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Internet – a new global knowledge space?

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Abstract

Learning is about knowledge. Research is about knowledge. Internet augments the traditional static knowledge modelling systems with its virtual, distributed nature, bringing in a completely new setting of knowledge creation. What are the new implications for knowledge creation and sharing that are emerging with the rise of Internet?

As more and more collaboration, e-learning and social networking systems emerge on Internet, it is important to have an explanation of underlying phenomena and domains in order to develop (a vision of) better functioning of knowledge-related systems. This thesis gives arguments for the view of Internet as a knowledge space, where knowledge is created, shared and transferred. Pierre Lévy presents a theoretical foundation which explains Internet as knowledge space. His ideas are discussed and compared with theory of knowledge creation by Nonaka and associates. Cognitive foundations of tacit and explicit knowledge are explored, and the importance of tacit knowledge is emphasized. Speech and writing are presented as traditional "knowledge modelling" systems as opposed to dynamic, virtual Internet, and their cognitive and societal implications are discussed. SECI model of knowledge creation is applied to knowledge space Internet. A model of Internet combined with SECI based knowledge creation is proposed. Furthermore, explanation of e-learning and knowledge creation at the university based on SECI model is proposed.

The conclusion that arises is that Internet-based systems which incorporate or enable sharing of mental models and tacit knowledge on some level, are likely to offer better support for creation and sharing of knowledge. Social networking sites' popularity is due to their functioning as a first stage of SECI model of knowledge creation within the knowledge space of Internet. This first *Socialization* stage of SECI model is mostly missing in e-learning or online-collaboration systems, which mainly promote the transfer of explicit knowledge.

Keywords: tacit knowledge, mental models, knowledge management, knowledge space, e-learning, social networking sites, SECI model, Internet

Kurzfassung

Lernen hängt mit Wissen zusammen. Forschung hängt mit Wissen zusammen. Internet erweitert die traditionellen, statischen Wissensmodellierungssysteme um die Dimension der Virtualität und Distribution, und führt somit ganz neue Bedingungen für Wissenskreation ein. Was sind die Implikationen, die sich für Wissenskreation und Wissenstransfer durch die Nutzung des Internet ergeben? Während immer mehr und mehr Kooperations-, e-learning- und Social-networking Systeme im Internet entstehen, wird es wichtig eine Erklärung von zugrundeliegenden Phänomenen zu haben, um ein besseres Verständnis von wissenserzeugenden Systemen zu haben. Diese Arbeit stellt Internet als „knowledge space“ dar, in dem Wissen erzeugt, verteilt und transferiert wird. Pierre Lévy hat die theoretischen Grundlagen erstellt, welche das Internet als “knowledge space” erklären. Seine Ideen werden diskutiert und mit der Theorie der Wissenserzeugung von Nonaka und Takeuchi verglichen. Die kognitiven Grundlagen von implizitem und explizitem Wissen werden erklärt, und die Bedeutung von implizitem Wissen wird hervorgehoben. Sprache und Schrift werden als klassische „Wissensmodellierungssysteme“ dargestellt, und ihr Unterschied zum dynamischen und virtuellen Internet herausgearbeitet; die kognitiven und gesellschaftlichen Implikationen dieser Systeme werden analysiert. Das SECI-Modell der Wissenskreation wird auf das „knowledge space“ Internet angewendet.

Es stellt sich heraus, dass internetbasierte Systeme (z.B. e-learning Platformen), welche die Bindung gemeinsamer mentaler Modellen und implizitem Wissen ermöglichen, d.h., die erste Phase aus dem SECI-Modell implementieren, eine bessere Unterstützung für Wissenskreation im Internet ermöglichen.

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1 Introduction

1.1 Motivation

"*The development of information technologies, and in particular the Internet, has created a completely new environment in which the role of traditional information services must be thoroughly revised. The potential of networking, cooperation and digitization modify substantially the functions of acquiring, storing and disseminating information and knowledge.*"[1]

At the beginning of this work there stand ideas that I gained through my occupation as software architect in different areas like Printing & Publishing Industry, R&D department in high-tech company, and not the last but not least, university. In all those areas I had a lot to do with modeling and shaping of knowledge and tools for knowledge, i.e. defining the structures for representation of knowledge and for processing of information from the real world. This experience connected with my interest and studies of more sociologic matters like history, development of human culture, politics and sociology, because I noticed that history of human kind is always history of knowledge, as much as it also is the history of art and history of religion are. Arts, technology, different religious and philosophical systems evolve throughout the history hand in hand with evolution of human knowledge.

Knowledge has a crucial importance in all areas of human functioning, because it always builds the foundation upon which man acts in the world.

We might have the dilemma of right and wrong knowledge, which is more a concern of epistemology, but apart from that philosophical question, knowledge is always the basis for any progress and development. In the cultural, economical and technological context the most important aspects are adaptation, creation, diffusion and preservation of knowledge.

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[1] UNESCO, http://portal.unesco.org/ci/en/ev.php-URL_ID=18765&URL_DO=DO_TOPIC&URL_SECTION=201.html, [1.5.2008]

Today, we are living in a time when new forms of knowledge organization emerge through the deployment of Information and Communication Technologies, most of all - Internet.

As a new form of organizing knowledge, it appears to be a formation of (informational and social) structures for creating, spreading, sharing and storing the knowledge – i.e. new knowledge structure. This is an idea I developed through comparing today's systems of knowledge and their creation & transfer with the traditional ones, which accentuated the possibility that Internet could be a whole new knowledge structure with new attributes and dimensions of knowledge creation.

1.2 Goals

The aim of this thesis is to examine a view of Internet as a new knowledge space. For that purpose, I will discuss and compare two different theories, one coming from humanities, and the other one from economics.

The first theory I will base my considerations on is Pierre Lévy's work on *anthropological spaces* and his humanistic approach to technology. The second one is the *theory of organizational knowledge creation* by Nonaka and Takeuchi which comes from economic sciences, particularly Knowledge Management. These two approaches will be applied on the phenomenon of Internet-based knowledge creation. I will also show what Lévy's concept of *knowledge space* has in common with the *theory of organizational knowledge creation* by Nonaka and Takeuchi on the example of Internet.

These two theories are also approached cognitively, because I argue that every information-processing revolution must take place on two levels – on cognitive and social ones.

I refer to "new knowledge space" in terms of a new phenomenon for distribution and creation of knowledge. Such a concept is insofar related to concepts as Semantic Web[2] or Ontologies[3], as these approaches form a functional parts of knowledge space, like for instance also does the wide area of e-learning. In this thesis these approaches are encompassed within the new space of knowledge, in which they form constituent parts, together with other Internet-related applications areas. So, it is apparent that I do not deal with Semantic Web, Ontologies or e-learning, but I merely view those phenomena as specific elements of Internet-based knowledge space. I am interested more in social and cognitive

[2] „ The Semantic Web is not a separate Web but an extension of the current one, in which information is given well-defined meaning, better enabling computers and people to work in cooperation", Berners-Lee et al., (2001)

[3] „In the context of computer and information sciences, an ontology defines a set of representational primitives with which to model a domain of knowledge or discourse. " Gruber, http://tomgruber.org/writing/ontology-definition-2007.htm, [10.12.2008]

aspects that are introduced through emergence of so called “knowledge-societies” and Internet.

This thesis should also be a contribution to a more human-based or human-centric approach to Internet and to new information technologies and knowledge-societies, which is an emphasis that is often absent from theories about knowledge societies.

The main questions that will be treated are:

- Is there a new form of knowledge organization that becomes available through Internet and that substantially differs from the previous forms of knowledge organization in society?
- Can Internet be viewed as a specific form of structuring the knowledge creation and how can we describe it, and if we can, what are the main new characteristics?
- What are cognitive and social impacts of Internet-based knowledge production and distribution, and in which areas are they most visible?

1.3 Structure and composition of thesis

The 2nd chapter “Fundamentals” defines the basic terms relevant for this thesis.

In the 3rd chapter I discuss historical information processing revolutions in terms of social and cognitive aspects, and analyze the influence of these revolutions on evolution of human knowledge. This chapter also forms a cognitive basis for understanding of both Lévy’s and Nonaka&Takeuchi’s theory, and presents a cognitive based arguments for these theories, since cognitive elements are implicitly included in Lévy’s theory, and are fundamental to Nonaka & Takeuchi’s theory.

In the 4th chapter I go over to discuss Lévy’s theory, followed by the 5th chapter where I examine Nonaka&Takeuchi’s theory.

For the conclusion in the 6th chapter, these two theories are compared and applied to the phenomenon Internet in order to present new aspects of Internet as a ”new space of knowledge”.

2 Fundamentals

2.1 Background

In this chapter I give basic definitions of relevant terms that are dealt with in this work, and present the background of this thesis.

'The impulse for the idea of new "*knowledge structure*" came from Manuel Castells' trilogy *The Information age* (1996[4], 1997, 1998), and his ideas about the network society.

Castells describes the new mode of development that he calls *informationalism*. He notices that in *informationalism*, which is opposed to previous agrarian and industrial modes of development, the main sources of productivity are *"knowledge generation, information processing and symbol communication*" (2000a, p. 17). He writes about the new created space of flows emerging in *informationalism* – flows of capital, information and symbols.

His analysis sparked in me the idea of the flows of knowledge, idea about new space of knowledge, created by Internet. This is an idea Castells brings up and which he treats only partially as flows of information, and as usage of *"knowledge upon knowledge*" (2000a, p. 17). But he does not deal explicitly with the creation and distribution of knowledge in relation to Internet as a "knowledge space", also because he tries to get away from the common concept of "*knowledge society*". Thus Castells puts more emphasis on the "*network society*" with its network structure and logic being the predominant form and mode of functioning of "*informational society*" and "*informational economy*" (2000a, p. 77) .

The question that arose from Castells' theory of network/informational society and his concept of "*space of flows*" was whether Internet could be something like a new space of knowledge, which is fundamentally different from other traditional knowledge organizations, with its new characteristics? Undoubtedly, Internet with its services provides new infrastructure for transfer and distribution of knowledge, both as communication medium as well as an

[4] 2nd edition was published in 2000

infrastructure for transmitting information, as is the case in, for instance, e-learning platforms and blogs. I suggest that it is more than medium that serves only for information transmission.

Through my research I moved away from Castells' theory and came across Pierre Lévy's book *Collective Intelligence* (1997), originally published in French in 1994, in which he treated the emergence of new technologies and their impact on society, giving the vision (both realistic as well as utopian one) of the future Internet as a new *knowledge space*, at the time when Internet was still at its very beginning (World Wide Web just started to evolve through the introduction of first wide used graphical Web browser Mosaic in 1994[5]).

2.2 Definitions of basic terms

Internet

Internet is defined in the context of this thesis as synonymous with the term *cyberspace*, i.e. not just physical network of heterogeneous networks that communicate together based on TCP/IP protocol, but also a totality of applications and distributed systems built upon it, for instance: World Wide Web and applications built on the top of it like social communities, e-learning platforms, digital libraries; newsgroups, collaboration tools, services based on SOA[6], business to business systems which are mostly invisible to public, distributed Grid applications, and the like.

This definition of Internet is based on Pierre Lévy's (2001, p. 74) definition of cyberspace, so Internet as it is here understood is: "*communications space made accessible through the global interconnection of computers and computer memories*".

It is already obvious from this definition that Internet is more than a medium.

[5] „A little history of the World Wide Web", http://www.w3.org/History.html, [14.7.2008]
[6] Service Oriented Architecture

Knowledge:

as understood by Nonaka and Takeuchi (1995, p. 58), who distinguish three main aspects of knowledge, is:

> *"1: unlike information, about beliefs and commitment. It is a function of particular stance, perspective, or intention.*
>
> *2: unlike information, is about action. It is always knowledge to "some end", or goal.*
>
> *3: like information, is about meaning. It is context-specific and relational."*

Ad 1:

Knowledge about something presumes a broader context; if we have knowledge about something we have a belief that something is like we think. A belief to present knowledge must be true and justified, according to epistemology, which has its roots in Plato's definition of knowledge. However, Nonaka&Takeuchi (1995, p. 58) emphasize the **relative nature** of knowledge, because they observe "*knowledge as dynamic human process of justifying personal belief toward the "truth""*, as opposed to the fact that in traditional Western epistemology knowledge is viewed as static, independent of humans. The relative nature of knowledge is probably most visible in exact natural sciences like chemistry or physics, where scientifically gained knowledge remains true and justified only as long as the results of new observations acknowledge it, and are continuously corrected as new different results appear. So knowledge is indeed a function of particular attitude and perspective.

Ad 2:

> Knowledge is inherently connected to the world, as a result of our cognitive reactions on the world and society. It is always constrained, limited to certain subject matter. It is always knowledge *about something.*

Ad 3:

> Knowledge must have meaning and is always context-specific and relational (to other knowledge or information)

Technology:

Technology as described by Lévy (2001, p. 4) is a non-autonomous, non-separate factor of society; and it is embedded into interactions between human beings, natural and artificial material entities (technological objects) and ideas and representations. It does not exist independently of human values, conceptions, way of using, and interpretations.

3 Cognitive aspects and historical evolution of knowledge

At the beginning of this chapter, in chapter 3.1, basic elements of cognition are discussed as a foundation for understanding Nonaka & Takeuchi's theory of organizational knowledge creation.

In order to find out the new characteristics of knowledge that are brought into existence by Internet, we must know how knowledge, its diffusion-structures and its vehicles evolved throughout the history. But also to understand Pierre Lévy's theory of anthropological spaces, the evolving of knowledge through the history in terms of social and cognitive aspects is given a close look in chapter 3.2.

3.1 Cognitive aspects of knowledge

Knowledge, for instance *scientific knowledge*, is socially produced phenomenon, based on collaborations and relations within scientific community; conclusively it cannot emerge without social interactions. On the level of the individual, knowledge has to be internalized, which means, it has to be created within an individual mind. In order to understand the interaction that leads to creation of knowledge it is important to know how knowledge relates to cognitive processes and how cognitive concepts describe representation and creation of knowledge. This chapter will describe the cognitive foundations, terms and concepts that underlie knowledge representation.

Cognitive Science deals with human perceiving and knowing (this is what the word "*cognitive*" refers to). According to Stillings et al. (1987., p.1) cognitive scientists try to understand perceiving, thinking, remembering, language, learning and other mental phenomena. All these phenomena lead to creation of knowledge in human mind.

There are two main directions of research in Cognitive Sciences: the **symbolic paradigm** and the **connectionist paradigm**. The symbolic paradigm is based on representations, i.e. organizations of symbols that are manipulated or processed. The symbolic paradigm resembles more the processes in the mind, and this is the paradigm that I will give an account of, because it suitably describes the way humans operate with and manage knowledge.

Nevertheless, I will give a brief overview of the connectionist paradigm, before elaborating representational concepts. Connectionist paradigm is non-representational and is called connectionism, sometimes also called Parallel Distributed Processing – PDP, or neural networks. Connectionism is more similar to the processing that neurons exhibit than the representationist paradigm, in that it tries to reproduce information processing of neurons connected in neural network of nervous system.

Connectionist paradigm is based on building parallel processing models that consist of simple processing elements (or units) interconnected by links. (Sun, 1999, p. 345). These processing elements resemble the neurons.

According to Elman (1999) „*each node receives input (which may be excitatory or inhibitory) from some number of other nodes, responds to that input according to a simple activation function, and in turn excites or inhibits other nodes to which it is connected*". The knowledge of the system is represented by the pattern of connections, as Elman (1999, p.346) states, "…*rather than using symbolic representations, working version of the vocabulary of connectionist systems consist of patterns of activation across different units*". It must be noted however, that human brain's activity is much more complex than it can be simulated by connectionist paradigm, and that artificial neural networks present high order abstractions of brain's neural activity.

3.1.1 Declarative and procedural knowledge

There are many different classifications of knowledge. Cognitive Science defines two basic types of knowledge referring to Computer Science – declarative and procedural type of knowledge. The concept of declarative and procedural knowledge is defined as follows:

- **declarative knowledge –** collections of information, “knowing what”
- **procedural knowledge –** collections of procedures, skills, “knowing how”

Concept of declarative and procedural knowledge aroused in computer sciences from the problem of representation and was borrowed by Cognitive Sciences when adopting “computer metaphor” to human mind. In computer sciences there is a set of data that are variables, which can have certain values; and a set of procedures that operate on them - algorithms. If we look at the human mind as an information-processing system, then the set of data corresponds to declarative knowledge – i.e. information, while the algorithms resemble procedures that operate on that data.

In philosophy, knowing a certain procedure of doing or handling is called “***knowing how***”, whereas “***knowing what”*** is associated with data or facts. Since we can remember things either as terms or in images, declarative knowledge can be further divided into two types that we already know as representations: propositions and images (Stillings et al., 1987, p. 20).

It must be noted however, that sometimes it is not easy to distinguish between what is actually part of declarative knowledge and what is part of procedural knowledge concerning the human reasoning, because there are some fuzzy situations that do not permit strict division into procedures of doing and independent facts. *Scripts* can be viewed as both declarative as well as procedural.

