Towards a Classification of Instruments for Valorisation of Academic & Industrial Knowledge. An exploratory analysis of eight European incubators in the life sciences

J.G. Goorden a, R. van Lieshout a, E.F.M. Wubben b, and S. W. F. Omta b

Abstract -- There are numerous instruments for knowledge valorisation creating economic value from academic and industrial knowledge, including incubators, spin-offs, contract research and post-graduate training. Their performance is unpredictable and enormously variable. In the absence of a theory as to how, why, and when these instruments work, universities, research institutions and companies are formulating their own policies for knowledge valorisation. Drawing on ideas from economics and social sciences, a definition and a model of knowledge valorisation are created. From that model, a typology of knowledge valorisation instruments is defined, as well as the operating principles underlying these instruments. An exploratory in-depth analysis of 8 European incubators in the life science academic area is used to illustrate both soundness and applicability of the typology. So the ultimate question may be answered: when and where does a specific knowledge valorisation instrument work best? The paper tries to fill a void by providing a systematic interpretation of knowledge valorisation instruments.

Index Terms – knowledge valorisation, typology, commercialization, incubators

I. Introduction

In today’s knowledge-based economy, the prosperity of individuals, companies, regions and countries derives more than ever from their ability to develop and exploit knowledge (OECD 1996). Creating business value from knowledge, which we will refer to as Knowledge Valorisation, is the foundation of this ability. In order to effectively increase this ability, various Knowledge Valorisation approaches are researched and implemented by universities (AUTM 1999, Kreijen & van Tilburg 2003). However, Knowledge Valorisation is not lectured or taught systematically, and insight into what constitutes effective valorisation of knowledge is currently lacking (Swarte, 2005).

Various aspects of Knowledge Valorisation such as spin-offs (e.g. Kreijen & van Tilburg 2003), intellectual capital management (e.g. Teece 2000b), and valuation (e.g. Tipping et al 1995) have been studied extensively. However, the subject has not yet been studied in its full range using a unifying...
theory. So the question remains: What is Knowledge Valorisation? Knowledge Valorisation encompasses a wide range of instruments, including incubators, campus companies, brokerage events, post-graduate education, corporate venturing, various schemes of intellectual property protection and licensing, and entrepreneurship incentive schemes etc. To enable thorough comparisons this multitude of instruments of Knowledge Valorisation will need to be structured. This brings us the following research question; How does a typology of knowledge valorisation instruments look like?

To be able to answer the research question key questions to be answered about each valorisation instrument include:

1) **How** does the instrument work: what does it do?
2) **Why** does it work: how does it create value from knowledge?
3) **When** does it work: under what circumstances does it work, and when not?

To answer question 1, a typology of Valorisation Instruments is developed. Based on this typology, we will introduce Valorisation Operating Principles, each of which explains one dimension along which a Valorisation Instrument works. We explain why each Valorisation Instrument works by mapping it with one or more Operating Principles, thereby answering question 2. Finally, as a start to answer question 3, we introduce several contingent properties based on a synthesis of prior research.

This paper contains the results of a definition study to capture the essential properties of (instruments for) Knowledge Valorisation. The study was set up to develop a typology of these instruments, based on the assumption that no single recipe for successful Knowledge Valorisation exists. In order to derive normative guidelines for Knowledge Valorisation practices, contingent factors such as industry sector, type of knowledge, macro-economic environment, have to be examined. Section II scans the challenges to Knowledge Valorisation. Next, in section III, the paper proposes a definition of Knowledge Valorisation. Based on the market for knowledge a model is developed, by which the Business Value of a Market Resource is defined. We develop the Typology of Valorisation Instruments in section IV. To explain how these instruments work, we introduce a number of Operating Principles which relate to elements of the knowledge market model. An Operating Principle is a fundamental lever to increase the total value of knowledge. The contingency properties related to the applicability of the typology are presented in section V.

Next, to link the framework to practical application, an exploratory study of eight incubators across Europe is presented, in section VI. The emphasis in this study is on services and benefits offered to by the incubator to the tenant ventures. Finally, section VI presents conclusions, mostly aimed at the usefulness of the classification, and identifies recommendations for further research on Knowledge Valorisation.
II. Theory

The strategic and economic importance of scientific knowledge has long been recognized (Kuznets 1966, Teece 1981). Governments and industry have invested large sums in research, expecting this to be a worthwhile investment. As public funding has risen drastically since the 1970’s, there has been an increasing demand for greater accountability of university technology transfer (Bessette 2003). This has resulted in a number of studies into the effectiveness of University Technology Transfer, particularly in North America (Rogers et al 2000, Foltz et al 2000 Thursby et al 2000, 2002, Siegel et al 2002, Carlsson et al 2002, PCAST 2003, Grant 2002). It is concluded that, while University-derived technology-based innovations have a considerable economic impact, the effectiveness of the transfer programs varies greatly (Rogers et al 2000, Parker & Zilberman 1993), with best-in-class being up to six times more effective (Grant 2002).

Other studies have focused on valuation methods for technology or knowledge (Tipping et al 1995, Park 2004). Valuation is the estimation of the worth or sale price of an asset. While valuation of a knowledge asset may be of use in deciding whether or not to commercialize it, it says nothing about how to do so in the most effective manner.

Often in literature the term commercialization is used to denote the market introduction of a product or service. The term usually refers to new products and processes to be launched on the market, and it is often used in the context of an University-based technology (Del Campo et al 1999, Friedman & Silberman 2003, Campbell et al 2004, Siegel & Phan 2004). Academic literature recognizes that there are different ways of commercializing University research. There has been some work on categorizing these routes, mostly based on the legal forms of the transaction (Del Campo et al 1999, Gu et al 1999, Read 2003). Much of this research is focused on the optimal use of resources, leaving untouched the question which methods are actually most suitable, given that you have developed some knowledge and are seeking to harvest its value. Pries and Guild have proposed a categorization scheme drawing on ideas from transaction cost economics (Pries et al, date?); this scheme is, however, still limited to a categorization based on types of transaction and does not address suitability of transaction types.

