D22.1

Analysis of intangible asset management in manufacturing for service-based innovation ecosystems

M06 – V1.0

Document Owner:	Christian Zanetti, Jacopo Cassina, Mohammadreza Heydari POLIMI
Contributors:	Manuel Hisrch DITF, Loichate Cid, Miguel; Sopelana Gato Amaia, Martín Benito Ana Cristina, Tecnalia
Dissemination:	Public
Contributing to:	WP 2.2
Date:	20/07/2012
Revision:	V1.0

VERSION HISTORY

	DATE	NOTES AND COMMENTS
01	27/02/2012	CHRISTIAN ZANETTI/ JACOPO CASSINA – INITIAL DELIVERABLE DEFINITION
02	13/03/2012	REVIEW AND INTEGRATION BY MANUEL HIRSCH DITF
03	26/03/2012	REVIEW AND INTEGRATION BY LOICHATE CID, MIGUEL; SOPELANA GATO AMAIA, MARTÍN BENITO ANA CRISTINA, TECNALIA
04	14/04/2012	REVIEW AND INTEGRATION
05	31/05/2012	REVIEW AND INTEGRATION AFTER SAN SEBASTIAN AND BORDEAUX MEETINGS
06	20/06/2012	REVIEW AND INTEGRATION AFTER STUTTGART MEETING
07	20/07/2012	REVIEW AND INTEGRATION OF REVIEWER'S COMMENTS

DELIVERABLE PEER REVIEW SUMMARY

ID	Comments	Addressed (✔) Answered (A)
1	All figures must be referenced and a table of figures provided	✔
2	This is not really an executive summary: should give a summary of main points to address / results achived in the deliverablen	✔ Corrected and in my opinion improved. Thank you for the comment.
3	I think the Introduction is too long and too vague. It should focus to introduce the contents of the document and not go into details	✔
4	Enabling of the representation or virtulization of ?	virtualization
5	The figure presented in Introduction and related text are more suitable here as an example on UK.	✔ Moved
6	Figure not referenced. The same comment, the figure is more relevant to chapter 1.	✔ Agreed. It's moved
7	These are not really introduction and should be moved to the main parts of the document	✔ Agreed. It's moved
8	Please give the complete reference in the reference section in the end of the document	✔
9	Is it a proposal of MSEE or just state-of-the-art?	A proposal based on the state of the art.
10	I can't see where the roadmap is in this chapter. It is a mixture of basic concepts and state-of-the-art. I would propose to remane and restructure it as 'Basic	✔ Figures indicating roadmaps were not emphasized clearly enough. Corrected. Also the chapter was

	concepts and definitions on intangible assets as a service’	divided into two.
11	GRAI methodology?	ECOGRAI method
12	Difficult to read	It’s enlarged a bit now. However, the point is to show that it is consisted of entities and relationships and it does not have to be read in detailed.
13	It would be good to draw some conclusions at the end of this chapter	✔ Agreed.
14	It would be good to give an example on intangible asset.	✔ A short explanaition has been added.
15	It would be good to draw a new figure with intangible sssets such as methodologies, expertises, knowledge,... to replace machines.	✔ Good point. The figure has been updated. However also moved. It is now on p. 49
16	The same remark than chapter 2: I think we need some conclusions on the SoTA study: for example what we will use? and what we need develop? What is missing? Etc...	✔ Agreed.
17	A strong chapter: What is the relation to the next chapter? Is FP7 vision consistent to MSEE vision? Or the two are complementary?	Yes, MSEE and FoF visions are on some topic quite aligned. The liason is described a bit in the main conclusion.
18	To check	✔ Corrected
19	This figure has already been presented before. It is not good to repeat it again. If necessary you can put the figure’s reference here. It would be good to draw a new figure with intangible sssets such as methodologies, expertises, knowledge,... to replace machines	✔ The first figure is now erased ✔ Added.
20	I think a ’Conclusion’ section is needed, either added as section 8, either to merge with section 7 and rename it as ’Conclusions et future works’.	✔ The section was renamed and the conclusion added.
21	References 1-24 must be completed with sufficient details	✔ Completed.
22	The method of referencing is not consistent to the way a reference is cited in the document. They must be harmonized.	✔ Corrected.
23	Some references used in the document are missing in this list	✔ Corrected.

TABLE OF CONTENTS

TABLE OF FIGURES

Executive Summary

This deliverable is the first out of three, which together constitute work package 22, where issues regarding intangible assets management are being addressed.

A classification of intangible assets has been made and their more and more important economic effect has been shown. Based on this, eight project specific intangible assets categories were indentified. Albeit, before continuing the research, an MSEE roadmap (figures 7 and 10) was composed in order to classify and clarify the use and interrelations among tangible and intangible assets, hence positioning **Intangible assets as a Service** (IaaS) in the MSEE roadmap. It was established that in order to actualized IaaS and use it effectively, the **virtualization** process of intangible assets had to be priorly well **designed** and afterwards established. Firstly, a communication language that would be able to describe such service networks had been identified, which was **USDL** (Unified Service Description Language) [Barros & Oberle, 2012] being the most prominent one. As its application on intangible assets in a manufacturing environment was questionable, its application had to be analyzed and tested. In order to increase productivity and maximize compatibility in terms of governance issues between different service providers (e. g. in an virtual enterprise) and other discrepancies, a **framework for service system modelling** had to be introduced, called Model Driven Service Engineering Architecture (MSDEA) that is operating on three levels (strategic, tactical and operational). The MSDEA model, at the strategic or at the so called Business Service Model level, had been proposed to be applied to the enterprise **Ibarmia** in the future, as a test application (with not "real life" data) had been performed. However the obtained information were not yet useful enough that Ibarmia would attain its goal, which was making its **assets (services) visible and published**. Hence, Ibarmia was modelled from a resource point of view on three levels (BSM corresponding to strategic, TSM corresponding to tactical and TIM corresponding to operational level). Afterwards, the **conceptualization of the virtual enterprise model** (figure 10) could be proposed, which allowed the application of the previously identified USDL language. The designed model is primarily based on a repository, from which data will have to be extracted and aggregated (called the **process of virtualization**) with different **methods** (e. g. data mining) form different types and **sources of knowledge** that are relevant to an enterprise. The entire process will be orchestrated by USDL, with environment specific **rules**. Then an enterprise could position itself higher in the value chain.

The conceptualized model is also the result of the analysis of other two main concepts. The first one is **knowledge**, with the goal to constantly create knowledge and being able to offer an exact piece of knowledge at an exact time and retain it in the organization afterwards, for later use. The second concept is **resources and competences**, where competence mapping was used to identify core competences; however those competences have to be transferred to a higher level, an enterprise or ecosystem level. For that purpose **organizational change theory** has been proposed to induce those changes in organizations, as organizations are often averse to changes. Three models were proposed.

For concluding, complementary characteristics have been found between MSEE and Factories of the Future (**FoF**) visions, as the latter one positions virtual factories as one of its three main pillars, specially emphasizing skills, organizational structure, which are stated to be as at least as important as technology, which directly relates to MSEE philosophy and specially to intangible assets. Also MSEE vision has been contextually linked to **FInES** Research Roadmap 2025 (March 2012), where the latter addresses some research issues that are also strongly related to intangible asset management within MSEE project.

Introduction

The main aim of WP2.2, as described in the DOW, is to develop a framework and related tools, enabling virtualization of service-driven management of intangible assets in manufacturing ecosystems. By applying this framework, manufacturing companies will be able to exploit intangible assets in a new, most flexible way and to offer tailored services, based on discovered or potential new value. The WP mainly consists of three tasks, which are related to:

- the analysis of Intangible Assets Management in Manufacturing for service-based innovation ecosystems,
- the development of methods for virtualization of MSEE intangibles,
- the development of Intangible Assets in Manufacturing Service (IAMS) for retrieval, filtering and managing of information.

The first task, led by Polimi in cooperation with DITF and Tecnalia, has to consider the collection, comparison and evaluation of all types of Intangible Assets Management frameworks for their applicability in manufacturing ecosystems.

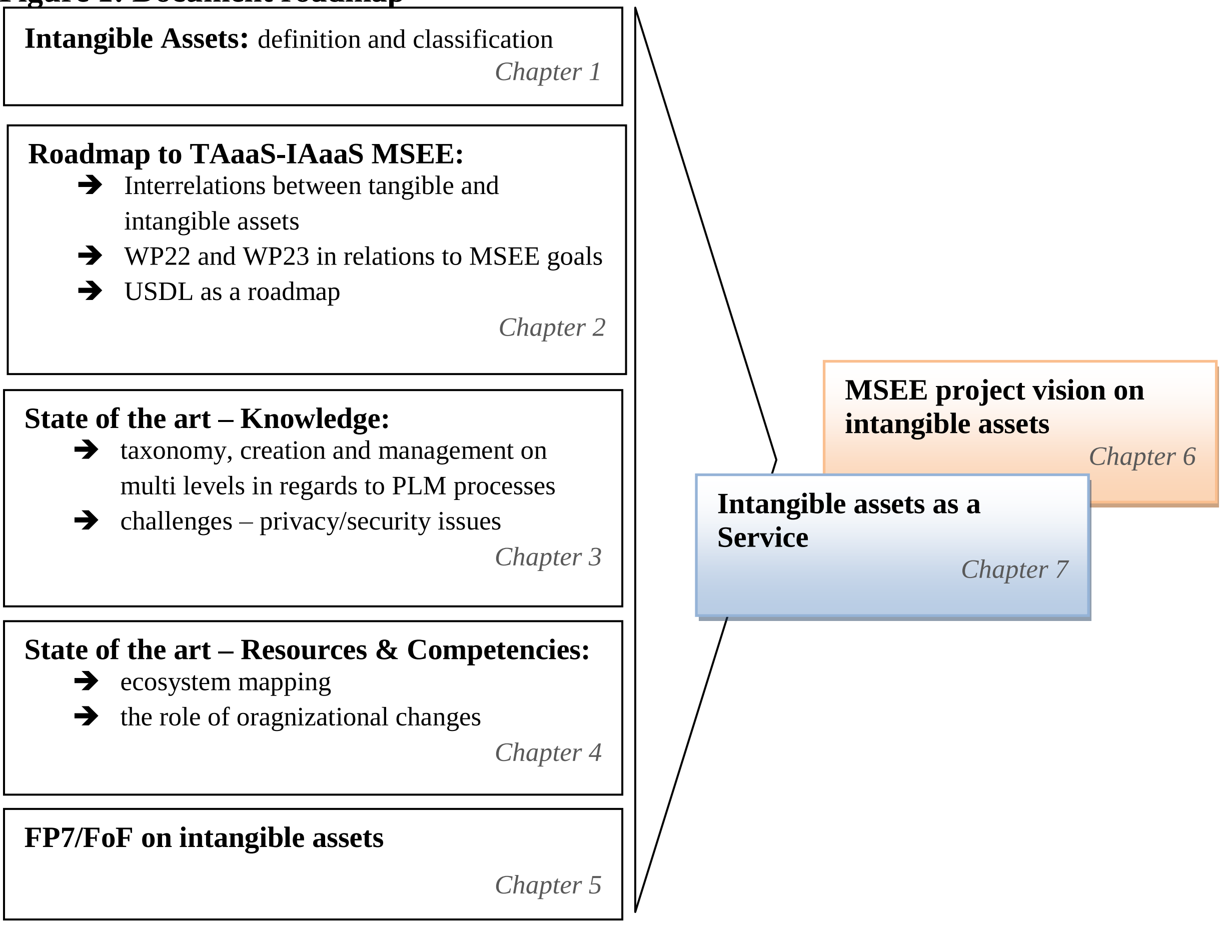
As defined for the purpose of the project, immaterial resources, that play a fundamental role in the value creation process of an enterprise upon which its competitive advantages are being built, are called ***intangible assets***. Nowadays investment into them is growing rapidly and in some cases it even exceeds the investment in traditional capital, leading to the fact that the value of some global companies, such as Microsoft and Facebook, are now mostly accounted by their intangibles. Regarding their great economic significance, it is urgent to be able to model and manage them, which is also the MSEE's main aim; hence describing intangibles and their characteristics from a service perspective leads to ***Intangible Asset as a Service*** (IAaaS). Accordingly, in WP2.2 a framework and relevant tools have to be developed, thus enabling their management within the Manufacturing Ecosystem providing innovative service solutions that can be either ***owned*** or ***used***.

Leaning on service-oriented architectures, ontology based efforts have been made to define service discovery, composition and interoperability. In addition, several ***languages*** have been adopted to describe those models. To date the most prominent language best describing IAaaS is the platform neutral Unified Service Description Language (***USDL***). Further requirements, both general and service-specific, have been drawn up to characterize this service description language.

By providing high value added services, one has to overcome many constraints, such as severe service classification granulation and potential incompatibleness of service partakers, thus urging for a coordinated ***orchestration on tactical, operational and strategic levels*** within the manufacturing service ecosystem (***MSE***). However intangible asset management has not be addressed only on an enterprise level, but also on higher levels, such as for instance the Innovation Ecosystem level, enabling to define requirements for ***ICT tools*** and ***IPR*** issues. The USDL as a tool based on specified ***ontologies*** and ***taxonomies***, uses bodies of knowledge and enables data selection and aggregation, thus forming optimal conditions for IAaaS to be exploited within a ***virtual enterprise***.

As presented in the following figure, this document mainly consists in a correlation of intangible assets within FOF multi-annual roadmap, EFRA 2013 vision and ActionplanT; by combining these guidelines with an analysis on the state of the art knowledge and Resources/Competencies, an overall vision of intangible asset management within MSEE is then discussed and a roadmap is presented. Also the figure bellow clearly indicates the course and structure of the document.

Figure 1: Document roadmap



This deliverable has to be considered as the first of two, containing the developments of D22.1 and which are going to be released in two steps: this document at M6 contains the initial analysis of intangible asset management in manufacturing for service-based innovation ecosystems, while D22.2, due at M15, is the sequel of this document, including the developments on the topic and the basis for the implementation in the other tasks and WPs of the project.

This deliverable represents the first iteration step towards the final goal, which is the analysis of Intangible Assets Management in Manufacturing for service-based innovation ecosystems, in order to develop Intangible Assets in Manufacturing Service (IAMS) for retrieval, filtering and managing of information.

1. Intangible Assets definition and classification

1.1. Intangible Assets definition

Several definitions of intangible assets are available in literature and a common understanding of terms is needed.

Intangible assets or intellectual capital may be defined as immaterial resources (not financial assets/financial capital or physical resources such as fixed/current assets) that, as a factor of production, play a fundamental role in the value creation process of an enterprise and that enable it to compete successfully [Juergen, 2005]

Intangible assets are those key drivers whose essence is an idea or knowledge, and whose nature can be defined and recorded in some way [Hall, 1992].

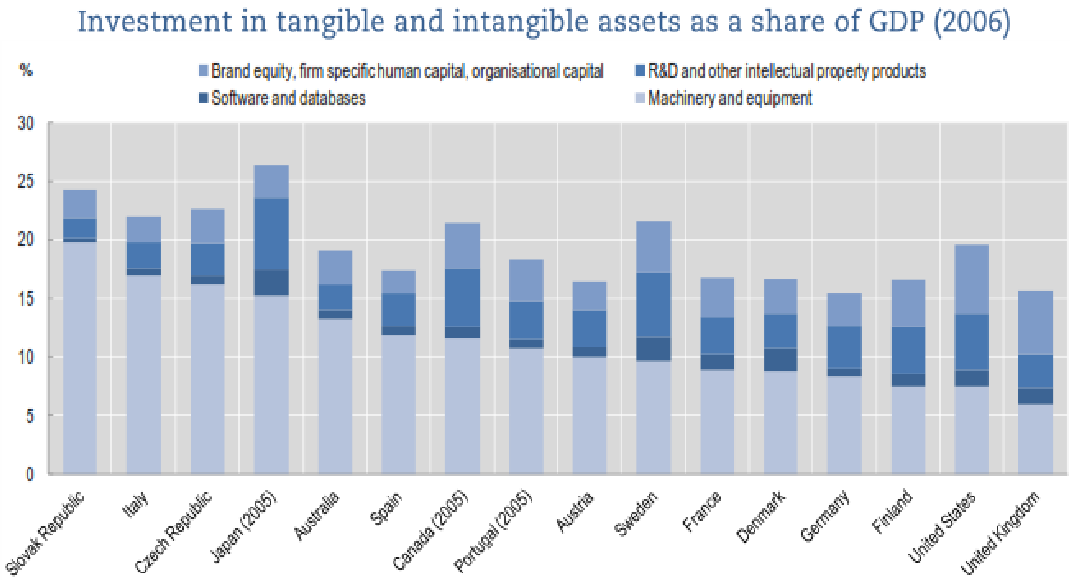
Other authors [Itami & Roehl, 1991] calls them invisible assets and includes technology, consumer trust, brand image, corporate culture as well as management skills.

It is important to realize that intangible assets are related to accounting, strategy, human resource management, information systems, knowledge management, among others [Marr, 2004].

The definition of intangible assets within MSEE is a combination of the above mentioned statements and is based on immaterial resources, such as knowledge, technology expertise, market trust, information systems etc, which play a key role in the value creation process of a manufacturing enterprise within an ecosystem of SMEs. In many countries, such as USA, UK and Japan, investment in intangible assets is growing rapidly. In some cases this investment matches or exceeds investment in traditional capital such as machinery, equipment and buildings. Intensified global competition, ICTs, new business models, and the growing importance of the service sector have all amplified the importance of intangible assets to firms, industries and national economies. In the United Kingdom, for instance, investment in intangibles is estimated to have more than doubled as share of market sector gross value added between 1970 and 2004 [OECD, 2010]. Recent studies estimate annual investment in intangible in the United States between USD 800 billion and USD 1 trillion, with stock of intangible of up to USD 5 trillion. In many countries, the proportion of off balance–sheet assets to on-balance-sheet assets (the price to book ratios of companies) has risen for decades [OECD, 2010].

Previously unmeasured intangible capital has been calculated to account for 18% of the growth in multi-factor productivity (MFP) in the United States between the mid-1990s and early 2000. The World Bank estimates that, for countries, the preponderant from of wealth worldwide is intangible capital. And key business outcomes can be linked to investment in intangible–in 2004 in the United Kingdom around half of export sales from winners of the Queen Award for exports could be directly attributed to investment in design.

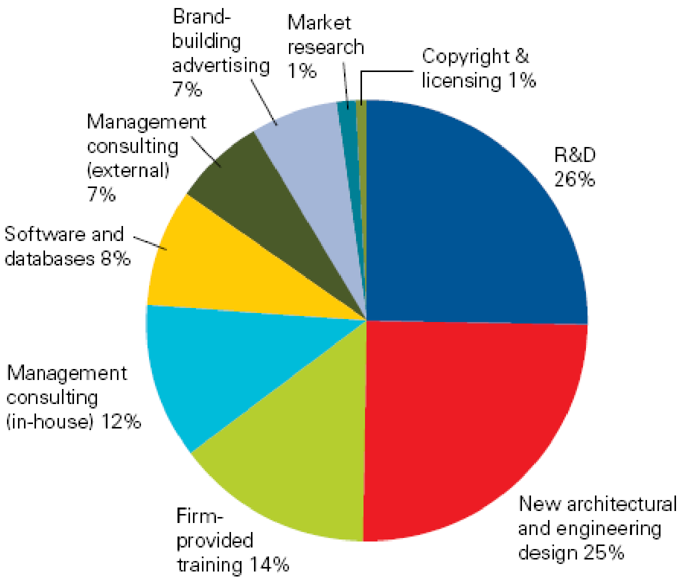
Figure 2: Investment in tangible and intangible assets as a share of GDP (2006)



The value of some leading global companies, such as Microsoft or Facebook, is now almost entirely accounted for by their intangible assets.

In parallel with the increasing economic importance of intangible assets, consequently rises the reconnaissance of other aspects of business, although a majority of UK manufacturing firms still consider production and assembly to be among their prime sources of competitive advantage. The following chart provides a breakdown of patterns of intangible investment in UK manufacturing .

Figure 3: Intangible investment in UK Manufacturing 2004



Source: DOW (2011), p. 97.

Therefore, the main aim of this WP is to provide manufacturing ecosystems with a framework of models and tools, to identify and valorize intangibles assets, to systematically monitor their performance during operations, to mitigate the related to risks within the management system and finally to allow new business opportunities from their exploitation to the marketplace (IA innovation).

Enterprise systems, such as PLM, ERP and Operation Management, should be deeply affected, to allow quick and efficient exchange of knowledge among managers and decision making. Information use should be optimized by means of continuous, strategic dialog throughout the company. This should result in a stronger position of the company, which could enhance its intangible asset-based strength and stay ahead of external competitors and their potential threats.

Intangible asset analysis is essentially based on the investigation of the following aspects: knowledge, resources and competencies and servitization.

Another important issue about intangible assets is the definition and measurement of ***indicators*** to monitor them. It is not easy to evaluate expertise or human resources in general sense. E.g. the human capital is assessed by indicators like average years of professional experience, number of employees with a certain qualification or net product per expert. [Spath 2003, Klingebiel 2001]

The intangible assets measurement approaches could be described by the following essential characteristics (see DOW):

- Main focus is the market value of a company.
- Intangible assets are considered as sources future success.
- Usually aligned to a long term perspective.
- Indirect measurement of intangible “soft facts”.

The Department of Trade and Industry in UK [DTI, 2001], developed a Self Assessment Tool, as a framework to enable enterprises to set clear aims, understand the critical success factors which drive value creation from their intangible assets, highlighting the need for enterprises to look beyond their existing financial statements and to consider how a wide spectrum of excluded intangibles contribute to their current and future potential to create value.

While a ***fully automated IT solution*** for intangible-asset evaluation and management is not yet available, providing opportunities for improvement especially for manufacturing service ecosystem enterprises.

