Sharing Knowledge with Future Generations. Sustainable Development as an Inter-Generational Communication Problem

Michael Paetau[1]

1. Introduction

According to the definition of the Brundtland Commission, that a development is sustainable if "current generations should meet their needs without compromising the ability of future generations to meet theirs," political strategies for sustainable development focus to maintain the opportunities for development and action of future generations. This principle of not compromising the ability of future generations to satisfy their needs cannot apply solely to material needs (e.g. the availability of material resources): it must also include immaterial needs like *knowledge*. This paper addresses an issue pertaining to the debate on the ongoing radical changes in the relations of communication, namely: how can society safeguard its knowledge in the long term (with which I am clearly referring to periods covering several generations)? This issue encompasses two aspects. On the one hand, knowledge needs to be safely, securely and, in the long term, accessibly condensed and sedimented, in whatever form this may assume. On the other, swift and equitable access has to be established that is tailored to requirements and is legally safeguarded. This second aspect has recently come to the fore increasingly because it is here in particular that the attractiveness of the so-called "knowledge society" is seen and the key difference to the use of knowledge in previous societal epochs (including industrial society) is established. Ultimately, however, the two sides of the issue cannot be separated from one another, as will be demonstrated below. Rather, they are mutually conditional.

I would first of all like to elaborate the issue in two steps and subsequently discuss some suggestions that are currently above all being presented by informatics. This inevitably implies an interdisciplinary

[1] University of Duisburg-Essen, Campus Essen, Faculty of Literatures and Languages, Department of Communication Studies, Email: michael.paetau@uni-essen.de; http:// www.uni-essen.de/ kowi/Paetau.htm

approach. The foundations of my argumentation will nevertheless be of a sociological nature. However, here too, I will be unable to remain within the confines of established academic boundaries but will have to apply explanatory approaches from sociology of communication and technology.

The central issue from that angle is that of the communicability of knowledge. Knowledge has been so intensively discussed over the last few years precisely because the transformation of knowledge is so problematic. This was already reflected in the debate on Artificial Intelligence in the eighties and the debate on organisational knowledge management in the nineties, and it has surfaced again in the more recent discussions on the societal memory. Organised handling of knowledge always involves the transformation of knowledge, and does so with regard to several aspects. In strongly condensed terms, the problem can be described as that of making partially generated, locally developed knowledge that is tied to certain carriers of knowledge generally available (throughout an organisation or even throughout society). Organising knowledge processes therefore has to be regarded as an attempt to ensure the transformation of knowledge in respect of the contents, social and temporal aspects. Two conditions have to be fulfilled for this process to be successful. First, experiences and observations have to be condensed and sedimented in a decontextualised version into suitable forms of storage, and second, coagulated knowledge has to be actualised (or re-actualised) in situations that clearly differ from the original emergence contexts. As will be demonstrated later, the central problem is that of identifying or establishing suitable structures for these conditions to develop in. The (social and technical) forms in which this mutual interaction of condensation and actualisation of knowledge constitutes itself is, ultimately, the basic problem that a solution has to be found to.

Two examples illustrate the relevance of this issue. Both of them draw attention to what is a new responsibility towards our descendants in a historical comparison. For unlike previous generations, we have altered our environment in a way that could be deadly to our descendants if we do not provide them with comprehensive information about it. The first example relates to the question of how we can succeed in demonstrating to coming generations the deadly threat that permanent nuclear waste disposal sites pose. The radioactive half-life of nuclear waste is known to be several tens or even hundreds of thousands of years. But since we cannot know whether nuclear power is going to play a role in future societies, we are also unable to make any statement on to what degree know-how about the corresponding technology will be available. So it is conceivable that the survival of the population in an area with permanent nuclear waste disposal sites will depend on whether it has been appropriately informed by us or not. But how can that be possible? How can accidental intruders be informed about the deadly danger in store for

them in, let's say, 10,000 years' time if we know next to nothing about the addressees of our messages? And, vice versa, what knowledge may such potential intruders have about our society and its technologies? We do not know in what material we ought to publish our messages, and neither do we know what symbols would make sense in this context.[2]

The second example, relating to genetic engineering, is not quite as extreme as the first one regarding the period in question. But it shows just as clearly how relevant the issue is. Genetic engineering interventions are practised nowadays, and it is conceivable that events will occur in 100 or 200 years' time that require precise accurate information on the interventions made at the time in question (i.e. today). If our society does not consider the issue of how this is possible today, we could well be exposing our descendents to a major, possibly deadly, threat.