We may derive from this literature, there is no common framework attempting to predict which routes of commercializing basic and applied knowledge work best under which circumstances. The starting point to develop that framework is the definition and modelling of Knowledge Valorisation.
III. From the Definition to a Model

As mentioned above a lot of prior research is centred on technology transfer. A useful starting point to relate our definition for Knowledge Valorisation to other concepts, may be the following definition of technology transfer: “The formal transfer of new discoveries and innovations resulting from scientific research conducted at universities and non-profit research institutions to the commercial sector for public benefit.” (AUTM 1999)

Knowledge Valorisation encompasses more than just technology transfer. Firstly, Knowledge Valorisation covers research in the commercial sector as well. Secondly, it is oriented at creating economic value from knowledge, so the focus is on private benefit more than on public benefit. That brings us to the definition of Knowledge Valorisation:

“Knowledge Valorisation is the formal transfer of knowledge resulting from basic and applied research in universities and research institutes, as well as from applied research and development in companies, to (other parties in) the commercial sector for economic benefit.”

In this context, we use the OECD classification for basic research, applied research, and (experimental) development (OECD 1993).

There is increased recognition that the competitive advantage of organizations depends on four important capabilities: being able to create, transfer, utilise and protect difficult-to-imitate knowledge assets (Teece 2000a). Creating and utilising knowledge will only be considered to the extend that they are directly influencing Knowledge Valorisation. Here, the focus is on the capabilities transferring and protecting knowledge, as they are an integral part of Knowledge Valorisation.

This definition enables us to build a basic Knowledge Valorisation model based on the principles of supply and demand. Our supply and demand model of Knowledge Valorisation takes a process view in which market participants (i.e. Knowledge Suppliers and Knowledge Customers) involve products and services (i.e. Knowledge Assets) in a transactional exchange. As Ulkuniemi (2003) points out, there are several advantages to using the market process view: it enables to examine various elements of the phenomenon under study, and it includes dynamism. Furthermore, it is suitable in studying markets in an industrial (i.e. business-to-business) context, because it allows for market relationships as well as closer relationships between buyers and sellers. The business-to-business context is typical for knowledge transactions.

To focus on only those aspects of product or service development that are relevant for Knowledge Valorisation, we will treat it as an idealised aspect system. Knowledge Valorisation can occur several times within the supply chain. Note that this does not necessarily imply a linear progression; iterative network models such as Open Innovation (Chesborough 2003) relate to multiple chains in different
configurations. To the extent that Knowledge Valorisation can be seen as identifiable transfers or transformations of knowledge, our definition and the forthcoming models are applicable. The model can be visualized, using a double unit cell representation initially developed by Van Engelen and presented in Omta (1995).

-- insert figure 1 here –

Figure 1 presents a simplified model of a knowledge market. A Knowledge Resource is some basic collection of scientific knowledge owned by a Knowledge Supplier. It is the knowledge equivalent of a resource, just like iron ore or labour. A knowledge transaction between a supplier and customer does not usually transfer the knowledge itself – it often stays with the supplier (Teece 2000b). To distinguish between the Knowledge Resource and that which is transferred, we use the term Knowledge Asset (Teece 2000a) for the latter. What is actually transferred can be a variety of items, as we will discuss later. On the other side of the exchange there may be one or more potential Knowledge Customers, typically a business, institution and/or investor wishing to exploit the knowledge. The Knowledge Customers are not usually the end-users; rather they transform the acquired Knowledge Asset into a Knowledge-based product or service (KPS): an end-product or service based on scientific knowledge. The restriction in the definition of Knowledge Valorisation to Knowledge Customers that focus on creating economic benefit, implies that the Business Value can be determined by traditional, economic valuation methods. We define the Business Value of a Knowledge Resource as the economic value of the sum of all transactions in Knowledge Assets (x) derived from that Knowledge Resource in a particular Knowledge Market within a specific time frame.

The Business Value of a Knowledge Resource is formalized in equation 1.

\[
BV_{KR} = \sum_{x} BV_{KA} = \sum_{x} TVa_{KA} * TVo_{KA}
\]

where

\[
TVa_{KA} = TP_{KA} - TC_{KA}
\]

This model does not explicitly specify the boundaries of the knowledge market. However, practical applications of this model will typically limit this market to a defined set of knowledge suppliers (e.g. European university biomedical research, or even a single research centre), or a defined set of knowledge customers (e.g. Knowledge Valorisation aimed at SMEs in a country or region). By this terminology, a Valorisation Instrument may be defined as a means to increase the total Business Value of a Knowledge Resource in a certain market context. From the formula, it derives that
this Business Value can be increased by summing over more Knowledge Assets (broadening the scope), as well as by increasing the transaction value of and/or volume in certain Knowledge Assets.

Having formalized the Business Value of a Knowledge Resource the research question can be reformulated as: Which Valorisation Instruments can be used to achieve higher Business Value across the Knowledge Market?

To answer the research question, we start by looking at examples of Valorisation Instruments. From these examples we derive a typology of Valorisation Instruments. There are many and diverse examples of instruments that aid Knowledge Valorisation. To be better able to understand how and why these examples work, we group similar examples into a class, which we call a Valorisation Instrument. Thus, each Valorisation Instrument is representative for a distinct class of examples. The results of this exercise are detailed in section four.

IV. Typology of Valorisation Instruments

The interpretation of the various aspects of the examples according to the double unity cell model facilitates the definition of the different classes of Valorisation Instruments. A study of best practices for the specific instrument of spinning out, conducted by the European Union’s PAXIS programme, has come to a classification of upstream, assistance, and downstream support activities (ITT, 2003). This matches with the stream of knowledge from a knowledge supplier to a knowledge customer in our model.