1.2. Intangible assets classification

Intangible assets or intellectual capital are immaterial resources (not financial assets/financial capital or physical resources such as fixed/current assets) that, as a factor of production, play a fundamental role in the value creation process of an enterprise and that enable it to compete successfully. Intangible assets are usually divided into the following main categories [Juergen, 2005]:

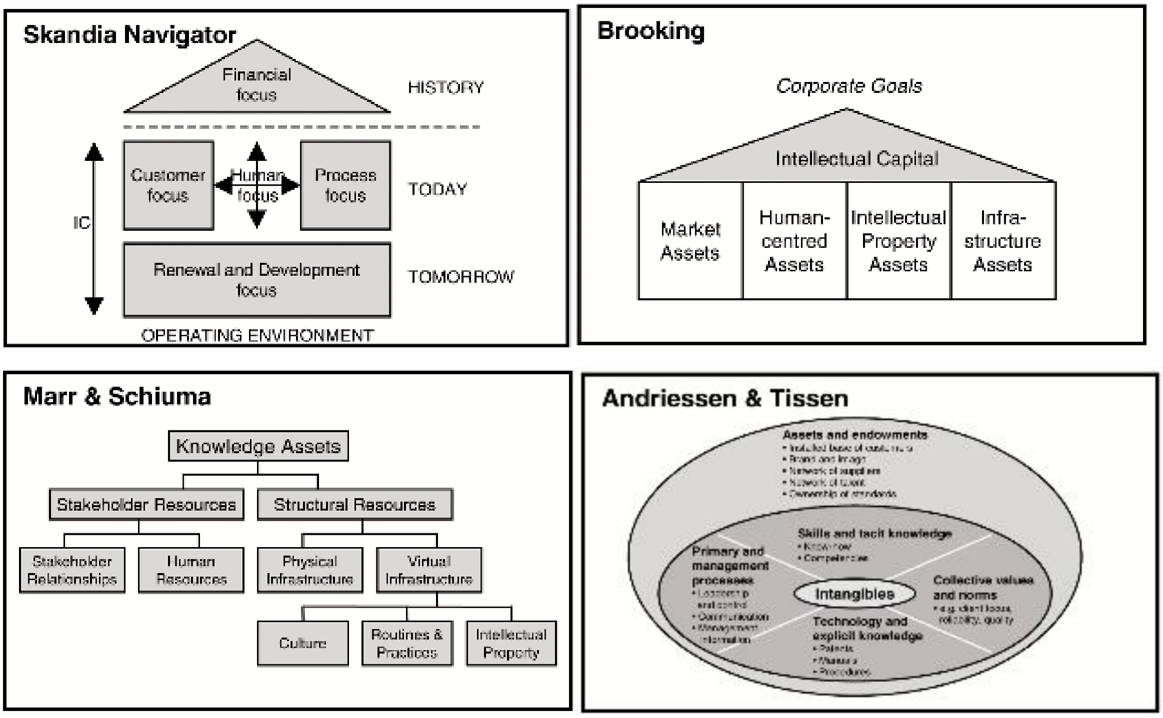
- **Human Capital**: Employees individual professional expertise and skills, social skills, entrepreneurial engagement, ability to innovate and respond to changes.

- **Relationship Capital**: Customer capital (brands, customer relationships, relationships with marketing and distribution partners etc.), other business partner capital (supplier relationships/ supplier network, contract manufacturing etc.), and relations with investors and banks/ financial service firms and with other important stakeholders (such as environmental pressure group in the oil industry)

- **Structural capital**: business infrastructure/ processes, working methods, information systems, databases, intellectual property (patents, copyrights, trademarks), organizational design, location advantages, corporate culture.

Understanding of the role of intangible assets in modern economics and the policies needed to foster their development and use is still poor. Research on intangible is scattered across finance, accounting organization and management discipline. This calls for a multidisciplinary approach in analysing key policy problems. One of the problems with intangible assets is that there are almost as many classifications as there are authors on the subjects. [Marr et al., 2004].

Figure 4: Intangible assets classification



Source: DOW (2011), p. 95.

Books, software products, equipment, patents, and inventions are prime examples. Intangible assets also are of considerable interest to investors. In the past, a company's book value often was closely associated with its market value. However, by the early 2000s market values often exceeded book values, and the difference was often attributable to the value of a company's intangible assets. The dollar value of such assets is considerable. *Futurist* cited information from the editors of the Harvard Business School's newsletter, *Harvard Management Update*, indicating intangible assets were worth "an average of three times more than the physical assets a company may possess, such as equipment and buildings."

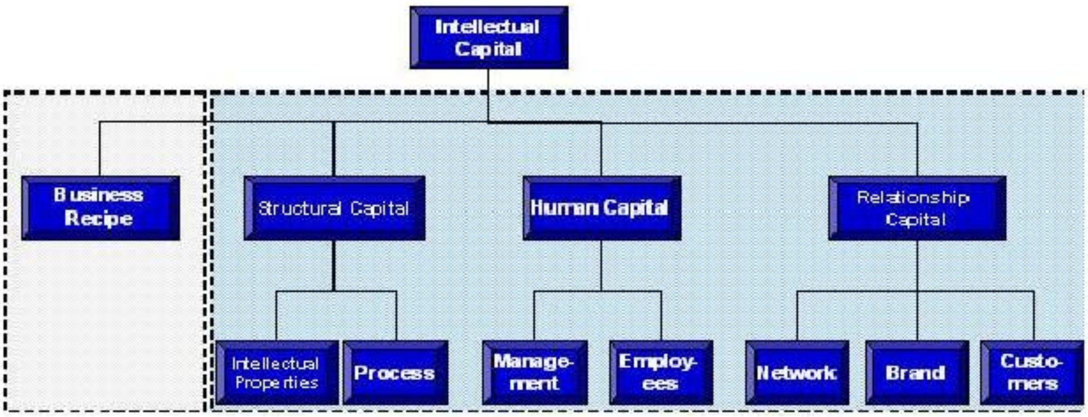
Service companies make money by leveraging the intangible (**intangible asset as a service**). Your "products" cannot be seen or put in a box. Your processes are much less visible than those on a Ford production line. Your core productive assets are not on your balance sheet. In fact, many of your most important assets walk out the door every night. Yet these intangible are the key to your company's, innovation, and competitive advantage. [Adams, 2004].

The portfolio of intangible assets of a corporation is referred to as its intellectual capital (IC). Intellectual capital includes a broad range of people, knowledge and relationship assets. Understanding the current strength and future outlook of this portfolio is a key strategic challenge for the management team of a service company. Meanwhile, Risk assessment plays as important role in the strategic management of intellectual capital.

The easiest and most graphic way to understand the importance of intellectual capital to service business is to look at stock market values of public companies. Today, the book value of the S&P 500 average less than 20 per cent of their market value. For some service companies, their tangible book value represents less than 5 per cent of their corporate value.

Figure 5: The ICT infrastructure

The phrase *intellectual capital* is frequently used as a synonym for knowledge. While knowledge is s critical part of IC, it is much more, as seen in the following graphic:



The specific intangible assets identified in this document are:

- **Customer capital**-trademarks, names protected as intellectual property; brand image and business reputation. The defining features of customer capital intangible assets are the ways in which they are located in the minds of buyers and represent the ways that trusted and their products and services appreciated. The professionals interviewed emphasized the value of customer capital intangible assets; they enable to make sales without incurring further marking expenditure. **[**Martin, 2006**]**

- **Customer relationship**-service, maintenance and customer supply contracts, people-based customer relationship, customer lists and website that attracted customers and provided routes for placing orders. They represented a basis for regular income, repeat sales, avenues for generating enquiries and a means of influencing customers design thinking. Service and maintenance contract intangibles might represent sources of assured income, whereas other customer relationship intangible assets created opportunities only to quote for business.

- **Supplier and input relationship**-favourable supply contracts, advantageous supplier relationships and employment contracts with key employees. Proprietary supplier and input relationship are sources of competitive advantage when they provide such benefits as supply price privileges, security of supply and access to particular resources.

- **Technical and process knowledge** is intangible assets identified were: proprietary business process, proprietary software, trade secrets, technical know-how, and job cards, drawings and patterns. Sometimes technical and process intangible assets underlay products and services but in other cases they formed part of wider competences and abilities to access historic production-route information. They ranged from website optimization capabilities to flock-coating manufacturing know-how.

- **Proprietary products and service-**incorporating protected intellectual property, other product designs and proprietary products, creative works, proprietary product documentation and successful service formats.

- **Learning & growth**: owners' entrepreneurial outlook, networks and collaborative agreements, and "atmospheres" encouraging innovation and change.

- **Reputations and company images** were protected by providing high levels of customer service and maintaining effective customer relationships.

- **The new intangible software products** being developed were not easy to copy but the developers needed to demonstrate ownership to commercialese their innovations.

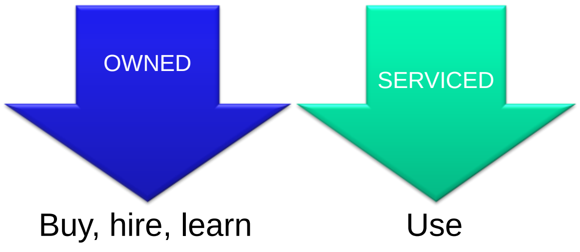
It is important to note that both tangible and intangible assets usually have mutual interactions within MSEE. A drilling station within the MSEE, providing "holes per hour" very often operates in combination with relevant expertise and knowledge.

With reference to DOW, ***tangible assets*** are whatever kind of physical objects with economic value (Allee 2008). They are distinguished into manufacturing assets and product assets, where manufacturing assets are used in processes that an organization performs in order to create product assets. Manufacturing assets include machines, tools, material, work place equipment, material flow components, control systems, storage systems, and the manufacturing environment (building, air conditioning, cleaning).

On the other hand, ***intangible assets*** are defined as those key drivers the essence of which is an idea or knowledge, and whose nature can be defined and recorded in some way (Hall, 1992). The author has split them into ***intellectual property*** (those assets for which the organization has property rights) and ***knowledge assets*** (those assets for which the organization does not have property rights). As such, accounting, strategy, human resource management, information systems, knowledge management, among others should be considered intangible assets (Marr, 2004).

It is important to note that both of them can be either owned or used as a service, as defined in the following figure.

Figure 6: Tangible vs intangible assets



In order to create high value products and services in this ecosystem context, all actors need to learn how to combine their complementary core competencies across sectors, and how to share highly specialized knowledge about new materials, features, and processing procedures [Senge & Carstedt, 2002]. In this respect, the ideas of knowledge and competence as services are currently gaining growing attendance [Xu & Zhang, 2005]. Scalability, flexibility and adaptivity are essential factors to meet the needs of interdisciplinary, dynamic, and dispersed actors in manufacturing ecosystems.

2. Roadmap to "tangible and intangible assets as a service"

The first roadmap of the MSEE servitization process is shown on the next figure in forms of a "diamond". With reference to it, the horizontal axis is referred to tangible and intangible assets, while the vertical one is related to serviced or owned assets.

In other words, assets may be classified according to their entity (i.e. tangible or intangible) or to their use, as proposed to the market (i.e. owned or serviced). Let us consider, for instance both tangible and intangible assets which are owned (a book, a car, a piece of software) and tangible/intangible assets which are proposed as a service (a rental, a haircut, a fee).

It is important to have a common agreement on the following topics:

- **Product**

  Classical business object that is tangible and sold en block in stores
- **Extended Product, Product & Service**

  Product that is supported by a service component, which has influence on the product‘s configuration
- **Hybrid Product, Product2Service**

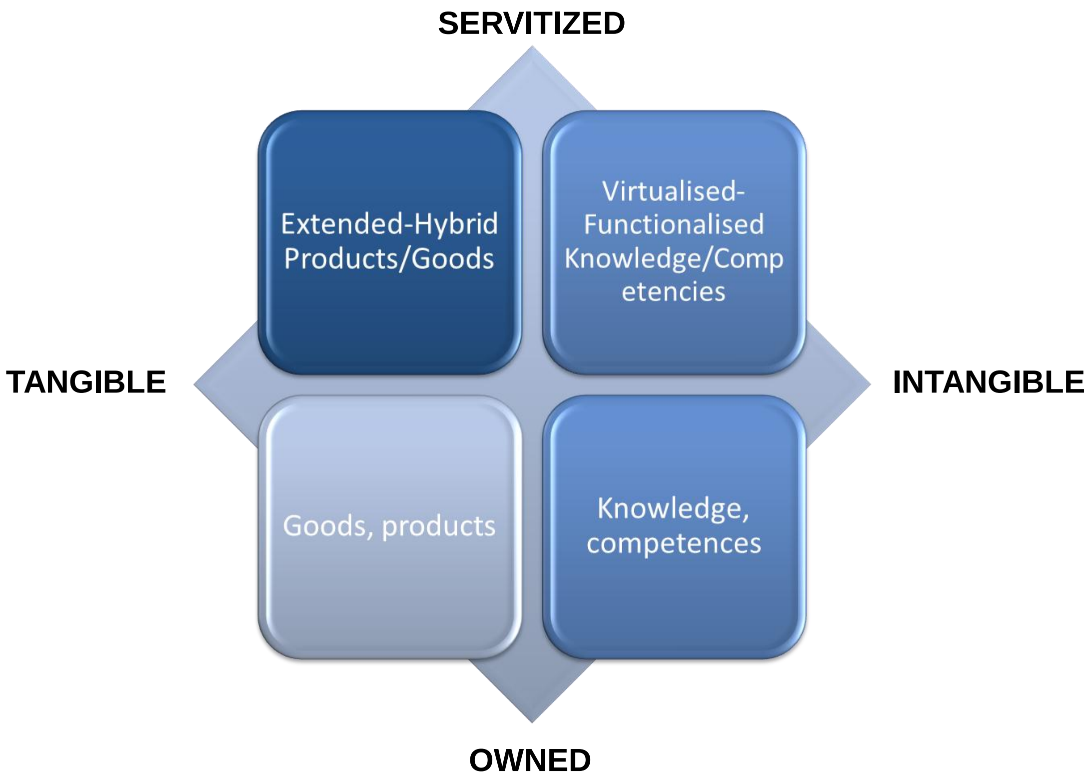
  A service is differentiating a classical product
- **Service**

  Classical intangible consultancy service that is performed on request of a customer

Therefore a product combined with a service is defined on the upper left part of the diamond; pure service is located on the top right part of the figure; hybrid product is considered on the bottom right part of the figure.

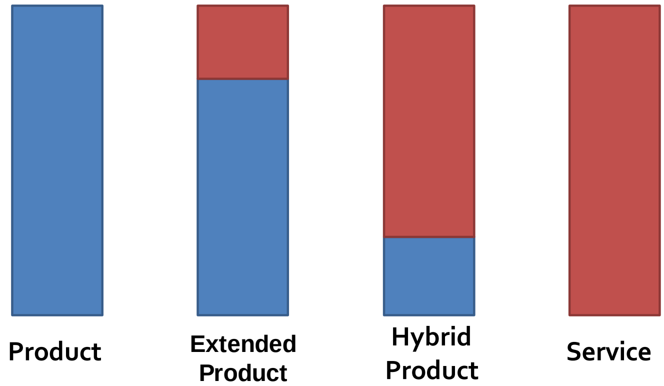
Hence the passage from one dimension to another in the diamond bellow, serves as a roadmap to the servitization process which is part of the MSEE project. It allows also one to position intangible assets in reference to the entire servitization process.

Figure 7: Interrelations between tangible and intangible assets



The servitization process leads the way lower to upper level, thus replacing the general meaning of possession of an object by using a function, as sketched on the next figure.

Figure 8: Servitization process



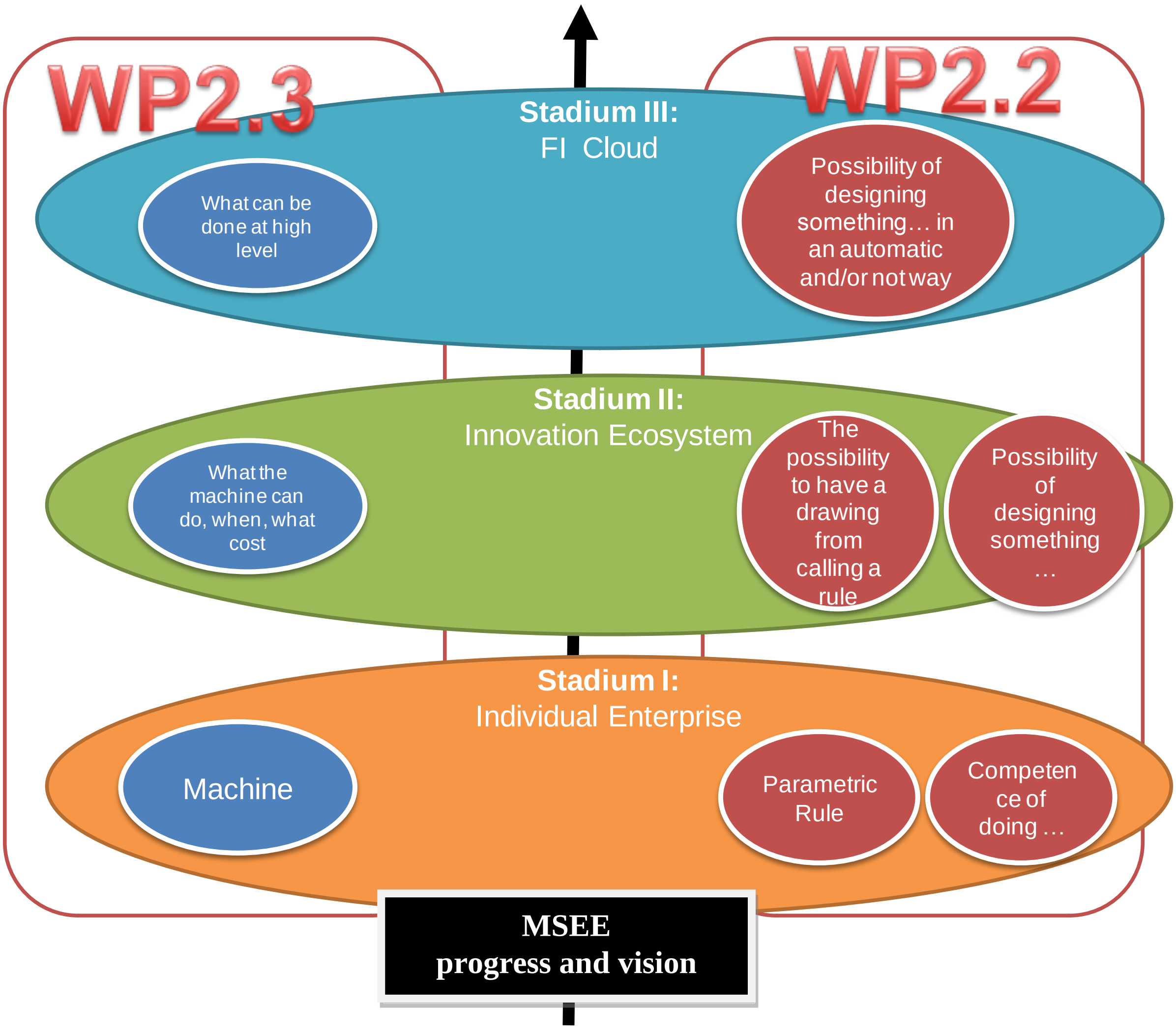
With reference to MSEE, both tangible and intangible assets will be involved on the different levels of the architecture, i.e. individual enterprises, manufacturing ecosystem and FI cloud.

As far as WP 23 is concerned, i.e. tangible asset management, product/machines are physically located at the single enterprise level. Further extension-hybridisation, in terms of service innovation within an ecosystem, is analysed at the second stage, while the third stage is represented by a wider open use of machines and products by the internet of service (FI clouds).

A similar approach may be adopted by WP 22, i.e. intangible asset management, where the three stages are applied to a different and innovative use of knowledge and human resources at the enterprise level, within the ecosystem or within FI cloud.

This figure bellow represents **the second MSEE roadmap** from a different point of view. It represents a different use of knowledge, namely how to pass to a higher innovation level in terms of knowledge. So when resarching how enterprises can funciton in an ecosystem, one relates to the second stadium.

Figure 9: Relations between WP 23 and 22 in relations to MSEE goals



Source: Restructured after DOW (2011), p. 152.

While bearing in mind that all three levels must be properly aligned and that they all interact with each other, appropriate management models and tools should be defined.

Before going on with an in-depth analysis concerning intangible asset management, it is important to consider how intangible assets can be modelled. The main aim of MSEE is to deal with services, therefore it is essential to describe intangible assets and their characteristics from a service perspective (Intangible Asset as a Service or IAaaS).
But what is a service and what are its main features? Despite the obvious answers related to economics, politics, business, etc, there are still many uncertainties and doubts in developing a general conception of services that may address the several notions of services within the different domains and applications.
Following the prominence provided by service-oriented architectures, different efforts have been made in terms of ontology-based descriptions to define service discovery, composition and interoperability through service reference models, e.g. OASIS SOA Reference Model [MacKenzie et al, 2006]. Further efforts have been devoted to address needs and requirements for **service networks**, focused on value

co-creation of services in partnerships and service bundling (e.g., Akkermans et al. 2004 and De Kinderen and Gordijn 2008).
In addition several l**anguages** have been adopted to **describe such models**. The first developments of service languages concerns Service-Oriented Architectures (SOA) and XML is the common representation of web service languages over the years, different standard bodies have specified many languages, the most prominent of which is the Web Services Description Language (WSDL), which provides a standard, XML-based definition of interfaces for software components implemented in different languages.
To date the most prominent language to describe services is the **USDL**, i.e. Unified Service Description Language [Barros, A. & Oberle, D. 2012], which has been developed across several research institutes and publically funded projects across Europe, Australia and Americas as part of a standardization push. USDL has been built and assessed in a collaborative and interdisciplinary way by the contribution of researchers such as computer scientists, security and SLA experts, business economists, legal scientists, etc. Therefore in the next chapter USDL is analyzed and its applicability to intangible assets in a manufacturing environment is tested.

2.1. Unified Service Description Language application analysis

As described by D. Oberl et al. among the services analysed through USDL IAaaS have been considered: human/professional, e.g. project management and consultancy, transactional, e.g., purchase order requisition, informational, e.g., spatial and demography look-ups. Among the others, IT environment use cases, cloud computing/IT virtualization, service marketplaces procuring services as complex as those from SAP's portfolio and ecosystem have been discussed. The initial assumption is that service need to extend beyond service providers to third parties such as brokers, aggregators and channel partners, to drive up the "network effect" of services or, alternatively, a service innovation ecosystem.

The question is whether USDL may be applied to both tangible and intangible assets within a manufacturing environment, which is the core objective of MSEE. If yes, it **can serve as a MSEE roadmap regarding intangible assets** in MSEE that is composed of all the major steps to be undertaken in the future regarding this research field. It starts from modelling passing to identification of knowledge of bodies and methodologies, finishing with rules to efficiently manage the virtualization process.

In MDA/MDI a system can be observed and analyzed from different points of view and it can be defined at three different levels of abstraction (i.e. BSM, TIM, TSM). TSM takes the specification at the TIM model and adds details that specify how the system uses a particular type of platform or technology. At TSM, the Web Services Description Language (WSDL - http://www.w3.org/TR/wsdl) can be used to provide a model for describing Web Services. WSDL is a description based on XML that indicates how to connect and use services. Web services languages, e.g. WSDL, mostly target the description of technical characteristics of services, but do not cover the more general scope of business services and do not support solutions from these conceptual considerations.