3.1.2 Cognition: a definition

Human mind is a *"... complex system that receives, stores, retrieves, transforms, and transmits information*" (Stilling et al., 1987, p.1). In this definition Stillings et al. point out the basic cognitive activities that are responsible for information manipulation and knowledge creation. Thus cognition relates to our mental processing, from perception and recognition up to reasoning and inference.

Cognition is defined by Ashcraft (1997, p. 8) as:

> *"The collection of mental processes and activities used in perceiving, learning, remembering,thinking, and understanding, and the act of using these processes."*

Mental processes operate on information, which is structured and stored in *memory*.

Memory is defined by Ashcraft (1997, p. 11) as:

> *"… mental system where information is stored, and the encoding, retention, and retrieval processes that operate on information."*

Memory, where information and knowledge structures are found, is of central concern in cognitive science. There are basically two kinds of information storing memory: short-term memory and long-term memory. There is also a sensory memory, which serves as interface between the sensory input system and the other two memory systems.

Knowledge in the long-term memory is interconnected (Ashcraft, 1997, p. 12), which means that every part of information is connected to many other parts, through associative links. This structure enables us make associations and draw inferences. For instance we associate with the concept of *dog* many other concepts – *legs* (dogs have legs), *barking* (dogs bark), and the other way round, *bark* → *dogs* (dogs bark).

In Stillings' definition of human mind another central paradigm for cognitive science becomes visible – that of human mind represented as an information processing system. This paradigm is a direct result of the "**computer analogy",** which emerged in the 1950ies with the beginning of the information revolution, and presents the model of human mind where unseen mental processes manipulate and transform information.

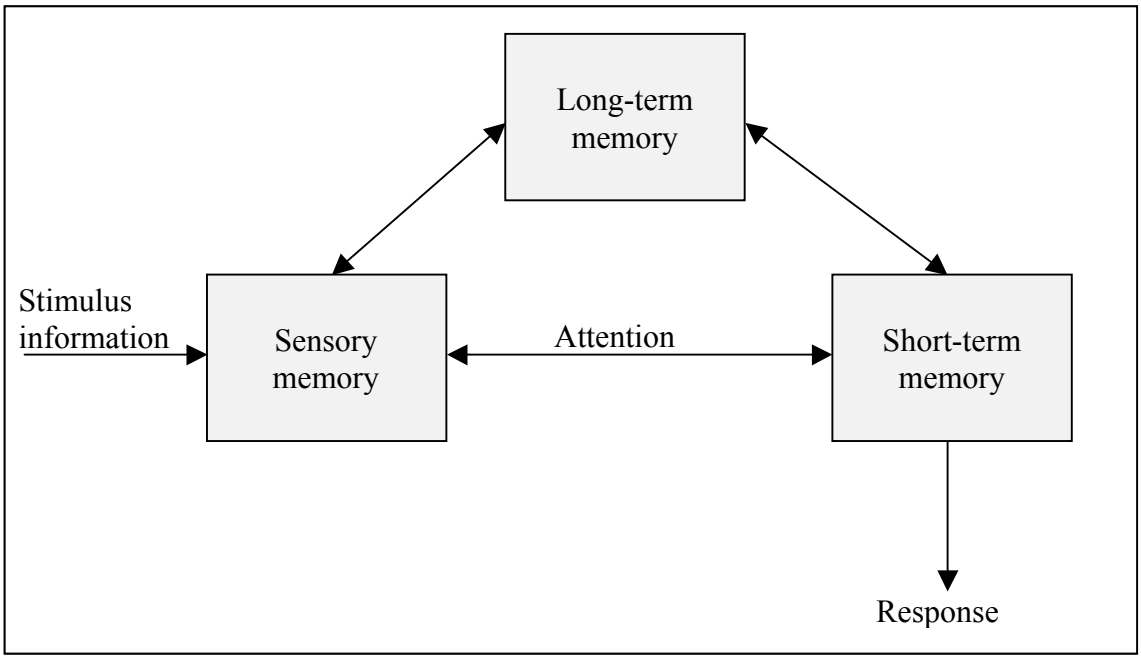


Figure 1. Human information-processing system, according to Ashcraft (1998, p. 25)

Information about the stimulus from the outside world is transferred to a short-term memory through a process of *attention,* which produces some kind of response, be it internally or externally visible. Decision to ignore the information about the stimulus is also response. Long-term memory is the storage where facts, knowledge and experiences are stored. When we remember some fact, we actually retrieve the information from the long-term memory.

I have already mentioned the symbolic feature and the unique significance of *human information processing/knowledge producing means* – alphabet and language. The basic entities that can be perceived as single units, used in spoken language are phonetic sounds. Phonetic sounds are the minimal differences that

are needed to distinguish between words, which stand for some meaning (compare Stillings et al., 1987, p. 226-227). Written letters are the symbols that stand for *phonemes*. Furthermore, written words formed by letters, are also symbols for something else – for a concept or an idea. This symbolic significance is approached in cognitive sciences through the concept of ***representation.*** More on the evolution of symbolic representation in language and writing will be said in chapters 3.2.1 - 3.2.2.

The concept of representation of (knowledge of) the world refers to mapping from the representational entity to the entity it stands for. Stillings et al. (1987, p. 3) name two distinctive properties that representations and mapped entities must have in order to **maintain the same structure**:

1) **Mapping** must be well-defined (e.g. mapping from strings to decimal numbers is defined by decimal place-value function)

2) **Formal processes** that operate on the representations must also operate in the same way as the operation in the real world, so that the structure of the processing is also preserved.

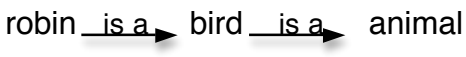
From above definitions follows that representations have a structure, which is defined by relationships of their properties. Representations are what is called *declarative knowledge* (propositions and images) – the factual knowledge, and the formal processes that operate on it are called *procedural knowledge* – the "knowing how".

3.1.3 Propositions, schemas, mental models

Propositions

Propositions are the simplest units of thought (Stillings et al., 1987, p. 23), which can be true or false. Propositions capture relations between symbolic entities. For instance, "*apple is green*" is a proposition that describes a relation between the concept "*apple*" and concept of "*green.*" "*Apple*" alone is not a proposition.

Knowledge can be represented by means of propositional networks. Propositional networks are also called semantic networks if they are about general knowledge or concepts. Knowledge and information within a semantic network are connected by associative (weighted) links, which lead from one concept to another. This theory is reflected in the way we think and reason (Stillings et al., 1987, pp. 26-27), and also in the way we acquire knowledge. For instance:



Schemas

According to Stillings et al. (1987, p. 30) schemas present abstractions of things, specifying the general properties of a type of object.

In order to be able to make an assertion like "*robin is a bird*", we must know what a bird is, and what robin is. In other words we must have a concept of both a bird and robin. General information about "bird" can be stored in form of propositions that are linked together in order to relate to general concept of bird (for instance, bird is an animal, it has feathers, it mostly can fly). Such collection of general information creates a conceptual *schema*. Schema of a concept specifies its **typical** characteristics (Johnson-Laird, 1983, p. 190).

Scripts

Schemas can also relate to social **knowledge** of situations and activities connected to that situations that people have when going to restaurant, theatre or catching a flight at airport. All those situations require certain procedure, which is to a great extent the same for all airports, all restaurants or all theatres, respectively. For instance, typical activities at airport involve: *identifying leaving or arriving platform, identifying the airline office, getting a ticket, checking in, going to customs, going through the police control, waiting for entering the airplane.* These

procedures, that is, schemas with specified activity are called *scripts* (Stillings et al., 1987, p. 31).

Mental images

Beside the knowledge of concepts and typical, situationally determined activities, there is a qualitatively different type of mental representations – *mental images*. Mental images or visual imagery are used in certain situations when the knowledge of visual appearance may give us the result we are searching for. For instance, when you are asked how your child's room looked, you may visualize a mental image – which can be more or less detailed, in order to describe it.

The common characteristic of schemas, scripts and mental images is that they all are imperfect, unfinished, approximated representations of the world. They abstract from certain details, and are also prone to errors. In that case they may be corrected. Schemas and scripts describe the typical concept - a concept that must be augmented with details perceived from the real world when used. Mental images are also hardly 100% complete and exact reproductions of outer, visually perceived sensations, but simplified approximations. As such, they play an important role in our reasoning and thinking, and can be associated with concepts and language-like memories like associations. Thagard (1996, p. 105) argues that visual imagery can be very useful in making plans on spatial or visual plane, since visual imagery supports functions like scanning, zooming, rotating, transforming and inspecting, or finding a certain object on a visualized mental image.

Mental models

Johnson-Laird goes further from propositions and schemas by introducing more complex concepts that he calls ***mental models***. He argues (1983, p. 3) that understanding a certain phenomenon (that means having a knowledge of it) includes having a mental representation of the particular phenomenon. This representation is a mental model of the observed object or process - for instance a

visually imagined model of atom, or an internal imagination of molecular interactions.

Johnson-Laird brings up an example for mental model pointing that a clock actually serves as a model for earth rotation. He argues that those models do not have to be accurate in order to be useful, but mental models must resemble in "relation-structure" the entities they model (Johnson-Laird, 1983, p. 3). In his words,

> *"… to understand a phenomenon, is to have a working model of it, albeit a model may contain simulated components"*

Propositional representations can be used as building blocks for constructing mental models, in order to create meaning and significance during spoken (or written) communication, whereby it must be noted that Johnson-Laird distinguishes between meaning of a sentence (which is semantic) and the significance of the utterance (more pragmatic aspect). He (1983, pp. 244-245) argues that significance of an utterance can be reached by embedding propositions into mental models, by which we reach the right context:

> *"The essential context of an utterance can be represented in a mental model, and the significance of the utterance is established by relating its propositional representation to this model and to general knowledge." (Johnson-Laird, 1983, p. 3)*

Mental models can also give an account of interpreting language, particularly discourses, for instance, discourses of imaginary worlds or abstract ideas. Johnson-Laird (1983, p. 407) distinguishes three levels of comprehension of a discourse:

1. **Level of phonemic or graphemic representation** (letters/words)
2. **Propositional representation** (sentences)

3. **Mental model**, which is constructed from the propositions (a collection of sentences, augmented with contextual and significant relations which specify the discourse to a particular situation)

In practice, mental models that different persons have about certain phenomenon that is object of their cognition can differ. A person who developed software has a different mental model about functioning of word-processing software than a person who only uses the software. A person who developed particular word-processing software has even more detailed knowledge about the functioning of this particular software than somebody who has general knowledge about word-processing software. Thus we can see that mental models that people build about the world differ from person to person.

3.2 Historical evolution of knowledge

Knowledge is inevitably and intrinsically bound to the world that surrounds us and to society we live in. As Pierre Lévy (1997, p. 12) puts it, "*it is inseparable from the construction and habitation of a world, and incorporates the full span of our life*". As society changes, knowledge and forms of knowledge evolve.

As the following chapters will show, human knowledge developed along the history together with the development of vehicles of knowledge, which were influencing knowledge – its diffusion, its quality, and its production systems in relation to scientific knowledge.

The main vehicles for human knowledge are **language** and its two expression forms – **speech and writing systems**. According to Lévy (1999, p. 6), language, together with technology and complex social systems, is what characterizes the species *Homo sapiens*.

3.2.1 Language

Although not all knowledge can be transmitted through language, as we will see later (and as is stated by Polanyi, Nonaka & Takeuchi), language is a precondition for the development of human knowledge. For instance, language enables development of highly methodical and systematic knowledge systems like science. It also makes possible systems of more speculative nature like religion, or more practical systems like natural medicine. Language does it so by enabling systematic processing and transfer of knowledge. Polanyi, on whom I will elaborate more in the following chapters, states this fact clearly (1962, p. 95):

> *"Nearly all knowledge by which man surpasses the animals is acquired by language."*

Language serves as a means for shared code within society, which establishes the context, to exchange ideas, memories and mental pictures in the society (Compare Deacon, 1997, p. 451). Berger and Luckmann (1966, p. 51), whose theory I will deal with later in this work, also emphasize the importance of language by stating that "*language is the most important sign system of human society*".

In his book about uniqueness of language, Terrence Deacon (1997, p. 50) argues concerning development and evolution of language, that "*language is an unprecedented form of naturally evolved communication*".

Deacon defines language as a mode of communication with main characteristics of having *symbolic reference* and having a *system of rules for representing complex relationships between the symbols* (1997, p. 44). In that context, he further speaks about the language as a system for "*information transmission*" (Deacon, 1997, p. 45). According to him, "*our ancestors found a way to create and reproduce a simple system of symbols*" which led to a **"*novel mode of information transmission***" (Deacon, 1997, p. 45).

Language, as a new mode that serves for information transmission, was partially decoupled from the other systematic mode of information transmission and encoding that we are equipped with, but on which we have no conscious influence – the genetic encoding through DNA - so that each new generation has to succeed in reconstructing the whole symbolic system from the beginning (this is the process that every child has to undergo when learning to speak). This fact implies that language is a social phenomenon, as was later also shown by Vygotskij (1978). In society, language serves as a means for sharing context, symbols, and significance (compare "*sharing of social-symbolic experiences and symbolic represantations*", Deacon, 1997, p. 451).

It is clear that language serves for information transmission, but why does language enable systematic processing of information? It is because language itself is systematic. Beside vocabulary, language conforms to a number of rules, it

has grammar. Natural languages are also highly redundant - the meaning of a phrase or a word does not disappear if we let out a single letter or even a few letters. For instance – in the phrase “I was sitting on a *c_air*”, it is clear that the last word is “chair”. The word “chair” itself presents a symbol for an idea, a concept of chair.

Using symbols in communication, i.e. symbolic communication, is a special form of communication used only by human species through the means of language. According to Deacon (1997, p. 22) symbolic representation is the main characteristic of language, and is as such found only in human languages.

Common meaning, or significance, which is shared by society through language, leads to specific shared “*spaces of significance”.* Lévy extends the concept of common spaces of significance that are shared by language, to the “*worlds of signification*”. He (1999, p. 144) conceives “*worlds of signification*” as produced by humanity, its values and its ideas; and being characterized by humanity’s typical modes of production, economy, and the modes of existence.

The advent of language was certainly a revolution for the humanity, probably the biggest one, as Deacon advocates, but usually we imply the use of language in our human communication, reasoning and thinking.

Another cognitive revolution was invention of writing. Stevan Harnad (1991, p. 1) a cognitive scientist, views language, writing and the printing press as “*three main revolutions in the means and production of knowledge*”.

But before humanity invented the external, pictorial representation called writing, the long time period before was the time of *oral tradition*. Oral tradition was predominant way of passing knowledge, expressing knowledge in myths and rites, which were main modes of knowledge of these societies, thus defining the first illiterate anthropological space. (Lévy, 1999, p. 6).

The period that followed after the epoch of oral tradition was the age of written tradition. This period corresponds to the “*second space of signification*”, which emerges with the advent of writing in Neolithic. According to Lévy (1999, p.

6) in this period, the "*dominant modes of knowledge are based on writing: history and the development of systematic theoretical, hermeneutic knowledge*".

Lévy makes a distinction between four anthropological spaces in relation to knowledge and its evolving through time/history. He describes three existing spaces, and announces in 1994 the emerging fourth anthropological space, which he names the *knowledge space.* This is the space of human existence that I want to show that has developed with arising of Internet. I have already mentioned above arguments that support the concept of the Lévy's theory, and will elaborate more on Lévy's theory of anthropological spaces in the following chapters. Now I will provide a brief overview on spoken and verbal tradition independently of Lévy's interpretations.

3.2.2 Spoken and written tradition

The phenomenon of language as a structured symbolic system with virtual reference to things outside and within itself (Deacon, 1999, p. 219) presents the basic system through which knowledge about the world is represented and shared. We think in language, with words that point to some objects, concrete things in the world or abstract ideas, and share those ideas with others.

Writing is the material objectification/representation of language, i.e. the written language is a system of *graphic* signs. Through its visual nature, it reflects the underlying syntactic and semantic structure in the material world. In "*History of Writing"*, Fischer defines writing as graphic reproduction of the writer's speech (Fischer, 2001, p. 13). From that follows that writing is a form of decontextualization, separation of the ideas from the direct speech. For Lévy (1999, p. 46) writing is related to drawing (notation of an idea by an image), but in its systematic aspect, it is codifiable and reproducible, thus becoming the first technology for recording and reproducing speech, and in further consequence for recording information and knowledge.

According to generally accepted theory, the invention of writing began around 4000-3700 BC in the form of impressing signs on clay tablets in Sumer, led over papyrus roles of Egyptians, the paper of Chinese, to printed books. (Fischer, 2001, p. 31).

The source of writing in Sumer was accounting or bookkeeping. The common adopted theory (Fischer, 2001, pp. 25-26) states that little clay tokens that used to represent real objects such as sheep or other goods were packed in clay envelopes, which were marked with the information of what kind of tokens and how many of them are inside the clay envelope. This represented a shift from direct reference (specific token points to a thing/being - sheep) to the form of indirect reference – the marks on the envelope represented the tokens inside (symbol points to a symbol). As we can see, compared with Deacon's theory of language evolution[7], this symbolic kind of reference resembles to the symbolic reference that is in the core of language. At the same time, Sumerians were using so called "*count stones*" with different shapes which were positioned together with the "symbolic" tokens on outside of the clay envelope, enabling the person to know how many different tokens were inside (Fischer, 2001, p. 26). According to the "token theory", once those tokens were systematized, this was the beginning of the writing.