As Figure 2 shows Knowledge Valorisation, essentially depicted by the dotted rectangular, can be understood as a process with an input, a transformation and an output. Different examples of Knowledge Valorisation should be placed in a different position in the Knowledge Valorisation model, representing different inputs and outputs. This provides us with the first three, out of a total of five, characteristics as the basis for the typology:

- What is the valorisation Input? In principle this can be a Knowledge Resource (KR), an (Knowledge Asset as held by the supplier (Supplier KA), an Knowledge Asset as acquired by the customer (Customer KA), (the supplier organisation), or the Knowledge Demand from a customer (KD).
- What Transformation takes place in the valorisation process? This summarizes the main activities executed as part of the valorisation process.
- What is the valorisation Output? This can in principle be any of the items listed under valorisation Input, or one Knowledge-based Product or Service (KPS).

-- insert figure 2 here –
Furthermore, several Valorisation Instruments have their own assets, used to facilitate the process. These assets, such as distribution channels, sales forces, and after-sales support are complementary to the transferred knowledge asset (Teece, 1986). The differences between these complementary assets provide another characteristic of Valorisation Instruments:

- What complementary assets are available as part of the valorisation instrument?

Finally, many Valorisation Instruments encompass a management function which is distinct from the transformation process. The steering function may be taken up by the knowledge supplier, knowledge customer or by a third party. This provides the final characteristic of Valorisation Instruments:

- Who manages the valorisation instrument? The management function can be taken up by the Supplier, Customer or Agent (third party)) (see figure 3).

By comparing examples to the characteristics derived from the model of Knowledge Valorisation, we arrive at the following typology of Valorisation Instruments:

This typology of Valorisation Instruments is useful for determining what classes of instruments exist, and for describing how they work. To explain why each instrument works, how it creates value, we will introduce Operating Principles. An Operating Principle explains a particular valorisation effect in terms of a subset of the defined elements from the Knowledge Valorisation Model. We then proceed to show which Operating Principle(s) are used in each identified Valorisation Instrument.

We defined Knowledge Valorisation, by equation one, as improving the Business Value over all transactions of a Knowledge Resource, where that Business Value consists of:

\[ BV_{KR} = \sum_{n} x TVa_{KA} \times TVo_{KA} \]

This gives us three areas to look for operating principles, namely:

- Creating additional KA’s (affects \(\sum_{KA}^X\))
- Improving the value of a transaction of a KA (affects \(TVa_{KA}\))
- Increasing the volume of transactions of KA’s (affects \(TVo_{KA}\))

The operating principles in the three areas are next to be detailed.

First, we look at the area of creating additional KA’s, which affects the number of Business Values to be summarized. This area clearly has the largest potential, for it opens up whole new value chains. In this area, we see the following Operating Principles:

- Developing Customers
The operating principle Developing Customers refers to situations where the greatest value may come from a transaction with a new knowledge customer. Typically this is the case when the knowledge asset opens up a whole new market. In such cases it may make sense to create a new knowledge customer, based on the analysis that the underlying business value of such a newly created knowledge customer is superior to the value existing customers may derive from it. In effect this means bundling the Knowledge Asset with more suitable Complementary Assets than other Knowledge Customers have.

The operating principle Supply Intelligence aims at structurally improving the chances that a customer looking for a Knowledge Asset finds existing Knowledge Suppliers. This includes informing knowledge suppliers about the kind of knowledge assets that the potential customer is looking for. As a result, Knowledge Customers will be more readily able to develop new or improved products or services, which results in new business value.

The operating principle Bundling Knowledge Assets occurs when the Knowledge Customer combines a knowledge asset with Complementary Assets, either internal (i.e., also owned by this customer) or external assets (i.e., obtained by cooperation with other Knowledge Customers). This is useful when the customer is better positioned to combine Knowledge Assets, which is due to either superior insight into available knowledge assets, a superior understanding of the synergistic effects, or when the customer has better access to available Knowledge Assets. The result is a greater compatibility with existing values, past experiences and needs of potential users (Rogers 2003).

Second, the area of improving the value of a transaction of a KA, which can be achieved by either increasing the price or reducing the transaction cost. Assuming that the Business Value of a KA is proportional to the (potential) Business Value for the customer (i.e. the Business Value of their KPS), then increasing the latter would also result in a potential for a higher transaction price. Suppliers with a monopoly through a unique value proposition can appropriate a large part of the market value. In a knowledge market, however, this uniqueness is limited due to the fact that the customer has the alternative to imitate the knowledge asset (Teece 2000b). In a heterogeneous knowledge market, a supplier with a unique value proposition can increase the appropriability by increasing the Market Value of her knowledge or by increasing the barriers to enter the market, i.e. raising imitation costs. Operating Principles to increase the transaction price are:

- Protecting the Knowledge Asset
- Bundling Knowledge Resources
The operating principle Protecting the Knowledge Asset usually means legally preventing others from using it without the supplier’s permission, for example by patenting the knowledge. From a valorisation point of view, protecting a Knowledge Asset aims at increasing the imitation costs, thereby improving the appropriability of the Business Value. Also, a Knowledge Asset may become more attractive to a customer if it is not available to its competitors. This can be achieved for example by acquiring exclusive rights to a Knowledge Asset. As Teece points out, the inherent replicability of the Knowledge Asset also influences the appropriability: inherently easy to replicate knowledge items have a low appropriability, which protection can only partly compensate (Teece 2000b).

The operating principle Bundling Knowledge Resources refers to the practice where the supplier creates a KA by combining a Knowledge Resource with complementary Knowledge Resources, either internal (i.e., also developed by this supplier) or external resources (i.e., obtained from other suppliers). This bundling is useful when the supplier is better positioned to combine knowledge assets through superior insight into available knowledge assets, superior understanding of the synergistic effects, or superior access to available knowledge. In our terminology, Open Innovation is an example of a method which promotes bundling Knowledge Assets from different suppliers with Knowledge Assets from different customers. (Chesborough 2003).

