work plan to gather, analyse and adjust the following data:

- Characteristics of the intangible: the operational control of the licensee will be complete without limitations;
- Nature, history and outlook of the business and industry in which the intangible asset operates: the industry is the medical one and it presents a high rate of growing and a whole wide market (according to the possible utilizations of the device);
- Historical financial information for the intangible: none available cause to the novelty of the device;
- Related assets and liabilities required for economic operation of the subject intangible asset: all competences needed to exploit the intangible asset are available and are referred to mature technologies;
- Nature and conditions of the relevant industries that have an impact on the intangibles value: all raw materials and components are available on the market without limitations or wide price fluctuations;
- Economic factors affecting the intangible: none specific, notwithstanding the negative economic conjuncture affecting the world economy and Italy more than other countries;
- Available rates of return on alternative investments and description of relevant market transactions: actually the rate of return on a risk free investment is in about 1,5% per year, whilst similar market transactions data is not available;
- Prior transaction involving the intangible: none. The MDP is a completely new invention never involved in buy-cooperate-sell decisions;
- Other relevant information: none identifiable.

As third step, the authors suggested to apply *three approaches to value* for appraising the intangible asset: cost, market and income method. The authors underline as the

choice of one method - instead to another – depends upon (i) type of property, (ii) use of appraisal, (iii) quality and quantity of data available.

Due to the absence of further about method selection, the authors' suggestion, of applying more than one method, has been followed choosing the methods for which the necessary information is available. In the case study the market approach is not usable cause to absence of required information (see table 4), in fact, there are not similar competitors' products. Instead, the data, related to the cost and income method, are available. It should be noted that the authors do not explain the characteristics of valuation methods and do not present how these methods should be applied.

*The cost method.* The application of the cost method indicates a value equal to € 15,680 (table 7). It has been established considering the following types of cost:

- patent cost (overhead cost in table 4): this type of cost is referred to the cost sustained to obtain the legal protection. This cost has been incurred in the year of the valuation of the MDP (year 0) and it is equal to € 5,900;
- medical researchers (labour cost in table 4): the costs of electrocardiograms, echographies, spirometries, test equipment, and medical examinations have been included These costs have been sustained three years prior to the data of the valuation (€ 2,000 per year);
- prototype cost (material cost in table 4): it is the sum of the costs of all the item used to realise a model of the medical device patent and it is equal to € 340.

10% capitalisation rate, 5% developer's profit and 10% entrepreneurial incentive have been considered. The data for estimating the obsolescence have been omitted because there are not to improvements in technology and no improvements are expected in the future.

Table 7: The value of the medical device patent established using the cost method.

		Years			
		-3	-2	-1	0
<b>Patent cost</b>	(€)				5,900
<b>Medical research cost</b>	(€)	2,000	2,000	2,000	
<b>Prototype cost</b>	(€)	340			
<b>Total cost</b>	(€)	2,340	2,000	2,000	
Capitalization rate	10%				
<b>Capitalized costs</b>	(€)	3,115	2,420	2,200	5,900
<b>Total capitalized cost</b>	(€)				13,635
<b>Developer's profit (5%)</b>	(€)				682
<b>Entrepreneurial incentive (10%)</b>	(€)				1,363
<b>Value</b>	(€)				<b>15,680</b>

*The income method.* To implement the selected method, data about future net cash flows, actualisation rate and time horizon, have been gathered thanks to the inventor's support (table 8). For making the valuation easiness, the inventor hypothesizes to

license the MDP only to an Italian firm. Inventor in defining the previous data and information considered the characteristics of Italian firms working in the circle of orthopaedic device. In Italy there are 21 firms, they are quite similar each other, thus the inventor collects data and information (e.g. projected sale units, price and cost of production) about a generic firm; the price and cost of production of medical device have been supposed to be constant; whilst a growth rate for the projected sale units has been supposed to be changeable.

Table 8: Collected data.