This invention gave the opportunity of "materializing" the knowledge, storing it in the outer world, thus making it more robust (providing a material persistence for ideas and concepts). It also made it easier to diffuse knowledge and information in the context of society, both in time and space. Information about the quantity of goods could have been stored, or sent together with the goods to other city. External structuring and diffusion of knowledge in turn give an advantage to the societies who manage to develop the ability of writing, i.e. storing the knowledge in the external artifacts and enable those same cultures to maintain their knowledge and knowing about the surrounding world, to develop it further for the good of society. (Compare Fischer: *"writing systems stimulating the economic*

[7] „*Grammatical rules and categories are symbolic rules and categories*", which operate on symbols. Deacon, 1997, p. 43-45.

activities in uniting the Sumer cities to a city-state, and "*the union of Upper and Lower Egypt"* at the time of invention of hieroglyphs", 2001, p. 36)

The invention of hieroglyphs in old Egypt enabled more rational organizing of the society, starting from simple representations of quantity, e.g. how much corn is present in corn-storages in particular year, over keeping track about the height of Nile flood and calculating the height of taxes according to it, to writing down religious matter around which the codex of society was based. The availability of knowledge in its written form also enabled further operations and planning, with the effect of emerging of more complex and more differentiated forms of society.

Lévy (1999, p. 58) states that "*the birth of writing is associated with the first bureaucratic states, which were based on top-down hierarchy, and the first forms of centralized economic administrations (taxes, the management of large agricultural domains, etc.)"*.

Before the invention of writing, most knowledge[8] in society was passed (only) verbally. Plato even argued against the use of writing in his Dialogues where he let Socrates speak with Phaedrus, calling the written form of knowledge a shadow, or dead knowledge, which is not to compare with a verbal speech. He emphasized the direct form of knowledge transfer – the oral or verbal form, and regarded the knowing of individual character as necessary for a rhetorician:

> *"Socrates:*
> *I cannot help feeling, Phaedrus, that* ***writing is unfortunately like painting****; for the creations of the painter have the attitude of life, and yet if you ask them a question they preserve a solemn silence. And the same may be said of speeches. You would imagine that they had intelligence, but if you want to know anything and put a question to one of them, the speaker always gives one unvarying answer. And when they have been once written down they are tumbled about anywhere among those who may or may not understand them, and know not to whom they should reply, to whom not: and, if they are maltreated or abused, they have no parent to protect them;*

[8] Excluding skills and arts, which also imply bodily, non-verbal dimension

and they cannot protect or defend themselves." (Plato, 1892a)

Plato compares here the written word with a picture, which is unable to explain and defend itself. He is right, because the written word becomes prone to misunderstandings and different interpretations; the right context may even become unknown or lost (a process that completely changes the perceiving of knowledge, according to definition by Nonaka & Takeuchi), and it becomes impossible to verify author's original intentions.

Except, the text preserves the context, which is achieved only within sharply, self-explaining, defined frame (as it is introduced for instance by science, or mathematical axioms). Lévy comes up here with the notion of ***universality***, which developed only with the advent of writing. According to him (2001, p. 94), linguistic communication in oral societies functioned in real time – messages were exchanged at the same place and the same time between participants, who share the same situation, and the same context (or could agree upon it). With transition to written culture, the same situation and context disappear[9], and the context has to be re-introduced by the help of universality. Lévy (2001, p. 94) states that "*messages exist "out of context"*". That is where idea of "*universal*" comes into being, in order to produce text that can be understood within the right context. Classical philosophy, science, but also "universal" religions strive for "*universality*" in order to be understood.

A good example for universal knowledge would be Pythagorean theorem - an idea that is still clear today – of course under conditions, that one has a basic knowledge of mathematics. Lévy points out that the universality without writing is impossible, because through speech, we have only an ephemeral context. We can say that the idea of universality, as a reaction to decontextualization, brings the context back to written works. The counterexample of non-universal knowledge would be myths and rituals of pre-literate, oral societies, which can be learned only within those societies, because those myths and rituals relate only to them, and are not based on self-justifications in written texts. A condition for universality with

[9] Writing is also an example for asynchronous communication, as opposed to synchronic speech

totality (which is brought along by universality) is expressed by Lévy (2001, p. 96) as:

> *The signification of the message must be the same in all places and at all times.*

A question closely connected to the universality and transition from oral to written tradition is the control of knowledge – how is diffusion of knowledge controlled in society? In oral societies, it was easier to control it insofar as every transfer of knowledge implied the direct communication, either through demonstrating the specific skill or verbal explanation/discussion. In literate societies, where the process of detaching ideas and thoughts from one's mind into the text occurred, there is one more possibility. If knowledge is recorded externally, i.e. it is written, one could gain knowledge by having access to the text; it did not require the direct contact with the person, under presumption that the person could read the text. Of course, the literacy was only for elites, so it were the elites, the priests and the scribes who could write and read, that were in control of knowledge. But once they had a physical access to the scriptures, they could understand a text that preserved universality more easily. The mechanism of control changed with transition to oral society. The knowledge is more widely distributed, but there must be physical access to the scripture. Moreover, an additional barrier occurred - that of literacy, making the access to knowledge now dependent of direct transfer, thus making possible the existence of small, literate and knowledge-endowed elites.

For Greek philosopher and mathematician Pythagoras it is said that he only taught verbally (Riedweg, 2002) not accepting writing. The reasons for that could be that he feared that he could not control the knowledge anymore, when it is once written down.

Plato feared that the written form is inappropriate for passing the knowledge to others, since it is a form of asynchronous communication, enabling

misunderstandings of the idea which is tried to be conveyed. Direct verbal approach that Pythagoras advocated is still used in today's education, in the form of teaching in classes at universities and schools, but it is augmented with the written form. Knowledge that is not stored externally, i.e. written down, is more in danger of getting lost through history, like it happened to unwritten teachings of Pythagoras, so that everything we know from him is what his successors and students wrote later about his ideas, and many of his original ideas remain unknown and lost.

One of the reasons why so many ideas of Pythagoras and Heraclitus that are said to originate from them, is that we lack the universality - their works did not preserved as whole, but only as fragments of ideas, as opposed to Plato's and Aristotle's universal philosophy and logic, that works were written in order to preserve the context.

The range of verbal tradition is, similar to apprentice-master mode of passing knowledge of skills, reduced to the range of personal contacts. Polanyi (1962, p. 53) points out at the fact that "*an art which has fallen into disuse for the period of one generation is altogether lost*". The same can be concluded for verbal knowledge.

In the case there is only oral knowledge, there is also a lack of robustness, because, as Lévy argues, every man is a library, and when he dies, the library burns up. Once knowledge is stored in books, manuscripts, there is more chance to preserve it, because books carry knowledge through space and time, under condition they are preserved. Oral tradition has therefore decreased chances to preserve the correct form of knowledge in the culture, because if we do not have a written source, so called "original", which serves as a reference point, we cannot trace the knowledge back. Of course, sometimes we cannot be sure about the authenticity of the source, but at least we have a source in the case of written tradition. However, there are many known types and systems of knowledge that survived in its verbal form, e.g. Indian Vedas[10], which were passed on verbally

[10] A collection of poems or hymns written down in archaic Sanskrit about 1500–1200 BCE, but it is thought that they were composed much earlier. Encyclopedia Britannica,

before they were written down. According to UNESCO report (2005, p. 35) on knowledge societies, Africa is still a continent of oral tradition.

Ong's (2002) treatise on orality and literacy points out some significant differences and characteristics of oral and written tradition. He claims that written word is an extension of thought into the space. Ong emphasizes the visual character of the word that is written on some material surface, thus enabling us to go on the distance to the written text, to analyze it and to think it over. Hence, writing constitutes "secondary modeling system" based on a "primary modeling system" speech, which is augmented by writing.

Furthermore, Ong suggests that writing was a precondition not only for history, but also for science and philosophy. Within oral tradition, knowledge has to be permanently repeated in order not to disappear. If we cannot recall something, we can rely on texts and books, where knowledge is organized. If there is no possibility of writing the knowledge down, there must be found another way how to organize knowledge only through oral tradition. According to Ong (2002, p. 35) oral tradition develops specific forms of knowledge-transfer, which happens in a patterned, formulaic and mnemonic way. This means that knowledge in oral cultures is organized and structured around certain patterns and verbal formulas in order to be easier remembered and recalled when needed (2002, pp. 33-36). From that follows that a form of "modeling system" of knowledge conditions knowledge in organizational and qualitative terms (Ong, 2002, p. 36).

Ong furthermore (2002, pp. 37-49) alleges some characteristics of orally based thought. According to him orally based knowledge is:

- rather aggregative than analytic (use of epithets in formulaic expression in order to more easily recall the material, the emphasis is on storing and recalling knowledge, not on analyzing)
- redundant (in order to maintain the continuity of thought, which is more easily established by writing)

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http://www.britannica.com/eb/article-9074947/Vedic-religion [1.6.2008].

- conservative or traditionalist (since not-repeated knowledge disappears, it must be repeated continuously, which needs a traditionalist authority, as opposed to writing which stores knowledge externally, and does not need dedicated "wise" men to preserve it)

Writing is seen within this context as more analytic (enables distancing from text, rethinking, "backward scanning"), less redundant, and less conservative since it easily disconnects from traditions. I already mentioned the visual aspect of the written word, which leads to imagining words as visual entities, something that did not exist in purely oral societies.

Kerckhove (1995, pp. 11-13) also agrees with Ong insofar, as he notices that there is a correlation between emergence of writing in Greek society and sudden emergence of scientific, technical and intellectual achievements of old Greeks. He claims that listening to narrative was replaced by thinking. Kerckhove (1995, p. 13) also argues that text produces distance by stating that "*text functions as a mirror*"[11], enabling "space" for reflection in thoughts.

Compared to print, Ong claims that while manuscripts are producer-oriented, printed books are consumer-oriented, since print provides easier writing and quantifying of knowledge.

Ong and Kerckhove's observations present clearly arguments for the idea that orality and literacy, as systems for knowledge modeling, condition the amount and the quality of knowledge. For instance a lot of today's mathematics is impossible without writing.

I suggest, on the basis of the above considerations that oral tradition has following characteristics:

[11] Kerckhove (1995) emphasizes the function and the meaning of alphabet as a special phonetic script, which disconnected writing and reading from speech, as opposed to pictographical Chinese script, or Semitic script which has no signs for vowels, thus implying the knowledge of the particular word. Kerckhove claims that invention of alphabet had serious cognitive impacts, like an emphasis on decoding the sequences needed for efficient processing of alphabet, an activity which in turn stimulated the left brain hemisphere, which is analytic and rational.

a) direct mode of transmission of information and knowledge, which implies that transfer of knowledge occurs within the same situation, time and space.

b) greater uncertainty, because:

- it is not sure what the original source is, that is lost somewhere in history

- oral tradition has potentially shorter range of diffusion within society: both intercultural and the intra-cultural levels of diffusion are much smaller than when there are written means for knowledge diffusion

c) less persistent in terms of temporal and spatial range:

It is harder to preserve oral knowledge, especially in a historical context where changes and disruptions in society's continuity often occur; if there is no other written source preserved on some other place, knowledge may get lost, and have to be eventually discovered again or completely forgotten[12].

Re-developing knowledge that has been lost is a process that can take more than 1000 years, as the example with the Antikythera Mechanism[13] shows. Moreover, forgetting the knowledge about the world and the processes of the world and its manipulation may be critical to societies (e.g. oral cultures that depend on the knowledge of medical plants) and may lead to the decline of the society.

There is still a lot of verbal tradition or oral knowledge today, which exists as indigenous or even local knowledge, that is often not codified (UNESCO, 2005, p.

[12] E.g., Iliad and Odyssey, as a product of oral tradition, is an outcome of many bards - oral poets, and eventually written down. Each narration of parts of Iliad or Odyssey by bards included slightly different versions, the whole Iliad or whole Odyssey was of course not recited at once. The structures – patterns and formulas around which bards oriented their narration remained visible until today in the written text. Those structures and patterns were necessary for recalling during narration. (Ong, 2002)

[13] Antikythera mechanism is a clock-like artefact that is dated to around 100 BC. It was found in an old Greek ship wreck, and presents the oldest known complex astronomic instrument/mechanical calculator. Its functions are still being scientifically investigated, but it is presumed that it served for orientation. (Freeth, 2006)

148) e.g. agrarian or medical practices and knowledge in the context of its cultural environment.

Egyptians invented papyrus, which was easier to write on than using the heavy Mesopotamian clay-tablets. It also fostered the way of continuous writing - the cursive, hieratic writing, which was according to Fischer (2001, p. 47) more practical for writing everyday documents. Writing inscribed on clay tablets is more robust than papyrus that may burn, but regarding the broader diffusion of knowledge and information in society, papyrus gives more "social" robustness to preservation of knowledge, because it facilitates the production of written manuscripts as well as their diffusion – it is easier to distribute manuscripts than clay tablets or inscribed stones. Even today, we use the letter "*m*" which is of hieroglyphic origin; it comes from Egyptian hieroglyph for the sound "*n*", which meant water[14]. Of course, the diffusion of written documents remained restricted to one (ruling) minority within a certain society. It did not leave this circle, but diffused to other societies (and their literate elites). Compared to the later age of printing presses, information written on papyrus roles was a very restricted mode of knowledge storing and distributing knowledge. Nevertheless, Egyptians developed a lot of further mathematical, astronomical geometric knowledge (that we do not find in cultures without written tradition), and undertook such complex enterprises like building pyramids, which required mathematical and geometrical knowledge, as well as practical knowledge of engineering and building.

There is no definite casual evidence, but the connection between writing systems including external knowledge and developed civilizations are obvious (broader and more detailed scope is found in "*History of Writing*"- Fischer, 2001). Therefore, I argue, also in context of Nonaka&Takeuchi's theory of organizational knowledge creating which is discussed in Chapter 5, that without the codified knowledge, it would be hard to the reach level of knowledge reached by Egyptians or Chinese, because it would be impossible to:

[14] The letter „m" was taken from Hieroglyphic script into Semithic script, and was then borrowed by Greeks for their phonemic alphabet, extending to Latin alphabet.

1. have a common knowledge base which could be shared by interested individuals as there is the case when there are writing systems

2. to share the knowledge sufficiently enough within society groups (through time and space), in a way which implies examination / combination of existing knowledge and creation of new knowledge (compare I. Nonaka, 1998, p. 43)

therefore

3. the first two requirements enable society to undertake complex projects that involve many people from different knowledge areas who can work together on a common project

Although Plato criticized the new technology of the "written word" in the context of a lively discourse, he was aware of advantages that writing provides. In the short story about the emergence of writing in Egypt, he points out at the advantage of using the written texts as an external memory, which can be used instead of internal memory, thus representing a cognitive shift in processing of information.

(Plato,1892a):

"Socrates:

… To him came Theuth and showed his inventions, desiring that the other Egyptians might be allowed to have the benefit of them; he enumerated them, and Thamus enquired about their several uses, and praised some of them and censured others, as he approved or disapproved of them. It would take a long time to repeat all that Thamus said to Theuth in praise or blame of the various arts. ***But when they came to letters****, This, said Theuth****, will make the Egyptians wiser and give them better memories; it is a specific both for the memory and for the wit****."*

Plato was also the first who was concerned with the problem of knowledge. The definition of knowledge that he proposed (1892b) in a dialog of Plato with Theaetetus, did not change substantially, since he already discussed knowledge as true and justified belief *("reason or explanation added to right opinion")* - a definition that is a valid definition of knowledge in epistemology. This definition is also adopted by Nonaka&Takeuchi in their definition of knowledge, with the difference that they stressed the dynamic, relative dimension of the nature of knowledge.

A belief in order to present knowledge has to fulfill the condition of being true. Since something that is true can also be guessed as such by accident, the belief has to be in addition to this first condition also justified, i.e. explained. One condition without the other is not sufficient to present knowledge. We can propose something which later turns out to be true. But if we cannot account for it, then this was only a guess. We did not have an explanation for our belief. On the other hand, we can account sufficiently for something, thus justifying it, but if this is not confirmed by an empirical test, it is just a belief that may be justified but not true.

Definition of knowledge as *true and justified belief* does not imply the absolute truth of an assertion. The truthfulness of and assertion or theory is of a relative nature (depending on the current perspective, approach and point of view, as pointed out in definition of knowledge by Nonaka & Takeuchi). Even if belief is justified and valid it is not absolutely true. For instance, what was considered as true some 20 years in medicine, or in physics, is no longer true today. This is the case with all natural sciences, also regarding the fundamental research where results are so long true until they are replaced by new results.

Although science tends to be totalizing, for instance through claims of "*scientific truth*", this is in fact not true. Polanyi (1962, p. 164) observes "*the scientific existing opinion as competent authority, but not as a supreme authority*". This opinion can be easily seen in the fact that a lot of scientific knowledge, gained by research, and verified by scientific methods is actually relative knowledge, and is subjected to change in the course of time and further research.