The other way to increase the Transaction Value of a KA is to decrease the transaction cost of the knowledge transfer. The transfer cost is higher when a higher portion of the knowledge is tacit (Teece 2000b).

Operating Principles to decrease the transfer cost are:

- Codifying a larger portion of the tacit knowledge
- Fitting a Knowledge Asset to the knowledge demand

Evidently, the operating principle of Codifying the tacit knowledge of a knowledge resource requires a good understanding of the knowledge (Teece 2000b). Once codified, the transfer may no longer need face-to-face contact and the transferred information on the Knowledge Asset will be less ambiguous. These factors greatly reduce the transfer costs.

The operating principle Fitting a Knowledge Asset to the knowledge demand refers to situations where the supplier adapts the KA, either physically or legally, to better suit the customer needs. Transferring codified knowledge may be profitable, but whether the codified knowledge will be considered meaningful by those who receive it depends on whether the latter are familiar with the selected code as well as with the different contexts in which it is used (Shannon and Weaver 1949). By improving the fit, suppliers may change the value proposition to a customer from one where customers see no viable business case, to one where they do.
Third and final, we find operating principles in the area of increasing the volume of transactions of Knowledge Assets. Improving this volume typically means finding more Knowledge Customers, particularly in a heterogeneous market. Note that achieving multiple transactions is only possible if the transfer of the KA is possible without transferring people from supplier to customer, i.e., if effective Knowledge Transactions are non-destructive to the KA. Increasing the volume of transactions is easiest with codified, autonomous knowledge and most difficult with tacit, systemic knowledge (Teece 2000b). In this third area, we see the following Operating Principles:

- Understanding Knowledge Demand
- Improving the Knowledge Asset fit
- Increasing the market volume

The operating principle Understanding Knowledge Demand (or Knowledge Demand Intelligence) is used to transform the potential business value into actual business value through market intelligence. A Valorisation Instrument can identify more Knowledge Customers interested in the Knowledge Asset (i.e., market penetration), or identify related Knowledge Assets that have a synergistic effect with the original Knowledge Resource, a so called knowledge cluster, or a technology cluster (Rogers 2003).

Another Operating Principle is Improving the Knowledge Asset fit with Complementary Assets of potential customers, such as competitive manufacturing capabilities, distribution channels, sales forces, after-sales support and complementary knowledge (Teece 1986). This unlocks potential business value by making the knowledge asset a viable proposition for customers where it otherwise would not be. This also serves to reduce the uncertainty for the knowledge customer, thereby increasing the chance of adoption (Rogers 2003).

A Valorisation Instrument may Increase the market volume for a Knowledge-based Product or Service (KPS), e.g. through marketing or through developing a complementary infrastructure. This is particular important for systemic knowledge: For example, without a system for generating and distributing electricity, the tungsten filament light bulb would not have found such a wide application (Teece 2000b). The assumption is that there is a high price elasticity, allowing the business value to increase significantly with an increase of volume. The Increase of the market volume is another operating principle to increase the volume of transactions.

Alternatively, the volume of transactions can be increased by decreasing the Transaction Price. When this leads to a net increase of Business Value, this is effective. We see the following additional Operating Principles in this area:

- Supplier development
• Imitating knowledge

The operating principle Supplier development refers to practices where the Knowledge Customer cooperates with an existing Knowledge Supplier to lower the price of a Knowledge Asset. This can be achieved, e.g., by giving the supplier insight into the customer’s development process. Supplier development can also refer to situations where the customer helps the supplier to set up pilot production facilities, thereby speeding up the knowledge asset’s learning curve.

Finally, the operating principle Imitating knowledge refers to practices where a customer creates a new knowledge supplier for the purpose of imitating a Knowledge Resource that already exists but that is too expensive to the customer’s market. The aim of imitation is to lower the transaction price so that previously non-viable products or services become viable, unlocking latent Business Value. Imitating knowledge is easier when the knowledge is observable (e.g., represented in a product) as opposed to non-observable knowledge (e.g., process technology) (Teece 2000b). Intellectual Property Rights may also hinder the imitation of a knowledge resource.

Summarizing, the definition of Knowledge Valorisation gives us three areas of relevance to look for operating principles. Analysing each area has resulted in twelve distinct Operating Principles. Figure 5 shows how the Valorisation Instruments identified earlier are associated with these Operating Principles.

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V. Contingency properties

In order to prepare a contingency theory for Knowledge Valorization, we have constructed a number of hypothetical dimensions of this contingency theory. This may function as an illustration of the applicability of the typology.

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Figure 6 shows an example of the positioning of Valorisation Instruments against the two properties Alliance Type and Technology Impact.

Another example of the positioning of Valorisation Instruments is shown in Figure 7. In this case, the development phase a Knowledge Asset is in is set out against the valorisation dynamics of the Valorisation Instrument. The valorisation dynamics indicates which actor (supplier, customer, or agent) initiates the knowledge valorisation process.
Next section links the framework to a practical application by an exploratory study of eight incubators. It lends support to the presented typology of Knowledge Valorisation.

### IV. Application: an exploratory study of eight incubators

In order to investigate the usefulness of the TVA, validate the applicability of the knowledge market model, the double unity cell framework, and the typology presented in Figure 7, we have studied a sample of eight business incubators across Europe in the life sciences.

Articles and reports on life sciences business incubators reveal the following two assumptions of the beneficial role of being located in a business incubator:

- ‘Companies develop better because of the business assistance offered by the incubator and its management.’
- ‘Companies develop better because of the help inside the incubator.’

Most of these studies focus on the business incubator itself (e.g. Tornatzky et al., 2002; CSEC, 2002). The few studies that concentrated on the relationship between the incubator and its tenants, only investigated relationships within the context of a single incubator (e.g. Bøllingtoft & Ulhøi, 2004; Seidel, 2001).