Further examples can be found in the currently much discussed initiatives in the area of science and art that have drawn attention to the fact that the concentration of ownership rights (copyright and right of exploitation) that can be observed among major corporations can result in an innovation problem in society.[3] Proprietary regulation of access to knowledge could result in the difficult selection question of what knowledge should be provided to posterity and what should not simply being solved by economic random processes. What happens to the archives when a company goes bankrupt?

But regardless of whether on a proprietary or a community basis, societal mechanisms will be in place in which a selection is made of what material is to be preserved for posterity and what is not. And there will be mechanisms defining the form this process assumes. And this decision on the form of such mechanisms will also be crucial to whether posterity gains access to our knowledge or not. Here, I have chosen to use the term form on purpose, and not merely as a metaphor. As a theoretical figure that is in widespread use in contemporary sociology, I regard it as the unit of a distinction. In the context given here, this is distinguishing between sedimentation and actualisation of knowledge in which the interaction of remembering and forgetting is organised. Usually, it is referred to by the term memory.

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[2] Cf. for this scenario Benford, G.: Deep Time: How Humanity Communicates Across Millennia. New York 1999: Avon Books, Schneider, R.: Countdown für die Ewigkeit. Atommüll als Kommunikationsproblem. 2003: Deutschlandfunk-Feature 30.12.2003. In the examples referred to here, an observation period of 10,000 years was assumed. In terms of communicating knowledge, this is an unpredictable period. Nevertheless, compared with the radioactive half-lives, it is still far too small. In Germany, radioactive permanent nuclear waste disposal sites are required to have an isolation potential of more than one million years.

[3] Cf. e.g. "Creative Commons« http://creativecommons.org/ (10.07.2004) or also "Wikipedia« http://en.wikipedia.org/wiki/ Main_Page (10.07.2004).

2. The memory of a society

The concept of the memory is so important because it effects interaction between the past and the present or between the present and the future (Hahn 2003). This means that the memory sees to whether and how future societies are going to have access to our current knowledge. The memory is the "instance of reflection" distinguishing between deleting and retaining, between forgetting and remembering (Luhmann 1996, p. 310).

Here, I subscribe to Luhmann's opinion that it would be immensely misleading to refer to society's memory as a "collective memory".[4] We are not discussing the aggregation individual memories, let alone an analogy to the individual, for example in the sense of a "collective conscience". For one thing, such a formulation would ignore the peculiarity of social forms of operation as distinct from the operations of conscience. Second, it would not do justice to the emergent character of social phenomena. "It is precisely the difficulty, if not impossibility, of socially reactivating the individually scattered memories that necessitates a specifically societal memory." (Luhmann 1996, p. 316).

So if a society's memory is to be described as a social fact, there is nothing it can consist of apart from the operations the social context itself generates, i.e. communication. But this alone would not provide the reason for a memory to be required as a special instance alongside the communicative processes that are normally in progress. Neither does the fact that knowledge is disseminated in societal communication, possibly retained by systems of individual conscience and handed down from generation to generation, justify any reference to an independent societal memory that would differ from the sum of individual memories.

Following Luhmann a societal memory can only be spoken of when there is a certain autonomy of observing communication compared to the mere processing of communication. And since this peculiarity is distinguished by historical variance regarding the relation between forgetting and remembering, one can refer to a form of the memory. How this form exactly appears depends of several factors to which I cannot go here into detail. However, above all I would like to stress that the form of the memory is not primarily a technological issue but results from the interaction between the structure of society and communication technology. In her book on "Social Forgetting«, E. Esposito emphasises this aspect as distinct from one-sided positions of cultural studies or engineering science. It is not only the communication technologies that are available in a given society that determine the form the societal memory assumes. Just as little as there used to be a letterpress memory is there an Internet memory today.