Concerning the relation between societies, their knowledge and writing, it must be noted that the level of knowledge, or similar levels, that were reached by Egyptians, which include mathematical, geometrical and astronomical knowledge were developed only by the cultures that also developed writing and number systems, such as Greeks, Chinese or Maya.

Thus they developed structures for storing and sharing the knowledge in the society, a system of writing, apart from the spoken language. The spoken language may be more alive, as Plato argued, but advantages of writing in the diffusion of knowledge and information are far more significant, as I have shown above.

In the words of Pierre Lévy (1997, xvii):

> *Through writing we have entered a new stage of our evolution. This technology has led us to the increased efficiency of communication and organization of human groups larger than ordinary speech could have accommodated*

3.2.3 Evolution of Knowledge societies

Knowledge, science and technology always have been tied together, and societies have actually always been knowledge societies (compare Tuomi, 2000, p. 5.). Castells (2000a, p. 17) also states that information and knowledge have always been critical factors in production. He further develops Daniel Bell's idea about the post-industrial society (Bell, 1973). Bell describes the new, post-war society as becoming post-industrial, with its main sources being information and services (which presents shift from industrial production to service-economy). Castells elaborates further Bell's ideas through bringing in the new aspects of new informational technologies and network logic, which continuously developed after Bell postulated his post-industrial theory.

But if the knowledge has been so important to the society through all the centuries, as both Lévy and Castells agree, what is the main difference to its significance compared with today?

Peter Drucker, who first introduced the concept of knowledge worker, argues:

> *"Applying knowledge to work has a long history. The priests who thousands of years ago organized Egypt's agriculture – and indeed her entire political and social life – around the knowledge of the flood tides of the Nile, were "knowledge workers" and applied knowledge to work. But these were exceptions. Knowledge and work, until very recent times, were separate and rarely touched each other. Knowledge was desirable for its intrinsic beauty, and at best as conducive to wisdom (..), Work was based on experience.." (1970, p. 254)*

The main difference is that knowledge which conditioned the direction of society in Egypt was knowledge owned by only a small elite, as opposed to societies where knowledge becomes dispersed to a broader base and potentially accessible for everybody (although this is the case to some extent only in developed countries which have developed educational systems). According to UNESCO (2005, p. 17), the organizing principle of those past "*exclusive knowledge societies*" was secrecy - restriction by controlling the access to knowledge. Yet in the age of Enlightenment, in 17th and 18th century, an idea of public knowledge began to develop, and become implemented in works like his Encyclopedia of Diderot. This can be seen as the first try of systematic diffusion of knowledge. Of course, beside the quantity aspect of diffusion of knowledge, there is a qualitative difference as well. Human kind developed many different systems and concepts in all areas of human existence – humanities, visual and musical arts, and in all natural and exact sciences like mathematics, physics, geometry, chemistry, biology, that also reached a great level of diffusion, a global one, no longer restricted anymore to few centers.

This view is consistent with Lévy's view (1999, p. 8) who argues that to each anthropological space corresponds a specific way of knowledge. Lévy agrees here with Castells' analysis in that there is a new aspect to our knowledge society. Lévy also points out at the speed, mass (quantity) and tools in terms of knowledge creation and Internet, but he also adopts new aspects of virtuality and new universality (2001).

Castells (2000a, p. 17) describes the difference to previous societies in relation to knowledge and information, stating that in informationalism information and knowledge become crucial productivity factors, in such a way that the specific factors for the new informational mode of development is the usage of knowledge on knowledge, with the specific effect of using knowledge to improve new technologies. This effect improves knowledge generation - which according to Castells becomes the main source of productivity in informationalist mode of development. UNESCO report (2005, p. 27) on knowledge societies defines them:

> *Knowledge societies are about capabilities to identify, produce, process, transform, disseminate and use information to build and apply knowledge for human development. They require an empowering social vision that encompasses plurality, inclusion, solidarity and participation.*

3.2.4 Invention of printing press and libraries

The invention of printing press by Gutenberg in 1493 was another big milestone in the evolution of knowledge, leading to a "Gutenberg Galaxy" (MacLuhan, 1995). With that, it became possible to reproduce more copies of a single book, which made possible to overcome the boundaries that were posed through the history by certain groups in the society, who understood that knowledge meant power (Bacon, 1620), and who posed so called information monopoles (UN, 2005, p. 38) on the society through the restriction of literacy.

Stefan Harnad (1991, p. 40) calls the innovation of printing press a revolution, concerning its implications for human thought and distribution and creation of knowledge. Lévy states that this is the time when science as we know it today begins to develop. Due to diffusion of books more knowledge gets generated in different areas, resulting in the fact that more focus is needed for particular areas of human knowledge.

A significant feature of printing press was the possibility to reproduce exact copies of the book, which lay down foundations for later emerging scientific work (for instance, thus citation was made possible). Although Gutenberg's was not the first to invent printing press with moveable types, because printing press with wooden and clay moveable types was invented in China already nearly 400 years earlier, Gutenberg's invention had one economic and practical advantage, which was essential for the quantity of printed books. The advantage was that Gutenberg's printing press worked within a writing system of only 45 letters, whereas Chinese books often included 5000 or more Chinese symbols that needed to be combined in order to print pages. Of course, this was not the advantage introduced by Gutenberg's press itself, but by usage of the Latin alphabet.

It was the new technology, actually a technological revolution that made a broader diffusion of knowledge reality, in dimensions unknown until then concerning the diffusion of ideas, thoughts and practices[15]. Printing enabled better, faster, and broader flow of different ideas, and brought traditiaonal monopoles of writing to fall (church, church-universities, ...). The base for modern, scientific transfer of knowledge was laid. This included cultural areas such as:

- religious matter – (e.g. Luther's protestant bible; shift from Latin to national languages)
- philosophy
- mathematics

[15] Compare Heinrich Heine's description of religious and philosophical revolution in Germany (2004, pp. 16-26)

- technology

In addition to this, printing press also laid down the foundations for the upcoming of the first industrial revolution. Lévy (1999, p. 58) calls the printing "*the first industry of mass production*", that promoted the technological and scientific shift towards industrial revolution. Herein we can see a parallel to the new information technologies initiating the new technological revolution that Castells (2000b, p. 28) speaks about.

Mass copying or reproduction of printed matter became the basic means for knowledge diffusion (compare Spinner, 1998). Print preserved this function also today in the times of virtual reality and virtual means of communication. Harnad (1991, p. 40) points out at the scope of the range and the speed of distribution of written words (human thought) that was achieved through introducing the printing press and movable type. Printing Press was according to Harnad a prerequisite for emergence of science and research, because science is a form of "*collective enterprise*", and collective enterprises need to share and exchange information and knowledge, which was enabled by mass-printing. In that point, he actually agrees with Castells who, although indirectly, points out at the importance of printing press as a foundation upon which the first industrial revolution relied (2000a, p. 30).

Castells, however, does not consider the invention of printing press and its impact as an information technology revolution, because according to him it lacks in range of *pervasiveness,* which is for him a crucial factor in determining if a certain technology really presents a revolution (Castells, 2000a, pp. 29-30).

But even if the effects of printing press were not all-pervasive, because, as Castells reasons, wide parts of population were still illiterate, this technology had one decisive factor which allows us to reckon it as information technology revolution - it brought a **technological discontinuity** along, and it had profound effects on science which was yet to emerge. Moreover, as Castells indirectly admits, it had impact on the first industrial revolution. The reason why Castells does not observe the advent of printing press as revolutionary different, is the

viewpoint from which he considers the new information technologies as revolutionary - it is the use of knowledge and information on knowledge generation, and on information technologies that are accountable for the generation of knowledge (Castells, 2000a, p. 31).

However, Manuel Castells emphasizes this importance of technology for the development of society, a statement that can be applied on the technology of printing press. He states that:

> *"The ability or inability of societies to master technology, and particularly technologies that are strategically decisive in each historical period, largely shapes their destiny, to the point where we could say that while technology per se does not determine historical evolution and social change, technology (or the lack of it) embodies the capacity of societies to transform themselves" (Castells 1996, p. 7).*

Other key factor for the dissemination of knowledge I want to emphasize is the phenomenon of libraries, as places where scientific, cultural and other knowledge gets accumulated in order to be distributed to those who visit those places.

UNESCO emphasizes the importance of libraries, presenting libraries as a key for promoting both reading and writing - *"Libraries are essential to the free flow of ideas and to maintaining, increasing and spreading knowledge."*[16]

Printing press and the sudden boost in production of books fostered establishments of public libraries in the 16th Century in most European countries**.** At the time of the invention of the printing press, libraries had already been established (the first public libraries were Roman's public libraries), which functioned along with universities, (in the Middle Age also with monasteries), as living centers of knowledge (this later emerged in what we call today research.) However, the invention of printing press fostered the foundations of libraries even more.

[16] UNESCO, http://www.unesco.org/cgi-bin/webworld/portal_bib2/cgi/page.cgi?d=1 [1.2.2008]

One of the biggest earliest libraries is the famous Library of Alexandria, which is thought to be founded around the 3rd century BC in the Hellenistic times (Brundige, 1991). This library was the first attempt to gather all available human knowledge at one place, which made it the first universal library. It became a centre where knowledge was stored and classified, and a point from which knowledge was disseminated throughout the literate society. It was also a centre for learning and research, just like our public/scientific libraries two thousand years later. It tried to collect "*every book on every subject in every language*" (Jochum 1999, p. 1) thus it was:

> *"…a monument to a more farreaching concept: all aspects of human knowledge, from scientific to everyday, were to be found on the shelves of the Alexandrian library."*

Library of Alexandria burnt down and was destroyed, leading to the loss of most of its documents, paying the price for centralized knowledge and neglecting the dimension of its distribution., This is understandable, if we keep in mind that reproducing a book only by writing may took a whole year or longer. The fall of a great idea of being the center of all knowledge was the non-availability of more sophisticated technological ways of reproduction, which will be invented 1000 years later.

External organization of knowledge started with writing, which was also the emergence of history. It is with the introduction of writing that we can speak about "history", because from that point onwards history becomes recordable, and "knowledge about knowledge" can be gathered. The first collections of clay tablets in Sumer consisted of records of quantities of economical resources and records of traded quantities, of the input into and the output from the system of human knowledge. Collecting clays tokens was also the first sign of tendency to accumulate external knowledge on one place, which is plausible for reasons of accessibility.

Hence the invention of writing, which became the major system for manipulating and diffusing knowledge, and the invention of the printing press

which enabled the mass-production of books, thus also enabling the mass-diffusion of knowledge in society, which concentrated around libraries and universities, where the basic forms of organizing the knowledge and its creation in society.

Industrialization of society and growing amount of new discovered knowledge from the 16th century onwards, led in the later nineteenth century to differentiation of scientific work and research on the university and society as we know it today (foundations of researchers / engineers labs). In Hellenistic times, the main ideal was still the all-encompassing knowledge, the result of which was the Library of Alexandria (Jochum 1999, p. 1), because the amount of knowledge that was important in then was still assessable. But during the 18th century the amount of knowledge generated through the industrial revolution was simply too big to be understood by every scholar or yet to emerge scientist. This expansion required specialization and division of scientific labor. According to Etzkowitz and Leydesdorff, this lead to the emergence of the "*modern university, which combines teaching and research*" (Etzkowitz, 1997, p. 1)

Emergence of science

Newton was an outstanding scientist in different areas (physics, mathematics, chemistry, astronomy, theology[17]). Similarly Leibniz[18] was also very involved in a number of different scientific areas. Both of them were living at the end of the 17th and beginning of the 18th century, before the first Industrial Revolution. But after the First Industrial Revolution, due to the rapid expansions both in industry and in the system of higher education, together with increasing cognitive complexity in the academic fields, division of scientific work began to emerge in the 19th century[19].

[17] According to Stanford Encyclopedia of Philosophy, http://plato.stanford.edu/entries/newton/, [12.10.08]
[18] Leibniz was both a mathematician known for the concept of binary system, and rationalist philosopher who wrote on many topics in the area of humanities.
[19] see Etzkowitz's and Leydesdorff's book "Universities and the Global Knowledge Economy", 1997.

The result of changing requirements in the society and industrial production was the diversification of scientific work and research, which began to evolve in Europe and USA in the second half of the 19th century (Shinn, 1997, p. 86), leading to the Second Industrial Revolution (development of chemical and electrical industries).

According to Terry Shinn (1997, pp. 85-86), another major factor for the emergence of modern science was also the global competiveness[20].

Summary

In this chapter I have presented the cognitive foundations of knowledge representation, and how speech and script, as "knowledge processing systems" influenced the development of knowledge. I also provided an explanation for how speech and script acted upon society in terms of knowledge diffusion and evolution. Three "information-processing" revolutions were discussed, the first one being implicit – the invention of language, and the invention of writing and printing press. The last, fourth information-processing revolution based on new information and computer technologies, will be discussed in the following chapters as a concept of a new knowledge space.

Beside language and writing seen as the main means for knowledge production in society, we can view every human made artifact as a sort of external representation of knowledge (knowledge that was put in it by making it). For instance, buildings incorporate architectural and mathematical knowledge, and knowledge of materials. Knowledge can be re-engineered (in part or entirely) through reverse engineering. Technology in general can even be seen as form of knowledge, as Gibbons does in "*New production of knowledge"* (1994, p. 24), speaking about technology as knowledge.

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[20] France and England overtook Germany in terms of inventions and manufacturing the instrumentations needed for research, so that Germany had to invest more in research of engineering issues.

Nevertheless, in order to know how buildings or computers function, we must first acquire knowledge through the means of written and spoken language. In that aspect, we can identify, in terms of cognitive abilities and in terms of societal changes in knowledge production and transfer, two (beside invention of language) principal early information-processing revolutions.

The first one is the invention of writing, and the second one the invention of printing press (compare Castells, 2000, p. 8, describing invention of paper and printing in China as "*first information processing revolution*").

In summary it can be said that the second information-revolution led to diffusion, accumulation and creation of knowledge in society on a greater scale than the invention of writing. The invention of printing facilitated emergence of today's traditional knowledge producing centers – universities and libraries.

In other words, those two revolutions were the prerequisites for mechanisms of knowledge creation and diffusion in society:

- **Writing and Alphabet:**

  System for recording personal and public knowledge. It tends to static forms and extends the dimension of language over space and time; it is easy to distribute in form of written manuscripts, and has a greater range of diffusion than oral knowledge. But compared to the print, the range of knowledge covered by manuscripts and written books is more limited because its creation (through manual writing) takes longer.

- **Printing press:**

  It presents means for the first mass-diffusion of knowledge in society. This enabled the emergence of public and university libraries on a larger scale, which together with universities, and later R&D sites, constituted centers for collecting and producing the knowledge – libraries, universities, R&D centers and scientific institutions[21].

[21] "*locations of basic research as main source of knowledge*", (Castells, 2000a, p. 124).

4 Anthropological spaces and technologies of knowledge

Pierre Lévy describes in his book on Collective Intelligence four spaces of existence and signification. The way he approaches technology is based on humanities, especially on anthropology and philosophy, more particularly on ideas of French philosopher Michel Serres[22]. Lévy tries to give a positive vision of recent development of cyberspace. His approach contrasts with Castells' approach to *society of networks* insofar, as Castells' considerations are based on analysis of forces of production and modes of production and development, strongly economically oriented. Opposed to the economical view that Castells develops (theory of global network economy), Lévy's elaboration on anthropological spaces is clearly culturally oriented, incorporating also media-aspects, since he deals with new emerging patterns of communication. His book is a detailed vision of Collective Intelligence, which can be created through the means of cyberspace. Lévy describes the transformations in communication, transfer and significance of knowledge through history; especially those changes that are emerging with the advent of cyberspace and that will eventually lead to the emergence of Collective Intelligence.

About the time (1994) when Lévy introduced his idea on development of Collective Intelligence, a similar view by Francis Heylighen (Heylighen & Bollen, 1996) was developed. That is a view of a World Wide Web as a global brain, whereby the global network – Internet - presents the infrastructure for it, with connections between computers and networks being a sort of "nervous system". In that model, World Wide Web would have functions of "associative memory" and connecting thoughts of individual brains into one "global brain".

The concept where human intelligence is augmented by the means of interconnected, computer mediation technology can be traced back to 1962, and Douglas Engelbart's work "*Augmenting human intellect: A Conceptual*

[22] Michel Serres is a philospher, professor of History of Science at the Sorbonne in Paris. http://epublications.bond.edu.au/french_philosophers/4/ [2.11.2008]

Framework"" (1962). Engelbart, inventor of computer mouse and *Graphical User Interface* elements that were later incorporated by Xerox, Apple and Microsoft into their operating systems, dealt with possibilities of extending human capabilities by the means of computer technologies. He made consideration how to enhance teamwork. In chapter called "*Hypothetical description of computer-based augmentation system"*, (Engelbart, 1962, p. 105) he describes advantages of computer-mediated collaborative work on interconnected computers, pointing out the advantages of synergies that emerge through "*working together with access on common working structures*".