Collected data	
Price (€/unit)	110
Cost of production (€/unit)	65
Projected sale units (1 <sup>st</sup> year)	500
Projected sale units – growth rate (% per year)	
1 <sup>st</sup> -5 <sup>th</sup> years	2
6 <sup>th</sup> -10 <sup>th</sup> years	1
11 <sup>th</sup> -15 <sup>th</sup> years	0
Actualisation rate (%)	15
Time horizon (year)	15

The value of the MDP using the income method is € 71,644 (table 9).

Table 9: The value of the medical device patent established using the income method.

		0	1	2	3	4	5	6	7	Years					10	11	12	13	14	15
Projected sale units	(u)	500	510	520	531	541	547	552	558	563	569	569	569	569	569	569	569	569	569	569
Projected unit price	(€/u)	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
<b>Total projected sales</b>	(€)	55.000	56.100	57.222	58.366	59.534	60.129	60.730	61.338	61.951	62.571	62.571	62.571	62.571	62.571	62.571	62.571	62.571	62.571	62.571
Cost of production	(€/u)	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
<b>Cost of production</b>	(€)	32.500	33.150	33.813	34.489	35.179	35.531	35.886	36.245	36.607	36.974	36.974	36.974	36.974	36.974	36.974	36.974	36.974	36.974	36.974
<b>Operating income</b>	(€)	22.500	22.950	23.409	23.877	24.355	24.598	24.844	25.093	25.344	25.597	25.597	25.597	25.597	25.597	25.597	25.597	25.597	25.597	25.597
<b>Tax expenses</b>	45%	10.125	10.328	10.534	10.745	10.960	11.069	11.180	11.292	11.405	11.519	11.519	11.519	11.519	11.519	11.519	11.519	11.519	11.519	11.519
<b>Income after tax</b>	(€)	12.375	12.623	12.875	13.132	13.395	13.529	13.664	13.801	13.939	14.078	14.078	14.078	14.078	14.078	14.078	14.078	14.078	14.078	14.078
<b>Patent cost</b>	(€)	- 5.900																		
<b>Net cash flows</b>	(€)	- 5.900	12.375	12.623	12.875	13.132	13.395	13.529	13.664	13.801	13.939	14.078	14.078	14.078	14.078	14.078	14.078	14.078	14.078	14.078
Discount rate	15%																			
<b>Discounted net cash flows</b>	(€)	- 5.900	10.761	9.544	8.465	7.509	6.660	5.849	5.137	4.512	3.962	3.480	3.026	2.631	2.288	1.990	1.730			
<b>Value</b>	(€)		71.644																	

Additionally, the authors suggest focusing on *contingent and limiting conditions*. A list of several limiting conditions is available in Reilly and Schweihs' work, but from liens to encumbrances, from external to hidden information, from environmental hazards to compliance with law, no one of these conditions meets the feature of MDP itself. Moreover, the suggested independent appraisal certify is not considered as necessary by the inventor.

As fourth step, the authors suggest focusing on *valuation conclusion*. As in this case study, even within the same valuation, different methods carry out largely different results and, consequently, different indications of value. The analyst should review the entire appraisal process for appropriateness and accuracy. Then if the different results persist, the authors suggest the adoption of the "process of reconciliation", which guides to obtain a final value. In this case the value of the MDP should be the average of the values previously obtained, i.e. € 43,662.



### 3.2.3 Chiesa, Gilardoni and Manzini

*Identifying the unit of analysis.* This process requires a precise identification of the unit of analysis; the medical device is composed by different elements: (i) the design and the materials of the device; (ii) the medical researches, (iii) the know how, and (iv) the patent right.

- The design of the device; it includes drawings, the bill of materials and a pre-built prototype; these allow the licensee to reproduce the device without any further information;
- The medical researches identified the trials that have been conducted for three year. During this period, the testers wore the particular device for three hours every day, they did not changed their ways of life in order to avoid any kind of alterations of the observed and controlled parameters. General and specific tests have been performed to collect data for identifying possible contraindications due to the use of the MDP. The gathered data highlights the utility and the importance of the medical device patent providing in addition positive results in terms of improvement of muscular strength and respiratory capacity;
- The know-how has been generated from the medical-sportive studies and the research protocol. For confidential reason it is not possible explain and clarify the nature of the know-how deriving from the research study and inventor's experience. Notwithstanding it represents a relevant part of the medical device because it makes the device unique and difficult to be replaced by competitors; moreover it could be the base for new medical devices;
- The patent is the legal right to exclude others from using the disclosed medical device. It is a legal instrument enhancing the importance and assuring the originality of the device, in fact similar device are not present and available on the market. As a consequence, in this specific context, the value of the medical device is increased, too; in fact, it grant a monopoly (for the next 15 years).