Based on the principles of Yin (1984) we have performed a multiple case study research. The primary research object was the life sciences start-up company, with the focus on the related business incubator. Data were gathered over 2004 by means of questionnaires, including direct and indirect questions on the background of the venture and the incubator, their relationship and performance. Interviews were taken by means of a questionnaire and follow-up telephone interview after completion of the questionnaire. Incubators have been selected on their life sciences orientation. Incubator managers have been asked to suggest high performing companies in the incubator, and CEOs of these ventures have been interviewed about their venture and the role of the incubator.

The study includes two Danish, two British, one Belgian and three Dutch incubators. Table 1 presents key properties of the incubators. All the Dutch incubators are of recent date, the other incubators are older. It is clear that incubators 1, 2 and 3 are large incubators, both by the amount of square meters and the number of companies inside the incubators. The oldest incubators, that is incubators 1 and 2, both Danish, realised the highest number of graduated companies. All incubators claim to offer a wide
range of services, including R&D assistance, accounting and legal services, management and strategic planning, marketing and sales advice, business development, financing, human resources management, and networking and search (e.g., clients, investors, and alliance partners). This data shows that older incubators also handle more companies per manager, an efficiency property that may relate to both scale and experience. Outlier in his efficiency parameter is the Belgian incubator number 4. Combined with the largest footprint per venture, this points at an incubator working under its optimal utilization rate.

-- insert table 2 around here -

The ventures in the study together show a wide spread in founding, degree of maturity, and company focus (see table 2). We also found diverse rationales for choosing the incubator. All companies valued highly the location of the incubator, either because of having academia or related companies nearby. The incubator itself had to offer the right office and laboratory units. Also the relationship with the incubator manager was considered to be of crucial importance. Interestingly the other companies inside the incubator were less important for the locating decision. The location itself turned out to be no discriminating factor. Discriminating reasons for locating could effectively be reduced to either the price or the business services.

-- insert table 3 around here -

Table 3 presents the results of asking both incubator and tenants about typical values added services (potentially) offered by the incubators: i.e. networking, coaching, and co-location. The difference in perspective is measured by relating the incubator score to the tenant score on the associated scale, in number of steps. This results in a positive difference if the tenant score exceeds the incubator’s score, and a negative difference if the tenant score is lower. The resulting difference metric can be seen as a measure of the incubator’s under-estimation (positive value) or over-estimation (negative value) of that value added service. When we analyze the incubators, incubator 1 is the only one in the study that consistently underestimates its benefits, and incubator 6 matches the expectations of the ventures perfectly. Looking at the differences per value added service, the largest differences can be found in the least tangible of the three offerings, that is networking, whereas co-location is the most overestimated service of the incubator.

From the case study data, further analysis has revealed the following:

- In 5 out of 8 incubator-cases the number of contacts amongst tenants is very low. Where these numbers of contacts were not low, they were mostly about access to finance.
In 3 out of 8 incubator-cases, all interviewed tenants were dissatisfied about the incubator. To their opinion the expectations concerning the services offered were higher than the actually offered services. Services promised but not offered are the biggest complaint.

Most incubator managers had the idea that companies want to solve business problems on their own. Although the incubator managers of incubators 4 and 8 have a tendency to help better performing ventures more, in both cases this was not perceived as such by the related ventures.

In those cases where pricing was more important than business services, tenants knew this and were satisfied by the offered services.

The incubator managers were not aware of the disappointment of some of the CEOs in their incubator and in the incubation process.

From the spread in difference metrics as well as the detailed analysis, one may derive that incubator managers seem to overvalue their contribution to successful knowledge valorization. This small sample size study matches the conclusions drawn by Scholten (2005) in a broader study of entrepreneurial success of spin-offs. His research shows that high levels of support by an incubator or mother university correlates with lower growth figures of the related ventures.

The study does confirm the position of the incubation valorisation instrument close to facility sharing in figure 7, and its independence from other valorisation instruments such as subsidizing and venturing.

V. Discussion and Conclusions

Previous research has identified such a variety of instruments and properties of knowledge valorisation that a definition study seems appropriate to capture the essential properties of (instruments for) Knowledge Valorisation as to which instrument works how, why and when. This paper tries to fill that void.

A typology of Knowledge Valorisation Instruments has been developed. This typology is based on a definition of Knowledge Valorisation a structural model of a knowledge market, and a formalized presentation of the Business Value of a Knowledge Resource. An initial set of Knowledge Valorisation Instruments, mainly from the Dutch context, has been collected and used to illustrate the suitability of the typology for answering the following two questions about each instrument:

1) How does the instrument work: what does it do?
2) Why does it work: how does it create value from knowledge?

As to the first question, the typology of Valorisation instruments is developed. Parallel a repository of instruments has been set up in which relevant properties (according to the framework) of each instrument are documented (see Swarte, 2005).
The answer to the second research question is based on a set of Valorisation Operating Principles: the underlying levers that can increase the economic value of scientific knowledge. These Operating Principles have been identified by elaborating upon the structural model of a knowledge market, itself based on previous research. The typology together with the operating principles is able to answer why certain Valorisation Instruments work.

Both the need for the typology as well as specific properties of the typology have been validated in an exploratory study on the key operating principles of a group of European life science incubators. The study confirms the added value of a typology of Knowledge Valorisation by demonstrating, first of all, a significant difference in the operating principles across incubators: some depend on subsidizing, some on venturing, some on facility sharing, and some on coaching. Secondly, the study highlights mismatches between the views of incubator and tenants about the importance and performance along these dimensions. The framework developed in this study addresses the key aspects of knowledge valorization, and as such, can provide a common language for improving incubator service design as well as execution.

Further verification of our typology by testing its applicability for other valorization instruments than incubators could lead to further improvements. Refinement of the model by inclusion of results from research into spill-over effects as well as network dynamics is another direction of future research. Also the appropriateness of Instruments in 1-on-1 and many-to-many contexts (such as open innovation networks) needs to be investigated. The current model does not yet cover highly exploratory open innovation, specifically in situations where it is unclear a priori who will be knowledge customer and who knowledge supplier.