[4] As is the case, for example, with M. Halbwachs Halbwachs, M.: La Mémoire Collective. Paris 1925: (German Translation: Das kollektive Gedächtnis. Stuttgart 1967)

Esposito accentuates that the form of the memory results from the specific mode of interaction between the factors of societal structure and communication technology. The different forms she describes can be outlined as follows:

Forms of Memory	***»Divination«***	***»Rhetoric«***	***»Culture«***	***»Autology«***
Differentiation of Society	differentiation of center/ priphery	stratificational differentiation	functional differentiaton	networks
Era	archaic (early adavanced civilisation)	traditional society. (antiquity; mediaeval times)	modernity	postmodern society (knowledge society)
Funktion	mysticism	storage	distribution	access
Media of Distribution	unphonetic writing	alphabetical writing	printing (archive; catalogue)	electronic media (internet; web)

Figure 1: Forms of Social Memory (Esposito 2002)

As far as the current situation of radical change is concerned, she puts forward the notion of a transition from a functional differentiated society to an intertwined network society. She regards the role of the media as the epochal distinction from the previous society with its functional differentiation and media based above all on the letterpress. It is no longer storage, as was the case in the Antique and the Middle Ages, nor dissemination, as in modern society, but securing access that will be the key function of the (electronic) media in the burgeoning network society (Esposito 2002, pp. 287). Her hypothesis is that only by the media seeing to it that society gains access to condensed knowledge will the memory gain its special form with the two sides of forgetting and remembering. But how is this possible?

In order to answer the question how knowledge can be saved in the long run, looking at the past no doubt suggests itself first of all. We can assume that all culturally developed societies maintained a sort of knowledge management in this respect. And there can be hardly any

doubts about knowledge having been successfully imparted across generations in most cases. However, we might well question whether knowledge that is today accessible for us is knowledge that the respective societies of posterity wished to retain.

Neither is it a question of the relation between storage and memory, as is frequently put forward in management literature. Rather, it represents a complex relation between condensing knowledge, forgetting and remembering. And since social systems are at issue here, as already emphasised, a complex relation between communication, media and societal structure has to be viewed.

In this context, brief reference ought to be made to the link between knowledge and information, for there is a considerable degree of disagreement in literature regarding this aspect. Here, I will define information as an event and knowledge as the result of this event, i.e. as the event in a condensed form. In this paper, I cannot go into more detail on the theoretical foundations of this delimitation. However, what is important is that this condensation should by no means be understood as a sediment in the sense of a sort of material substrate in the shape of symbols, books, etc. As Max Weber already maintained, these sediments themselves by no means represent “a growing general knowledge of the living conditions” but are merely “knowing or believing in being able to acquire this knowledge at any time if one wants to (...)” (Weber 1973: 594). Indeed, would anyone seriously claim that our children’s knowledge is in their satchels?

Nevertheless, this statement would not be completely wrong. Following Alfred Schütz, one could speak of “virtual knowledge “here. Potential knowledge. However, in order that this “knowledge in potentia“ can turn into actual knowledge, “knowledge in actu«, actualisation or re-actualisation is required. If this is not accomplished, the knowledge will be forgotten. This is why Elena Esposito referred already to the letterpress as a technology of forgetting. With books, one can afford to delegate the storage of the events to texts and keep the brain clear for the processing of new information. What is important is that one has to know how to access the condensates when necessary. Here, in modern society, we have set up archives offering us this option of access. Knowledge is not stored in a big stack of papers but carefully catalogued. If we want it, we can get it

This means that forgetting is not the same as destroying. Forgetting is delegating to a medium. However, one has to be able to pick up the thread again and again in order to re-actualise what has been forgotten should the need arise. And this thread is provided by the specific form of memory.

The problem of the so-called information or knowledge society is an overplus of information, a lack of selective ability and insufficient semantic support. The interaction of network society and digital media produces a paradox: it must be represented a semantic, which has to

bring to mind something absent. The model of “culture“ as the general form of societal memory in the modern society is associated to the technique of storage data and to get an access by using the catalogue as a kind of port to the archive, where the real documents are. But the model of “network“ is using a technique which search-engines gives us an access to surrogates of the real documents, which will created during the search process. “The static model of storage data will be replaced by the dynamic model of their construction“ (Esposito 2002, p. 357).