The Unified Service Description Language [Internet of Service] is a platform-neutral language to describe services. It was consolidated from SAP Research projects in services-related research as an enabler for wide leverage of services on the Internet. USDL is one effort which covers both IT and Business aspects, serves both for reference and exchange purpose and considers business network related information. USDL has been used in various projects as a generic service description language, for domains as banking, healthcare, manufacturing and supply chains (see DOW).

In the following paragraphs USDL application will be analyzed, starting from the concept of service which sets the perspective from which intangible assets should be examined. Services constitute encapsulated and exposed functionality, drawing from core artifacts, e.g., those related to business processes, applications, objects, and resources, constituting the enterprise phenomena surrounding services [D. Oberl et al., 2012]. While business processes are managed across collaborating resources related to a supply chain, services are delivered to consumers by providers. They provide value-added functionalities aimed at meeting the consumers' expectations and needs, even if subject to delivery constraints, e.g., availability, pricing, copyright or disclaimers. The consumers do not need to own the resources and relate to costs or risks, but they need functionalities.

Services may be analysed in terms of functionality (what), interface (where), and interaction (how).
Since one of the main features of the SLM is that a service should in principle be reusable, it should be as flexible/modular as possible through more abstract descriptions of service functionality.

A distinction is relevant to service players, who may be divided into owners of services and the providers, whom the delivery responsibility is delegated to. Constraints might be raised by other stakeholders, such as the Government or the Municipality, in terms of laws and regulations, issued for a specific field. Hence, several intermediaries may be found in the service chain, which can raise constraints to be properly dealt with and orchestrated.

Providing a service consists of the preparation of all necessary parts, which are based on core and supportive resources, which can be both tangible and intangible. Let us think, for instance, of a purchase order service: it relies on a business process (i.e. enterprise solution), stock checking or service availability, order management services, technical/functional knowledge, payment processes, IT tools, etc.
Indeed, the order placement may be consisting of elementary services such as order creation, modification, cancellation and shipment request. Therefore, there is a structural granularity classified as a complex service solution (i.e. core, capabilities are not externally exposed), compound services (based on capabilities of a single business object) and composite services (consisting capabilities of several business objects).
Different service providers may not be compatible with each other, in other cases services overlap in purpose and functionality, thus raising conflicts. This lack of governance must be properly addressed within a manufacturing service ecosystem (MSE), defining appropriate management directions at different levels:

- Tactical: searching and selecting partners
- Operational: joining the MSE, applying MSE rules, providing tangible and intangible assets as a service, SLAs, etc
- Strategic: searching for additional capability or capacity, limited performances or lack of results, agreement cancelling or upgrading, etc

While the above mentioned subjects will be discussed in details in the next steps of the project, it is useful to provide examples to anticipate some consequences, which will contribute to the definition of this document. At the **tactical** level both general and specific criteria should be identified to drive the search and selection of partners within an ecosystem; ontology and taxonomy should be developed, which can support such a task. At the **operational** level appropriate governance procedures should be granted to control partners while joining MSE and operating within a Virtual Enterprise (VE) by means of both tangible and intangible assets as a service; both developing, interoperability and monitoring (SLAs) aspects should be taken into account. At the **strategic** level management decisions and business opportunities/threats should be considered, thus addressing issues such as lack of capability/capacity within a VE, poor performance of a partner, strategic decisions based on modified constraints.

As defined on the following figure, information and data related to intangible assets may be derived from different sources of knowledge, such as:

- CAD systems
- ERP
- Data Base
- Patents
- QMS (Quality Management Systems)

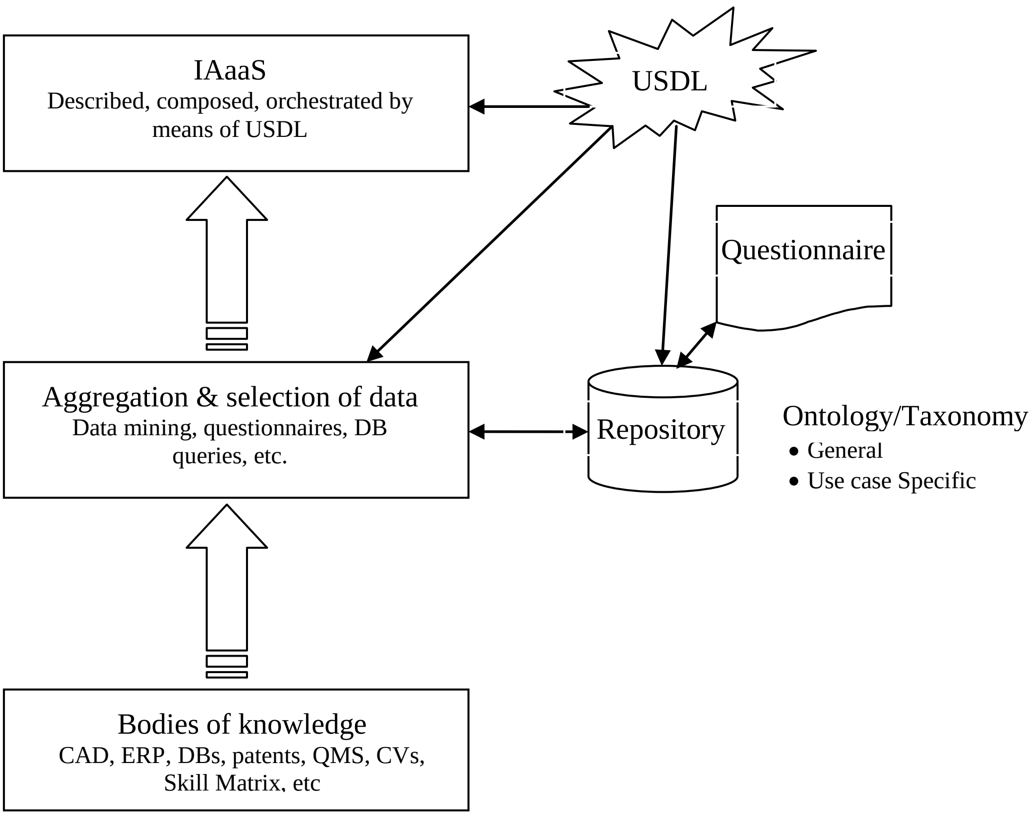
- CVs (Curriculum Vitae)
- Skill Matrix
- etc

Through an ontology and taxonomy definition, the previously gathered data may be organized, classified and standardized, to provide data aggregation and selection on occurrence; data mining and similar techniques can be used for this purpose. Specific questionnaires can be submitted to end users, to test special applications and to get a straightforward feedback; a two ways interaction between the knowledge repository and the questionnaires should be granted to populate the data base with incremental information and to test on purpose requests.
In principle the following management criteria should be implemented on the knowledge repository:

- Knowledge acquisition.
- Knowledge modelling.
- Knowledge retrieval.
- Knowledge reuse.
- Knowledge publishing.
- Knowledge maintenance.

Let us assume, for instance, that a Chinese speaking machining expert is needed to start a maintenance joint venture enterprise in Shanghai. A previously issued questionnaire was not aimed at discovering such a piece of information, but this data can be obtained by querying the repository through a data mining method, providing that proper information have been defined and classified. This information, together with additional services, may contribute to the creation of a Virtual Enterprise, made by different intangible and tangible assets as a service.

Figure 10: Conceptualization of a virtual enterprise



Before dealing with ontology it is useful to remind a general definition, given by Tom Gruber in 1993: “In the context of knowledge sharing, I use the term ontology to mean a *specification of a conceptualization*. That is, ontology is a description (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents”. Ontology is therefore

is the definition of being, existence, or reality, as well as the basic categories of being and their relations.
The word taxonomy comes from the Greek taxis, which means arrangement or order, and nomos, meaning law or science or method. The term is herewith used as a hierarchical classification or categorization system, aiming at organizing knowledge. Taxonomy is therefore the definition of groups on the basis of shared common characteristics. Each group is assigned a name and a rank; groups of a given rank can be aggregated to form an aggregated group, thus creating a hierarchical classification.

As far as IAaaS are concerned, both general (i.e. related to the MSE) and specific (i.e. related to use cases) ontology/taxonomy will be further investigated in the next steps of the project.
While bearing in mind that a reference model for Virtual Enterprises has been discussed in D11.1, which is based on Ecograi modeling method used to design and to implement Performances Indicators Systems for industrial organizations, a similar aggregation/decomposition approach could be used to define a general ontology, related to BSM, and specific ontology, related to TIM and TSM.
Some typical examples of general characteristics are listed below:

- IA capacity
- IA capability
- Reference list of success cases
- Location
- OTD, i.e. On Time Delivery
- Pricing
- Legal issues
- Lead Time
- Interoperability
- SLAs compliance

Alternatively, examples of specific characteristics are:

- Maintenance capacity/capability for drilling stations
- Logistic support and special tool warehouse
- Availability of Chinese Machining expert.
- Etc

Based on the reasoning about services described above, the following requirements, both general and service-specific, characterize a service description language such as USDL.
Among the general requirements, the following are to be mentioned:

- a conceptual description of services from all the stakeholders' perspectives;
- expressive power, to reach full conceptualization
- modularity, so to address different service complexities;
- comprehensibility.

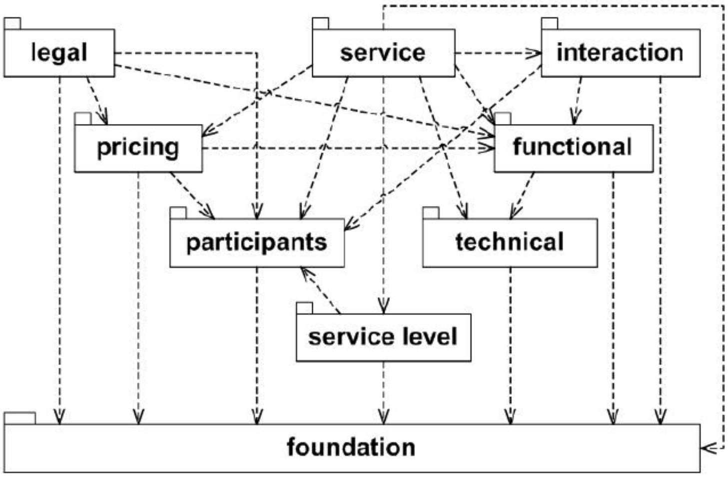
Service specific requirements are based on suitability with different service domains and relevant features are listed below:

- organizationally embedded, since services are developed within virtual enterprises;
- business knowledge through business process models. The main aim is to integrate information about control and data flow, resources, etc., through models that reduce the need for assumptions to be made due to missing details. The following questions should be clearly addressed:
  - How is service delivered to consumer?
  - What are details of individual service operations?
  - What are the conditions and penalties during delivery?
  - What impact does an individual service operation have on delivery conditions and penalties?
- Information hiding, which is intrinsic to most services which are encapsulated, reusable and deployed units of functionalities.
- Symmetric, i.e. consistent and coherent, regardless of how they have been used or upgraded among the partners within the ecosystem.

- Exception handling should be considered to promptly react in case of deviations through pre- and post-conditions and action specifications.

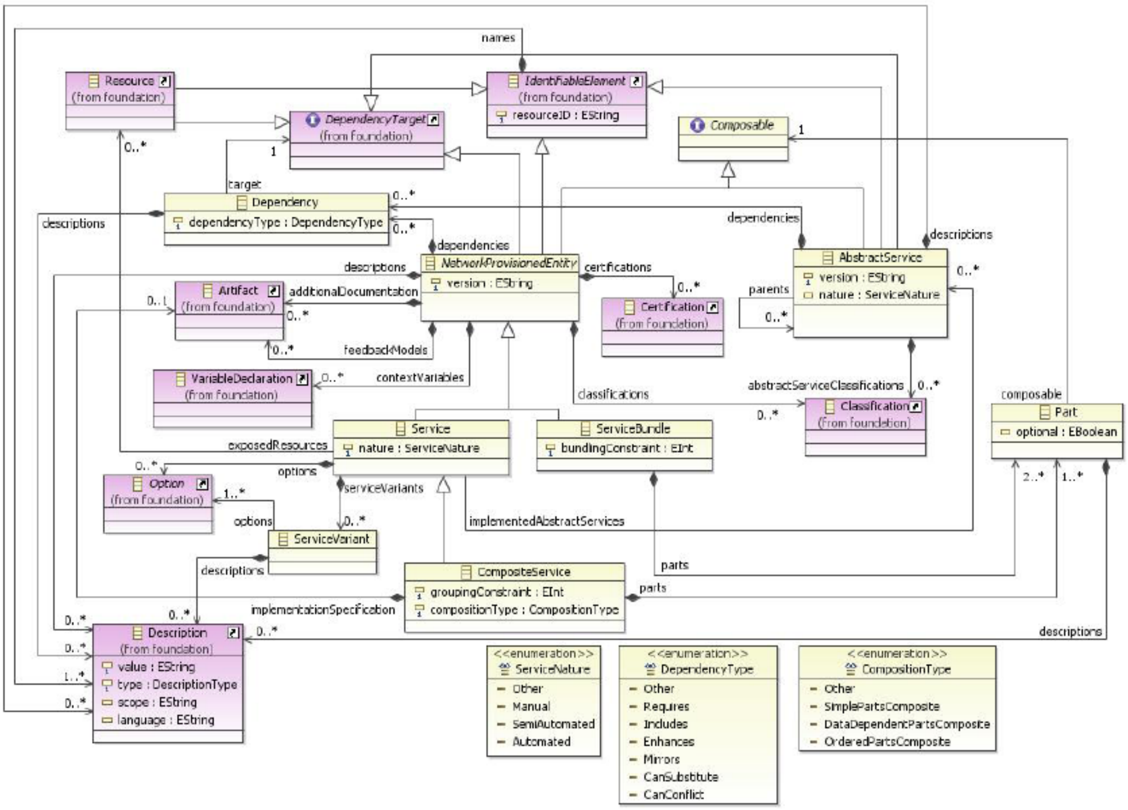
As mentioned by [D. Oberl et alt., 2012], USDL modularity is guaranteed by several packages, which represent one USDL "module" and contains one class model. Such modules originate from non-functional aspects such as pricing and legal constraints and proceed to interfacing with delivery and service level agreements, partners and service functionality, as shown in the following figure.

Figure 11: USDL modularity



The initial module is the ***service module***, which is focused on the essential structure of the service with reference to dependencies, composition, resources, etc (see following figure).

Figure 12: Structure of service module



The ***participant module*** consists of a knowledge repository, where relevant resources information are stored, as far as service owners, service providers, stakeholders, intermediaries and consumers are regarded.

The ***functional module*** allows the description of service functionality at an abstract level and free from technical implementation details. An example of properties shown at this level is presented in the following table.

Service Name	Functions	Input/Outputs	Conditions	Resources
Road Transport	Point-to-point transport on road	I: Shipping instructions, Cargo O: Cargo	Pre: Weight of a single cargo item less than 30 tons	Utilizes 5, 10 & 40 t trucks
Shipment Manager	Lookup Rate	I: Shipment Details O: Rate Information	-	-
	Order Shipment	I: Shipment Details O: Order Confirm.	*(see Road Transport)*	-
Ocean Export	Organize and Manage Export, Subfunctions: Plan & Book, Orchestrate Pre-Carriage, Process Documents, Orchestrate Export	I: Invoice, Shipping instructions, Letter of credit, etc.	-	-

The ***interaction module*** captures is complementary to the Functional and Technical modules and defines how participants interact within the service and with each other (see following example).

Service Name	Protocol Type	Phases	Interactions (r – reverse, o - optional
Road Transport	Simple	-	Pre-delivery: Request Quote (o), Do Booking (Place order)
			Delivery: Pickup cargo at origin, Drop off and hand over cargo at destination (r)
Ocean Export	Complex	Pre-Delivery: Order Entry	Place order, Receive order confirmation (r, o)
		Delivery: Booking and Pre-Carriage	Provide documents and shipping instructions, Receive booking confirmation (r), Update instructions (o)
		Delivery: Export and Main Carriage	Receive cargo receipt (r), Receive change notification (r), Receive draft waybill/bill of lading (r), receive final waybill/bill of lading and other documents (r)

The ***technical module*** assesses the technical interfaces (access mechanism) of services and it is based on two categories, i.e. operation-based and resource-based interfaces.

The ***pricing module*** is related to service charging and relevant features.

The ***service level module*** represents the monitoring model to control the service and to specify contractual agreements.

The ***legal module*** addresses the need for legal compliance in service networks and in trading services on marketplaces.

The ***foundation module*** resumes common aspects not defined by the other modules.

USDL demonstration of utility, quality, and efficacy has been carried out though feature comparison, theoretical and conceptual investigation and empirical tests. As far as feature comparison is regarded, it has been pointed out that USDL addresses all service requirements and represents the state of the art of WSDLs. From a software specification point of view, it provides the most detailed approach to date to comprehensively describe software services, based on literature evaluation. Finally, several empirical test have been carried out and a Delphi study has been implemented to prove efficacy and efficiency of the language.

3. State of the art in knowledge assets as a service

3.1. Intangibles in Manufacturing Ecosystems

In the increasingly competitive global market environment, enterprises have realized that efficient management of product and service information cannot be done without both tangible and intangible assets.

"The distinction between goods and services has been traditionally interpreted by economists as if it were equivalent to a distinction between physical commodities, or tangible material products, on the one hand and immaterial, or intangible, products on the other. The economics literature is full of statements to the effect that goods are material, or tangible, whereas services are immaterial, or intangible. Such statements are casual and conventional rather than scientific, as the nature of an immaterial product is not explained. In practice, intangible products deserve more serious attention because they play a major role in the 'information economy.' They are quite different from services. [Fulcher und Hills, 1996)]".

While service is generally considered an economic concept, within MSEE we aim at defining a framework for a service-oriented use of both tangible and intangible assets. Let us assume, for instance, that a marketplace is where requirements and needs, both explicit and implicit, are raised; the MSE (i.e. Manufacturing Service Ecosystem) is the environment where different enterprises and interested parties look for a solution to meet the customers' requirements. A proper interface will be defined within MSEE, to gather this information from the marketplace and to present it to MSE, where the solution will then be implemented by a virtual enterprise (i.e. VE). Such a VE may combine both tangible and intangible assets of the interested parties available in the Ecosystem (e.g. Universities, SMEs. Labs, etc), to reach the goal. A VE may consist of SMEs and other Entities, but also part of them, and its tangible/intangible assets will be regarded as a service or, in other words, the equivalent function of tangible asset. Let us consider, for instance the pay-per-use concept of aircraft engines, which are provided as a service (flying hours) instead of being sold as tangible asset.

To begin with, it is useful to better understand what intangible assets are and what the difference to service is. To answer this question it is necessary to examine the economic characteristics of assets in general (in- or tangibles) in contrast to services:

- ✓ Assets are entity over which ownership rights may apply.
- ✓ Some assets are material objects; others are intangible entities, originally produced as outputs by persons, or enterprises, engaged in creative or innovative activities, scientific, engineering, and artistic or entertainment nature. Broadly speaking, the original intangibles consist of additions to knowledge and new information of all kinds.

In contrast to (intangible) assets, a service is not an entity that can persist in time independently of its producer or consumer and therefore should not be treated as if it were some special kind of asset, namely an 'immaterial' one – even though services in general are intangible.

Examples for intangible assets (so called intangibles) however are:

- the text of a new book produced by its author or a new musical composition, a new design for a fabric or clothes
- film produced by a film studio or a new recording of a musical performance
- formula or a new chemical or genetic product or process
- plan for a new building or other structure produced by an architect or engineer
- blueprint for a new machine, vehicle, aircraft or other equipment
- a description of a method for production
- a computer program

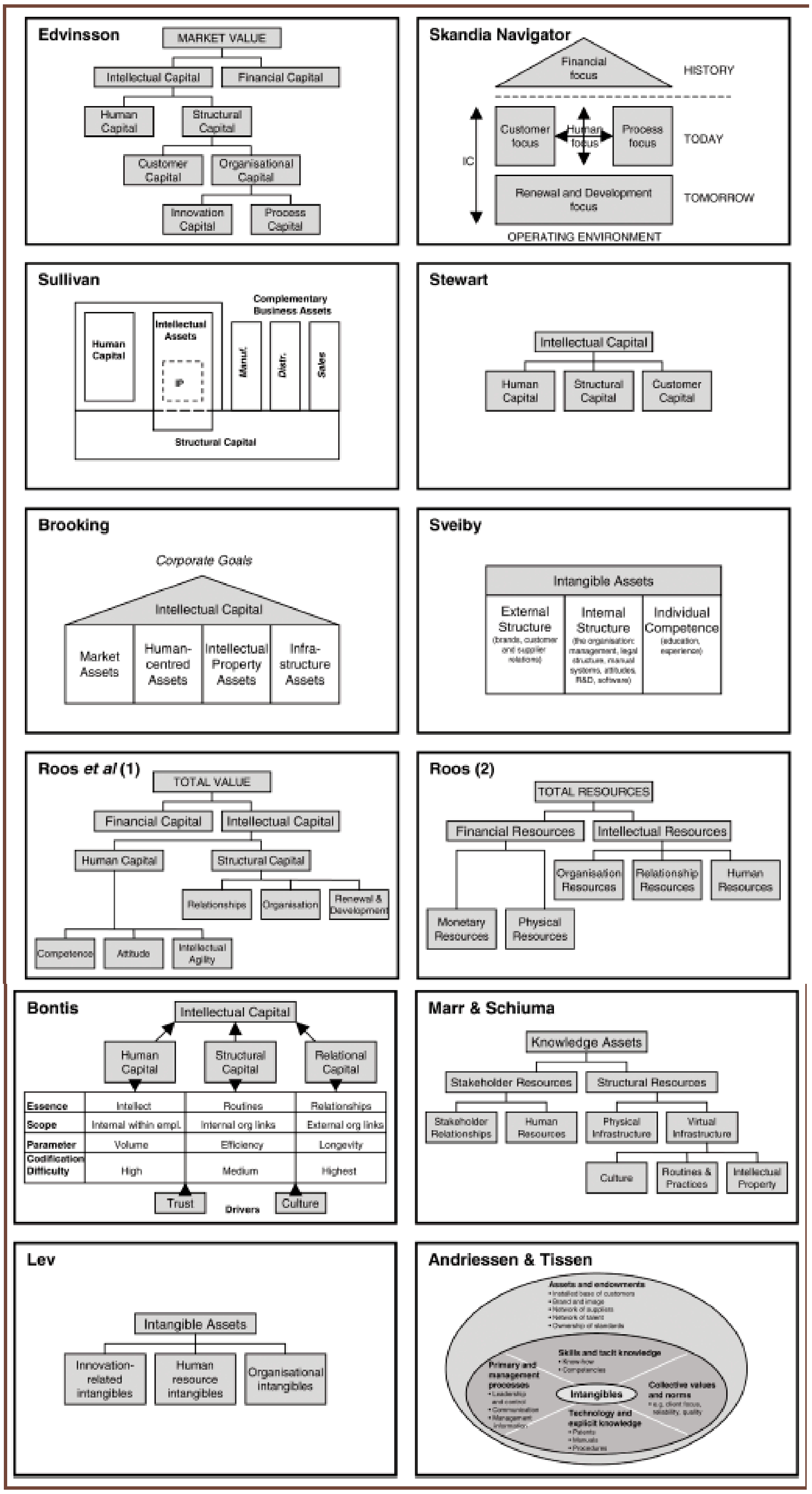
Human skills and expertise, competencies, good practices, organizational know-how and intellectually property are significant intangible assets. Therefore, one of the most common enterprise problems is the management of intangible assets. Companies have to face it when key personnel leave, retire or just get ill. Recent studies have established a direct link between organizational knowledge management (KM) practices and enterprise market value, suggesting that although IT is instrumental in improving KM, significant more benefits are expected by paying more attention to enhancing tacit knowledge by placing people and communities of practices at the centre of KM processes [Choi and Jong, 2010]. Enterprises with efficient KM processes have been shown to gain a competitive edge through enhanced innovation success performance [Cantner et al. 2009]

This problem is also significant in organizations, wherein the sheer size of the body of knowledge embedded in key personnel constitutes rich intangible resources that are rarely appropriately managed or exploited and can often be irreplaceable. It is exacerbated when significant growth fluctuations force organizations to re-structure their staff, often loosing key personnel. The same problem is transversal to all departments of the company, from the management, to the marketing as well as in the production, logistics and after services such as maintenance. In addition, any possible synergies among the different sources of knowledge go undetected as the knowledge is not explicitly shared amongst all stakeholders. With the impending retirement of the baby boom generation, the “knowledge gap” caused by the mismanagement of knowledge presents itself as a daunting challenge to corporations across Europe, in particular SMEs, which do not have an integrated knowledge management of know-how and intangible assets.