Lévy (1999, pp. 13-15) defines *collective intelligence* as a "*form of universally distributed intelligence, which is permanently enhanced and coordinated in real-time, which lead to mobilization of skills*". In 1994, Lévy's ideas were still visions, but MIT has recently founded a Center for Collective Intelligence, which carries out theoretical and practical research[23] on issues of Collective Intelligence. A central question for researchers at MIT is "*How can people and computers be connected so that-collectively-they act more intelligently than any individuals, groups, or computers have ever done before?"* (MIT CCI, 2006), which is very similar to Lévy's original idea, and is also an extension of Engelbart's work.

However, Lévy also emphasizes the cultural dimension in human collaborations, stating that collective intelligence is formed within a culture. That is in other words, through individual use of ideas, values, languages inherited from community. It is actually diversity that he accentuates, with respect to individual skills and unique abilities (1999, pp. 16-17). It is the same relevance of diversity that UNESCO mentions in its report on Knowledge Societies (UNESCO, 2005, p. 17):

> *"A knowledge society is a society that is nurtured by its diversity and its capacities"*

[23] Research projects of MIT Center for Collective Inteliigence: http://cci.mit.edu/research/projects.htm, [2.11.2008]

UNESCO world report on KS agrees with Lévy that there is something more of value to knowledge societies, beside the economic results. Human knowledge has to be integrated and valued in its entirety and in its all diverse aspects.

4.1 Spaces of signification in relation to knowledge

> *"Human beings do not inhabit only a physical or geometric space, they simultaneously live in emotional, aesthetic, social and historical spaces, spaces of signification in general"* (Lévy, 1999, p. 144)

We live in multiplicity of different spaces, some of them ephemeral, short-lived, some of them more permanent. Through communication, we constantly create new spaces, where we share views, values, ideas, and also change them. In Lévy's words (1999, p. 143) "*a simple conversation could be seen as the shared construction of a virtual space of signification*". The conversation as a construction of the shared space of signification consists of persons who participate in discussion, ideas exchanged through messages, and representations they create (compare Deacon and language as a means for sharing ideas). It is a space of communication, but also a space of signification. Our interpretations of reality and our valuing of relevant phenomena are cognized within certain historical, social, technical spheres. At the same time we establish different connections to different human beings within different spaces in terms of different proximities. Each space has its specific system of proximity, and valuing. This system can be related to time, physical space, territorial (state or city), emotional (friends, family) or intellectual proximity (relationship that emerges through reading of works of a certain author can be intellectually much stronger, within space of thoughts and ideas, than with somebody who is personally known to me). Different objects or persons have different meaning in different spaces. Living in the world can be "*seen as modifying and improving the spaces.., connecting and separating them, articulating and solidifying them, introducing new*

objects, displaying the forces that structure them, jumping from one space to other" (Lévy, 1999, p. 144). Therefore we simultaneously live in a multitude of spaces.

While there are many personal and many ephemeral spaces of signification, the four anthropological spaces spread over whole humanity and act as structuring, organizing basis for the many diverse spaces contained within. The four anthropological spaces emerged along with development of humanity, and one main characteristic of them is that they are irreversible, as we will see in following elaborations.

To better understand the social construction of the spaces it is advantageous to shortly mention the theory of social construction of reality, by Berger and Luckmann (1966).

According to Berger and Luckmann, knowledge is a social phenomenon, it is socially constructed knowledge about the world. They assume that knowledge is socially distributed and constructed. Furthermore, they present our picture of society as reality that is socially constructed. Knowledge about it society is acquired and learned through "'internalization of reality". Internalization of reality consists of two basic social processes (Berger and Luckmann, 1966):

- **primary socialization**
  is construction of one individual's world through the identification with significant ones – *family*
- **secondary socialization**
  internalization of *institutional* based "sub-worlds". consists of education and acquisition of role-specific knowledge

Berger and Luckmann suggest that language builds zones of meaning or semantic fields (1966, p. 55) within a particular society (that relates to "*the social stock of knowledge"*). Within these zones of meaning, biographical and historical experiences are gained and accumulated. (Berger and Luckmann, 1966, p. 56). This corresponds to the way that anthropological spaces are created by humanity, or more particularly, by specific societies.

4.1.1 Nomadic space of earth

Pierre Lévy postulates four anthropologic spaces, three of them already existing and one that was about to emerge around 1994, when his book came out in France. The first space of signification that was created by humanity was the Space of Earth. There was no formal territorial organization; people wandered the spaces of earth in search for food and material. Language, speech was the main communication form, and implicitly the main form of passing the traditional knowledge – which was organized in form of myths, rituals and as a story. Belief systems like animism and totemism were the main systems of thought, around which the identity was constructed, within smaller organic groups like families, clans and tribes, and was in relation to the surrounding world-cosmos, which means relationship to nature and the ideas that constructed the religion. Lévy (1999, p. 6) states that the *space of earth* is based on three fundaments, on language, on first forms of technology (Palaeolithic, technologies of stone and wood), and on first forms of social organizations, which are common to humans, like religion. The name becomes the distinctive feature of identification. When Lévy describes the space of earth, he means "*a cosmos in which humanity communicates with animals, plants, landscapes, locales, and spirits*" (Lévy, 1999, p. 131). This space is a meeting "frame" of humanity, nature, animals, and deities, permanently re-created by human interactions, both on a level of signification as well as on a material level.

4.1.2 Territorial space

Territory emerges with first appearances of state. States emerge with existence of agriculture, which forces people to abandon nomadic life-style, and to settle down to more stable structures. It also provides an added value in the form of food products that can be exchanged for other food products or something else. With emergence of first city-states there is also appearance of writing, which structures the society into the ones who process the information, and into the other part that is "administered" – by the state officials (Lévy, 1999, p. xxviii). Thus, the

second space of signification is based on agriculture, on the city/state and on the new form of communication – writing. It begins somewhere in Neolithic and dominates the organization of human world until the emergence of the third space. It does not remove the first space of nomadic earth, but extends it into new dimension of human existence. It tries to change the first space, but it never completely removes it from the plane of existence (even today we have existing nomadic societies). Lévy (1999, p. 6) points out that the dominant knowledge modes in that new space were based on writing, and he identifies history and the development of systematic, theoretical, and hermeneutic knowledge. Semiotically, between signs and things now come the state, the hierarchy and the scribes. (Lévy, 1999, p. 165). It is now when the sign becomes its transcendent meaning, it represents the thing, which may not be there (as opposed to the sign which is there).

Instead to earth, there is a relationship to land, borders of the agricultural field, and zones of influence that do not belong to a clan anymore, but a territory that belongs to the city or the state. The distinguishing attribute of identity is augmented by the relation to the territory – the address comes to the name to identify our position within the space of territory. Use of writing leads to more complex hierarchies and bureaucracies, rules get written down. According to Lévy (1999, p. 133) the territorial space has been existing for about the past twelve hundred years, and came to appearance in the Near East, between Iran and Anatolia, which is also the source of writing, according to Fischer (2001).

As a new dominant space, the territorial space of signification tries to organize the older space of earth within its own system of values, thoughts and ideas, destroying its sources of identity and production of the space of earth. It introduces the concept of clear borders, and knowledge based on literacy, a fix address were we belong to. But the old space of earth does not give up so easily, as there are still people living nomadic lifestyle, for instance in Sinai (Israel/Egypt). They exist on both planes, but their primary space of meaning is nomadic space of earth. And for the most people the space of territory was the main space of existence-they were peasants, until the beginning of the Second World War (Lévy,

1999, p. 135). Storage, accumulation of goods and thoughts are characteristic for that space. Silos as storages of food products, and inscribed clay tokens, papyri and papers become "*storages of meaning*" (Lévy, 1999, p. 177).

4.1.3 Commodity space

With the discovery of overseas regions and following development of world markets, a commodity space began to form, over the invention of printing press and first industrial revolution in the 18th century. It was based on the flow of materials, goods, and with advent of printing press increasingly of information and knowledge. According to Lévy (1999, p. 7), "wealth *was no longer based on controlling borders but on controlling the movement"*:

Control of the movement of goods, material, knowledge, resources, and human beings, (as slavery came into the existence again), in other words control of the extra-territorial movement of capital, is a decisive factor for the grade of power of the state. To possess an identity in such a space of capital, it means to participate in the production of goods. In relation to the territorial space this leads to addition of particular occupation to our identity within the spaces - name and address.

Typical mode of knowledge now becomes science. Through the flow of commodities, deterritorialization of the old space of territory takes place. It is still there, but the leading role now takes over the new space of goods. The existence of individual is now defined by participating in the processes of manufacturing, movement and consuming of goods and information. Lévy (1999, p. 153) states that "*signs of identity are quantified: income, salary, bank accounts*" and emphasizes the fact that consumption has become an important constituting factor for identity. Economy and the relation to it becomes the basis for the individual identity. To cite Lévy (1999, p. 154):

> *Thus the capitalist machine deterritorializes and accelerates a number of social processes, tirelessly constructs new cosmopolitan mechanisms, while it paradoxically limits the extent of subjective identity, which, in the commodity space, gravitates around the family, work, and money.*

In the territory space, there is writing as a principal mode of knowledge. With the printing press that fosters distribution of knowledge through books, there is a creation of a new form – media, mass-production and reproduction.

The basis of commodity space is economy, and the dominating mode of economy is capitalism, which according to Lévy (1999, p. 136) can only function through the territorial state, reinterpreting the surrounding cosmos (of existence) as a resource.

When the space of commodity establishes its autonomy over the space of territory, it has a deterritorializing effect. Lévy, as opposed to Castells, speaks of networks of flows of capital, goods and resources, which spread over the space of territory in the context of space of commodities. That is, these flows of capital and resources emerged after the first industrial revolution and before the information technology revolution: "*networks of communication, transport, distribution, and production are inextricably bound together, weaving a space of circulation*" (1999, p. 177), making the capitalism a planetary phenomenon.

4.1.4 Knowledge Space

In 1994, *space of knowledge* did still not exist, but it was coming into existence with the increased spreading of Internet, especially with the increasing use of World Wide Web which started in 1994/95. Lévy (1999, p. 8) describes three fundamentally new aspects of the emerging space of knowledge within cyberspace:

1 **Acceleration** of evolution of knowledge: science and technology develop so fast as never before. (compare Castells' (2000a) elaboration of deploying knowledge upon new information technologies to produce new knowledge)

2 **Quantity**: previously restricted, new knowledge is getting increasingly distributed and accessible

3 **Tools**: new cyberspatial tools for navigating the information – this is what later will be developed on the basis of WWW as specific scientist databases, digital libraries, and scientific tools and applications for instance Grid Systems on the basis of Service Oriented Architecture

According to Lévy, knowledge space is to emerge through (the use of) cyberspace. Its technology is digitization, through which it comes the shift towards virtuality. We can see the knowledge space growing more and more today, as more and more people shift their communication into various platforms on Internet and knowledge. Cyberspace, or as I call it in this thesis, Internet introduces virtuality and universality without totality into the sphere of communication and redefines it. I will elaborate more on virtuality and universality without totality in the chapter 4.2.

Information and knowledge become "dematerialized". There is a shift from printed matter, from reproduction in the more fluid dimension of interaction:

> *"Within the knowledge space, collective intellects reconstruct a plane of immanence of signification in which beings, signs, and things exist in a dynamic relationship of mutual participation, escaping the separation of territorial space as well as the circuits of the spectacle that characterize the commodity space".* (Lévy, 1999, pp. 168-169)

Of course, Internet cannot escape entirely from the space of commodity, or territory, as all those spaces do not replace each other, but coexist simultaneously.

But the organizing principle of the new knowledge space and its technologies differs from the previous organizing principles. Lévy (1999, p. 183) puts clearly the dynamic, virtual nature of Internet as structural difference of the new knowledge space:

> *The territory attempts to maintain borders, hierarchies, and structures. The knowledge space on the other hand is always in emergent state.*

Self-emergence of Internet

Internet as it is today in 2008, that means as a new communications space and space for sharing and distributing knowledge, was not developed by some specific state (space of territory) or a commercial company (space of commodity). Rather it is a self-emergent form of human culture, its needs and its use of technologies. Internet as a communication infrastructure was for a long time[24] a project of DARPA[25], but at that time, it could not be and it was not used as it is used today. Yet as it was given for the use to the community (first to the scientific, later to the public community), it developed into what we use today. Means of communication of Internet were developed mostly by scientists for their own research purposes, and were later embraced by public users. For instance, Internet Newsgroups as ancestor of today's online-forums were originally collections of information grouped according to the subject, distributed among servers and refreshed once per day. World Wide Web was developed by a scientist as a system for sharing documents among scientists; open-source software which is developed by non-commercial open-source community. Many other systems of communication and knowledge production on Internet also emerged independently from the space of commodity and capitalist mode of production[26].

[24] from 1969 until beginning of 80ies, when TCP/IP set of protocols was adopted
[25] DARPA - Defense Advanced Research Projects Agency
[26] For instance - IRC – Internet Relay Chat, a synchronous messaging system, was used as an idea for commercial (but free for users) chatting systems like ICQ or Skype;

Another new aspect of knowledge space can be seen also as a view of a new "cognitive ecology", because according to Lévy (1999, p. 200), "*the system for production and distribution of knowledge does not depend on the individual features of the human cognitive system alone, but also on collective methods of organization and the instruments with which information is communicated and processed*". This is what Castells would call network-logic, which becomes an autonomous factor.

4.2 Virtuality and universality without totality

Virtuality (Lévy, 2001, p. 29) and the new form of universality (Lévy, 2001, pp. 91-102) are two important features that cyberspace establishes. Virtuality in the cyberspace is created through the use of digitization and globalisation. Universality without totality is formed through interactive and dynamic re-creation of context on the Internet.

4.2.1 Virtuality

Virtuality as a concept is not new. Philosophically, virtual is everything that is in state of potential being – "*that which exists potentially rather than actually*" (Lévy, 2001, p. 29).

Virtuality of Internet emerges because of the use of digital information technologies. Digitization brings another level of representation into existence of cognitive dimension. It "represents the representation".

With writing, new dimension of representation came into existence, where letters in alphabet represent phonemes and words; words represent ideas and

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USENET was a forerunner of forums; both systems still exist but are not user-friendly in terms of today's GUI and functional standards, and are used mostly by IT-related people

concepts (through propositions and their combination into mental models, as it was described in chapter 2.2.2 and 2.3.1).

With the beginning of the use of computer technologies, digitization of information comes into existence, representing graphic symbols or picture by digital signs – bits that are readable only by computer, and dependent on the actual interpretation.

Because of the global aspect of Internet, information within it exists but has to be actualized; it is "*virtually present at each point of the network when it is requested*" (Lévy, 2001, p. 30). The perception of network dimension of Internet produces the important distinction – computers and digital information existed before Internet, but that alone did not create a knowledge space, because they were used mainly as substitution for processes that already existed.

Lévy states "*Cyberspace encourages a relation that is nearly independent of geographic location …*" (2001, p. 31), extending the aspect of virtuality to virtual communities, which are groups formed by the means of collaborative instruments on Internet, and identifies "*a general virtualization of the economy and society*".

> *"Ubiquitous information, interconnected interactive documents, reciprocal asynchronous communication within and among groups – the virtualizing and deterritorializing character of cyberspace has made it the vector of an open universal. At the same time, the extension of a new universal space expands the field of action for the processes of virtualization."* (Lévy, 2001, p. 32)

4.2.2 Universality without totality

The concept of universality in communication was already brought up in chapter 2.2.2. The shift from verbal communication to written text brought along the loss of shared context, which had to be re-established by the means of

universality. Reducing the text to fixed semantic frame enabled producing of self-explanatory texts, which could convey mathematic or religious knowledge. According to Lévy (2001, p. 96), this universal of writing is totalizing, because the meaning of the message, or discourse, must be the same in all times and all places.

Cyberspace introduces a new universality, because it dissolves modes of communication that bring together universality and totality in writing. Lévy claims that cyberspace communication brings us back to the verbal mode of communication through the creation of shared-context, "*but on a different scale and on a different plane*" (Lévy, 2001, p. XIV). Messages and knowledge exist in a dynamic context, dependent of the hyperlinked, non-linear structure, where every link adds a potentially new view of the text/information/knowledge in cyberspace. The global meaning is always constructed, and impossible to control. – In Lévy's words (2001, p. 101) "*Cyberspace is not disordered, it expresses human diversity*". It is without centres (it has network and non-hierarchical structure)[27].

Another important, but different aspect of universality is pointed out by Tim Berners-Lee et al. (2001). Tim Berners-Lee, the inventor of World Wide Web, states that in WWW any kind of document can be linked with any other kind of document. This means on media level, that WWW integrates all traditional media types like text, speech and video (newspapers, TV, radio). This new characteristic is unique in the history of media, since Internet collects all the media at one place, which no previous media did. Internet increasingly eliminates, or will eliminate the distinction between video, radio or newspapers, as distinct media. Classical distribution channels of traditional media will get more and more eliminated – whereas new ways of information distribution through Internet and ubiquitous access will gain more influence and space.