Subsequent to the grant of the patent, it incorporates these four units of the analysis into a specific IP, which, for this reason, has to be considered as one independent and indivisible economic unit. In fact, the patent represents a tool for transferring the know-how and benefits of the medical device (benefits that have been supported by the medical studies), in addition to the technical features of the new product.

In this case the identification of the unit of analysis does not present any trouble.

*Identifying the aim and scope of analysis.* The owner of the medical device patent has theoretically two different possibilities; he, in fact, could exploit the device internally or externally, for example by licensing or selling the patent to other companies. Because he is unable to (i) sustain high production and marketing investments and (ii) exploit the patent in some geographical areas, he decided to exploit

the device externally. Moreover he aims at licensing the patent for preventing problems with further researches.

This activity requires the identification of the potential licensees, in fact, as the authors have shown, in their foregoing works, how the choice of potential licensees is very important in valuing the assets because it influences the value (Chiesa *et al.*, 2005). In this case the owner identifies, among the 21 Italian firms, the potential licensee. It is a small-middle size firm located in the North of the Italy and interested in signing a licensing agreement with the inventor and owner of the medial device patent.

*Identifying the most appropriate method(s).* Considering the context of valuation, critical for the success of the process is the identification and adoption of a method able to capture the future economic benefits associated with the patent. Thus the cost method does not seem adequate to the aim of this valuation; this method, in fact, does not take into account incremental profits of the medical device patent. The market method cannot be considered adequate as well, because other medical devices similar to the object of this valuation are not on market.

On the contrary, the income method seems to be the best option, according to the aim and scope of the analysis. As a consequence the factors influencing the adoption of a specific valuation method (e.g. the variables of the decision process) are the unit of analysis, the aim and scope of analysis and the available time and resources as well as the available data. The available time and resources do not represent a real constraint, in fact, at the moment there are no competitors and, up to today, the medical device is under patent process. Concerning specific resources, such as competencies needed to apply more sophisticated methods, are easily finding. The available data does not represent a problem, too; in fact the appraiser is also the inventor and the owner of the MDP so he can access to data without problem of confidentiality and “secrecy” for this reason the data is always easily accessible.

*Comparing necessary and available data (usable method).* The situation of available and necessary data required by the most appropriate method previously identified (income method) for valuing the medical device patent is here presented. The time horizon and the actualisation rate do not present troubles; on the contrary the future net cash flows will be estimated referring to potential client, who showed interest in MDP.

*Collecting data.* To implement the selected method, some data about future net cash flows, actualisation rate and time horizon, have to be collected. In doing this, external sources of data have been used and they are Kompass Italia, a database containing data on Italian firms, private and public bodies, and the National Institute of Statistic and the International Yearbook of Industrial Statistic. Referring to the potential licensee, the collected data and information are reported in table 11.

The price has been defined starting from the full cost of the medical device supposed a mark up equal to 70%. The cost of production has been supposed variable during the time horizon. The marketing expenses have been considered due to the characteristics of potential licensee, in fact, it is a small-medium firm requiring specific marketing and expenses for promoting the medical device among orthopaedic community.

Other assumptions have been required concerning the time horizon and the actualisation rate.

Table 11: Collected data about the identified licensee.