The key question is that of semantically selection. Which events from the infinite horizon of the world are selected by us, and for what reasons? And in the Web, we are dealing with a “virtual world«, i.e. not with the infinite horizon of options but with restricted options. Not everything that exists is the world is available in the Web, but there is quite a lot, and selecting is required. The condition for this to work is the possibility to interpret the content, in other words: the semantic access.

3. “Semantic Web”

For some years, considerations have been made aiming at contributing to enriching the individual pages in the WWW with descriptions of their contents so as to simplify the retrieval and condensation of material by machines. These considerations have been subsumed under the catchword “Semantic Web“.

The – well known – initial situation is that, put in casual terms, today’s Web enables machines to “read“ documents but does not allow them to “understand“ these texts. In this case, reading means that thanks to the standard HTML format coding, the machine is able to recognise the formal structure of the document independently of the operating system and the browser that are being used. So the machine can answer questions such as: What is a title? What is a reference to another document? What is a blank line? etc. However, the machine is unable to say anything about the meaning of a title, a sentence or a word. And this is why machines can only distinguish to a very limited degree between informative and non-informative data or messages. If they do happen to do this, and no doubt it does happen, they require a classification schema made by a human being to this end. And this is why, basically, the mechanisms of finding a document are organised according to the very classical rules of “Information Storage and Retrieval“ (ISAR).

The basic notion of T. Berners-Lee and the subsequent activities regarding the “Semantic Web“ (Berners-Lee 2001) consists of providing the machine with an ability that has so far been a privilege of human beings or, also, the social system: that of generating information out of data. But how can this be possible? Setting out from this, and bearing in mind that, surely, it is undisputable among arts scholars and social scientists that machines do not operate in the medium of sense, what

could enable them to ascribe meaning to data?

Berners-Lee attempts to achieve this with an ensemble of technical goals:

• using agent technology to search the Web

• establishing comprehensive domain-specific ontologies

• developing suitable ontology representation languages in the context of RDF (Resource Description Framework) or ISO 13250 (Topic Maps)[5] and implementing them with the aid of languages such as (XML).

It is a fundamental thesis – and I am repeating myself here – that the traditional mechanisms of human and social selection of information will no longer be applicable in the changed circumstances, and that the surplus of information is leading to the above-mentioned paradox. Esposito and Berners-Lee share this assessment. Berners-Lee's conclusion is: the application of machine information processing, which above all means using "autonomous agents" that can establish communicative relations with fellow members of their species.

The Semantic Web will bring structure to the meaningful content of Web pages, creating an environment where software-agents roaming from page to page can readiliy carry out sophisticated tasks for users" (Berners-Lee 2001).

Here, "communicative relations" means that each of the agents represents a systems environment to each other, and there is no direct relationship between them. Information can solely be generated on the basis of observing the behaviour or utterances of the counterpart. It is a double contingent situation. Autonomous closure is an extremely important aspect. For an agent with an extensive knowledge of the context of action of his client (which is what today's "users" will probably be called in future) must not completely open up to other agents because he will otherwise not be in a position to reach his targets (e.g. strategic business communication).

3.1 Agents

In spite of the high demands put on agents in the network, they are nevertheless no more than programmes or software objects. What distinguishes them is that they represent another object in a virtual network world. What is actually represented may differ considerably and can range from a human user through a machine to another programme or file.

Co-ordinating autonomous software agents can be accomplished in different ways. Here, there are different levels of autonomy. A distinction is made between "Distributed Problem Solving" (DPS) and "Multi-Agent

[5] RDF was developed by the W3W-Consortium (1999), whereas Topic Maps were defined by the International Standard Organization (ISO) (1999). Both standards aim at representing knowledge about information resources by annotating them.

Systems“ (MAS). DPS follows a top-down approach in which the problem as a whole is broken up into sub-problems and each agent is assigned a certain task. MAS work according to the bottom-up principle. Here, there is no defined hierarchy of problem solution levels and no instance seeing to the co-ordination of the individual agents on the basis of a central plan for the overall solution. The agents have very special problem solution programmes at their disposal for certain sub-areas. The overall solution is then the result of an emergent process.