Richard Hall [1989, 1992] introduced the concept of intangible assets to the strategic management research field. Intangible assets are defined as those key drivers whose essence is an idea or knowledge, and whose nature can be defined and recorded in some way [Hall, 1992]. An other author [Itami, 1991] calls them invisible assets and includes technology, consumer trust, brand image, corporate culture as well as management skills.

While considering different definitions of intangible assets, depending on the context and the purpose of the classification, it is important to realize that intangible assets are related to accounting, strategy, human resource management, information systems, knowledge management, among others [Marr, 2004].

Figure 13: Intangible assets relations to other concepts



Source: DOW (2011), p. 95.

Most definitions converge towards an overall framework consisting of knowledge, human capital, organizational and relational [MERITUM Guidelines, 2002].

3.2. Knowledge Management

3.2.1. Knowledge Management principles

The definitions of the term 'knowledge' belong to an inflationary universe and may significantly vary, depending on the context of utilization.

According to [Probst et. al., 1999] knowledge may be defined as being the entirety of cognitions and abilities, used by individuals to solve problems. This comprises theoretical perceptions as well as practical day to day rules and guidelines. Further, knowledge is based on data and information, however it is always bound to individuals. It is generated by individuals and represents their expectance about cause-effect relationships.

Hence Knowledge Management (KM) is the systematic, goal oriented application of measures to steer, control and foster the tangible and intangible knowledge assets of organizations, with the aim of using existing knowledge inside and outside of these organizations to enable the creation of new knowledge, and generate value, innovation and improvement out of it. [Wunram et al., 2002]. Cooperation among companies and thus knowledge management among organizations, are primarily interactions of people who are acting under specific social, organizational, economic, strategic and legal conditions.

The question may be raised on what the preconditions and enablers are, as far as knowledge creation, sharing, changing, upgrading and cancelling are concerned.

These preconditions and drivers have been investigated [Wunram et al., 2002], thus leading to barriers which are predominantly to be allocated to the 'People' and 'Organization' category.

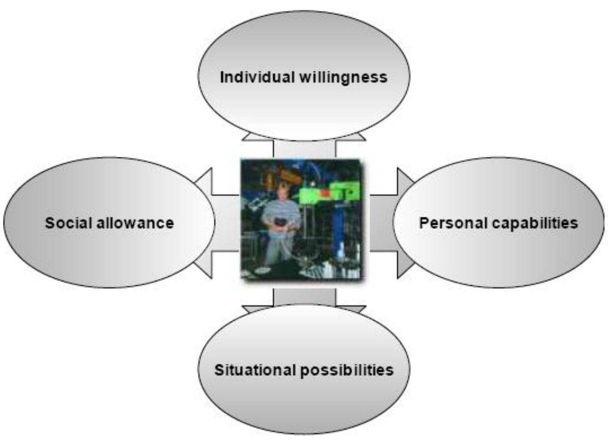
The creation of knowledge in an organization must therefore be conceived as a process that enhances the knowledge created by individuals and contributes to the intangible values of the company, provided that barriers are overcome and key drivers and enablers are considered [Wunram et al, 2002].

An important driver of knowledge creation is based on the ***individual behavior***, which is basically driven by four factors as defined in the concept of v.Rosenstiel [Wunram et al., 2002] both external and internal (see following figure):

- Individual willingness (relates to motives and values)
- Personal capabilities (refer to skills and competencies)
- Situational conditions (refer to impeding or favorable conditions)
- Social allowance (refers to group norms and regulations)

Therefore there are internal preconditions (individual commitment, personal capabilities) and external factors (social allowance, situational conditions) that must be present for a certain behavior to take place in social processes.

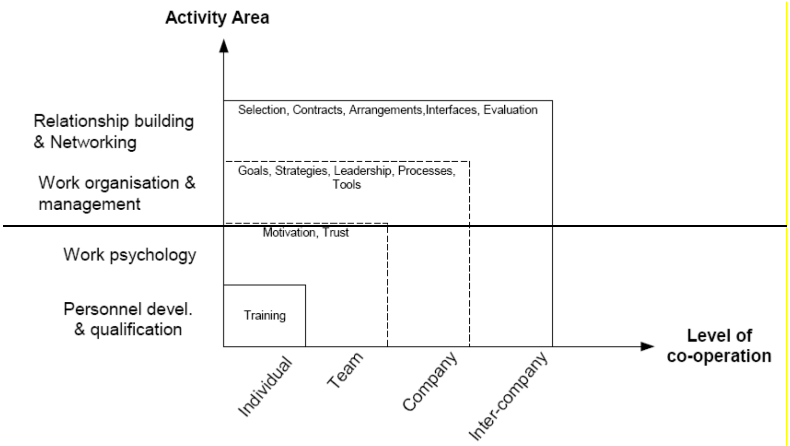
Figure 14: Individual behavior



Source: Wunram et al., 2002, p. 155.

With reference to the next figure, the creation and management of knowledge may be expressed as a function of the level of cooperation and the area of activity, in which measures have to be taken [Wunram et al, 2002].

Figure 15: Change of focus in knowledge management activities



Source: Wuram et al. 2002, p. 4

While going from the individual level to the intercompany level different ***preconditions*** related to different ***activity areas*** must be established at each level. The assumption is that knowledge management begins at the smallest hierarchical level of cooperation, which is represented by the ***individual*** employee. Therefore, the first precondition is that skills and competencies must be available at an individual level; this is achieved through training and professional development.

The second level of cooperation is the work in ***teams***. In this case the main activity to be performed is creating motivation and trust by means of psychological initiatives, in order to reduce fears and increase altruism. The main barriers to be overcome on this level are mistrust against others as well as every fear that can arise when sharing knowledge with others.

At the ***company*** level, the main activity to be carried out is the provision of defined goals, strategies, processes and tools that enable the practice of knowledge management in teams and of individuals, thus providing the organizational environment in which knowledge is to be created and shared. The key preconditions here are represented by the availability of an appropriate environment and a strong leadership.

When entering the highest level of cooperation, which is the ***intercompany***, focus must be drawn on goals, strategies, processes and tools of interacting enterprises. Therefore, the main activities are represented by setting up relationships, contracts, agreements, arrangements, as well as the definition of interfaces and security procedures to preserve intellectual property rights (IPR's) and interests. Enterprise leaders play a double-sided role: on one hand they must guarantee processes within their organization, on the other hand they have to assume responsibility towards their activities with the cooperating enterprise or partners. Many intercompany cooperation fail due to the bad choice of partners [Fontanari 1995].

Furthermore, enterprise leaders must ensure that the decisions are spread and shared at each level of the business environment, as appropriate, from operations, to enterprise and to the external ecosystem, thus making necessary a strong leadership.

3.2.2. Knowledge Management process

Knowledge management is considered a dynamic process, which includes interaction cycles between knowledge actors and knowledge objects.

This is a continuous process that comprises two kinds of knowledge [Nonaka, 2000]:

- explicit knowledge, which is characterized by an easy interpretation and transferability, e.g. description of processes
- tacit knowledge, which is difficult to be shared and communicated; it has deep roots in the personal experience and it affects values, emotions, trust

Characteristics of tacit and explicit knowledge are presented on the next figure [McInerney, 2002].

TABLE 1. Characteristics of tacit and explicit knowledge.[a]

Implicit or tacit knowledge	Explicit knowledge
Subconscious	Formally articulated
Perceived	Elucidated
Unaware	Aware
Difficult to articulate or unspoken	Fixed
Experienced based	Codified
Transferred through conversation	Documented (written, taped, recorded, digitized, etc.)
Embedded in stories and narratives	Stored in repositories (databases, files, etc.)
Escapes observation	Can be viewed or heard
Held within self	Shared with others
Personal	Organizational
Insights and understandings	Pushed or pulled
Judgments	Reports, lessons learned
Assumptions	

"We can know more than we can tell" (Polanyi, 1983, p. 4).
[a] Adapted from Polayni (1962, 1983) and Baumard (2001).

Explicit knowledge must be carefully managed, in order to prevent information overload within an enterprise.

Tacit knowledge must be translated and made explicit, in order to become a shared asset of the enterprise.

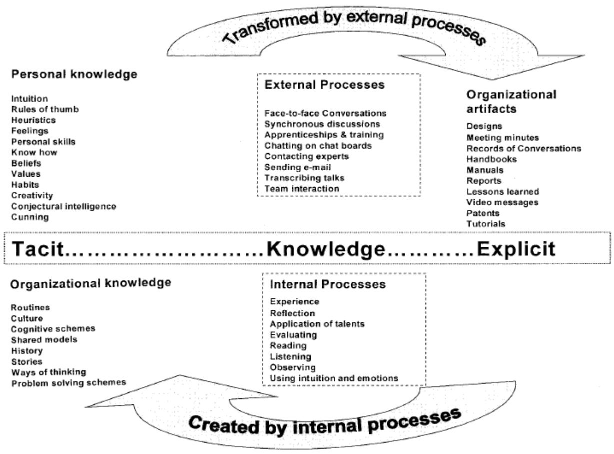
Knowledge is dynamic because it is constantly changing through experience and learning. It is a powerful force that can be used to overcome barriers, influence decision making, and generally "enable" and refresh individuals and organizations so that they can accomplish goals and complete work successfully [Stewart, 2001].

Knowledge management is a process aimed at enhancing the enterprise performances, while knowledge is changing. Knowledge management process may be classified as follows [Nonaka 2000]:

- ✓ Socialization (tacit to tacit knowledge transfer)
- ✓ Externalization (tacit to explicit knowledge transfer)
- ✓ Synthesis (synthesis of explicit knowledge to create new knowledge)
- ✓ Internalization (embodiment of explicit knowledge to tacit knowledge)

Continuous knowledge creation, Nonaka and Takeuchi (1995) argue, is what keeps organizations healthy and innovative. On the next figure a graphic representation of a knowledge continuum is presented; tacit knowledge and explicit knowledge interact through internal and external processes within an organization.

Figure 16: Continuous knowledge creation



An enterprise constantly defines the processes on which business is managed by translating personal knowledge into practices; operational procedures may trigger individual knowledge by stimulating intuition, creativity and personal skills within an innovative environment.

The two ways process is essentially based on on-going ***training*** of human resources and on procedural ***definition of knowledge***.

3.3. Knowledge as a service

The concept of knowledge virtualization is the first step towards managing knowledge as a service. In order to exploit both tangible and intangible assets within a manufacturing ecosystem, it is useful to identify meta-models, to search, to discover, to orchestrate, to execute, to monitor, to assess and to govern virtualized parts of knowledge and individual competencies, with the aim of creating innovative services. In other words, knowledge must be represented in a virtual format, which can cover most different instances in the manufacturing ecosystem and to which each specific occurrence can be related to.

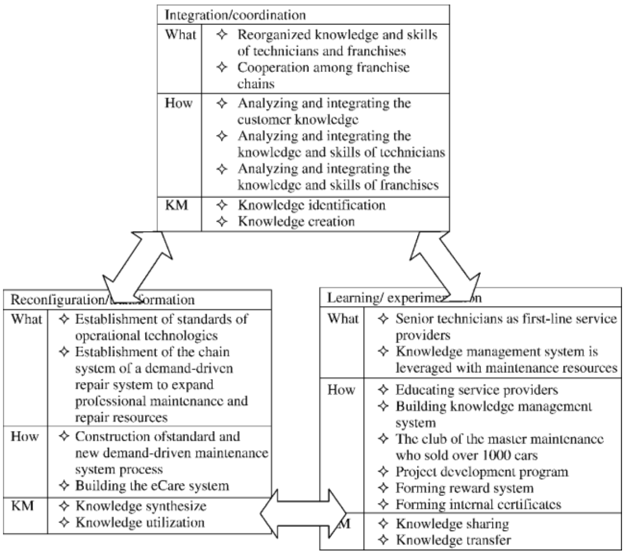
Let us assume for instance that a make-or-buy decision should be taken by the To Managers; a meta-model should be created, to virtualize the information needed, to combine them according to defined rules and to provide a solution, based on existing knowledge and innovative opportunities.

Alternatively, let us consider the design and development of the machining cycle of a CNC station, which should deliver holes on an aluminum extrusion profile. It would be difficult to manage all the specific information concerning most CNC centers worldwide, raw material, tool parameters, etc. A virtualization of specific knowledge would be needed, to find results which can meet the input requirements in terms of cycle time, tolerances, quality level, utilization ratio, swarf reduction, etc., while considering all innovative solutions which can be identified by a combination of tangible and intangible assets, eventually used in an innovative way.

A typical example of service innovation applied to knowledge management has been provided by Shang in 2009 [Shang et al., 2009], when it has been shown how an automobile service company applied dynamic knowledge management concepts to create new service processes.

The company turned its performance around after linking dynamic capability with its knowledge management practices to create new service processes. The case study examined a KM system developed and implemented by Fortune Motors, an automobile service company operating in Taiwan. A set of dynamic knowledge management initiatives named *eCare* system was developed, based on three processes: integration, knowledge acquisition, and transformation. As shown on the following figure, these processes were interrelated and underwent a cyclical path constantly.

Figure 17: Case of knowledge management practice



The company integrated customers' profiles, car maintenance and repair records, and data on the skill levels of technicians at franchisers and to find a model, which could match the service demand with the supplied skills.

Knowledge and skills of different technicians among franchisers were analyzed and input into a knowledge database, which was stratified according to competences needed for maintenance and repair and which included the accumulated knowledge. Resources were properly assessed, to enhance the service quality within a more predictable service period, and they were leveraged to maximize the utilization ratio. A common agreement and mutual trust was established, to enhance cooperation a knowledge sharing. Finally a KM database was created to upload and share best practices concerning knowledge and information-related to customers, operations, products, technology standards, quality norms, and repair knowledge etc. As a consequence, eCare system has turned the experience of senior technicians into a key asset for the whole organization.

3.4. Towards a taxonomy of requirements for hybrid product.

Several companies have designed and developed hybrid products, composed of HW, SW and service components. In fact, designers must address the requirements for each of the product elements, as well as the interfaces and interdependencies among them and the service organization. Requirement categories for hybrid products may be classified as follows [Herzfeldt, 2011]:

1. **Project Requirements:** General constraints and mandates placed upon the design team. If project requirements were left unmet, the proposed hybrid product would not be acceptable or satisfy success-critical stakeholders.
2. **Functionality Requirements**: Refers to the purposes the hybrid product should serve and the services it should provide and its behavior.
3. **Lifecycle Requirements:** Accounts for the different requirements in each of the phases in the lifecycle of the hybrid product.
4. **Interfaces Requirements:** Accounts for all the applicable requirements on how the hybrid product should interact with users, hardware, software, and services for input and output.
5. **Level of Service Requirements:** Accounts for all requirements related to how well given requirements should be performed.

3.5. Knowledge Management in MSEE

The basic concept of knowledge within the manufacturing service ecosystem project (MSEE) relies on using intangible assets as a service.

With reference to the following figure, requirements and needs are expressed on the marketplace and they are submitted to the manufacturing service ecosystem (i.e. MSE) through an appropriate interface. All partners within the MSE may contribute to meet the customers' specification through the creation of a Virtual Enterprise, which could consist of parts of existing enterprises or interested parties within the MSE.

Let us assume, for instance, that a customer is looking for specific parameters to drill a 50 mm hole through a 100 mm thick aluminum plate, with a tolerance of 0.01 mm. A virtual enterprise should be defined with the necessary information to address the problem; the solution should be based on a knowledge data base, on similar occurrences, on the competence of an experienced machining supervisor, etc. Intangible assets in this example are represented as the expertise or know-how, that is required to process such requirements.

There is no need to mention that the MSE should be the place where innovative solutions should be investigated, eventually deriving from a feasibility analysis which could provide alternative and completely new solutions in terms of creativity and process innovations.

Therefore the answer to the above mentioned production concern might be leading to a completely new approach with a pre-machining task on both sides of the plate, so that standard tools and required tolerance are assured.

The first step should be to search and to match the customers' requirements with the intangible assets within the MSE. A Virtual Enterprise should then be defined and modeled, to implement the solution. Finally a feedback to the system should be provided to monitor the MSE performance through the PLM and SLM, to update the knowledge base, to enhance the training of human resources and to improve the ICT tools used within the occurrence.

3.6. Knowledge Management in PLM processes

The term Product Life-Cycle Management (PLM) defines the integration of different kinds of activities, from the technical, organizational and managerial point of view, which are performed by engineering staff along the entire life-cycle of industrial products. This cycle covers the concept, the development and the design of the product, together with the manufacturing process planning, the factory and supply-chain planning, till to the final disposal/recycling of the product itself. Generally, PLM is an integrated approach for the management of product data along the product lifecycle ("from the cradle to the grave"). As such, it entails [Garetti, 2004]:

- a strategic management perspective, wherein the product is the enterprise value creator,
- the application of a collaborative approach to better use the enterprise competences distributed amongst diverse business actors,
- the adoption of plenty of ICTs in order to practically establish a coordinated, integrated and access-safe product information management environment in the extended context.

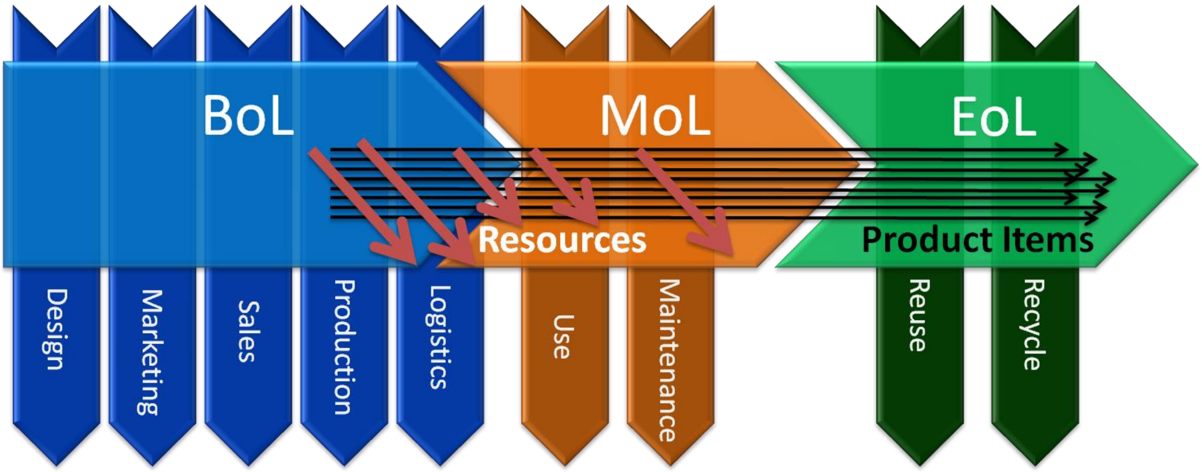
Then, PLM deals with the management of all the product data that are created, stored and managed along the lifecycle of a product, from its design to end of life. In such a way, it is possible to say that PLM is assuming a "holistic" role: according to Stark [Stark, 2004], "*PLM brings together products, services, structures, activities, processes, people, skills, application systems, data, information, knowledge, techniques, practices, skills and standards*".

PLM is not primary an IT problem, but at first, is a strategic business orientation of the enterprise. From a strategic organisation point of view, the adoption of a "product centric" approach means a remodelling of all the relations established between the resources (people and equipment) involved into the relevant business processes oriented to a "product" lifecycle direction, with all that it concerns in terms of task allocations and measurement of the obtainable performances.

In literature there are many different lifecycle models, the most common being presented by three phase life cycle:

- Beginning of Life (BoL): when the product is in the hands of the manufacturer.
- Middle of Life (MoL): when the product is owned by the consumers.
- End of Life (EoL): when the product has finished its useful life and has to be dismissed.

Figure 18: Three phase life cycle



As we move from the industrial age into the information age, knowledge is critical to competitiveness. According to the theory of "economics of ideas" developed by Paul Romer [Romer, 1993], making people knowledgeable brings innovation and continued ability to create products and services of the highest quality which will eventually lead to the economic growth both company-wide and nation-wide. Innovation relies on creativity and creativity is most likely to happen in open environments which facilitate inclusion of the best ideas. In a creative environment, the pool of talent is expanded and collective body of knowledge is accessible for individuals. A creative environment is highly collaborative and keeps all players always informed thus facilitating communication among different parties. When the greatest possible numbers of creative minds collaborate, they will innovate. As can be seen in this figure, different technological modules are integrated through IT tools as common communication platforms.