Collected data	
Price (€/unit)	= C (1 + %mark up)
Mark up (%)	70%
Cost of production – C (€/unit)	
1 <sup>st</sup> -5 <sup>th</sup> years	75
6 <sup>th</sup> -10 <sup>th</sup> years	70
11 <sup>th</sup> -15 <sup>th</sup> years	65
Marketing expensing (€/year)	
1 <sup>st</sup> -5 <sup>th</sup> years	10.000
6 <sup>th</sup> -10 <sup>th</sup> years	6.000
11 <sup>th</sup> -15 <sup>th</sup> years	4.000
Projected sale units (1 <sup>st</sup> year)	400
Projected sale units – growth rate (% per year)	
1 <sup>st</sup> -5 <sup>th</sup> years	2
6 <sup>th</sup> -10 <sup>th</sup> years	1
11 <sup>th</sup> -15 <sup>th</sup> years	0
Actualisation rate (%)	15
Time horizon (year)	15

*Determining the value of the asset.* In order to establish the value of the medical device patent, the income approach has been applied and the value ascribed to the patent is € 45,420 (table 12).

Table 12: Income method.

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Projected sale units	(u)		400	408	416	424	433	437	442	446	451	455	455	455	455	455	455
Projected unit price	(€/u)		128	128	128	128	128	128	128	128	128	128	128	128	128	128	128
Total projected sales	(€)		51.000	52.020	53.060	54.122	55.204	55.756	56.314	56.877	57.446	58.020	58.020	58.020	58.020	58.020	58.020
Cost of production	(€/u)		75	75	75	75	70	70	70	70	70	70	65	65	65	65	65
Cost of production	(€)		30.000	30.600	31.212	31.836	30.308	30.611	30.917	31.226	31.539	31.854	29.579	29.579	29.579	29.579	29.579
Marketing expenses	(€)		10.000	10.000	10.000	10.000	10.000	6.000	6.000	6.000	6.000	4.000	4.000	4.000	4.000	4.000	
Operating income	(€)		11.000	11.420	11.848	12.285	14.896	19.145	19.395	19.650	19.907	20.166	24.441	24.441	24.441	24.441	
Tax expenses	45%		4.950	5.139	5.332	5.528	6.703	8.615	8.728	8.843	8.958	9.075	10.999	10.999	10.999	10.999	
Income after tax	(€)		6.050	6.281	6.517	6.757	8.193	10.530	10.668	10.808	10.949	11.091	13.443	13.443	13.443	13.443	
Patent cost	(€)		- 5.900														
Net cash flows	(€)		- 5.900	6.050	6.281	6.517	6.757	8.193	10.530	10.668	10.808	10.949	11.091	13.443	13.443	13.443	13.443
Discount rate	15%																
Discounted net cash flows	(€)		- 5.900	5.261	4.749	4.285	3.863	4.073	4.552	4.010	3.533	3.112	2.742	2.889	2.513	2.185	1.900
Value	(€)		45.420														

### 3.3 Remarks on the empirical application of the valuation processes

The three selected valuation processes have been applied to the case study and the following remarks, about their practical application, have been identified:

- the collection of necessary data and information could not be an easy task. This is a weakness points of all valuation frameworks, for example:

- the identification of potential licensee in generally could present some problems. Referring to Chiesa *et al.*'s framework, this problem seems to be minimised, in fact the authors try to identify the potential licensee and identify its characteristics, such as its competences, its marketing strategy and/or cost structure. Referring to Reilly and Schweihs' framework this problem is not solved, in fact the authors collect data and information about a generic licensee,
- the computing of discount rate (referring to the Park and Park's contribution) is not a trivial, first of all because the authors do not support it description with an exhaustive example and thus it is not clear how calculate it;
- the assignment of weights and scores to VOT factors (referring to the Park and Park's contribution) is a subjective activity;
- the management of different values, obtained by the application of more than one valuation method, is quite problematic, in fact only one contribution suggests how face this problem (i.e. Reilly and Schweihs' contribution).

Other problems that an appraiser could meet during the application of proposed frameworks are the following:

- about the Reilly and Schweihs' framework, the authors did not suggest:
  - how the steps of the valuation process have to be managed through a real and specific case;
  - how some problems emerging during the appraisal process (such as how the value of a intellectual property assets embedded in a complex product can be valued can be overcome);
- about the Park and Park's framework, the authors did not suggest:
  - how value the IP when the income method is not applicable;
  - if the pre-determined relationship between "weighted sum" and "adjusted factor" is given common currency;
- about the Chiesa *et al.*'s framework, the authors did not suggest:
  - how support the appraiser when he or she uses several valuation methods and a wide range of value is obtained.