The third question put forward in this paper is more difficult to answer:

3) **When**: under what circumstances does a Knowledge Valorisation instrument work well?

To answer the third question further research is needed to find out which properties of each of the elements of our Knowledge Valorisation model significantly affect the efficiency and effectiveness of Valorisation Instruments. Although this has been done for several of the valorisation instruments identified (such as spin-offs), the relative success across different instruments leaves room for future research. Moreover, the various instruments must be classified according to their usefulness for industry, university, or policy institutes as either knowledge suppliers, customers, and valorisation agents. Obviously, more research is needed to confirm the validity of the proposed effectiveness for each Knowledge Valorisation instrument. The results needs to be validated in further empirical analysis of best practices. The results may help to develop effective regional, national, or international policies for Knowledge Valorisation.

A direct output of this research is the better understanding of the essential properties of (instruments for) Knowledge Valorisation. This may help to discuss, compare, and disseminate examples and
experiences with Knowledge Valorisation Instruments. Also, because it builds on a systematic understanding of why Knowledge Valorisation instruments are effective, it improves the understanding of a proper valorisation instrument selection (for policy makers) and of implementing a certain instrument. For example, an instrument’s Key Performance Indicators derive naturally from the key operating principles.

The research may also function as a basis for educational programs directed at key people involved in setting up and running Knowledge Valorisation Instruments in industry and science; the research provides both a solid background on the possible operating principles of various instruments, and examples to learn from. In order to support such education, Simbon has developed the Knowledge Valorization game, a simulation board game in which participants can experience the relative impact of different valorization mechanisms during the lifecycle of new technologies.

Summarizing, this research develops a typology for studying Knowledge Valorisation. The key aspects of Knowledge Valorisation have been defined, a model to understand their functioning has been developed, and areas for future research have been identified. However, the results of this study have also shown practical value for policy discussions, training, and for supporting effective management of Knowledge Valorisation Instruments.

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VI. References
Campbell, Eric G., Joshua B. Powers, David Blumenthal and Brian Biles (2004), “Inside the Triple Helix: Technology Transfer And Commercialization In The Life Sciences” Health Affairs, Vol 23, Issue 1, 64-76


Chan, K.F. and Lau, Theresa, 2004, Assessing technology incubator programs in the science park: the good, the bad and the ugly, Technovation, article in press 51


DG Enterprise Innovation Policy Unit FIT-04 DOC 6, “Research to Reality” Conference, February 2001

Elfring, Tom and Willem Hulsink, 2003, Networks in entrepreneurship: The case of high-technology firms, Small business economics 21, 409-422


Grimaldi, Rosa; Grandi, Alessandro, 2003, Business incubators and new venture creation: an assessment of incubating models, Technovation, article in press


Grant, Geoffrey (2002) “Benchmarking University Technology Transfer Programs”, University of North Texas Health Science Center, Office of Research and Biotechnology


Phan, Phillip H.; Siegel, Donald S. and Wright, Mike, 2004, Science parks and incubators: observations, synthesis and future research, Journal of business venturing, article in press

Pries Fred and Guild Paul “Analyzing the commercialization of university research: a proposed categorization scheme” University of Waterloo


Tornatzky, Louis; Sherman, Hugh and Atkins, Dinah, 2002, A national benchmarking analysis of technology business incubator performance and practices, NBIA, National Business Incubation Association report, NBIA Athens (Ohio) USA


Yin, Robert K., 1984, Case study research : design and methods , SAGE, Beverly Hills, US.
Appendix Description of the incubators studied

**Incubator 1** is a very large Danish incubator that is orientated on biotech and ICT. The incubator is an initiative of the government and academic institutes. The incubator’s goal is to improve entrepreneurship and commercialize academic know how. The incubator manager has industry management experience. Venture 1 is a medical chemistry company, which provides specialized laboratory services. The company is independently established and 100% privately owned, moved into the incubator and became profitable in November 2003. The start-up team consists of two people; both have research background in a company environment.

**Incubator 2** is a Danish incubator that is set up in collaboration with academic institutes and local government. The incubator’s focus is on young biotechnology companies. The incubator manager has industry management experience. Venture 2 produces human therapeutical peptides. The company is a university spin-off and is already older than 20 years. The company is largely owned by venture capitalists. The start-up team consists of two, both worked in academic research. The current CEO had its own business and joint the team in July 2004. The venture has become profitable in January 2004. Venture 3 produces medical screening equipment. The company is a university spin-off and is 100% privately owned. They started doing business and moved into the incubator in April 1998. The venture has become profitable in January 1999. The start-up team consists of four, all worked in academic research. CEO had its own business.

**Incubator 3** is a British incubator set up together with local academia and government. The main focus is on young biotech companies in the human health. The incubator manager had her own business and has a scientific background. Venture 4 produces allergy-monitoring products. The company is independently established and is 20% privately owned and 80% by private investors. The company started doing business in July 1999, moved into the incubator in January 2000 and will become profitable in December 2004. The start up team consists of two; both have research background and worked in a company environment. Venture 5 provides services and products towards identification of molecules. The company is a university spin-off and is 35% privately owned and 65% by the incubator. They started doing business in June 2000, moved into the incubator in November 2001 and started to generate revenue in November 2004. The start-up team consists of one person, experienced in the research, worked in a company environment and research lab. After half year a CEO followed and a product developer.