The question of whether there is a common (overarching) target or not is very important for the architecture of the agents. In this context, a distinction is made between “closed“ and “open“ systems. In the case of internal business processes, there is often an overarching goal that suggests the use of so-called “blackboard systems«, whereas communication will occur more frequently in the Internet.[6]

So it can be noted that the vision is that of different agents in different contexts, commissioned by different people, and equipped with different vocabularies have to attempt to understand each other. In order to enable agents to communicate with one another, a standard language was developed towards the end of the nineties that is to ensure that agents can understand each other. The “Agent Communication Language“ (ACL) (cf. FIPA 1998) is based on speech acts (Austin 1962; Searle 1971).[7] With this language, agents are to be able to select the communicative behaviour of partner agents according to speech acts or identify the speech acts contained in communication and behave correspondingly. However, this does not settle the question of how one responds to a respective speech act (e.g. a request: rejection/approval). In order to respond in an appropriate manner, the agents require a considerable amount of context knowledge. The agents that are currently in practical use commonly use a set of rules to this end. However, this leads to the AI problems of the eighties and nineties. Presently, problems of this kind are solved by restricting the autonomy of the agents. In this context, one refers to “semi-autonomy“. However, one is also aware in informatics that this initially reduces the potential envisaged for the “Semantic Web“ vision. Much research is still required here.

3.2 Ontologies

Establishing “ontologies“ is the second major focal area in the Semantic

[6] Here, however, translated into systems theory terms, “open « means “operatively closed «, whereas the “closed« architecture displays an “open« system behaviour in the sense of a controlled input-output relation

[7] “KQML« (Knowledge Query and Manipulation Language) is a further language that also uses speech acts Labrou, Y.; Finin, T.: A Proposal for a New KQML Specification. Report No. CS-97-03. University of Maryland, Computer Science and Electrical Engineering Dept. .

Web programme. One takes up the notion outlined above that human selective performance when searching in large classification systems is not sufficient to actualise sedimented knowledge adequately. In order for agents to perform this task, they have to be given semantic access to the sediments. If necessary, they have to be able to settle via ACL or another agent language in an up-to-date context whether the desired sediments are contained in the data stock represented by agent x or not. Since machines do not communicate in a meaningful way, they can only achieve this by the data they are accessing containing instructions themselves on how they are to be interpreted or structured. This means that the data have to be equipped with so-called meta-data informing the machines about their semantics. In order to be able to do this, representations are required that can be compiled while archiving the data and can be referred to by machines in assigning meaning to data. In informatics, the term ontologies has become commonplace in referring to these representations (Hesse 2002).

> »An ontology is an explicit specification of some topic. For our purposes, it is a formal and declarative representation which includes the vocabulary (or names) for referring to the terms in that subject area and the logical statements that describe what the terms are, how they are related to each other, and how they can or cannot be related to each other. Ontologies therefore provide a vocabulary for representing and communicating knowledge about some topic and a set of relationships that hold among the terms in that vocabulary.«[8]

Ontologies dispose of a standard structure that (usually) complies with the conventions of the "Ressource Document Framework" (RDF) or the ISO Standard 13250 (Topic Maps). The subject-predicate-object (What is the object? In what relation to each other? Related to what?) schema provides the basis. Thus categorisations are created and data are logically associated with one another. In terms of programming, this structure is then implemented via languages such as XML (eXtensible Markup Language).

In connection with the long-term availability of societal knowledge, ontologies ought to ensure the legibility, interpretability and comprehensibility of the data. Even though work is currently in progress in several areas on the compilation of such ontologies, there are still many open questions. For example, the question has to be raised to what degree the formal languages the ontologies are based on are capable of ensuring establishing, searching for and accessing knowledge.

The protagonists of the Semantic Web stress that one of the advantages of formalising the descriptive language in the context of developing ontologies is the option to store a correctly controllable

[8] http://www-ksl-svc.stanford.edu:5915/doc/frame-editor/what-is-an-ontology.html

deduction of the terms using knowledge representation languages such as XML. They maintain that, in this way, complete translations from one (natural) language into another can be achieved with a very high degree of precision.

From a communications science angle, the question whether understanding can be ensured in a heterogeneous inconsistent and dynamically developing social context by using formal languages is given a sceptical appraisal. What is above all viewed critically is that there have been doubts for several years as to the claim to be able to describe the essentials or the identical aspects of things or circumstances with the aid of ontologies in a consistent and binding manner. Basically, the entire epistemological debate on constructivism and second order cybernetics that has been going on for the last twenty years is simply ignored. Since there can be no description of the world or facets of the world unrivalled, the desire to achieve a uniform, logically consistent semantics that is applicable world-wide appears to be a very dubious if not illusionary venture.