Knowledge becomes meaningful when embodied in people. In its explicit form it can be considered more as structured or unstructured information. It is the embodiment of this information into the bearers of knowledge, people, which puts substance into this information. The way humans internalise this knowledge into tacit knowledge is when the information becomes knowledge. However, for human actors to communicate tacit knowledge among them, they must first establish a common understanding or context for this knowledge [Nonaka et al. 2000].

3.7. Manufacturing enterprise 2.0 and collective intelligence

In ICT parlance, **Collective intelligence** (CI) refers to emergent, structured processes that result from the collaboration and competition of many individuals, generally in a distributed, non-centralised manner. These processes have been enabled by collaborative information channels of the Web, such as bulletin boards, blogs, micro-blogs and wikis: the so called Web 2.0 applications over which ideas, opinions and knowledge are transmitted, argued about, defended and collaboratively refined [O'Reilly, 2005]. The study of collective intelligence mechanisms is the focus of interdisciplinary research in computing, sociology, physics and mathematics. As such CI can be viewed as a sub-field of complex system research (physics), game theory (mathematics), computational sociology and Web Science (computing). The products of collective intelligence - emergent, synthetic ideas or processes, influential users or groups, domain-specific folksonomies may be viewed as the products of a type of Darwinian natural selection, whereby less fit ideas, tags, and sources of information are gradually discarded by the user population in favor of those that are better adapted to the current information needs. While the Web provides an underpinning infrastructure for the collective, competitive generation of ideas and knowledge as well as their propagation, an open research issue is the development of a formal understanding of the relationships, social structures and behaviors that allow some ideas to emerge and grow and others to fade into oblivion.

Current research on detection of emergent processes into Web 2.0 communities can be classified into 3 non–exclusive approaches. The first of these is content-based analysis in which emerging topics and trends are detected from the textual content posted by the community. For example, in blog analysis, [Glance et al. 2004] use TDT-inspired techniques to extract the most commonly occurring phrases in blogs in order to mine and track topics. In another example of a content-based approach, As part of the Tagora project (www.tagora-project.eu), [Hotho et al. 2006] monitor topic trends in collaborative tagging systems using Folkrank, an adaption of the PageRank algorithm. At the most fine-grained level, a topic may be defined in terms of an individual thread of conversation. Wang et al. propose a graph analysis approach to recover implicit conversational threads where connections between messages are inferred using message similarity [Wang et al. 2008].[Nakajima e tal. 2005] propose that authoritative and influential bloggers can be identified according to whether they fall into the role of agitator or summarizer in previous conversations. In link-analysis approaches, such structures (users, posts, threads) are represented as a graph and the goal is to identify or trace the emergences of topic-driven cliques. For example, Kumar et al. identify topic-driven Web communities by identifying sub-graphs with dense bi-partite cores [Kumar et al., 1999]. By adding a temporal axis to the graph analysis, the authors conjecture that communities in blog space undergo periods of 'bursty' intra-community link creation Kumar and Novak]. Adar and Adamic use the presence of URL citations in blogs as an indicator of information flow. Where links are not present, they use machine learning classification on text and link features to predict likely links. Adar and Adamic' work is ultimately concerned with determining the source of an information 'infection' in blog space by drawing upon techniques in animal epidemiology [Adar and Adamic, 2005].

In related research, users are modeled as nodes in a directed graph with each edge representing the probability that one blogger will 'copy' the other. The edge probability takes into account the posting history of blog neighbors, visiting frequency and the 'stickiness' of the topic [Gruhl et al. 2004]. An underlying theme in this work is the determination of emerging experts, topic leaders and communities of practice. [Alani et al. 2003] propose a social network-analysis method over linked data extracted from semi-structured sources to identify such communities of Practice and experts.

The identification and modeling of how innovation diffuses in online communities and social networks is a relatively new topic, although innovation diffusion in society in general has been a subject of sociological and economic research since the 1960s [Bass, 1969]. For online societies, diffusion models from sociology, physics and epidemiology have been explored. [Adar and Adamic, 2005], [Gruhl et al. 2004] and [Leskovec, et al. 2007] have examined different variants of the SIR epidemiological model. However, the challenge lies in devising epidemiological models suitable for the multivariate networks typical of online human interaction. For example, it is not clear how the symptoms of information contagion can be detected. Clearly, if a URL is cited then it is reasonable to infer the flow of ideas from one blog to another. However, as Adar and Adamic describe, explicit links between blogs are generally sparse, leaving other traces of information infection undetectable. So, implicit symptoms of information contagion need to be detected by examining content and behavioral traces left by users online. Content analysis offers an obvious possibility.

A less obvious route is behavioral analysis – for example, monitoring of the usage of certain tag sets may suggest contagion, but also the types of user who may be most likely to spread infection. For example, Hayes' work in tag analysis demonstrates that the use of certain tags indicate 'expert' users in a topic. A related idea is the detection of 'information backbones' in human-mediated networks generated by 'likely paths' of information infections which can be inferred by examining information paths over extended periods. This idea has its background in research of IP networks. However, whereas the path of a data packet is relatively easy to trace, the detection and tracking of the equivalent information 'packet' and its route is a much more difficult task.

The collective intelligence techniques are designed to externalize the tacit knowledge captured in the platform through the social tools made available to the social constellations. Such techniques will need to be tailored to the real-time requirements of dynamic knowledge communities. Collective and collaborative behaviors generate several types of intelligent processes:

- ✓ Collaborative search or recommendation whereby user preferences or past interactions are aggregated and mined to suggest relevant resources to the target user.
- ✓ Topic mining and tracking where emerging topics and trends are detected by statistical mining of unstructured or semi-structured content and interaction data from a community of users
- ✓ Folksonomy generation where an agreed vocabulary for categorisation emerges from community usage patterns
- ✓ Collaborative expert and expertise-finding where agreed experts emerge from community interactions.
- ✓ A related but fundamental topic involves the determination of the information pathways and the social mechanisms by which new ideas, and innovations flow in human communication pathways.

What is common to the processes listed above is that the socially derived data that drives them is usually noisy, semi-structured or unstructured and intelligence generally has to be extracted by data cleaning and data and pattern mining techniques. So while social, collaborative processes provide the raw material, refinement by data analysis and data mining algorithms is necessary for the generation of collective human intelligence. This post-processing contrasts with the definition of collective intelligence in the bio-inspired computing domain, where macro intelligence is generated by the interaction of micro entities algorithmically following simple social rules (such as artificial ants). However, extraction of refined intelligence is not confined to post-processing.

Smart data analysis and mining techniques can operate in parallel with community activities, deriving socially-inspired recommendations, finding current experts, suggesting vocabulary and providing summarization and visualization of emerging topics in real time. In this scenario, human collective intelligence will complimented by and refined on-the-fly by data analysis techniques that summarize emergent topics & ideas, connect users, communities, identify influential community members and automatically filter non relevant material to the community context. Such types of real time analysis techniques support the circular idea-seeding and ideation processes by harnessing and distilling the community's data, so that can be understood and reused within a useful time frame. This opens several challenges: it requires a mixed-initiative decision support for innovation communities, where the underlying data analysis is carried out in near real time from the streams of dynamically, socially produced data. This work will need to integrate and extend research efforts in the fields of dynamic graph mining and analysis, social network analysis and topic detection and tracking, focusing on current problems in scalability and the analysis of highly dynamic data. Thus, this WP will need to design efficient supervised and unsupervised stream-mining algorithms. In the latter, condensation techniques map incoming data points to micro-clusters.

A drawback is that much information is discarded. Efficiently tracking communities has strong similarities with finding clusters of entities, like documents and posts, across time. Typically, summaries are kept of clusters, and updates are only made to summaries when the summaries become too inaccurate. A challenge is to be able to mine data as it comes online, in near real time, without discarding potentially useful structures and the research will seek make advances in this front.

3.8. Knowledge Transformation

Another big challenge Ecosystems have to cope with is the management and transformation of knowledge during all phases of the product and/or service life cycle. During each phase knowledge and competences from various actors are used to form new experience or to carry out tasks. The knowledge used and formed can range from unstructured (e.g. collection of product ideas) to highly structured (e.g. machine settings for the final product). Not only the heterogeneity of knowledge representation but also the evolution (e.g. product characteristics will be more detailed from phase to phase) and transformation (e.g. transformation of market survey to product features) of knowledge during the development challenge. The management of knowledge in the Ecosystem has to deal explicitly with the availability of the required knowledge at the right time (e.g. availability of a service provider for materials research during material testing) but also to conserve the new knowledge for later phases of development and production (e.g. experiences gathered during material testing could be helpful for anticipating problems in production processes). In short: How can Ecosystem organize and manage the organizational, ICT and knowledge aspects of concurrent development of ideas, prototyping, and later on collaborative manufacturing as well as marketing of valuable products and services spanning the whole life cycle?

The industrial models, open models for cross-sector collaboration both in development and production of (knowledge-intensive) manufacturing principles, and innovation related methodology outlined and further developed in other MSEE Work Packages like WP2.3 are taking on this challenge and focus on establishing holistic industrial products and services in Ecosystem. They will provide network members with the necessary concepts, methods and tools to guide them through organization-, ICT- and knowledge-related network adaptations which are typically required in the value-adding process from idea generation to product/service exploitation. The transformation from development- /deign-related knowledge to production-/deployment-related knowledge will guarantee an efficient use of the resources knowledge, personnel and IT throughout the whole product and service life cycles.

3.9. Knowledge challenges – privacy/security issue on an ecosystem level

An efficient knowledge management in a business ecosystem cannot afford to overlook privacy protection. It is not practically possible to have meaningful and productive knowledge-handling processes in place without active user engagement. Yet, the actors involved in knowledge-rich processes have their own identities and concerns and the whole enterprise value-adding knowledge landscape is often undermined by a feeling of insecurity, mistrust and insufficient protection of data and knowledge.

Once privacy protocols have been established, such as the distributed personal data management Polis [Efraimidis et al, 2009], Secure Multi-Party Computation technologies [Yao, 1982, Yokoo and Suzuki, 2002] and Zero-Knowledge Protocols [Goldwasser et al. 1989], as well as the usage of data licenses [Cha and Joung, 2003][Tasidou et al., 2009], methodologies must be defined to ensure that the knowledge management ecosystem tools are taking into account important non-functional privacy requirements.

At the same time, an issue of critical concern for stakeholders involved in the knowledge management process is the issue of data and knowledge protection. Both organizations as well individuals often feel strong insecurity about sharing data and knowledge, as it is understood that their rights may not be adequately protected by existing shared knowledge systems. It is therefore of imperative importance to equip knowledge management with adequate protection at multiple levels:

- Security for integrity preservation
- Multiple levels of user authentication and access
- Security in data transfer
- Maintenance of enhanced data availability (any time, anywhere and to anyone authorized to have access)
- Protection against external threats and attacks

Security is often handled at the level of database security, application-level security, and software platform security.

Some ideas on how to cope with IPR issues are as follows:

- providing general information about the basic topics of the IPR, protection and exploitation;
- defining how to protect the results (that could be not only products, but also software, methodologies and/or processes);
- defining a “flexible” IPR workflow, suitable to manage any possible result generated;

- implementing the "flexible" IPRs and exploitation workflow: this would allow to define the IPRs and Exploitation Matrices.

Several results will have to be protected in Ecosystems. Two main categories were identified:

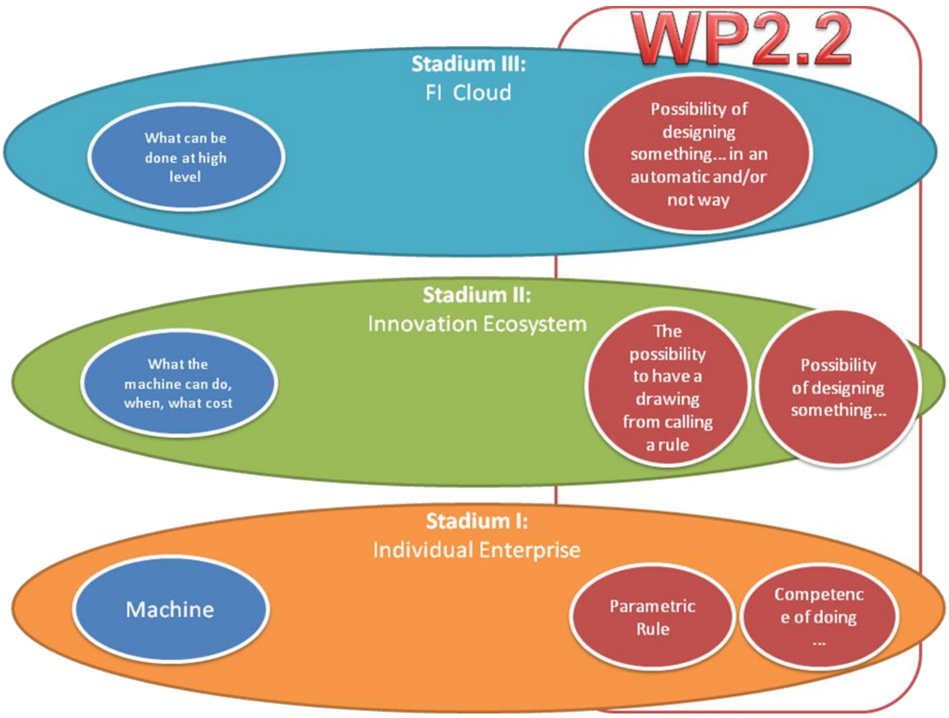
- Tangible Results
  - Product(s)
  - Tool(s)
- Intangible Results
  - Service(s)
  - Concept(s)
  - Method(s)
  - Process(es)

It is worth to notice that the first category of results (tangible results) is easier to be protected than the second category (intangible results).

In MSEE special attention is laid on protecting IPRs on multiple levels of interaction, publicity, and trust:

1. Stadium I: Internal
2. Stadium II: Ecosystem level
3. Stadium III: Future Internet Cloud of actors and agents

Figure 19: MSEE IPR levels



Focusing on (flexible) IPR workflows, to be followed for the protection & exploitation of the results coming from an Ecosystem, in particular, both temporal sequence and actors have to be identified. The "Flexible" IPR Workflow is valid both for tangible & intangible results and the methodology. The IPR workflow is characterized by 8 (eight) main operative steps:

STEP 1: Idea generation;

STEP 2: Collaborative phase (added value);

STEP 3: State-of-the art (SoA) analysis;

STEP 4: CIED check;

STEP 5: Innovation development;

STEP 6: Protection instrument definition;

STEP 7: Ownership definition;

STEP 9: Protection system implementation.

A general overview of knowledge management has been discussed with reference to MSEE. Additional investigation and specific analysis, especially concerning alignment of the level of architecture, will be carried out in the next iteration.

To **conclude** this chapter, a quick overview is presented. To begin with, it was useful to better understand what **intangible assets** are and what the difference to service is. Intangible assets have their challenges, as if not **manage correctly** they are time dependent, hard to identify and consequently not efficiently used. Therefore more attention has to be paid to **organizational knowledge management**, as recent studies have established a direct link between it and enterprise market value. Thus enterprises with efficient KM processes have been shown to gain a **competitive edge** through enhanced innovation success performance [Cantner et al. 2009]. This problem is also significant in organizations, wherein the sheer size of the body of knowledge embedded in key personnel constitutes rich intangible resources that are rarely appropriately managed. Regardless of the preconditions for knowledge creation and management, an enterprise must **continuously create knowledge**. However, only creating knowledge and not using it efficiently is not enough. If one wants to **manage knowledge as a service** for instance at an ecosystem level, the concept of knowledge **virtualization** is then the first step. In this case, **knowledge transformation** and management during all phases of the **product/services life cycle** should be sustained, because explicit knowledge has to be available at the exact right time and being able to conserve knowledge for later use. Different knowledge management approaches in a new environment brings altered **challenges** in terms of **privacy and security**. This is why privacy protocols and methodologies must be clearly defined. Nonetheless, the entire knowledge management process has to be adequately protected at multiple levels, to be effective at an ecosystem level. Knowledge management process has to take into account all those different issues at all levels in the entire product/services life cycle.

4. State of the art in human competencies assets as a service

4.1. Competencies

Ecosystems constitute new working environments where new processes and activities will take place and where workers will have to act effectively. Therefore, not only policies must be defined and shared but personal competencies have to be aligned with the new requirements.

But, what is it understood by competency? Competency (or competence) has different meanings and is one of the most diffuse terms in the management development sector and the organizational literature. According to the English dictionary, competence is the condition of being capable; ability.

Furthermore, the business dictionary displays a most complete and accurate definition:

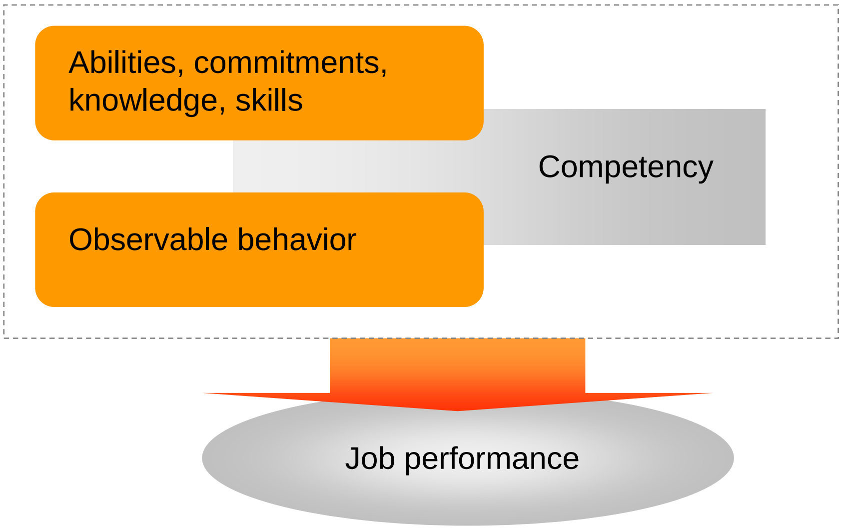
> A cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation. Competence indicates sufficiency of knowledge and skills that enable someone to act in a wide variety of situations. Because each level of responsibility has its own requirements, competence can occur in any period of a person's life or at any stage of his or her career.

As it is understood today, the term “competence” appeared for the first time in an article written by Craig C. Lundberg in 1970 titled "Planning the Executive Development Program". The term gained traction when in 1973, David McClelland, Ph.D. wrote a seminal paper entitled, "Testing for Competence Rather Than for Intelligence". Since then, it has been popularized by several authors and human resources companies as the Hay Group (former McBer & Company)

Its use varies widely, however, the main concepts [P. Green, 1999] of the definition of competence are:

- Competency is a combination of skills, job attitude and knowledge which is reflected in **job behavior** that **can be observed, measured and evaluated**
- Competency is a determining factor for **successful performance**
- The focus of competency is **behavior** which is an application of skills, job attitude and knowledge

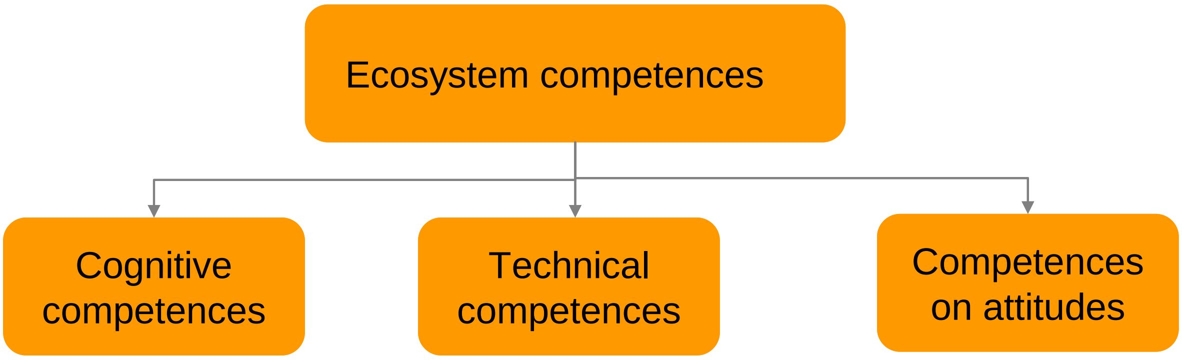
Figure 20: Competences



Let us consider, for instance, a welding operator; to become a competent welder, he must learn the main principles of welding, he must practice for a certain period of time, he should be skilled and he should have the proper job attitude. Every characteristic may be developed through appropriate methods and level of competence can be measured against performance indicators.
In order to have the best competences to work in a SMEs ecosystem, it is important to understand the following concepts:

- **Corporate competences:** refers to the knowledge, attitudes, abilities or skills of an organization that have to be owned by all its members, regardless their position. Individuals with corporate competence contribute to the success and productivity of the company. For example, companies with specific skill in the development of software solutions may be said to have a core competency in that area. In our context, this type of competences could be renamed as **Ecosystem competences**
- **Cognitive competences:** is a term used to describe formal knowledge that is needed to perform job functions in an efficiently manner. This sort of competence refers to academic studies
- **Technical competences:** knowledge of, and skill in the exercise of, practices required for successful accomplishment of a job. Instead of being corporate, technical competences are identified for groups of positions or for each position.
- **Competences on attitudes:** attitudes combining abilities and cognitive skills consistently to show the capacity of individuals to obtain results in a fast an effective way. It guarantees the success in the performance of a specific position. It also includes personal attitudes showing personal efficiency.

Figure 21: Ecosystem competences



Therefore individual competences are a combination of knowledge (cognitive characteristics), skill (technical characteristics) and behavior (attitude). While moving from bottom up within an organization, enterprise-level and ecosystem-level characteristics should be developed.

Moreover, having the most competent people assigned to every job function, means defining a management of competences program, which deals with upgrading/topgrading strategies, acquiring missing competences, monitoring and assessing performances, defining new training needs and dismissing obsolete competences.