**Incubator 4** is a Belgian incubator and is an initiative of Universities and research institutes. The incubator has its role to commercialise patents and ideas from the academics. The incubated companies should be of high growth (e.g. from 4 to 50 people). The incubator manager has PhD in chemistry/molecular biology and has research and management experience from the industry. The rest of the incubator management provides the services, each from its own speciality. The incubator
takes equity in the incubated ventures. Venture 6 provides in screening assay services and products in
the field of infectious human diseases. The company is independently established. The venture is
100% privately owned. The company started doing business in June 2001 and moved in the incubator
in September. The venture has become profitable in September 2003. The start-up team consists of
three, one had his own business, two have research background and all have previous management
experience. Venture 7 is an internationally orientated biotechnology company, which produces
bioinformatically designed therapeutic peptides. The company is a university spin-off. The company is
largely owned by a private capitalist. The company started business in July 1999, they moved into the
incubator in February 2001. The company will reach financial break-even in 2005. The company start-
up team consists of four. All have research background, two had previous management experience
and one had his own business, one member left.

Incubator 5 is a small British incubator that is focused on the development of young life sciences
companies in the human health and environment. There is strong relation with the nearby academics
specialized in human health. The incubator manager has a management background. Venture 8 is a
Systems Biology company focused on the discovery of new drugs for diabetes and obesity through the
use of novel, human, cell-based technologies. The company is a university spin-off and is 25%
privately owned and 75% owned by private capitalists. The company started doing business in
The start up team consist of three, all have academic research background. The current CEO is not
part of the start-up team and joined the company in January 2004. Venture 9 provides products and
services for human therapeutics. The company is independently established and is 100% privately
owned. The company started off in January 2000, started to generate revenue and moved in the
incubator in September 2001 and became profitable in August 2002. The start-up team consist of four;
all have research background and had their own business.

Incubator 6 is a Dutch incubator that is mainly focused on young human health related biotech
companies. Incubator manager has her own business. Venture 10 provides services and products in
catalysts. The company is a research centre spin-off and is 100% privately owned. They started doing
business in January 2003, when they moved into the incubator. The venture will become profitable in
December 2004. The start-up team consists of two and both have academic research background.
One had its own business. Venture 11 provides genomics and proteomics services. The company is
independently established in June 2002, when it moved into the incubator. It became profitable in
June 2003. The venture is 100% privately owned. The company is a price fighter. The start-up team
consist of five and all have research background. Two have their own business.

Incubator 7 is a Dutch incubator set up with a university hospital and other local academia. The
incubator has its focus on young biotech companies in the human health. The incubator manager had
his own business and the management experience. Venture 12 is a human diagnostics service and product company. The company is independently established and is 55% privately owned, 33% venture capitalist. They started doing business in April 2002, moved into the incubator in June 2003 start-up team consists of three, two had their own business and three have research experience and one worked at a research lab. Venture 13 is a human therapeutics product company, focused on skin diseases. The company is independently established and is 100% privately owned. They started doing business and got in the incubator program in October 2001. The company will generate revenue in December 2004. The startup team consists of three, one had his own business and two have research experience and worked at a research lab. All three worked in accompany environment.

**Incubator 8** is a Dutch incubator that has its focus on agro technological biotechnology. The incubator manager has its major expertise in marketing and sales and has a broad experience in management. Venture 14 produces genetic screening products. The company is a university spin-off and is 100% privately owned. They started doing business in December 1998, moved into the incubator in May 2003 and are already profitable since its start in December 1998. The start-up team consists of two; both have had their own business and have a research background. Venture 15 provides genetic screening services. The company is a university spin-off and has an exclusive contract with a large industrial organization. They started doing business, moved into the incubator and became profitable since June 2003. The start-up team consists of two, both have research background; one worked in a company environment.
Figures with TEM paper

Figure 1 - The Knowledge Valorisation model

Knowledge Valorisation model based on Double Unity Cell (van Engelen 1989, Omot 1995)

Legend:
KR: Knowledge Resource
tr: transformation
KA: Knowledge Asset

Knowledge Supplier

Management

KR

tr

KA

VT

Management

Knowledge Customer

KPS

Legend:
KR: Knowledge Resource
tr: transformation
KA: Knowledge Asset

Knowledge Supplier

Management

KR

tr

KA

VT

Management

Knowledge Customer

KPS

Figure 2 – Example of a Knowledge Valorisation instrument
Figure 3 – Different management of a Knowledge Valorisation instrument
<table>
<thead>
<tr>
<th>Valorisation Instrument</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
</tr>
<tr>
<td><strong>Brokering</strong></td>
<td>Supplier KA or KD</td>
</tr>
<tr>
<td><strong>Contracting</strong></td>
<td>KD</td>
</tr>
<tr>
<td><strong>Facility Sharing</strong></td>
<td>KR</td>
</tr>
<tr>
<td><strong>Incubating</strong></td>
<td>Supplier or Supplier KA</td>
</tr>
<tr>
<td><strong>Licensing</strong></td>
<td>KR</td>
</tr>
<tr>
<td><strong>Spinning-in</strong></td>
<td>Supplier</td>
</tr>
<tr>
<td><strong>Spinning-out</strong></td>
<td>Supplier KA</td>
</tr>
<tr>
<td><strong>Subsidizing</strong></td>
<td>KD</td>
</tr>
<tr>
<td><strong>Training</strong></td>
<td>Supplier KA or Customer KA</td>
</tr>
<tr>
<td><strong>Transferring</strong></td>
<td>KR</td>
</tr>
<tr>
<td><strong>Venturing</strong></td>
<td>Supplier KA</td>
</tr>
</tbody>
</table>

KR = Knowledge Resource. KA = Knowledge Asset. KD = Knowledge Demand. KPS = Knowledge Product or Service.