[27] The fact that was intended by Tim Berners-Lee(1989): hierarchical structuring does not allow the modelling of the real-world like WWW does. Competitors of the early WWW such as Hyperwave by TU-Graz, or Gopher had hierarchical structure and did not succeed, although Hyperwave was meant to be „The next generation Web". Sometimes too much structure simply restricts the potential of a system.

4.3 Technologies of information and communities of technologies

Lévy identified in “Collective Intelligence” (1999) for every anthropological space a specific kind of knowledge, identity and technology that characterize particular space.

4.3.1 Technologies of information

Concerning the technologies of information, he identifies three principal kinds of technologies (Lévy, 1999, p. 46-48):

1. **Somatic** (bodily): messages that require the presence of body and enable direct communication and direct transfer of knowledge. These comprise speech, dance, singing or playing an instrument, or acquiring some other skill for which it is essential to be in a physical proximity of a person who performs it. Somatic messages are always multimodal. Verbal communication consists of speech, body and face gestures. Somatic technologies of information are always unique in their presenting context, and cannot be exactly reproduced.

2. **Media**: technologies that reproduce messages distributing them temporally and spatially, as Lévy (1999, p. 46) puts it, “*messages continued to be distributed in the absence of their creators”*. They include writing, which describes as an element of the first technology of reproducing speech. Those technologies are hence decontextualizing, distributing, and introduce massification of messages. They tend to exactly reproduce the messages, although this is not always possible (for instance, the analog recording of the sound or scanning pictures to be printed in the book always implies some loss of information). Media technologies were largely affected by printing.

3. **Digital**: based on information technologies, which extends the dimension of reproducing and distribution of messages. According to Lévy (1999, p. 48) "*digitization enables us to create, modify, and even interact with messages, …, bit by bit*". Once the message is created, there is no loss when reproducing or changing or recreating it. In cyberspace, those technologies create "*a dynamic matrix through which a navigator, reader, or user can create an individual text based o the need of the moment.*" Lévy (1999, p. 49).

The recreating of a desired context through technologies of digitization creates a *dynamic* cyberspace that virtually connects all information that it comprises. There is no more stable, static space of scientific and public libraries and books, where the context is hard-wired in the book. This old space still exists, but it is augmented by the new space of information in motion and fluctuation. It is this dynamics of cyberspace that leaves it essentially uncontrolled. According to Réka et al. (1999, p. 130), "*the continuing changing of documents and links makes it impossible to catalogue all the vertices and edges*".

Réka et al. conducted a study where they tried to determine the diameter of the World Wide Web, which they viewed as a large graph, where documents present vertices, and links correspond to edges. They draw on Lawrence and Giles' (1999) study, who estimated in 1999 that there were about 800 million of documents in the WWW. Surprisingly, Réka et al. determined the average diameter, which they defined as the shortest path or the smallest number of links between two randomly chosen documents, to be of approximately only 19 clicks. They also determined the logarithmic dependency between the diameter and the number[28] of the documents in the WWW, which means that if Web grows for a factor of 10^3, the average number of the clicks between two random documents will increase from 19 to only 21.

Almost 10 years after Réka's study, the number of indexed pages in WWW is at least 25.07 billion pages[29]. But this number does not include the "invisible

[28] $d = 0.35 + 2.06\log(N)$; d=diameter, N=number of documents in WWW; Réka et al., (1999).
[29] http://www.worldwidewebsize.com/, [30. November 2008]

Web" – a big part of web that cannot be reach by indexing mechanisms of searching machines, but creates an immense knowledge and information space - pages secured by authorization, pages generated at demand from specialist databases and applications, and pages with no links to them (for instance, documents/illustration/information within Adobe Flash Player and other applications which can not be indexed because the are not presented in machine-readable HTML-format).

4.3.2 Human communities

Lévy identifies three types of human communities which resemble the technologies of information. The first group is the *organic group*. This type of community comprises smaller groups whose members have a direct contact with each other. This is the case with families, clans and tribes. The members are aware of activities of the members.

The second group is more organized. Its shape began to emerge in the space of territory and commodity; its main feature is organization, so this *organized* group consists of institutions, nations, and big corporations. Members of the group are not aware of each other, so some kind of mediation is needed. Differentiation is introduced by bureaucracy. These groups usually form around some center – king or president, who is the organizing center. Individuals within the group are seen as a quantity, seen in relation to the whole, as members of some category.

Self-organized groups stand in contrast to *organized* type of groups, and they emerge within larger organizations. They are flexible, centered around and seen in relation to their projects, with strong emphasis on social bond and individual qualities. Space of knowledge, cyberspace as Lévy calls it, will provide a platform for self-emergence of self-organized groups, and will contribute to weakening of media-based communication.

5 Theory of organizational knowledge creation

In the previous chapter I have elaborated Lévy's theory of anthropological spaces and knowledge space in particular. Lévy's aim is to describe human spaces of existence in terms of classifications, to describe technological revolutions within a scope of society and to give an account of the emerging knowledge space in Internet, and not to describe how knowledge creation happens in detail. In this chapter I shall describe in detail how knowledge is created and distributed by humans in society, particularly in organizations.

For this purpose I will describe the theory of organizational knowledge creation by Nonaka and Takeuchi. Nonaka and Takeuchi are economic scientists. Their theory is positioned in the area of Knowledge Management, and can be adapted to creation of scientific knowledge at universities as well[30]. I will discuss which parts of it can be adopted on knowledge creation in science, and later on knowledge creation in Internet and knowledge space postulated by Lévy.

I had already adopted the definition of knowledge postulated by Nonaka & Takeuchi in chapter 2.1. This definition of knowledge is a synthesis of Japanese view of knowledge and the Western rationalist approach to knowledge.

Japanese notion of knowledge is closer to notion of tacit knowledge that was introduced into Western scientific thought by a chemist and a philosopher Michael Polanyi (1962) (1966). Japanese view is valuing more the aspect of direct, personal experience (Nonaka & Takeuchi, 1995, p. 31), as opposed to Western view, which is more rationalist in its approach, focused at systemizing and organizing knowledge, and is characterized by the dualism of subject and object (Nonaka & Takeuchi, 1995, p. 25). This rationalist approach can be traced back to Aristotle (inventor of logic) and Descartes (duality of body and mind). It found a way to manifest itself through developing conceptual and theoretic systems determined by accurate methodology – the biggest one being science. Nonaka & Takeuchi try to complement this western rationalist view of science and knowledge

[30] Nonaka & Takeuchi present big Japanese companies as use-cases for their theory

in drawing on works of Japanese philosopher Kitaro Nishida[31]. As the most important principle in Japanese philosophical tradition they name the "oneness of humanity and nature", which relates to a view of nature that can be seen also in the Japanese language through the often use of pictures, relating to "*the concrete pictures of experience*" (Nonaka & Takeuchi, 1995, pp. 27-28) – "*Japanese think more visually and manipulate tangible objects*". Nonaka and Takeuchi view this tradition as complementary to Cartesian separation of body and mind. In the same way is "*oneness of body mind*" observed, a principle expressed philosophically by Kitaro Nishida. He denies the separation of body and mind in relation to the direct experience of the reality, and bases his philosophical approach on the "question and answer" principle of Zen, neutralising the duality of body and mind. According to Nonaka and Takeuchi (1995, p. 31), this approach results in valuing more the direct experience (expressed as personal knowledge, know-how).

Nonaka & Takeuchi consider knowledge creation in combining Japanese view of personal, hard-to-formulate knowledge, with the approach of western rational, more static view of knowledge. They develop their theory on the example of Japanese companies, which they use as case studies, and their knowledge-management techniques. Through analyzing how Japanese companies manage innovation and create competitive advantage, Nonaka & Takeuchi display the strength of Japanese companies' skills and expertises in knowledge creation.

One of the renowned recent theories which reflect on knowledge and learning is constructivism[32]. It basically states that in order to acquire knowledge we must "construct" it in our mind. It thus emphasizes the role of the learner and the individual aspect of learning. It has some parallels to theory of mental models, insofar as according to Piaget, people when acquiring knowledge, internalize it through accommodation and assimilation into existing psychological frames, but it denies the fact that knowledge exists anywhere except in the human mind. Opposed to classical constructivist theory, which declares that knowledge exist

[31] Kitaro Nishida was the most important Japanese philosopher in 20th century. Stanford Encylopedia of Philosophy, http://www.science.uva.nl/~seop/entries/nishida-kitaro/, [2.11.2008]

[32] For further inquiries into constructivism see works by Piaget and Von Glaserfeld.

only within an individual mind (Peschl, 2003), Nonaka and Takeuchi (1995, p. ix) assume that knowledge exist on three levels:

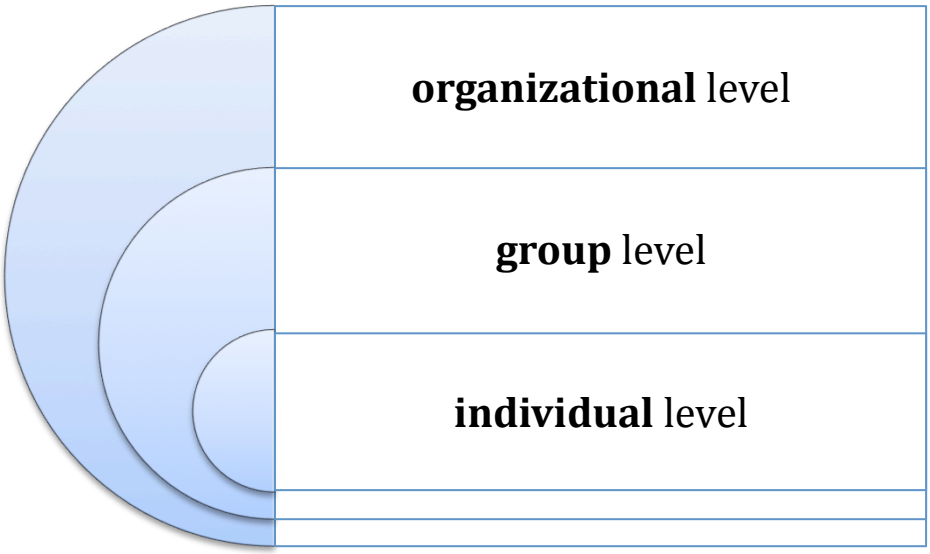

Figure 1: Levels of knowledge according to Nonaka & Takeuchi,1995

According to the taxonomy in Figure 2, Nonaka & Takeuchi describe knowledge creation as a process of dynamic interaction that permeates those three levels. These "*three levels of knowledge creation*" present the first component of knowledge creation. The second component in their theory are the "*forms of knowledge creation*" (1995, p. ix) – interactions between individual and organizational level, and interactions which they describe as conversion from tacit to explicit knowledge (1995, p. 61). The notion of tacit and explicit knowledge is crucial for Nonaka & Takeuchi's explanation of organizational knowledge creation, and will be elaborated here in detail.

5.1 Tacit and explicit knowledge

Michael Polanyi was the first to realize the importance of tacit knowing. He was a scientist coming from natural and exact sciences (medicine & chemistry) but he made a shift towards philosophy and social sciences. He coined the term "***tacit***

knowing", which describes the implicit mode of personal knowledge, upon which according to him, we build all our knowledge.

Polanyi argues: "*we can know more than we can tell*" (1966, p. 4), the "t*acit knowing*" is hard to tell, but possible to communicate, as he expresses. *Tacit knowing* is highly personal, as opposed to the otherwise striven objective scientific knowledge and truth. Moreover, for Polanyi is tacit (personal) knowing the hidden source of all scientific knowledge, because:

> *"Tacit knowing is shown to account:*
>
> *1. for a valid knowledge of a problem*
>
> *2. for the scientist's capacity to pursue it, guided by his sense of approaching its solution*
>
> *3. for a valid anticipation of the yet indeterminate implications of the discovery arrived at the end"*
>
> (Polanyi, 1966, p. 24)

In form and content, tacit knowledge corresponds to mental models that are highly personal constructions, but it also corresponds to feelings about something, and intuition, all of which flows into creation of new knowledge when solving a problem.

Codified knowledge can be seen in opposition to tacit knowledge but the relation is more a complementary one than an oppositional. Polanyi (1969, p. 144) states that these two types of knowledge are not sharply divided. Moreover, Polanyi argues that all knowledge is either tacit or rooted in tacit knowledge, since explicit knowledge must first be implicit. In Polanyi's words (1969, p. 144) it is "*being tacitly understood and applied*" first. This process of "*being tacitly understood*" perfectly corresponds to creating internal mental models, which are

according to Johnson-Laird created when people try to understand certain phenomena.

Nonaka and Takeuchi draw on Polanyi's description of tacit knowledge. In their theory there is an emphasis on the importance of tacit knowledge for creating and sharing knowledge.

> *"Tacit knowledge is personal, context-specific, and therefore hard to formalize and communicate. Explicit or "codified" knowledge, on the other hand, refers to knowledge that is transmittable in formal, systematic knowledge."* (Nonaka &Takeuchi 1995, p. 59)

Codified knowledge thus comprises formalized, explicit knowledge in forms of recipes, documents, and research-papers. According to Polanyi (1962, 1966) explicit knowledge is the outcome of the tacit knowledge. When we posses a skill, we cannot tell exactly or specify how we are doing it. For Polanyi, this is tacit knowledge. But also when we recognize people on pictures – we are not able to tell how exactly we recognize them. When we learn a language – this surely represents a tacit process of learning, because we may never be able to specify how we learnt a language, although we know it. It is then called "learning-by-doing".

Nonaka and Takeuchi (1995, p. 61) further elaborated the concept of tacit knowledge, combining it with the concept of mental models. They distinguish two main components of tacit knowledge, **cognitive** and **technical** component. They identify the cognitive elements of tacit knowledge with mental models, schemas, but also with more personal perspectives and beliefs. Skills and concrete know-how are ingredients of the technical component of tacit knowledge[33], and can be best learnt by direct learning from an expert. It is this that Lévy calls "somatic", because it needs a physical presence of the demonstrator. This includes all kinds of skills, artistic as well as manufacturing.

[33] Compare Polanyi on "*concept of apprenticeship*" (1962, p. 53) and transmission of knowledge learning from a master.

Table 1 shows the characterization of tacit and explicit knowledge by Nonaka and Takeuchi.

Tacit Knowledge (subjective)	**Explicit Knowledge** (objective)
• Knowledge of experience (body) • Simultaneous knowledge (here and now) • Analog knowledge (practice)	• Knowledge of rationality (mind) • Sequential knowledge (there and then) • Digital knowledge (theory)

Table 1: Tacit and Explicit Knowledge. according to (Nonaka/Takeuchi, 1995, p. 61)

According to Table 1, tacit knowledge is subjective and experience-related, whereas explicit knowledge is objective and "rational". Explicit knowledge is thus about specific instances that happened in the past or shall happen in future, i.e. it is sequential, where tacit knowledge is formed and exist "here and now", within a specific individual context. Since it is knowledge of experience, it can also be called "analog" knowledge that is learnt by apprenticeship, by intelligent imitation, by doing; and not by learning mere discrete facts, which corresponds more to explicit knowledge. Explicit knowledge comprises clear, systematically organized facts that are codified when taken out of a personal context, or extracted from individual mental model.

The process of conversion from tacit into explicit knowledge is the actual process of knowledge creation. Nonaka and Takeuchi (1995, p. 61) define it as:

> *"Human knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge"*

5.2 SECI Model of knowledge creation

Nonaka and Takeuchi (1995, p. 62) describe the process of knowledge conversion as going through four phases, within which knowledge gets converted:

1. **Socialization**: from tacit to tacit
2. **Externalization**: from tacit to explicit
3. **Internalization**: from explicit to explicit
4. **Combination**: from explicit to tacit

Socialization

Socialization is the process of converting tacit knowledge to tacit. It happens between individuals through informal contacts. What is exchanged are more personal values, views, opinions, and personal approaches. This phase is stil not about transferring factual knowledge. It presumes physical proximity. It is about "*sharing mental models and technical skills*" (Nonaka&Takeuchi, 1995, p. 62), and "coming together", getting to know each other's way of thinking, and as Nonaka & Takeuchi emphasize, sharing and creating experience. This phase is a starting point of organizational knowledge creation, but it also presents a mode of knowledge transfer relating to skills, when an apprentice (today we could say trainee) "learns by doing" from master/expert. The fact that matters here is getting experience - which cannot be specified in words or through language. This shared experience is embedded within a certain context.

One example of socialization process is the direct learning from master/expert, where the trainee gets the experience and later the skills that master already has. Other example of socialization process is when a company sends certain department on a short trip, may it be one afternoon, or couple of days, where people get together and exchange their views, and later have informal talks on some company-matter projects they work on. Apart from exchanging their

mental models, they create in an informal way a shared mental model-of the situation or a task they work on.

Nonaka & Takeuchi view contacts with customers that are carried out by organizations also as sharing tacit knowledge. This is a perspective that can be important for the latter examination of Internet knowledge space.