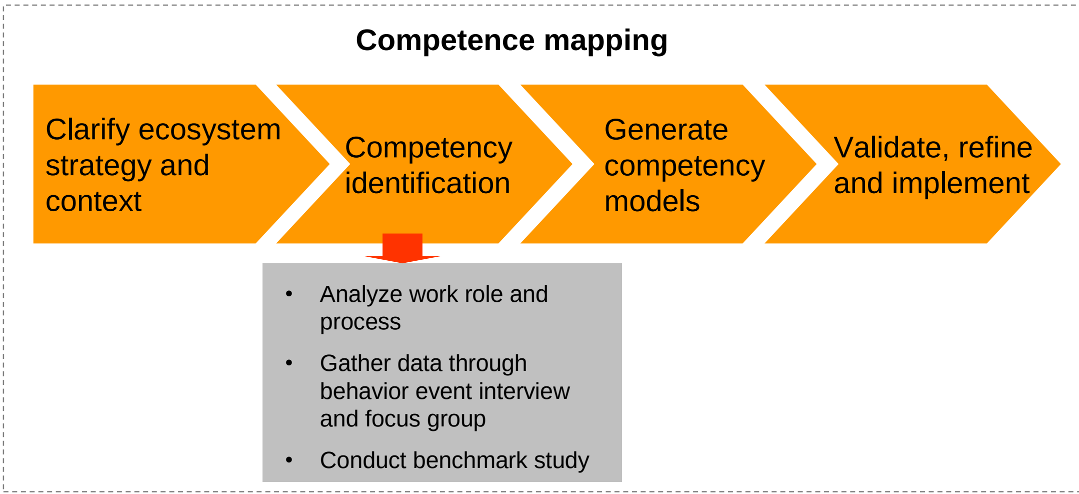
Ecosystem competences will be aligned with its strategy, new activities and processes. Cognitive and technical competences will probably be more focused on service providing whereas competences on attitudes will include, among others, adaptability / flexibility, communication skills, team working and cooperation, creativity, ability to learn and organizational knowledge

- **Adaptability / flexibility:** ability to modify our own behavior to reach certain objectives when difficulties o new data appears. Ability to adapt with versatility, efficiency in a constructive manner to environments, processes, responsibilities and changing people.
- **Communication skills**: ability to create and maintain the communication flow between the team members, using the most appropriate channels. Ability to express ideas, concepts and/or criteria in a clear and persuasive manner using the most suitable technical language for each group and / or clients. Oral skills are included (listening and understanding showing empathy and assertiveness) and written skills (writing ideas in a clear manner, grammatically correct that can be clearly understood)
- **Team working and cooperation**: taking part actively in goals achievement with other people, departments or organizations. It implies the intention to collaborate and cooperate with others, to be a part of the group and to work together. Ability to establish cooperation relationships among groups, using several communication/information sources aiming at harmonizing interests to achieve common goals.
- **Creativity:** ability to suggest solutions and / or innovative alternatives. People with this skill propose and find new and efficient ways to do things. They are innovative and practical. They search new alternatives and take risks to break paradigms.
- **Ability to learn:** ability o assimilate new knowledge and skills, concepts and information to put it into practice at work.
- **Organizational knowledge:** ability to understand and interpret the situations affecting directly to the organization, or ecosystem, as well as to show the high level of knowledge of the ecosystem's processes and services as a strategy to implement and/or manage tasks, projects or specific needs of clients or programs.

4.2. Competence mapping and assessment

Competence mapping is the process of identifying key competencies for an organization (ecosystem) and / or job and incorporating those competencies throughout the various processes (i.e. job evaluation, training, recruitment) of the organization. Competency mapping play a significant role in recruiting and retaining people as it gives a more accurate analysis of the job requirements, the candidates capability of the difference between the two, and the development and training needs to bridge the gaps.

Figure 22: Competence mapping



Competency mapping plays a vital role in selecting, training, recruiting and retaining the right people to work in SME ecosystems.

Why competency mapping?

Over the last 10 years, human resource and organizational development professionals have generated a lot of interest in the notion of competencies as a key element and measure of human performance. As it has been mentioned above, competencies include the collection of success factors necessary for achieving important results in a specific job in a particular organization. Success factors are combinations of knowledge, skills and attributes that are described in terms of specific behaviors and are demonstrated by superior performers in those jobs or work roles.

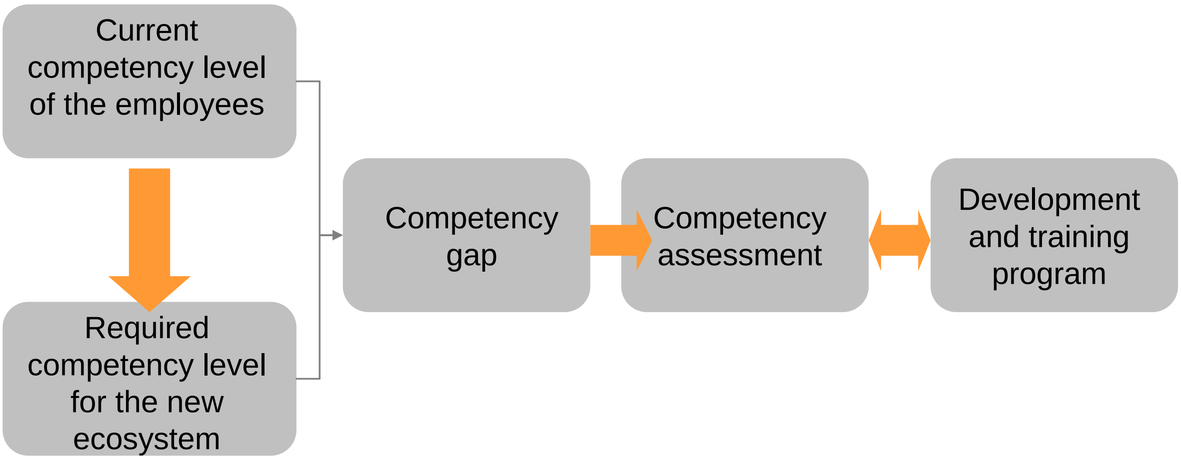
The slowing economy around the world has put new and increased pressure on an organization's capability to get more out of the available resource they have, and this often translates into pressure of the individual employees. That is where it is important to correlate performance result with competencies. It is therefore imperative to define a set of core competencies which corresponds the organization's key market differentiator.

Ecosystems will have to rely more on their competent people than any other resource. It is a major factor that determines the success of the new organization. **The right competencies will be the inner tools for motivating employees, directing systems and processes and guiding the ecosystem towards common goals that will allow it to increase its value**.

The competency mapping process does not fit the one-size-fits all formula. It has to be specific to the user ecosystem organization. It is better to develop models that draw from but are no defined by existing research, using behavioral interview methods so that the ecosystem creates a model that reflects its own strategy, its own market, its own activities and the competencies that bring success in that specific context.

Competencies needed for the new ecosystem might not probably be identical to the existing ones in the participant organizations. Therefore, it is necessary to identify the gap between the current and the desired situation and design a process to reach the optimal situation.

Figure 23: Competency gap



Competency assessment is important not only to evaluate current personal experience and abilities, but also its potential and possible professional development. Competence assessment processes permits a company to obtain a deeper knowledge about its people. At the same time, professionals may take part in a direct and conscious manner in their own professional career, as they take conscience about their own attitudes, competences, limitations, etc.

Competency assessment consists on an evaluation tool aiming at identifying and evaluating the abilities of people to perform the functions of a certain job position. Competence are identified and assessed through job analysis or task analysis, using techniques such as the critical incident technique, work diaries, and work sampling.

Techniques are based on the observation and registering of the workers behaviors by several evaluators. Behaviors come up from several situations and similar context to those that workers will find in the new ecosystem. They would be design and implement to identify the level of competences of each participant. Some of the most used techniques are:

- The critical incident technique is a set of procedures used for collecting direct observations of human behavior that have critical significance and meet methodically defined criteria. These observations are the kept track of as incidents, which are then used to solve practical problems and develop broad psychological principles. A critical incident can be described as one that makes a significant contribution –either positively or negatively, to an activity or phenomenon. Critical incidents can be gathered in various ways, but typically respondents are asked to tell a story about an experience they have had.
- Work sampling is the statistical technique for determining the proportion of time spent by workers in various defined categories of activity (e.g. setting up a machine, assembling two parts, etc.). in a work sampling study, a large number of observations are made of the workers over an extended period of time. For statistical accuracy the observations must be taken at random times during the period of study, and the period must be representative of the types of activities performed by the subjects.
- Other techniques as group dynamics as role plays, presentations, interviews, etc.

A competence assessment process in an Ecosystem should be approach taking into account the competencies to be assessed. They must be design close to the real characteristics of the new environment so that results would be precise.

4.3. Competences upgrading or evolution

The settlement of an ecosystem will imply new tasks, processes and organizational changes. This will definitely affect people and the objectives will be achieved only if everyone is compromised. But no one wants to be changed and strong oppositions will not probably take much to arise.

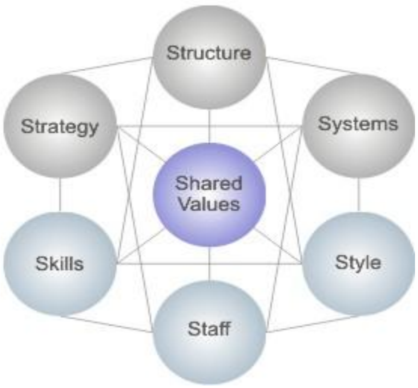
Unfortunately, some people will genuinely be harmed by change, particularly those who benefit strongly from the status quo. Others may take a long time to recognize the benefits that change brings. It is necessary to foresee and manage these situations. The change process must be managed.

Change management is a structured approach to shifting individuals, teams, and organizations from a current state to a desired future state. It is an organizational process aimed at helping employees to accept and embrace changes in their current business environment.

There are many different change management models. Three of the most relevant ones are: McKinsey 7-S Model, Lewin's Change Management Model and Kotter's Eight Step Change Model.

Figure 24: McKinsey 7-S Model

Figure 1: The McKinsey 7S Model



Source: http://www.12manage.com/methods_7S.html, 2012.

The **McKinsey 7-S Model** was created by Tom Peters and Robert Waterman while they were working for McKinsey & Company, and by Richard Pascale and Anthony Athos in 1978 [12Manage, 2007]. It is a holistic approach to company organization, which collectively determines how the company will operate. There are seven different factors that are a part of the model: shared values, strategy, structure, systems, style, staff, and skills, which all work collectively to form the model.

Those seven elements are distinguished in so called hard S's and soft S's. The hard elements (3 circles above: strategy, structure and systems) are feasible and easy to identify. They can be found in strategy statements, corporate plans, organizational charts and other documentations.

The four soft S's (Skills, Staff and Style) however, are hardly feasible. They are difficult to describe since capabilities, values and elements of corporate culture are continuously developing and changing. They are highly determined by the people at work in the organization. Therefore it is much more difficult to plan or to influence the characteristics of the soft elements. Although the soft factors are below the surface, they can have a great impact of the hard Structures, Strategies and Systems of the organization.

- **Strategy:** Actions a company plans in response to or anticipation of changes in its external environment.
- **Structure:** the way the organization is structured and who reports to whom.
- **Systems:** the daily activities and procedures that staff members engage in to get the job done
- **Style:** The culture of the organization, consisting of two components:
  - **Organizational Culture:** the dominant values and beliefs, and norms, which develop over time and become relatively enduring features of organizational life.

    - **Management Style:** more a matter of what managers do than what they say; How do a company's managers spend their time? What are they focusing attention on? Symbolism – the creation and maintenance (or sometimes deconstruction) of meaning is a fundamental responsibility of managers.

- **Staff:** The people/human resource management – processes used to develop managers, socialization processes, ways of shaping basic values of management cadre, ways of introducing young recruits to the company, ways of helping to manage the careers of employees
- **Skills:** The distinctive competences – what the company does best, ways of expanding or shifting competences
- **Shared Values:** Guiding concepts, fundamental ideas around which a business is built – must be simple, usually stated at abstract level, have great meaning inside the organization even though outsiders may not see or understand them.

Effective organizations achieve a fit between these seven elements. This criterion is the origin of the other name of the model: Diagnostic Model for Organizational Effectiveness.

The model can be used to help identify what needs to be realigned to improve performance, or to maintain alignment (and performance) during other types of change. Whatever the type of change – restructuring, new processes, organizational merger, new systems, change of leadership, and so on – the model can be used to understand how the organizational elements are interrelated, and so ensure that the wider impact of changes made in one area is taken into consideration. On the other hand, the major disadvantage is that when one of the parts is changed, all parts change because they are all interrelated.

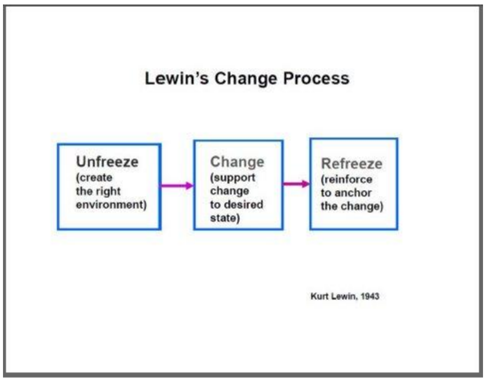
One of the cornerstone models for understanding organizational change was developed by **Kurt Lewin** back in the 1940s, and still holds true today. His model is known as **Unfreeze – Change – Refreeze**, refers to the three-stage process of change he describes. Lewin, a physicist as well as social scientist, explained organizational change using the analogy of changing the shape of a block of ice.

Figure 25: Lewin's model of organizational change

Unfreeze: This first stage is about preparing ourselves, or others, before the change (and ideally creating a situation in which we want the change. This first part of the change process is usually the most difficult and stressful. When the "way things are done" is cut, everyone and everything is put off balance. Strong reactions in people may appear and that's exactly what needs to done. The steps that have to be followed in this stage are the following:

1. Determine what needs to change: survey the organization to understand the current state
2. Ensure there is strong support from upper management. Identify and win the support of key people within the organization. Frame the issue as one of organization-wide importance.
3. Create the need for change. Create a compelling message as to why change has to occur. Communicate the vision in terms of the change required. Emphasize the "why".
4. Manage and understand the doubts and concerns: Remain open to employee concerns and address in terms of the need to change.

Figure 26: Lewin's change process



Change or transition: Kurt Lewin was aware that change is not an event, but rather a process. He called that process a transition. Transition is the inner movement or journey we make in reaction to a change. This second stage occurs as we make the changes that are needed. After the uncertainty created in the unfreeze stage, the change stage is where people begin to resolve their uncertainty and look for new ways to do things. People start to believe and act in ways that support the new direction. In order to accept the change and contribute to making the change successful, people need to understand how the changes will benefit them. Not everyone will fall in line just because the change is necessary and will benefit the company. Time and communication are the two keys to success for the changes to occur. The main steps that have to be followed are:

1. Communicate often.
2. Dispel rumours: Answer questions openly and honestly and deal with problems immediately
3. Empower action: Provide lots of opportunity for employee involvement
4. Involve people in the process. Generate short-term wins to reinforce the change.

Refreeze: As the name suggests this stage is about establishing stability once the changes have been made. The changes are accepted and become the new norm. People form new relationships and become comfortable with their routines. The refreeze stage also needs to help people and the organization internalize or institutionalize the changes. This means making sure that the changes are used all the time; and that they are incorporated into everyday business. With a new sense of stability, employees feel confident and comfortable with the new ways of working. The main steps of this stage are:

1. Anchor the changes into the culture: Identity what supports the change and barriers to sustaining change
2. Develop ways to sustain the change: Ensure leadership support. Create a reward system. Establish feedback systems. Adapt the organizational structure as necessary.
3. provide support and training
4. Celebrate success!

The benefits of this model include that this is a simple and easily understood tool. On the other hand, the main disadvantage is that it is timely and also, that at the refreezing period, many people are worried that another change is coming, but nowadays, most of the people are conscious that live implies constant changes.

The third model is the **Kotter's Eight Step Change Model**. John Kotter is a professor at Harvard Business School and world-renowned change expert. Kotter introduced his eight-step change process in his 1995 book, "Leading Change." The eight steps for leading change are shown below.

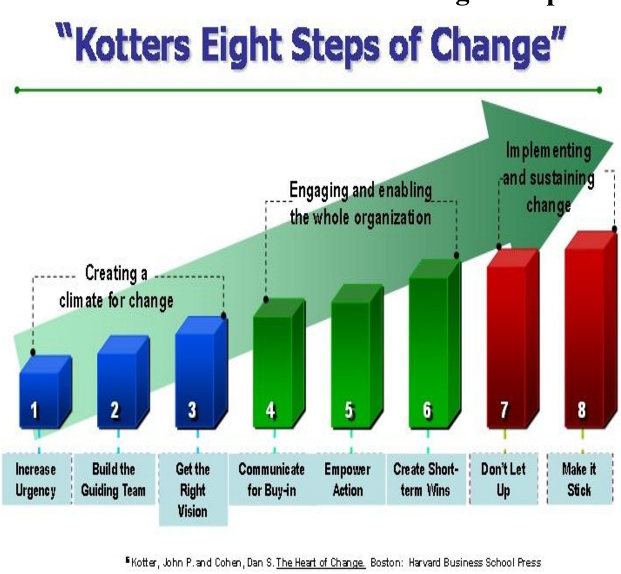


Figure 27: Kotters eight steps of change

1. **Create Urgency:** this means that we have to convince the employees that this change is necessary for the company to survive. This isn't simply a matter of showing people poor sales statistics or talking about increased competition.

Open an honest and convincing dialogue about what's happening in the marketplace and with your competition. If many people start talking about the change you propose, the urgency can build and feed on itself

2. **Form a powerful coalition:** build a team for the change, which has to be of some respected employees within the company. You can find effective change leaders throughout your organization – they don't necessarily follow the traditional company hierarchy. To lead change, you need to bring together a coalition, or team, of influential people whose power comes from a variety of sources, including job title, status, expertise, and political importance.
3. **Create a Vision for Change:** construct the vision, which will show clear direction to how the change will better the future of the company and their jobs. A clear vision can help everyone understand why you're asking them to do something. When people see for themselves what you're trying to achieve, then the directives they're given tend to make more sense.
4. **Communicate the Vision**: communicate this vision. In order for the vision to work it must be fully understand by the employees, which means that it is necessary for the leaders of the change group to follow this vision. Don't just call special meetings to communicate your vision. Instead, talk about it every chance you get. Use the vision daily to make decisions and solve problems. When you keep it fresh on everyone's minds, they'll remember it and respond to it. It's also important to "walk the talk." What you do is far more important – and believable – than what you say. Demonstrate the kind of behavior that you want from others.
5. **Remove Obstacles**: empower the employees to execute the change. Is anyone resisting the change? And are there processes or structures that are getting in its way? Put in place the structure for change, and continually check for barriers to it. Removing obstacles can empower the people you need to execute your vision, and it can help the change move forward.
6. **Create Short-term Wins**: Nothing motivates more than success. Create short-term targets – not just one long-term goal. You want each smaller target to be achievable, with little room for failure. Your change team may have to work very hard to come up with these targets, but each "win" that you produce can further motivate the entire staff.
7. **Build on the Change:** this step is about persistence. Kotter argues that many change projects fail because victory is declared too early. Real change runs deep. Quick wins are only the beginning of what needs to be done to achieve long-term change.
8. Anchor the Changes in Corporate Culture: make the change permanent by moving fitting it into the company’s culture and practices, such as promotion. Change should become part of the core of your organization. Corporate culture often determines what gets done, so the values behind the vision must show in day-to-day work.

One of this model advantages is that it is a step by step model, which is easy to follow. Another is that it does not focus on the change itself, but on the acceptance and preparedness for this change, which makes it an easier transition. On the other hand, one disadvantage is that any step cannot be skip because the change process will fail.

A common idea of a change management process is that hard work must be done to change an organization successfully. Chances of success increased if proper foundation is built. Impatience to expect too many results too soon is one of the most common errors.In conclusion, the analysis brought us to define the structure of competencies and thus to define it. All this was done at the lowest level, the individual one. Albeit the real challenge lays how those competencies could be transferred to a higher level, at an enterprise or at an ecosystem level, which will result in corporate competences that are owned by all members of an organization. Firstly a need for characteristics of competences on higher levels is needed, therefore competence mapping and assessment has been introduced to identify key competencies for an organization (ecosystem). However, it was still not clear how to induce those changes on an enterprise or ecosystem level, as organizations are often acting aversively to changes. Consequently there was a need to introduce the concepts of organizational changes that would allow inducing the planned changes in an organization (ecosystem).

5. FP7 Factories of the future vision on intangible assets

As described in the ***DOW***, by 2015 novel service-oriented management methodologies and the Future Internet universal business infrastructure will enable European virtual factories and enterprises to self-organize in distributed, autonomous, interoperable, non-hierarchical innovation ecosystems of tangible and intangible manufacturing assets, to be virtually described, on-the-fly composed and dynamically delivered as a Service, end-to-end along the globalized value chain.

The **Factories of the Future** Public-Private Partnership (FoF PPP) multi-annual Strategic Roadmap (http://ec.europa.eu/research/industrial_technologies/pdf/ppp-factories-of-the-future-strategic-multiannual-roadmap-info-day_en.pdf) addresses the development of the next generation of production technologies that will be applied from 2015 onwards; such a roadmap identifies in "ICT-enabled intelligent manufacturing" one of the four pillars to support European manufacturing industry in the challenging transition from post-crisis recovery to a European STEEP (Social, Technological, Economical, Environmental and Political) sustainability and re-gain competitive advantage in the global market competition. Three priority areas have been identified:

- **Smart Factories**, i.e. agile manufacturing and customization,
- **Virtual Factories**, i.e. value creation, global networked manufacturing and logistics,
- **Digital Factories**, i.e. manufacturing design and product life cycle management.

Technology, even though it plays an important role, is only one term in the equation that leads to economic success and sustainable growth for Europe. Human skills, the organizational structure, the medium- and long-term strategic goals and the rules for financial decisions are at least as important. Knowledge-based innovation in processes, products, and systems is the key concept: innovation leading to new life-cycle based product-services, manufactured in a sustainable way, and responding to the demands of customers and society.

On November 2011 the European Commission has published its proposal for ***Horizon 2020***, the new framework programme that will replace FP-7, while keeping on supporting its successful 'Factories of the Future' public-private partnership (FoF PPP) project. Horizon 2020 leans on three main pillars:

- Excellence in the science base.
- Creating industrial leadership and competitive frameworks (including FoF PPP).
- Tackling societal challenges.