On the other side, several useful suggestions emerged:

- Reilly and Schweihs introduced the concept of "reconciliation process", i.e. a phase during which the appraiser has to analyse, understand and comprehend the real meaning of values obtained from the application of valuation methods.
- Moreover, the Reilly and Schweihs' process introduces
  - the sensitivity analysis, in order to strength the valuation. This specific suggestion appears more relevant if linked to the "identification of the counterpart" (Chiesa *et al.*). In fact , during negotiation phase could emerge new and more precise data, by the licensee, which impact on the value of the IP. If a sensitivity analysis has been carry out before the negotiation, this allows to be aware of the probable changing in the IP value.

- independent appraisers certification that the analyst has conducted the appraisal without personal interests and biases. This is another way for strengthening the valuation;
- the Park and Park's process introduces:
  - structural model that considers the relationship between several technological factor and market factor and
  - systematic model that decomposes the complex valuation process into several modules.
- The Chiesa *et al.* framework highlights as:
  - the choice of the valuation method is not trivial, it is influenced by several factors (e.g. the availability of time and resources, the unit of analysis, the aim and scope of analysis, etc.);
  - coherence throughout the process and consistency among the various hypotheses and assumptions, needed to finally identify a (range of) final value(s), are required;
  - increases the bargaining power of the appraiser during the negotiation with a potential counterpart, allowing a clear and complete understanding of the value of the asset.

Moreover, it is remarkable to note as:

- the Park and Park, differently from the other authors, recognised that some specific IP characteristics can affect the IP value and proposed an operative procedure for include them in the valuation;
- differently, in Reilly and Schweihs and Chiesa *et al.* recognised the value is strictly related to several factors characterising the particular place, time and circumstances the IP is in. Nevertheless, it is not clear how quantify these factors and how use them in valuation. A partial listing of factors influencing the value has been outlined.

#### **4. MANAGERIAL IMPLICATIONS AND FURTHER RESEARCH**

In the literature as well as corporate practice great attention is paid to the problems of IP valuation and several valuation process frameworks have been presented. However an in-depth analysis of these was lacking. In view of this, the paper aims at taking some steps to amend this situation.

The paper has recognised the importance and usefulness of a complete framework for supporting the appraiser during the IP valuation due to the complexity of the valuation process. Regarding this aspect the paper selected three valuation process frameworks, among the several contributions available in the literature, and analysed them. The analysis confirmed that the involvement of different competencies and specialists with

expertise into the valuation process, for accomplishing the appraiser's knowledge, is necessary.

Additionally, thanks to the availability of a well-detailed process, people (even if not directly involved in the process) can understand how the value of the asset has been determined and the validity, reliability and precision of the results obtained.

About the aims of the paper, the application of the processes to the case study has:

- documented how the valuation process framework affects the value of IP, in fact, the application of the three frameworks brought to different MDP value. The reasons seem to be, basically, ascribable to:
  - the factors influencing the IP value; it, in fact, is related not only to the IP itself, but also to other elements, which are differently highlighted by the authors,
  - the management of the subjectiveness of collected data and information, (e.g. Park and Park try to clarify and explain the relationship between IP value and other factors, such as the proprietary position or the degree of completeness);
- showed the limits of the existing frameworks in a real context and identified opportunities to enrich, improve and complete such frameworks,
- illustrated as different frameworks present different levels of accuracy concerning factors considered during the valuation; this seems to explain the difference of the final monetary value.

Considering the strength points identified from the presented and discussed frameworks, suggestions for further research emerge. Chiesa *et al.*'s framework could be complemented according these emerged suggestions. The renewed framework will be applied to a considerable number of significant and different case studies to improve its strength and to identify specific problems and characteristics not emerged up to today.

## 5. NOTE AND REFERENCES

This paper is the results of the joint work of the authors. However, Vittorio Chiesa wrote section 1, Elena Gilardoni sections 2.2, 2.2.2, 2.2.3, 3.2.2, 3.2.3, Raffaella Manzini section 4 and Emanuele Pizzurno sections 2.1, 2.2.1, 3.1, 3.2.1, 3.3.

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