Externalization

It is in the process of externalization that tacit knowledge gets expressed as explicit. Nonaka&Takeuchi argue that this process creates new explicit knowledge from the tacit knowledge. When they suggest that this should happen preferably by the use of metaphors and analogies, they have more creation of new concepts in relation to products or projects on their mind. In order to describe something new, you have to use old concepts, but applied to new matter, which can indeed be best expressed through metaphors and analogies. But when defining models, we can specify their characteristics without use of metaphors. At the beginning I tried to express the new concept of Internet as “knowledge structure”. This would be exactly the externalizing of tacit ideas by metaphor. Lévy uses another metaphor to describe human social constructs, a term that I adopted, namely the term “space”, although there is no physical space created, but a “space of human relations, values and technological and social structuring”. This is another use of a metaphor.

Combination

The 3rd phase of knowledge conversion/creation is a combination process of externalized, explicit knowledge. In this process explicit knowledge, which can be of different kind and from different sources, is first found – extracted from reports or documents, and then eventually distributed among organization e.g. through meetings or lectures and trainings, to be finally processed in order to create a basis for the next step – internalization of the external knowledge. Recombination of existing knowledge thus leads to new knowledge, in finding new relations and connections between existing codified, systematized knowledge.

Nonaka&Takeuchi state that formal education, or MBA education is founded on that mode of knowledge creating.

For instance, a lot of research for this thesis was conducted online, which involved finding relevant documents and studies, comparing and combining material that was found.

Internalization

Finally, the explicit knowledge that was found and combined must be internalized in order to be really understood and applied in practice. Learning only to memorize certain facts is not yet knowledge, it has to be put in action. Nonaka & Takeuchi speak of embodying the explicit knowledge, which is stored in systematic documents, diagrams, manuals or stories. Thus knowledge gets converted to the individual know-how, which is in organizations achieved through “learning-by-doing”, training and exercises, or by using simulations/virtual situations.

5.2.1 Examples for SECI

Successful software development in an organization is basically a process which passes through all four stages of SECI-knowledge creation. Shared mental models have to be created through socialization in teams, so that everybody understands the concepts and ideas. Secondly, through documentation of software and requirements, tacit ideas and concepts are made explicit. This is the stage of externalization. Then, already exiting concepts can be found and re-used, code-examples, concepts and similar solutions (for instance MSDN for Microsoft-world, or numerous online-tutorials for other platforms) are located and combined so that new desired result is achieved. Finally, the external explicit concepts and code-examples cannot be reused as they are. Rather, they have to be adapted to the specific task, that means changed, and understood. This resembles the stage of Internalization of explicit knowledge.

Creation of this thesis is also the product of the SECI-based knowledge creation. Through informal discussions with friends, through sharing ideas about Internet, “socializing”, and attending the lectures at the university, the idea of knowledge space developed. Through externalization, that is verbalization of tacit knowledge and ideas took place. Combination of that explicit ideas with the explicit ideas of others lead to internalization process of knowledge gained through studying other ideas written down in scientific papers and books. Knowledge made explicit in this thesis will eventually be used later by someone else in the scientific community, thus continuing the spiral of knowledge creation.

Visually presented this process looks like in Fig. 3.

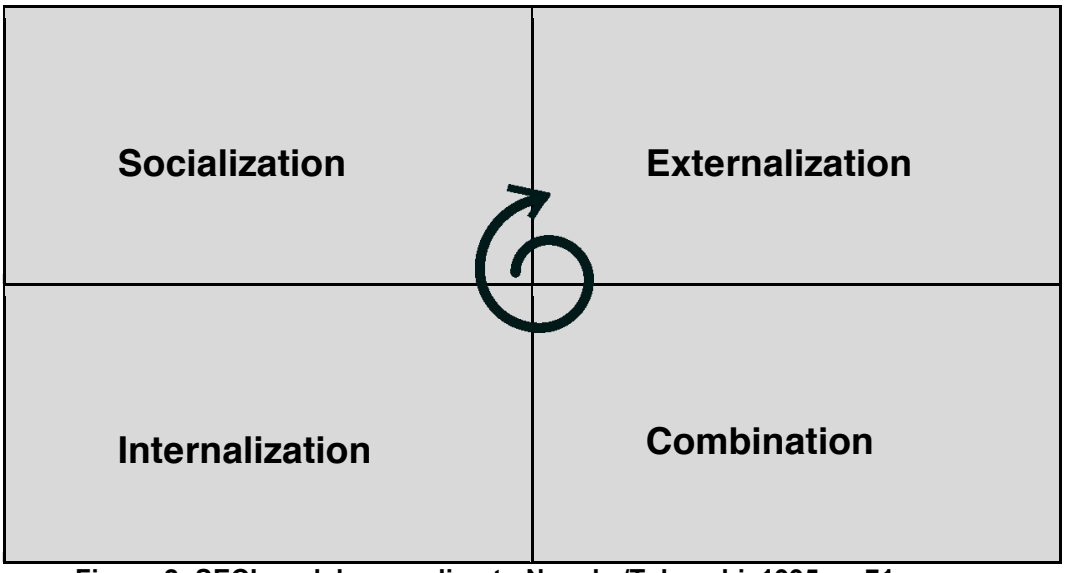

Figure 2: SECI model, according to Nonaka/Takeuchi, 1995, p. 71

SECI processes connect individual knowledge with the organizational (above-individual, collective) knowledge and the other way around, describing a way of transcending oneself and one self’s limited scope of knowledge. Within organizations, this means that individual tacit knowledge is the basis for organizational knowledge creating. As the knowledge evolves within an organization, it expands, but it also can happen that it crosses organizational boundaries and eventually disperses (for instance into Internet).

5.3 Concept of "*ba"* - common space for knowledge sharing

What is the difference between knowledge and information, and what is its practical dimension? When can we speak about knowledge and when is there only information? Nonaka & Konno propose simple and practical solution to the problem of distinction between knowledge and information.

Nonaka and Konno introduce the concept of "*ba*", which is Japanese word for *place,* as a constructive platform for knowledge creation. They (1998, p. 40) define it as a "*shared space that serves as foundation for knowledge creation*", or in another aspect, a "*context which harbours meaning*".

While the first definition relates to "knowledge space", the second definition is useful for distinction between information and knowledge. Nonaka and Konno state that knowledge is contained in one of the shared spaces (which can be according to them physical, virtual or mental spaces), where it is acquired and shared through SECI interactions, but once when it leaves the shared knowledge space – *ba*, it turns into information Thus knowledge dwells in *ba,* while information exists in media and networks (Nonaka & Konno, 1998, p. 41).

This distinction between knowledge and information corresponds very well to the view of Davenport and Prusak, another two distinguished scientists in area of Knowledge Management. Davenport and Prusak are also concerned with knowledge creation within organizations. It is not the aim of this thesis to compare these two theories, but in order to clarify the concept of knowledge creation relating to *ba*, I will briefly compare it with the concept of knowledge by Davenport and Prusak.

Davenport and Prusak (1998) view knowledge, as opposed to Nonaka and Takeuchi, as a resource that is exchanged between interested buyers, sellers and brokers. Buyers are people who need knowledge, sellers are people who have it and can sell it to others. Brokers are people who connect the former two groups.

Davenport and Prusak give, what they call "*a working definition of knowledge*", because as they say, "*Knowledge derives from minds at work*" (1998, p.5).

They define knowledge as:

> *"Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the mind of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms". (Davenport & Prusak 1998, p.5).*

This definition is similar to Nonaka and Takeuchi's view in that it defines knowledge as a personal asset, contextually dependent, residing in the individual mind (tacit), but also exchanged through the means of documents, and "learning-by-doing", which corresponds to the processes of knowledge transformation that Nonaka and Takeuchi specify within SECI model.

Information is identified by Davenport and Prusak as a meaningful message – "*Information is data that makes difference"*. Information put in broader context gives knowledge. Table 2 gives an overview about data, information and knowledge according to Davenport and Prusak.

Data	Information	Knowledge
Simple observations of states of the world • easily structured • easily captured on machines • often quantified • easily transferred	Data endowed with relevance and purpose • requires unit of analysis • need consensus on meaning • human mediation necessary	Valuable information from the human mind Includes reflection, synthesis, context • hard to structure • difficult to capture on machines • often tacit • hard to transfer

Table 2: Data, Information and Knowledge, according to Davenport/Prusak, 1997, p. 9

If we neglect the aspect of Data in the Table 2, we can conclude that both Davenport and Prusak, and Nonaka and Takeuchi have similar concepts of Information and Knowledge. "*Needed consensus of meaning*" resembles creating of shared mental models, when there is still no explicit knowledge exchanged, which happens in stage of Socialization, as well as through the human mediation. "*Hard to structure*" and "*difficult to capture on machines*" resembles the phase of Externalization and Combination, while "*hard to transfer*" resembles the stage of Internalization.

UNESCO World Report Towards Knowledge society gives an extensive comparative explanation of knowledge and information:

> ***"From information to knowledge and vice versa***
>
> *Transforming information into knowledge presupposes an effort of reflection. Information as such is only raw data, the basic material for generating knowledge. It follows that information can in a very real sense be "nonknowledge".*
>
> *… .*
>
> *However, the reflective nature of the judgment required to convert information into knowledge means that this process involves more than a mere verification of the facts. It implies a mastery of certain cognitive, critical and theoretical skills that are precisely what knowledge societies will seek to develop. While we may drown in a flood of information, knowledge is precisely what enables us to "orient ourselves in thought".*
>
> *The distinction between knowledge and information would remain fairly simple if we were to focus simply on the transformation of information into knowledge. However, information is not only raw data but also the product of an operation by which it becomes such – namely, a shaping or packaging to make it manageable, transmissible and consumable. This operation can be performed equally in respect of knowledge and non-knowledge. Thus, the distinction between knowledge and information must also take into account the process whereby knowledge is shaped as information (known in the current jargon as the "informationalization" of knowledge). In this process of commoditization, knowledge acquires a material dimension that*

> *makes it more operational and easier to process. It thus becomes the means for producing new knowledge. Information is what is transformed, through appropriate processing, whereas knowledge is what is produced – knowledge production always being based on a level of knowledge and on the transformation of information.*
> *While knowledge production arises from a kind of transmutation of information, knowledge itself is transformed into information so that it may be processed and produce new knowledge. The innovation that gives rise to new knowledge productivity gains is located precisely within this "virtuous circle". (UNESCO, 2005, p. 47)*

UNESCO report distinguishes between information and knowledge and states that transition of information into knowledge requires an act of reflection, i.e. cognitive process of creating knowledge, which resembles embedding of information into the context through the creation of an internal mental model. This is exactly the stage of Internalization in SECI model. In general, we can say that knowledge is result of cognitive processes that transform information into more meaningful context

In the same place, the report points out at the inverse process – getting new information from the current knowledge, which in turn becomes again new knowledge. It describes the process of knowledge creation from the gathered information by including into it the epistemological dimension expressed by Plato (*knowledge as justified, true belief*), but also using the concept of *ba* and SECI model, when referring to creating information from knowledge, and vice versa.

Ba is according to Takeuchi and Konno also a frame within which knowledge is created and concentrated as a resource for creation of new knowledge. Organizationally, its borders are that of time and space. Participating in *ba* means becoming a member of team for knowledge creation. Knowledge creation always means transcending of one's own limited perspective, but it happens within *ba* – which exists on many levels, for instance, physical, virtual and mental. One *ba* can be contained within other greater *ba*. This happens for instance when an individual is a member of a team (which presents a greater *ba),* and a team is a part of an organization (even greater *ba*).

For instance, knowledge made explicit by an individual working on a project "degrades" to information when the individual leaves the organization that he belongs to, and, if this knowledge was only part of the individual's mental *ba* and was not spread among other members of organization. This happens because with this individual leaving the organizational *ba*, knowledge too leaves the boundaries of the organizational *ba*. It then has to be incorporated again by someone else who is member of the organization, into his own mental *ba* and into the broader organizational *ba.*

5.3.1 Types of *ba*

Ba is a central concept in a spiral model of knowledge creation of Nonaka and associates (Nonaka & Konno, 1998; Nonaka & Takeuchi, 1995). Corresponding to four levels of SECI model, there are four types of *ba*.

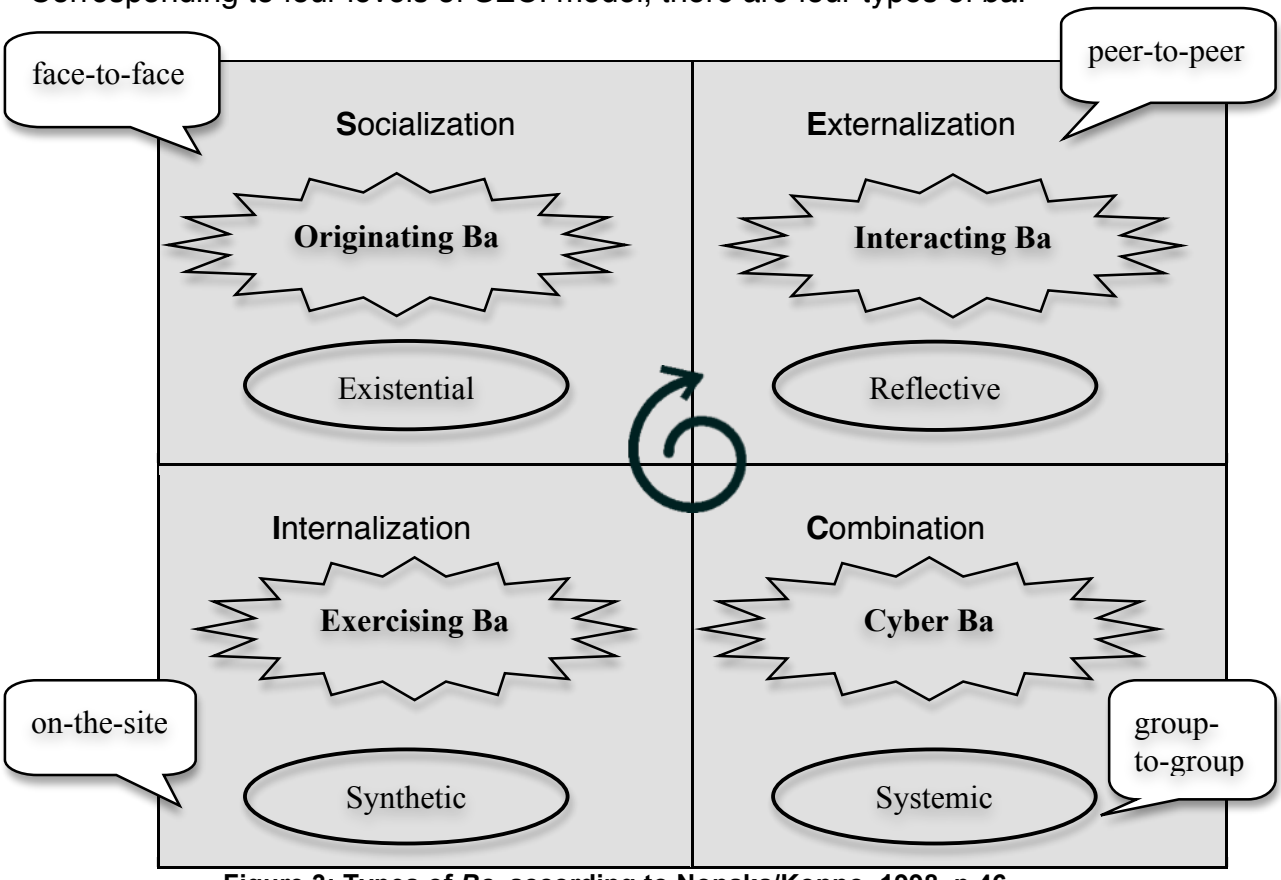

Figure 3: Types of *Ba*. according to Nonaka/Konno, 1998, p.46

Originating *ba* is positioned in the Figure 4 as a b beginning, primary ba for knowledge creation. Socialization, i.e. direct, face-to-face communication, and physical proximity is the important feature of this type.

Interacting *ba* is a conscious attempt of converting individual mental models and skills into common, shared, but more formal concepts.

The third type is called cyber *ba* because interactions happen here on a virtual level. What Nonaka and associates mean here with “virtual world” is the dimension of databases, electronic documents and reports, and organizational cooperation with the means of collaboration tools. In cyber *ba*, knowledge from different sources gets combined and spread throughout organization, efficiently supported by new information technologies

Exercising *ba* is where external knowledge is put into personal practice. Tacit knowledge is created through training with experts, learning-by-doing or training in simulated environments.

These are not four different spaces for knowledge creation, but rather different qualities of one knowledge creation cycle.

6 Discussion and conclusion

In Chapter 3 I discussed the role of language and writing as knowledge-modeling systems, and pointed out at the implications of the invention of printing press and printed matter for knowledge creation. In Chapter 4 I discussed Lévy's concepts of anthropological spaces, in order to highlight new aspects of existence that the new anthropological space of knowledge is introducing.

What are these new aspects?

First of all, aspect of Internet as a new knowledge-modeling system - the knowledge space.

The knowledge space postulated by Lévy emerges from the paradigm of network. Network distributes its resources and its points of access on a greater scale than it is possible in the "space of commodities", which is limited by matter the commodities are made of, and its non-digital mode of transfer of information. Opposed to this are the immaterial software-service and dematerialization of information and knowledge – virtualization, as the new principles.