The **ActionPlanT** (http://www.actionplant-project.eu/) is another project, co-funded by the European Commission under the Private-Public Partnership (PPP) "Factories of the Future" within the Seventh Framework Programme. ActionPlanT aims at developing a vision on the short, medium, and long term role of Information and Communication Technology (ICT) in the European manufacturing industry. It is focused on the following tasks:

- Establishing a vision for the role of ICT in manufacturing of the future, in cooperation with EFFRA, the Factories of the Future Research Association. ActionPlanT activities include the development of a roadmap to prioritize most promising topics for the next Framework Programme for Research and Innovation ('Horizon 2020', covering the period 2014-2020).
- Developing and validating a concept for industrial learning, extensively piloted via Industrial Learning Pilot Events (ILPEs) and workshops amongst stakeholders in industry, academia, and the European technology platforms alike. The related activities include the development of an IL model and methodology, their testing and evaluation through the organization of ILPEs and workshops, and the dissemination of the validated results to reach a wider audience among European manufacturing workers

The question is how manufacturing SMEs can become smarter, virtual and much more digitalized.

In the **EI/FInES** research cluster (http://cordis.europa.eu/fp7/ict/enet/), the above challenges have been addressed with a special focus on manufacturing SMEs.

The ***FInES Research Roadmap 2025*** (March 2012) has identified some Qualities of Being (i.e. Humanistic Enterprise, Sensing Enterprise, and Agile Enterprise), which will make European ***enterprises smarter*** and more competitive in the global economy, e.g. by launching participative and human-centered innovation, by adopting STEEP sustainability principles, by going beyond passive knowledge management, by empowering employees in the strategic decisions and by getting the community involved in a global business perspective.

The Future Internet-Based Enterprise System, i.e. the socio-technical methodologies, platforms, applications, systems, and, in general, ICT solutions aimed at supporting emerging future enterprises, is organized on three basic dimensions: the Knowledge Dimension, the Functional Dimension and the Engineering Dimension.

As far as the knowledge dimension is concerned, the degree of penetration of ICT in the production reality will continue to a point where all we need to know about the enterprise will be coded in digital form, equally accessible and processable by computers and by humans (cf. Digital Enterprise).

Among the other Research Challenges (RC), which have been faced by FInES Research Roadmap 2025, the following issues are strongly related to intangible asset management within MSEE, because they determine the liaison to the exploitation of intangible assets within a manufacturing service ecosystem:

- *RC2. Linked Open Knowledge.* A Unified Digital Enterprise (UDE) is a complex structure that emerges from the collection of several knowledge resources logically and geographically distributed, inside and outside of the enterprise. It will be important to achieve a tight integration between 'internal' and 'external' knowledge, so that what today is external can be internal tomorrow, and vice versa (ref. Cloud Enterprise.).
- *RC6. Cooperation and collaboration platforms.* This functional area includes a rich number of services aimed at supporting a productive exchange of information, knowledge and services, among humans (cooperation, social computing), among computers (interoperability) and between the two. The flow of information and services will also contribute to the constant updating of the UDE knowledge.

In MSEE it will be essential to investigate SMEs interactions within the manufacturing ecosystem and to analyse cooperation and collaboration services, which will be needed to continuously improving knowledge management and trust relationships.

Several projects in the cluster, such as ECOLEAD (http://ecolead.vtt.fi/), DBE (http://www.digital-ecosystems.org/cluster/dbe/ref_dbe.html) and COIN (http://www.coin-ip.eu/) have been focused on ***virtual enterprises*** and business innovation, renewing not just products/services but also business processes, human competencies, ICT systems and, last but not least, business models and value propositions. Knowledge-oriented collaboration and semantic interoperability was one of the four Grand Challenges identified by the EI Cluster Research Roadmap.

In the ***FI Assembly sessions*** held in Stockholm, Valencia and Poznan (http://www.future-internet.eu/events.html) the issue of ***digitalization*** and FI adoption by enterprises have been deeply discussed in terms of vision, socio-economic and technical perspectives. The EI Cluster Research Roadmap and the COIN project respectively introduced and implemented the so-called ISU (Interoperability Service Utility) concept, which will provide SMEs with low-cost, easy-to-access, available-to-all utility services to allow every enterprise to go digital and to solve interoperability and collaboration gaps.

Talks at ***Future Internet Assembly Session in Poznan*** stressed that Future Internet is the key to Europe‟s economic recovery and „smart growth‟. New developments in internet architecture, software, applications, networked media and the Internet of Things will provide the foundation for regional development in Europe and will support healthy innovation and competition not just within the internal market but also on a global scale.

6. MSEE vision on intangible assets

The MSEE 2015 Vision (see DOW) stems upon two complementary pillars: ***Service Oriented Architectures (SOA)*** and ***Digital Business Ecosystems (DBE).*** Implementing and fully adopting both principles will decisively contribute to make European Enterprises ***smarter***, ***more virtual*** and ***more digital***.

SOAs have de facto revolutionized information systems, by providing software engineers with powerful methodologies and tools for decomposing complex systems into autonomous components, with the final aim to support enterprise vital processes and workflows, by simple orchestrations and compositions in the hand of business specialists. Thanks to SOA and its components, complex distributed information systems have dramatically improved their interoperability, so that it is now possible to think of dynamic, on-the-fly composition of services on the global Internet scale.

More recently, a new research stream is emerging, trying to systematize the multi-disciplinary knowledge involved in service systems: **Service Science Management and Engineering** (SSME) was the name given by IBM to this new discipline, in analogy with the Computer Science term coined by IBM in the 70's.

It is worth to mention that service-orientation for EU manufacturing industry is meant in MSEE as a sustainable measure to improve the competitiveness of Europe in the global market arena, by keeping physical goods production/assembly and considerably improving their attractiveness and user-orientation by intangible added value services.

The **first Grand Challenge** for MSEE project is therefore to make MSEE evolve towards Manufacturing Systems and Factories of the Future, i.e. from a methodological viewpoint to adapt, modify, extend SSME concepts so that they could be applicable to traditionally product-oriented enterprises.

DBEs have created new perspectives for enterprise collaboration, overcoming the rigid and hierarchical models of traditional supply chains and opening the door towards Open Innovation and Living Labs models. However, the real adoption of DBE principles to virtual factories and enterprises is still at the very beginning, mostly because current DBE implementations have not proved to be effective in providing value propositions and business models which could be certified in terms of return on investment and best practices. Other reasons are related to the lack of effective policies, mechanisms and processes to protect knowledge and property rights during collaborations and scarce native support by current Enterprise Software Applications (ESA) to business innovation, enterprise collaboration and distributed decision making.

The Future Internet seems to provide the right answer to the above needs with its federated-open-trusted platforms and innovative utility-oriented business models.

It is another MSEE dream to be able on the one side to answer the question "What do Virtual Factories and Enterprises expect from the FI?" and on the other side to proceed with the scientific and technical foundations of next generation FI-based ESAs towards a 2015 Enterprise Innovation System.

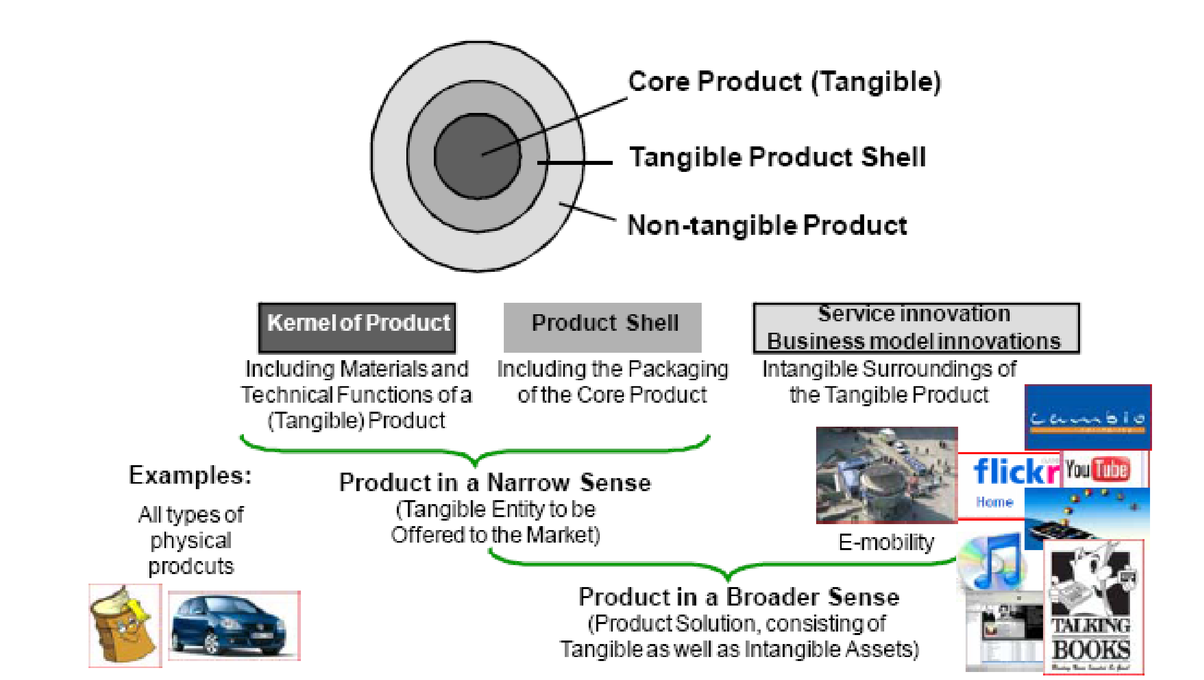
The **second Grand Challenge** for MSEE project is to transform current manufacturing hierarchical supply chains into manufacturing open ecosystems, i.e. on the one side to define and implement business processes and policies to support collaborative innovation in a secure industrial environment (see S&T Objective II); on the other side to define a new collaborative architecture for ESA, to support business-IT interaction and distributed decision making in virtual factories and enterprises (see S&T Objective IV).

The synthesis of the two Grand Challenges above in industrial business scenarios and their full adoption in some European test cases will result in new Virtual Factory industrial models, where service orientation and collaborative innovation will support SMEs competitiveness.

Customers are looking for **solutions and benefits** (not for products) or even more they are requesting intangibles like fun, success, fame, vanity etc. This is true for most types of customers (end-users as well as suppliers, manufacturers, etc.).

To succeed in the competitive global market place, manufacturers and suppliers have to come up with novel ways to sell their wares (Johnston and Clark 2008). Therefore their core products should be integrated by additional services to make their products more attractive. This leads to enhanced user requirements, such as mobility concepts with implemented ICT systems supporting the people in selecting the most appropriate travelling option. The concept of **extended products**, introduced by Thoben et al. (2001, 2002) delivers an appropriate model to link products, product related services and the needs of the users.

Figure 28: Basic ideas behind service product



Source: DOW MSEE (2011), p. 60.

The upper figure shows that some products such as iTunes or talking books offer a certain customer value for themselves.

As defined in the DOW, an ***extended product*** itself describes the bundling of value added products and services to a core product to fulfill customer needs over the whole product lifecycle.

A typical example of an extended product can be found in the ICT field: a smart phone is sold not only as a product (tangible asset), but also for the solution or applications (intangible assets) which are provided to meet the customers' requirements.

Two main scenarios are included in MSEE:

- The **Product2Service** scenario: while in most cases physical goods remain the property of the manufacturer and are considered as investment, revenues come from the services only. See for instance the case of pay per use business models, such as selling flying hours instead of an aircraft engine.
- **Product+Service** scenario: it essentially consists in a simultaneous offering of physical products extended with proper tailored services. In this case, both physical products and services contribute to the revenues, their balance needs to be adaptively determined and continuous innovation of services assumes a key competitive advantage. Let's consider for

instance a European TV set manufacturer willing to provide additional Internet-based services to its customers (e.g. multimedia services for children, elderly people, pregnant women teaching them arts and music, wellbeing, dietary principles, relaxation techniques).

These are usually really a revolution for our traditional manufacturing industries. Moreover, usually the manufacturing enterprises need to provide the potentially very large ecosystem of service providers with proper development environments and platforms (easy to use and trusted) so that services could be developed according to some predefined methodologies and tools and their subsequent search, discovery, selection, orchestration, delivery turns out to be facilitated. In essence, enterprises need to develop new competencies and processes in order to support the overall service life cycle. For instance, the Mobile Phone manufacturer (e.g. Apple store) needs to create communities of users, motivate them and completely modify their approach to marketing and sales. Last but not least, implementing Service-orientation and Open Innovation Grand Challenges in European virtual factories, i.e. implementing Service Innovation, requires the capillary dissemination of the related concepts and methodologies, the exploitation of the tools and IT systems, as well as the training and formation of a new generation of managers and knowledge workers, who will be able to transform our enterprises into service oriented, collaborative entities.

An Enterprise could then offer both tangible and intangible assets as a service, within a specified environment, where additional and innovative services may be created by the aggregation of relevant resources provided by different Enterprises, collaborating very closely towards the common goal of making the sale of the package attractive.

A ***Manufacturing Service Ecosystem*** is defined within MSEE as an appropriate environment, where enterprises and interested parties may be participating and contributing to innovative solutions to specific problems; they can provide specific expertise on a permanent basis, while stimulating innovation.

To begin with, a ***marketplace*** for manufacturing services should be created, to define appropriate customers' requirements and to deliver relevant results. The marketplace should have a management interface (***orchestrator***) among the Customers and the Ecosystem, to translate general requirements into solutions for the Customers.

Actual cases may significantly differ, according to the scope and objective of the service. If just a machining task within a complex production cycle is concerned, both customer requirements and boundary conditions (e.g. fit and function characteristics) should be considered; on the other hand, if we deal with a turn-key service, customers' requirements only are compulsory, while intermediate checks are monitored according to internal control plans.

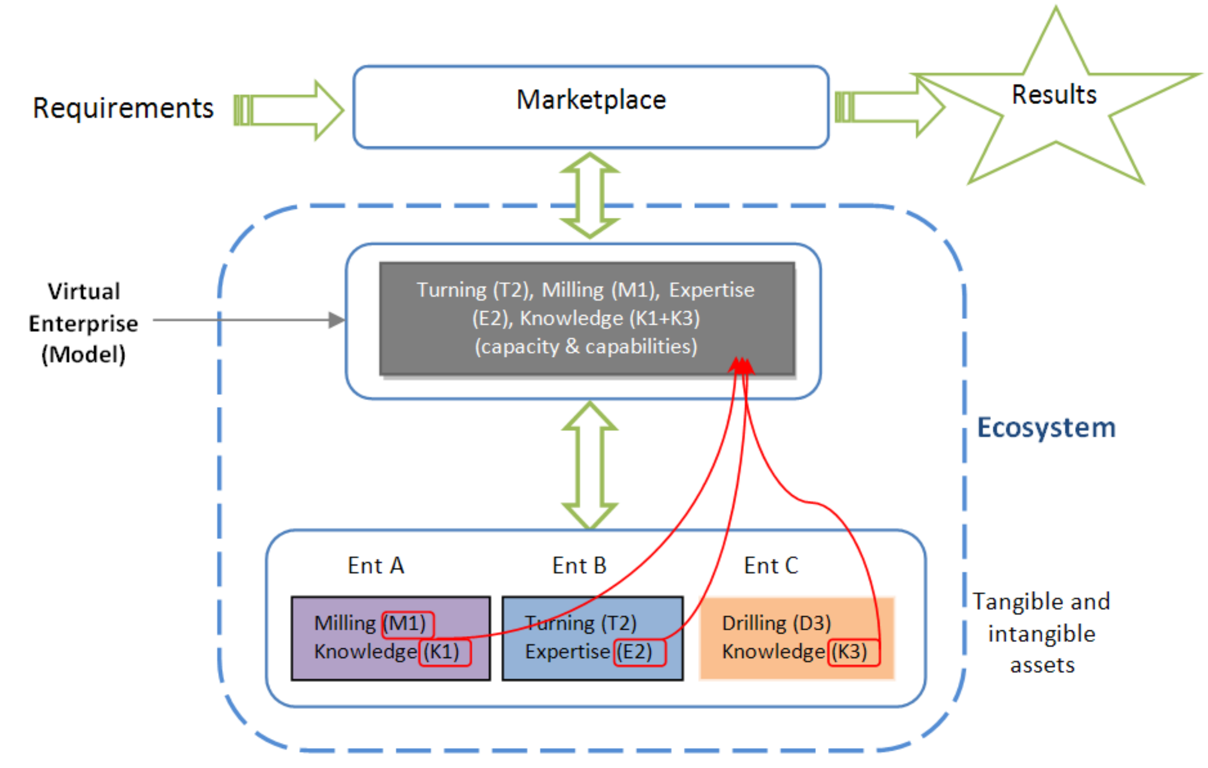
A similar analysis will be investigated on the ***demand*** side in the next iteration due in M15. It mainly consists in the definition of BP and Projects as meta-models used within the ecosystem level.

Let us assume, for instance, that a customer needs to have 100 parts drilled until the end of the month at a certain price and specified technical conditions. This should be expressed in terms of a BP to the Ecosystem, which should provide different alternatives, eventually optimized against the enterprise strategy, by verifying compliance with existing tangible and intangible assets as a service. A similar reasoning can be applied in case of a project. e.g. training of service people, which should be supported by a Gantt chart, considering expertise, competencies, knowledge sources, etc.

As described in the next figure, the requirements gathered on the marketplace should be provided to the Ecosystem. One or more solutions are processed by an Orchestrator and implemented through a

Virtual Enterprise, which may combine both tangible and intangible assets available on the Ecosystem.

Figure 29: Virtual enterprise and ecosystem



A definition of ***Virtual Enterprise*** given by Bullinger describes a Virtual Organisation as temporary horizontal and/or vertical cross-site cooperation between different companies, which organises the flow of activities based on efficiency aspects and not on organisational affiliation and also presenting itself to the customer as one unit. Camarinha-Matos and Afsarmanesh [CA04] skip the idea of one face to the customer in their definition, which describes a Virtual Organisation as s set of (legally) independent organizations that share resources and skills to achieve a mission/goal.

In other terms, as defined within MSEE, a virtual enterprise is determined to create synergies among different enterprises (or parts of them), in order to deliver the service and to meet a specific objective (e.g. marketing requirement, solution defined by a SME, etc) within a specified timeframe. The Virtual Enterprise actually performs the business.

As far as the Manufacturing Service Ecosystem is concerned, both tangible and intangible asset should be managed as a service; in other words, a traditional machining enterprise is not going to sell either machines or tools any longer, but machining hours and related to knowledge (i.e. optimized toolpaths, machining parameters, specified tools) to meet the customers' requirements.

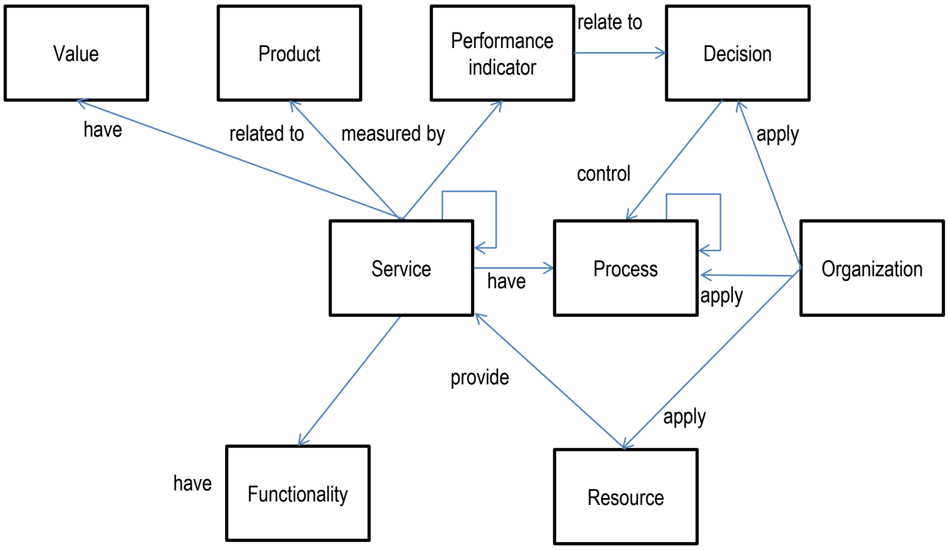
It is necessary, therefore, to define the following ***functionalities***, through a virtual representation of a tangible/intangible asset: requirements defining and validating, searching of expertise, matching of demand/offer, composing/aggregating of resources/assets, service designing/developing/executing, after sale servicing, service monitoring in terms of KPIs and SLAs, location and environmental aspects, such as laws and regulations, stakeholder interests, etc.

In addition, ***general purpose models*** and tools should be defined to manage MSE system aspects, such as tangible/intangible initial assessment (i.e. maturity level) and on-going monitoring (i.e. performance evaluation), change management, accounting and administration functions, claiming issues, logistics, documents and ICT architecture.

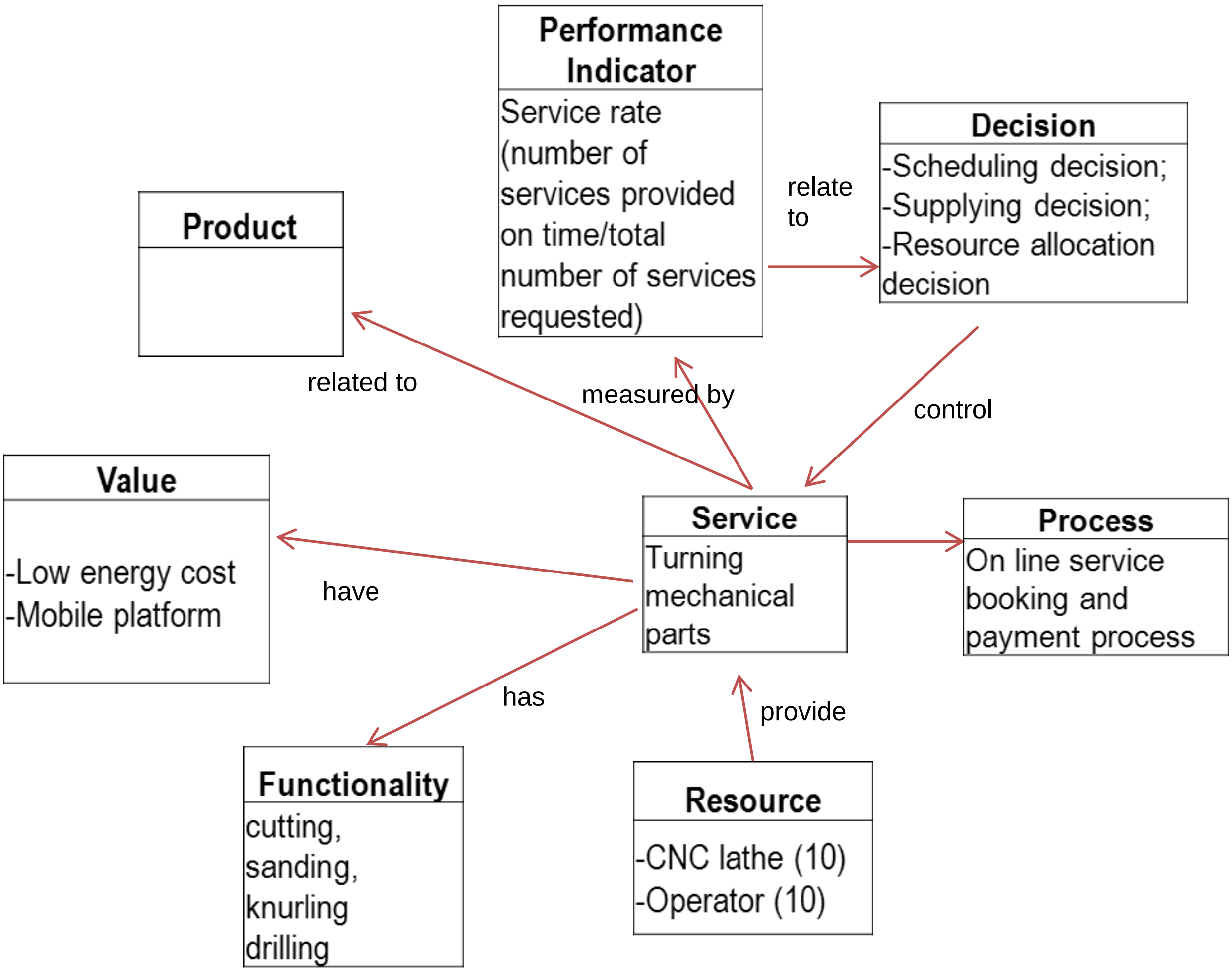
These features will be investigated in details on the second iteration of this document, due in M15.