Figure 4 – A typology of Valorisation Instruments
### Operating Principles

<table>
<thead>
<tr>
<th>Additional KA’s</th>
<th>Greater Value</th>
<th>Greater Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing Customers</td>
<td>Supply Intelligence</td>
<td>Bundling KA</td>
</tr>
<tr>
<td>Brokering</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Contracting</td>
<td>±</td>
<td>+</td>
</tr>
<tr>
<td>Facility Sharing</td>
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<td>+</td>
</tr>
<tr>
<td>Incubating</td>
<td>±</td>
<td>+</td>
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<tr>
<td>Licensing</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Spinning-in</td>
<td>+</td>
<td>±</td>
</tr>
<tr>
<td>Spinning-out</td>
<td>+</td>
<td>±</td>
</tr>
<tr>
<td>Subsidizing</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Training</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Transferring</td>
<td>±</td>
<td>+</td>
</tr>
<tr>
<td>Venturing</td>
<td>+</td>
<td>±</td>
</tr>
</tbody>
</table>

**Legend:**

- Operating principle is definitely applicable for this instrument
- Operating principle could be applicable for this instrument

KA, KR Knowledge Asset, Knowledge Resource

**Figure 5 - Relation between Operating Principles and Valorisation Instruments**
Figure 6 – Valorisation Instruments set out against Alliance Type and Technology Impact

Base: necessary and available to all
Key: source of competitive advantage
Pacing: technology expected to be future key
Emerging: early stage with unclear potential

Figure 7 – Valorisation Instruments set out against Phase and Dynamics
<table>
<thead>
<tr>
<th>Incubator #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<td>Country</td>
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<td>UK</td>
<td>UK</td>
<td>NL</td>
<td>NL</td>
<td>NL</td>
<td>DK</td>
<td>BE</td>
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<tr>
<td>Square meters</td>
<td>20000</td>
<td>500</td>
<td>4200</td>
<td>855</td>
<td>3500</td>
<td>1100</td>
<td>10865</td>
<td>3750</td>
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<td>Companies (now)</td>
<td>80</td>
<td>6</td>
<td>21</td>
<td>5</td>
<td>6</td>
<td>12</td>
<td>58</td>
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<td>Companies (graduated)</td>
<td>250</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>120</td>
<td>0</td>
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<td>Management (fte)</td>
<td>8</td>
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<td>8</td>
<td>2</td>
<td>1</td>
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<td>7</td>
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<tr>
<td>Surface per company</td>
<td>250</td>
<td>83</td>
<td>200</td>
<td>171</td>
<td>583</td>
<td>92</td>
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<td>Companies per manager</td>
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<td>Yes</td>
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<td>x</td>
<td>x</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Production</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
<td>x</td>
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<tr>
<td>Alliances</td>
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<td>x</td>
<td>x</td>
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<td>x</td>
<td>x</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Subsidy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Services offered**

| Pre incubation services | x | x | x | x | x | x | x | x |
| Research and development advice/assistance | x | x | x | x | x | x | x | x |
| Administrative services | x | x | x | x | x | x | x | x |
| (e.g. legal, accounting) | x | x | x | x | x | x | x | x |
| Management and strategic planning | x | x | x | x | x | x | x | x |
| Marketing and sales advice | x | x | x | x | x | x | x | x |
| Business coaching | x | x | x | x | x | x | x | x |
| Business development | x | x | x | x | x | x | x | x |
| Financing | x | x | x | x | x | x | x | x |
| Networking | x | x | x | x | x | x | x | x |
| Assistance with finding potential customers | x | x | x | x | x | x | x | x |
| Assistance with finding alliances | x | x | x | x | x | x | x | x |
| Assistance with finding investors | x | x | x | x | x | x | x | x |
| Human resource management | x | x | x | x | x | x | x | x |
| Introducing company in the sector | x | x | x | x | x | x | x | x |

Table 1 – Key properties of the incubators in the study
<table>
<thead>
<tr>
<th>Incubator #</th>
<th>1</th>
<th>2</th>
<th>2</th>
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<td>7</td>
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<td>9</td>
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<td><strong>Incubator perspective</strong></td>
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<td>active</td>
<td>active</td>
<td>no</td>
<td>passive</td>
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<tr>
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<td>no</td>
<td>passive</td>
<td>passive</td>
<td>active</td>
<td>active</td>
<td>no</td>
<td>passive</td>
<td>passive</td>
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<tr>
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<td>low</td>
<td>low</td>
<td>low</td>
<td>high</td>
<td>average</td>
<td>high</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td>average</td>
<td>high</td>
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<tr>
<td><strong>Venture perspective</strong></td>
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<td></td>
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<td></td>
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</tr>
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<td>passive</td>
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<tr>
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<td>high</td>
<td>average</td>
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<td>low</td>
<td>very low</td>
<td>low</td>
<td>average</td>
<td>high</td>
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</table>

**Table 2 – Incubator and venture perspectives on colocation, networking, and coaching**
<table>
<thead>
<tr>
<th>Venture #</th>
<th>Founding</th>
<th>Maturity</th>
<th>Financial structure</th>
<th>Patents</th>
<th>Business model</th>
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<tr>
<td>1</td>
<td>indep</td>
<td>established</td>
<td>private</td>
<td>0</td>
<td>service</td>
</tr>
<tr>
<td>2</td>
<td>spin-off</td>
<td>established</td>
<td>vc/private</td>
<td>4</td>
<td>hybrid</td>
</tr>
<tr>
<td>3</td>
<td>indep</td>
<td>middle</td>
<td>private</td>
<td>0</td>
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</tr>
<tr>
<td>4</td>
<td>indep</td>
<td>middle</td>
<td>n.a.</td>
<td>4</td>
<td>product</td>
</tr>
<tr>
<td>5</td>
<td>spin-off</td>
<td>middle</td>
<td>vc/parent</td>
<td>7</td>
<td>hybrid</td>
</tr>
<tr>
<td>6</td>
<td>indep</td>
<td>middle</td>
<td>private/vc</td>
<td>2</td>
<td>hybrid</td>
</tr>
<tr>
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<td>spin-off</td>
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<td>product</td>
</tr>
<tr>
<td>8</td>
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<td>parent</td>
<td>n.a.</td>
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</tr>
<tr>
<td>9</td>
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<td>0</td>
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</table>

Table 3 – Key properties of the ventures in the study