Self-organized groups

New knowledge space has initiated the emergence of self-organized groups, as it was proposed by Lévy. These self-organized groups are "virtual communities", coming into existence through the use of Internet and centered around different personal interests. There are groups based on common fun interests (online games), on educational interests (university forums and blogs, but also *Facebook*), business (*Linked-in* community), artistic (many virtual community services with the goal to connect artists from similar areas like painting, film or photography), and religious ones (different religious platforms, for instance Christian or Muslim ones).

Facebook, a social networking site, was initiated as a service to connect students to share their interests and activities. Its members can join diverse

interest groups in order to create public pressure or just to exchange ideas and "socialize". But it is exactly this large community and distributed nature of the service that give a considerable amount of influence to *Facebook*. A study conducted by ITU in 2008 on the use of ICT by children and youth showed some interesting data. According to data about *Facebook* membership growth (ITU, 2008, pp. 35-36), *Facebook* gained around 1 million members only 8 months after it was started. Between 2006 and 2007 the number of its members jumped from around 10 million to approximately 55 million, having in February 2008 more than 60 million of users. The reasons for popularity of such social networking services will be discussed later, but this fact illustrates how popular such services are, that enable the emergence of self-organized groups within a larger organization.

The ITU study on use of ICT by young population also shows that mode of communication is changing. In 2006, 31% of 12-17 years old in USA spent time with their friends every day, 27% sends text messages over cell phones, and 21% communicates over social network sites (ITU, 2008, p. 39)[34]. 74% of 15-24 years old persons used Internet in 2003. 64% of 15-24 years old persons used it for educational or learning purposes in 2003. In Austria 68% 16-24 years old persons used Internet every day in 2006, and 41% of those persons used it for educational or learning activities (ITU, 2008, p. 72). The study also shows that young people are not using the Internet just as consumers (as this is the case with print or video media), but are actively producing and generating the content, in form of creating blogs and publishing pictures, texts and videos. This content is called *User Generated Content*, and presents and important distinction to classic media, where communication is mostly unidirectional one-to-many communication → one author addresses the mass public through newspapers or a documentary film. In Internet there is a many-to-many communication, where consumers are at the same time producers of content through the means of blogs ("Web 2.0" technology[35]).

[34] ITU relies here on PEW-study: http://www.pewinternet.org/pdfs/PIP_Teens_Social_Media_Final.pdf
[35] „Web 2.0" is actually a buzzword for the new possibilities of creating WWW-content. Web 2.0 enables persons who are not interested in technical details of WWW-creation, to easily create their own multimedial content. This results in more and more persons producing their own web-content. Examples: YouTube.com, Wikipedia.com, Flickr.com

Another example of self-organized groups is the community of open-source[36] developers, grouped around the idea of free-software and the idea of changing the society with their work. For instance, numerous Linux-distributions and other open-source projects[37] would be impossible without the Internet that connected people from different parts of the world working on the same project. Although there are smaller closed groups that develop open-source software, the open source Linux operating system is developed by the large community from all over the world. It also must be said that this mode of software-development presents an important counter example to patent-based mode of development.

Arguably, Internet and social networking sites are used in daily communication, and communication is increasingly becoming technological, being based on ICT. Internet and mobile phones (in USA still landline phones (ITU, 2008, p. 39)) are the main means of technologically based combination, but social networking sites have a different quality of communication than text messages on the mobile phone, since they enable more diverse exchange of information such as exchange of pictures, videos and stories.

Knowledge space is not only an infrastructure and a medium, beyond that it is also a virtual space where knowledge is diffused, shared and acquired through social contacts. When Castells (2000a, p. 404) speaks about the *real virtuality:*

> *"It is a system in which reality itself (that is people's material/symbolic existence) is entirely captured, fully immersed in a virtual image setting, in the world of make-believe, in which appearances are not just on the screen through which experience is communicated, but they become the experience."*

- he actually speaks about the knowledge space as defined by Lévy. Castells' real virtuality is a good explanation of knowledge space.

[36] Open source definition can be found at OSI-site: http://www.opensource.org/docs/definition.php
[37] For open-source projects go to http://sourceforge.net/

How can the theory of organizational learning be applied to Internet as knowledge space?

Internet as knowledge space can be viewed as shared knowledge space - *ba*. It fulfils the requirement of Nonaka and Konno (1998, p. 40) who allege that *ba* is differentiated from ordinary human interaction by its concept of knowledge creation – an important feature that we find on Internet.

Three aspects of Internet in relation to organizational knowledge theory can be identified.

First, Internet is an extension of organizational (physical or mental) *ba*. Those shared knowledge spaces expand through the Cyber *ba* into Internet. The Cyber *ba* of an organization extends into Internet through the publication of organizational documents (R&D publications and results, company's best practices, tutorials, use of Internet-collaboration tools). This direction of extension resembles producing information towards the greater *ba*. The other direction is gaining information from the Internet and integrating it into personal and organizational *ba*. Again, tutorials, best practices, examples, use-cases from Internet can be identified and integrated into organizational knowledge.

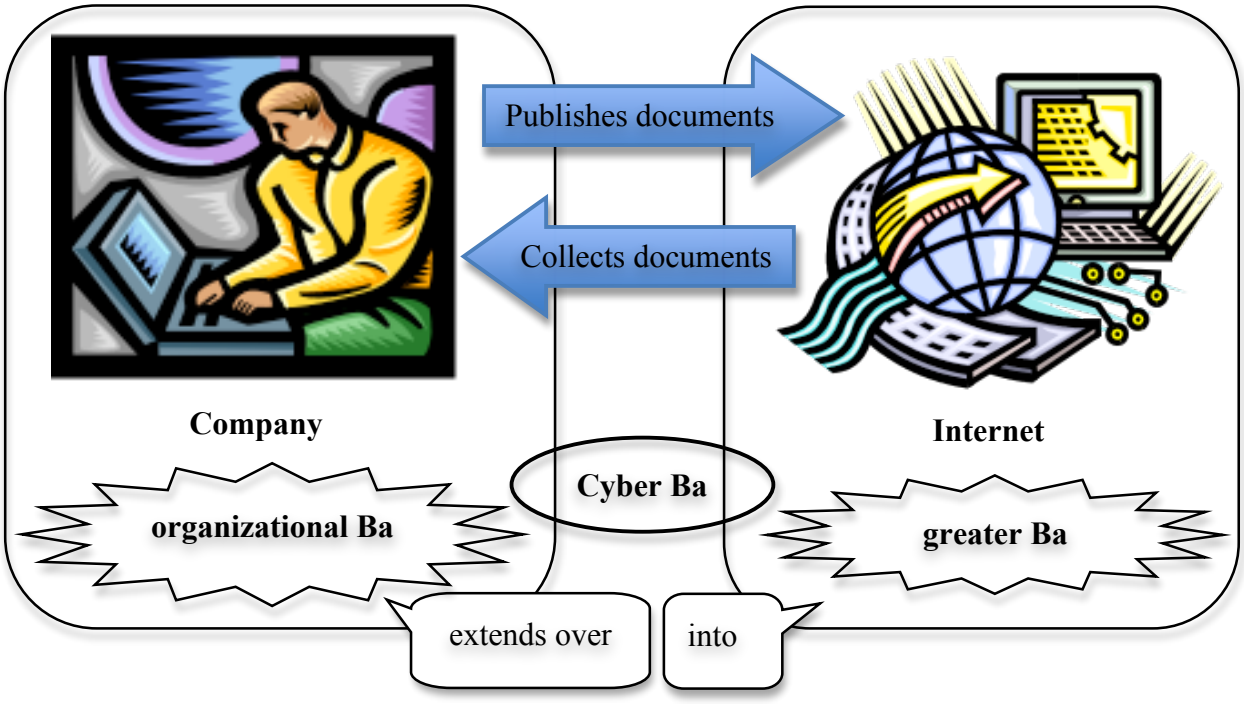

Figure 5: Extension of organizational Ba

Hence, knowledge space of an organization gets integrated into greater *ba* of Internet and is at free disposal for others to integrate it into their own *ba*.

Second, Internet is a greater *ba* that encompasses various knowledge spaces, stretching from individual ones, over knowledge spaces of self-organized groups (such as open source community), and including those of commercial and non-commercial other organizations. This greater *ba*, as a virtual shared space for emerging social relationship that enables knowledge creation and sharing, resembles exactly the knowledge space of Lévy. The characteristics of this new knowledge space/greater *ba* can be depicted as tensions between the new and the traditional knowledge structures.

oral and written knowledge systems	**Internet as knowledge space**
hierarchic structure reflecting human organizations	network paradigm / self emerging on a large scale due to WWW without hierarchy
linear – sequences of written or spoken words	distributed knowledge / information
static knowledge	dynamic context
spatially bounded knowledge (situationally, or restricted to printed matter)	space- and time-unbound: ubiquitous
more constant (residing in books/fixed tests)	virtual / recreating

based around centres of authority: libraries, universities (schools)	all pervasive accessibility
restricted to certain geographical areas (centres of knowledge production)	less or no geographical restriction of diffusion
fixed context	dynamic → more fluid due to dynamic context generation
centralized knowledge sources – few scientific magazines	variety of sources - specialist online databases for drugs and medication, patents, publications databases
bound to material (books)	online resources and courses, online books, digital libraries
stable	ephemeral
collected in libraries	more redundant

Table 3: Tensions between traditional and new knowledge modelling systems

And third, the implications that follow from the fact that Internet is a greater *ba* which encompasses other levels of *ba*, are that Internet must include the whole SECI model of knowledge creation.

A good example of an organization where knowledge gets disseminated and created is university with its scientific educational and research conducting work. Creation of new knowledge on organizational level happens here mostly through the means of research. In more individual aspect, knowledge creation happens through the teaching, when knowledge gets transferred or conveyed from teacher to students. Here, students are members of university, and according to SECI, the most important phase in knowledge creation is the Socialization stage.

Socialization with other students enables sharing and creating of common mental models, in this stage so-called “informal learning” takes place. Attending classes enables creation and sharing of common mental models with lecturers, because it implies direct face-to-face communication. Although lecturer’s goal is to articulate and convey explicit knowledge, direct personal communication implies more than formalized verbal communication. In addition to diverse didactic methods, it creates common ground for understanding tacit ideas and implicit concepts of the lecturer. Lectures resemble not only to Socialization phase of SECI, but also to Externalization, Combination and Internalization of the conveyed knowledge.

Of course, all SECI-phases of knowledge creation and transfer at the university are further deepened by the means of other formal academic teaching methods (exams, tests → Internalization; students producing papers → Externalization + Combination + Internalization; self-study → Combination + Internalization). The Socialization stage is extended through students forming groups, meeting and studying together/informal learning. There is complete SECI cycle of knowledge creation in case of university courses and lectures.

But in case of e-learning courses at university, there is a danger of omitting or neglecting the Socialization phase, if the e-learning course is wholly conducted over Internet, and students have little or no chance for socializing. Most e-learning systems provide platform for discussion, but this opportunity is very scarcely used by students for communication. A good example of that is study done by Dougiamas et al. (2003) about Learning Communities using *Moodle*[38]. Dougiamas et al. realized “*that students had tended to engage in serial monologues rather than in rich dialogue*”, and that they have to make changes that lead towards a dialogue in the course they conducted over *Moodle*. These results correspond with my own experience when doing a couple of university-courses based on the Moodle. Students did not develop any, or developed hardly any formal communication through the *Moodle*-forum that was intended for discussion. Non-formal communication as it was required by the Socialization stage, did not exist.

[38] Moodle is open-source Learning Management System that enables educational institutions to offer online courses and educational material over the Internet. Moodle also supports interaction among the learners and the teachers.

Students merely posted as many comments as it was required by the course. The lecturers readily responded to few questions that were posted, but they did not contribute otherwise to the development of discussion or communication, except the posting requirements and data about course – which resembles traditional one-to-many communication known from print-media.

If this course was conducted only on the Internet, this would show a clear deficit in the process of knowledge creation. Luckily the course had an introductory phase where students met and were given a few lectures, and at the end the papers that students produced were presented in real physical environment. This enabled at least some of Socialization stage to take place. Otherwise, students could not exchange their tacit knowledge and ideas, and could not build a proper basis for the later stages of knowledge creation.

The other forms of e-learning platforms are "Wikis" and lecture-blogs[39]. They are intended to augment real, face-to-face lectures with a platform where course material and news are posted by the lecturers. Interaction from students is wanted and expected in the case of Blogs, whereas Wiki[40] resemble more a structured home-page of course, or it presents a structured collection of some kind (scientific, technological, and other kinds) of knowledge, with not much space for informal students-to-lecturers or students-to-lecturers interaction, but with an emphasis on collaborative website construction. Wiki thus covers Externalization and Combination stages of SECI, whereas lecture-blogs try to involve also the informal communication, covering at least some aspects of Socialization phase.

How important the Socialization phase for learning is, shows the example of the MIT online courses platform *OpenCourseWare*[41]*.* UNESCO report (2005, p. 85) states that MIT undertook "…*to make all its course material – plans, notes, exercises and solutions, and reference works – available online…Knowledge of a high standard is thus accessible to students all over the world*." This is not true.

[39] Nice example for lecture-blog is „Gesellschaftliche Spannugsfelder der Informatik"-blog by Peter Purgathofer, http://twoday.tuwien.ac.at/gsi/, [1.11.2008]

[40] Good example for Wiki about Information Visualization: http://www.infovis-wiki.net/, [1.10.2008]

[41] „MIT OpenCourseWare is a web-based publication of virtually all MIT course content. OCW is open and available to the world and is a permanent MIT activity".
http://ocw.mit.edu/OcwWeb/web/about/about/index.htm, [5.1.2009]

Instead of online reference works, OCW offers for the most courses a list of references with links to Amazon.com. For instance, a visitor who is interested in course "*From Print to Digital: Technologies of the Word, 1450-Present*"[42] will only find information and not knowledge. This is because knowledge is residing within knowledge space - and this *ba* includes Socialization phase in the classroom with the lecturer and outside among students them. This is of course not present on the Internet as such. As it says on the page of the above mentioned course: "*Active class participation is central to our work together. Attendance is mandatory*". MIT's *OpenCourseWare* presents extension of organizational Cyber *ba* into the Internet, but not a complete knowledge space, because it does not include all stages of SECI model, and doesnot include the complete organizational *ba*. This is the reason why knowledge from MIT courses becomes only partial information when offered through the *OpenCourseWare.*

The reason why *Facebook* and other social networking sites are so popular among students is that *Facebook* fulfills exactly the need for the Socialization stage within Internet as knowledge space. Students are getting to know each other, joining interest groups and synchronizing their activities inside and outside of the university. This is what e-learning software is missing, focusing mostly on the Externalization and Combination phase of transmitting information, reflecting a formal scope of course. For non-educational organizations, there are also popular social networking sites. I have already mentioned *LinkedIn*[43] which fulfills the same Socializing part of SECI model for organizations and professionals. Art-producing community has its socializing sites; the biggest and most important one is *MySpace*[44], where artists keep in touch with each others and with their audience. This presents again the Socializing phase – since contact with customers is viewed by Nonaka & Takeuchi as sharing tacit knowledge – it enables artists to plan and work on new projects that are of interest for their audience.

I have depicted cognitive factors that underlie the knowledge representation, and showed how tacit knowledge and mental models account for

[42] „From Print to Digital: Technologies of the Word, 1450-Present", http://ocw.mit.edu/OcwWeb/History/21H-418Fall-2005/Syllabus/index.htm, [1.11.2008]
[43] www.linkedin.com
[44] www.myspace.com

knowledge representation and sharing. These concepts of human knowledge should not be neglected in design of knowledge-related systems in Internet.

Language, speech and writing present specific knowledge modeling systems and influence creation of knowledge in society. I discussed such characteristics of these systems that contribute to he emergence of anthropological spaces in relation to knowledge. Finally I showed the arguments for the view of Internet as a new knowledge space, and distinguished its features concerning knowledge and communication from the characteristics of traditional knowledge modeling systems - speech and writing/print.

Further research on cognitive and social implications from the perspective of Internet as knowledge space would be necessary. I could not focus here on areas like distributed cognition, social cognition or small-world networks, or problems like *digital divide* and *digital illiteracy*, because this would go beyond the scope of this thesis. But these concepts surely can contribute to better understanding of knowledge space, as well as better understanding of Internet as knowledge space can contribute to cope better with *digital divide* and *digital illiteracy*[45].

I could also show how the concept of Internet as knowledge space resembles the concept of *ba*, in applying the SECI model to knowledge creation in Internet. My explanation of functionally different systems like *Facebook* or *Moodle* fits very well into this model, since these systems are seen within a broader context - the context of *ba*. It comes out that SECI model applied on Internet as knowledge space/*ba*, has important implications for e-learning, collaboration and social networking systems. Systems involved in (organizational or individual) online knowledge creation should support all four phases of SECI in order to enable complete knowledge creation cycle. Further research here is pretty straightforward, since the principles of SECI have to be taken into account when testing or designing online learning systems.

[45] As speech is the most direct method of knowledge transfer, and books and texts imply literacy, participating in knowledge space Internet implies access to technology and digital literacy.

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