The following figures sketches a basic set of service modeling constructs and an example of a service system in virtual enterprise, described at BSM level, where the main services are defined and relevant references are identified.

Figure 30: Virtualization of a service at BSM level



Should a traditional machining company virtualized as machining service and be represented in such a way, the following diagram could be provided:



Therefore a model of the above mentioned enterprise at BSM/TIM/TSM level, as far as resources are concerned, the virtualized machining resources as tangible assets could be described as follows:

Resource (lathe) virtualized as tangible assets at BSM/TIM/TSM level

	Header	
	Construct label	[‘Resource’]
	Identifier	R1
	Name	Lathe
	Body	
BSM	Type	Machine
	Function	cutting, sanding, knurling, drilling
	Capability	- Capable of machining square, hexagonal, or round stock - About 8 inches maximum diameter - About 42 inches maximum length
	Constraint	Can only produce round parts
	Relationships to other model elements	
	SERVICE	Marching parts (turning operations)
TIM	Automation level	Full automated
	Technical characteristics	- Bar capacity : 42 mm - Spindle speed : 300 - 5000 tr/min - Strokes : X=85 ; Z=200 mm - Chuck diameter : 125 mm - Nb of turrets : 2 - Nb stations/ turret : 6 stations (2 turrets 6 stations)
TSM	Technology	Electric
	Vendor or Brand	IBARMIA
	Price range	15000 – 20000 euros
	Other attributes	Equipped with : - 1 CN NUM - 1 Complete set of standard toolholders - 1 Barloader IEMCA TAL 65
	Other Relationships	
	RELATED TO MODEL LEVEL	[Refer to BOM, TIM, TSM modeling level] : TSM

7. Intangible assets as a Service in MSEE

As far as service is concerned, applied to intangible asset management, it is useful to deal with knowledge management and with some operational examples.

Intangible assets are represented by human skills and expertise, good practices, practical experience, organizational know-how and intellectually property.

Sometimes it happens that offering a service related to intangible assets is just an opportunity for an enterprise to create a new revenue stream, by better using end exploiting its free intangible capacity. Let us assume, for instance, that a design department or a consultant enterprise sells its expertise as a service to other organizations.

On the other hand enterprises may decide to move to service based business model, thus offering their experience on the market.

Three business cases are herewith briefly discussed, to begin considering the key aspects of intangible asset management as a service.

7.1. Bivolino

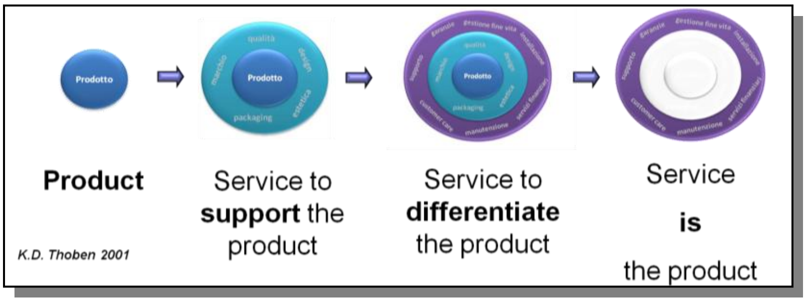
Bivolino was founded in 1954 by the brothers Louis and Jacques Byvoet, as a Belgian clothing manufacturer, specialized in customized shirts.

In 1969 a new parametric, ergonomic measurement system has been studied and introduced, allowing each shirt to be individually fitted to the body.

Bivolino moved to computerised production in 1981 and by now it was producing 900.000 shirts a year and employing 270 people. The growth of the internet opened up new possibilities for Bivolino and the brand established a new digital studio at the Limburg Science Park.

The first *on-line* shirt was sold in 1997 on Bivolino.com website. In 2000, after two years of anthropometric research, Bivolino launched its biometric sizing technology (patented) and in 2010 the latest technology was implemented, i.e. a 3D shirt design platform under the Open Garments research project.

At the moment Bivolino business model is across level 3 and 4 of K.D. Thoben approach to servitization, but its expertise could be exploited within a SMEs ecosystem, to gain further opportunities on the market.



7.2. Dallara (excerpts from website)

Following a distinguished career in the automotive industry Gian Paolo Dallara founded Dallara Automobili in 1972. Today the company has an enviable record of success around the world, designing and manufacturing cars for a range of different major motor racing formulae

From concept through to realisation, every component of every car built at Dallara has been designed and developed to the most exacting standards possible. With such a wealth of experience to draw on and a vast database of track, wind tunnel and R&D information, Dallara's engineers are continually pushing the limits of design in a quest for the ultimate in performance.

In a world of fast-paced change, this flexibility allows for the cost-effective rapid incorporation of design changes and the tailoring of the design to customer's unique requirements Dallara's reputation for engineering excellence and efficiency has resulted in a dramatic increase in the amount of consultancy work undertaken for major motor manufacturers. 'State of the art' facilities combined with a wealth of experience gained over 30 years, give Dallara the ability to produce results and solutions in a fast, cost effective way.

In order to ensure that customers can optimise the performance of our cars, Dallara have a worldwide network of agents and support teams, with technical and spare part back-up services at races and tests. Customers can draw upon a wealth of data and set up information and discuss in fine detail set up information with Dallara's engineers both at the circuit and back at the factory.

Dallara can also provide individually tailored development programmes for clients' own special requirements, which can include aerodynamic testing, 7 post rig evaluations and component manufacture.

7.3. A virtual manufacturing company (storytelling)

It is business as usual for Suzanne, who is the Chief Engineer of the R&D department; it is Monday morning and the staff meeting will be held in half an hour, as every week. The Managing Director and the Controller of the 450 employees Plant are putting a lot of pressure on the Steering Committee members, to find improvement initiatives and to reduce costs. Next week the Group President is going to pay a visit and he expects to see an overall plan to get out of the tunnel. The message is clear for top and middle management, either they are ahead of their time or they can leave the company. She has reviewed the action plan over and over again, as far as operations are concerned, but no significant improvements have emerged. R&D capability is positioned in the higher range of the market, but unfortunately the capacity is not saturated. She has become a Cost Manager, actually, instead of a R&D Manager, since she has looked at every detail to squeeze costs, but this does not seem to be effective and to deliver good results.

In the last weeks she has become much more nervous and this results in poor cooperation by her subordinates and a constant fight with her colleagues.

Even worse, she has taken home both work and concerns and her family life has been affected as well.

A breakthrough is necessary, not a smooth step by step improvement, but a radical change in strategy, which may consider the whole product life cycle management and eventually the service lifecycle management. A new perspective should be investigated and additional services might be provided to the customers by exploiting third party skills, which can lead to synergies and to additional service opportunities.

That is a different story, definitely, but how to handle this?

Should R&D department provide a different product/service, to fulfill its free capacity?

7.4. Key aspects of intangible assets management within a manufacturing ecosystem

Several additional examples could be reported to prove how intangible assets can be used as a service.

While bearing in mind that first step is to define virtual enterprises, in order to overcome the implementation of real tangible and intangible assets (e.g. location of tangible/intangible assets, time to set-up, material flow, logistics, etc), proper interfaces and interoperability management models should be determined, as described in the previous paragraphs.

Based on the above mentioned examples, the following general assumption can be made:

- Human skills and expertise, know-how and intellectually property can be maximized and can deliver additional revenues, if additional opportunities on the market are pursued.
- Service companies must be market leaders, at least within a niche, in order to meet the toughest requirements and to provide the missing expertise for the customers.
- Know how and expertise must be preserved and appropriate interfaces must be established, to guarantee that both solutions and results are delivered without depleting the organization's skills.
- Both IT resources and tangible facilities should be combined, to provide an extended solution.
- Continual improvement and technological upgrading is necessary, to ensure state of the art achievements.
- Flexibility and quick responses, combined with tailor-made solutions are a success key
- Service based organizations try and integrate product/service within their own ecosystem.
- It takes time to build up an integrated and reliable ecosystem.

Entering a manufacturing ecosystem could represent opportunities and threats for service based companies. In addition to the previously defined key assumptions, there are some features, which should be taken into account while joining an ecosystem:

- Additional expertise and service innovation could be fostered by bilateral synergies.
- New market opportunities could be granted, based on an integrated product/service.
- Tangible assets might be enhanced as well.
- Know how and expertise might be easily cloned
- Human resources retention may become more and more difficult
- Reliability and trust relationship may be at risk, in case of a partner failure within the manufacturing ecosystems

Further investigation is necessary, to verify intangible assets management models and their protocols.

8. Conclusion and future works

This deliverable represents the results achieved at first iteration step towards the final goal, which is the analysis of Intangible Assets Management in Manufacturing for service-based innovation ecosystems, in order to develop Intangible Assets in Manufacturing Service (IAMS) for retrieval, filtering and managing of information.

Intangible assets play a fundamental role in the value creation process of an enterprise upon which its competitive advantages are being built. Nowadays investment into them is growing rapidly and in some cases it even exceeds the investment in traditional capital, leading to the fact that the value of some global companies, such as Microsoft and Facebook, are now mostly accounted by their intangibles. By defining intangible assets, it has been showed that one has to tangle with many different concepts; the most relevant ones are definitely knowledge, competencies, organizational change theories, servitization and innovation.

Based on this eight project specific intangible assets are indentified. However in order to take advantage of intangible assets that could be used **as a service**, firstly the **virtualization process** of IaaS has to be designed and established. Consequently we have chosen USDL as the most prominent language to describe such service networks. With the goal to reduce multiple governance issues and increase efficiency of integration is the MSDEA model is introduced. Albeit, in order to apply USDL and virtualize intangible assets, we have related to **knowledge management** principles on multi levels in relations in order to enable the knowledge creation on higher levels, to make it available during the entire lifecycle of the service and specially to make the exact piece of knowledge available in a specific timeframe; last, tough not the least, the knowledge, that is used once, has to be retained in the organization (ecosystem). Prior applying USDL and virtualizing the process, **competences** had to be taken into account which was identified on an individual level. The challenge is however to transfer them to higher levels. Firstly **competence mapping** and **assessment** has been introduced to identify key competencies for an organization (ecosystem). However, it was still not clear how to induce those changes on an enterprise or ecosystem level, as organizations are often acting aversively to changes. Consequently there was a need to introduce the **concepts of organizational changes** that would allow inducing them in an organization (ecosystem). The analysis resulted in three models; however the most suitable one has to be chosen by WP24.

Assumptions have been made, which should be verified against relevant findings of industrial partners and on the models developed by other WPs. Till now we have identified and made available **tools** that will contribute greatly to an efficient virtualization, like MSDEA, USDL etc. The **key concepts** that affect the process have also been identified, such as knowledge management, multi level human resources management and organizational change theories. In order to complete the virtualization process an identification of relevant **types and sources of knowledge** to an enterprise should be performed, as also data extraction and aggregation **methods** should be chosen. Simultaneously information management **rules** should be defined, so the virtualization process would induce expected results.

Next steps that are to be taken is to challenge our assumptions and discoveries angainst real world use cases.

Also a deeper analysis of interactions and cross references with other WPs, such as WP2.3 (i.e. tangible asset management) and SP1 should be further analyzed.

Expected results in future steps are the definition models and tools to properly exploit intangible assets within an ecosystem, by creating/adding new value in combination with tangible asset management.

Other objectives of the WP are the following:

- Defining methods to virtualize IAs such as competencies and knowledge.
- Defining methodology for managing IAs in a manufacturing service ecosystem, in terms of knowledge management and competencies management.
- Privacy and security management at different levels of information architecture, i.e. enterprise, ecosystem or internet level.
- Input to WP2.5 as far as USDL formalism is concerned.
- Defining requirements for IAs representation and virtualization software environment.
- IAs life cycle management in the ecosystem at different levels, i.e. tactical, operational strategic (including data mining from enterprise textual documents).
- Input to WP 2.6 as far as alignment tools for enterprise, ecosystem and internet levels are concerned.

References

1. Fulcher A.J., Hills P. (1996). "Towards a Strategic Framework for Design Research", *Journal of Engineering Design*, Vol. 7, No. 2, pp. 183-193.
2. Cantner, U.; Schmidt, T. (2009). The effects of knowledge management on innovative success – an empirical analysis of German firms. Economic Studies.
3. Nonaka, I., Toyama, R. & Konno N. (2000). Unified Model of Dynamic Knowledge Creation, *Long Range Planning* . SECI, Ba and Leadership: A, Vol 33, p. 5-34.
4. Garetti, M. (2004). "PLM: a new business model to foster product innovation". *Proceedings of the International IMS Forum 2004: Global Challenges in Manufacturing*, Italy, p. 917-924.
5. Romer, P. (1993). "Idea gaps and object gaps in economic development," Journal of Monetary Economics, Elsevier, vol. 32(3), pages 543-573.
6. O'Reilly (2005). What Is Web 2.0. O Reilly online publishing.
7. Glance, N. S. Hurst, M., & Tomokiyo, T. (2004). BlogPulse: automated trend discovery for weblogs. In *Proceedings of the WWW '04 workshop on the weblogging ecosystem: aggregation, analysis and dynamics*
8. Hotho, A.; Jäschke, R.; Schmitz, C.; Stumme, G. (2006). Information retrieval in folksonomies. p. 411–426. Springer.
9. Wang, H., Kesinger, J.W., Zhou, Q., Wren, J.D., Martin, G., Turner, S., Tang, Y., Frank, M.B., and Centola, M. (2008). Identification and characterization of zebrafish ocular formation genes. Genome 51(3): p. 222-235.
10. Kumar, R; Raghavan, P.; Rajagopalan, S.; and Tomkins, A. *Extracting large scale knowledge bases from the Web*, Proc. VLDB, Jul 1999.
11. Adar and Adamic, How to search a social network. 2005
12. Gruhl, D.; Guha, R.; Liben-Nowell, D.; and Tomkins, A. 2004. Information diffusion through blogspace. In *WWW'04*.
13. Alani, H.; Kim, s.; Millard, d.; Weal, M.; Hall, W.; Lewis, P. and Shadbot, N. (2033). Automatic ontology based knowledge extraction from web documents. *IEEE Intelligent Systems*, 18(1): p.14–21.
14. Bass, F. (1969). "A new product growth model for consumer durables". p. 215–227. *Management Science* 15 (5).
15. Leskovec, J., Adamic, L. A., and Huberman, B. A. (2007). The dynamics of viral marketing. ACM Transactions on the Web, 1, 1 (May 2007).
16. Efraimidis, P.; Drosatos, G.; Nalbadis, F.; Tasidou, A. (2009) "Towards privacy in personal data management", Information Management & Computer Security, Vol. 17 Iss: 4, pp.311 - 329
17. Yao, A. (1982). On Constructing Minimum Spanning Trees in k-dimensional Spaces and Related Problems", SIAM J. on Computing, 11, 721-736.
18. Yokoo, M. & Suzuki, K. (2002), Secure multi-agent dynamic programming based on homomorphic encryption and its application to combinatorial auctions. In 'proceedings of the First International Conference on Autonomous Agents and Multiagent Systems (AAMAS-2002)', ACM, New York, NY, USA,
19. Goldwasser, S.; Micali, S.; Rackoff, C. (1989). The knowledge complexity of interactive proof systems. SIAM Journal on Computing.
20. Cha, S.-C. and Joung, Y.-J. (2003). From p3p to data licenses. In *Privacy Enhancing Technologies*, pages 205-222.
21. Tasidou, A., Efraimidis, P., and Katos, V. (2009). Technical Report LPDP-2009-01, Democritus University of Thrace, Greece.
22. OECD (8 Dec 2010). A new OECD project, new source of growth.
23. Juergen H. Daum (2005). Intangible Assets-based enterprise Management-A Practical approach.
24. Marr, B. & Adams,C. (2004) the balanced scorecard and intangible assets: similar ideas, unaligned concepts.
25. Adams, M. (July 2004). Risk/factor.
26. Martin, C. (2006). SME intangible assets.
27. Service innovation through dynamic knowledge management, 2009

28. Green, P. (1999). Building Robust Competency. John Wiley and Sons.
29. Wunram, M.; Weber, F.; Pawar, K.; Gupta, A. (2002). Proposition of a Human-centred Solution Framework for KM in the Concurrent Enterprise
30. Wunram, M.; Weber F.; Pawar, K.; Gupta, a, Barson, R. (2002). Barriers within the inter-organisational management of knowledge and the proposition of a human-centred solution framework. ICEIMT/IEMC.
31. McInerney, C. (2002), Journal of the American Society for Information Science and Technology, 53(12):1009–1018
32. D. Oberle, A. Barros, U. Kylau, S. Heinzld: A Unified Description Language for Human to Automated Services
33. MacKenzie, C. M., Laskey, K., McCabe, F., Brown, P. F. & Metz, R. (2006) Reference Model for Service Oriented Architecture 1.0, Official OASIS Standard
34. Akkermans, H., Baida, Z., Gordijn, J., Peña, N., Altuna, A. & Laresgoiti, I. (2004) Value Webs: Using Ontologies to Bundle Real-World Services. IEEE Intelligent Systems (EXPERT)
35. de Kinderen, S. & Gordijn, J. (2008) e3Service - An ontological approach for deriving multisupplier IT-service bundles from consumer needs.
36. Barros, A. & Oberle, D. (2012) Handbook of Service Description: USDL and its Methods.
37. Gruber
38. , T. (1993). A translation approach to portable ontologies. Knowledge Acquisition.
39. Benarie, M. (1988). Delphi and Delphi like approaches with special regard to environmental standard setting.
40. Romer, P., (1993). Idea Gaps and Object Gaps in Economic Development," *Journal of Monetary Economics*.,32(3), 543.
41. Probst, G. J. B., Raub, S. and Romhardt, K. (1999) Managing Knowledge: Building Blocks for Success. John Wiley & Sons. England.
42. Stewart, T.A. (2001), The Wealth of Knowledge: Intellectual Capital and the Twenty-first Century, Doubleday, New York, NY, pp. 75, 112, 115.
43. Herzfeldt, A.; Briggs, R.; Read, A.; Krcmar, H. (2011).Towards a Taxonomy of Requirements for Hybrid Products. International Conference on System Sciences.
44. Stark, J., (2004), *Product Lifecycle Management: Paradigm for 21st century Product Realisation*, Springer, ISBN: 1852338105
45. Cantner, U.; Joel, K.; Schmidt, T. ().The effects of knowledge management on innovative success - an empirical analysis of German firms. JEL Codes: O32, L23, L25, M11
46. 12Manage. (2007). *7-S framework (mckinsey)*. Retrieved 2012, from 12Manage Web site: http://www.12manage.com/methods_7S.html
47. Itami, H. & Roehl, T. (1991). Mobilizing Invisible Assets. USA
48. Department of trade and industry (2001). Science and innovation strategy 2001. UK.
49. Senge, P, Carstedt, G.; porter, P. . (2002). Innovating to the next industrial revolution. MIT Sloan Management Review.
50. Fontanari, M. (1995). Voraussetzung für den Kooperationserfolg – Eine empirische Analyse. In: Schertler, W. (Hrsg.). Management von Unternehmenskooperationen. Wien. Ueberreuter.S. 115-187.
51. S. Xu and W. Zhang. Knowledge as a Service and Knowledge Breaching. In the Proceedings of IEEE International Conference on Service Computing (IEEE SCC'05), IEEE Press, pp 87-94.
52. Internet of Service (2012).USDL. http://www.internet-of-services.com
53. Hall, R. (1992). The strategic analysis of intangible resources. Strategic management journal, vol 13/2, p. 135-144.
54. Hall, R. (1989). The management of intellectual assets: a new corporate perspective. Journal of general management, 15/1, p. 53.
55. MERITUM (2002) Guidelines for managing and reporting on intangibles. Eds; Cañibano, L., Sanchez, P.; Garcia-Ayuso, M.; and Chaminade, C. Fundación Airtel Móvil.
56. Fontanari, M.: Voraussetzung für den Kooperationserfolg – Eine empirische Analyse. In: Schertler, W. (Hrsg.).
57. Management von Unternehmenskooperationen. Wien. Ueberreuter. S. 115-187, 1995.
58. Description of work (2011). Virtual factories and enterprises.

59. Shang, S.; Lin, S.; Wu, Y. (2009). Service innovation through dynamic knowledge management. Industrial data management & data systems, 109/3, p.322 – 337.
60. Thoben, K.-D., Jagdev, H., Eschenbächer, J. (2001) Extended Products: evolving traditional product concepts. 7th International Conference on Concurrent Enterprising: “Engineering the Knowledge Economy through Co-operation” Germany.
61. Thoben, K. D., Wbere, F., Wunram, M. (2002). Barriers in knowledge Management and Pragmatic Approaches. Studies in Informatics and Control, 11, p. 7-15.

Glossary

Nbr.	Abbreviation	Meaning
1	USDL	Unified Service Description Language
2	IaaS	Intangible assets as a Service
3	BSM	Business service model
4	TSM	Technology independent model
5	TIM	Technology specific model
	FoF	Factories of the future
7	KM	knowledge management