What also seems dubious is the concept's orientation on domains and its being centred on experts. This could entail comprehension, orientation and navigation problems for non-experts.

Summing up, an enormous amount of research is required here, as well. In addition to the critical aspects already referred to, there are a number of unsettled issues relating to questions of formal logic standards and symbolisation methods, to their social and cultural implications, to the search for suitable visualisation methods, to the development of criteria for social and technical robustness in connection with the organisation of knowledge (knowledge management) and to methodical aspects such as suitable survey methods to establish collaborative (societal) knowledge.

4. Data-Mining and Machine Learning

An alternative concept to the Semantic Web approaches based on ontologies has been developed in the context of work on "Knowledge Discovery". This approach is based on statistical methods applied in the area of Machine Learning and Data-Mining, and it also stems from the AI debate of the eighties. However, it has drawn different conclusions from the failure of the symbolic representation approach in AI. Here, no attempt is made to secure access to data in future by a maximum of completeness in the representation of semantics in comprehensive ontologies.

Since the context in which knowledge is to be applied by future (unknown) users in generating information is not known, the reverse approach to that I have shown above is sought here. At the centre is long-term storage of all sorts of information in archives with an optimum level

of comprehensiveness. Here, it is not the search for selection and collection data that can be objectified or the attempt to achieve a semantic standardisation that is at the forefront, but the development of intelligent and robust accessing methods for multimedia data and the application of statistical methods (e.g. trained algorithms to automatically classify texts). Here too, activities still focus on basic research. However, there are considerable differences regarding the information classes. Work in the field of text mining has made a relatively large amount of progress, while activities in the field of audio and video recognition are still in their initial stages.[9]

5. Conclusion

The notes above set out from the societal relevance that the long-term availability of knowledge has. It was pointed out that societies develop historically different forms of organising how forgetting and remembering relate to each other. If autonomous structures of a society's self-observation result from this context (e.g. culture), following N. Luhmann, one can refer to a "form" of societal memory. E. Esposito's hypothesis was taken up that we are currently witnessing the emergence of a new form of societal memory developing in the bosom of functional differentiated society. This memory has its roots both in changes in social differentiation and in new communication technologies. The role of the media is a further new aspect. Whereas, according to Esposito, the primary issue in modern society used to be that of disseminating knowledge, securing societal access is now at the forefront. However, the paradox form of this new memory presents a number of problems. The question was examined to what degree more recent developments in informatics could contribute to solving these problems. Here, two rival approaches were given a closer look at that were referred to as "ontology-based approaches" and "knowledge-discovery-oriented approaches" (KD-approaches). The two positions set out from different aspects of societal memory.

The ontology-oriented studies attempt to provide the data to be stored with semantic additional information at the moment of its being generated in order to simplify finding information for information-searching software. This approach has opted for solutions to the development and structuring of knowledge archives (ex-ante) and

[9] A considerable amount of research and development is also required with this approach regarding the storage media. The mass of data material, which has not been classified in advance, puts new demands on the storage architectures. However, the longevity of the storage material represents a problem as well. For unlike traditional storage modes, such as papyrus or parchment scrolls, etc., present-day mass storage systems only guarantee that material is stored for a few decades.

promises semantic access to knowledge for future generations as well. The KD-approach opts for reconstructing multi-medial data at the moment they are required (ex-post).

The relation described above between social science and information technology issues results in a socio-cybernetic research programme that, on the one hand, contains a critical communications- and media-sociological analysis of the accessing technologies that are currently being developed and, on the other, raises new issues for sociological research. This clearly becomes apparent when observing the concrete forms that a society's memory assumes. As convincing as the work of civilisation studies (Assmann) and social theory (Esposito) research may be, a look at the problems with setting up and structuring knowledge archives shows some needs for investigation. Especially the question for accessibility in the field of tension between ex-post and ex-ante selection that, in respect of the contents, social and temporal aspects of knowledge, the interaction between condensing of knowledge and actualisation options for it has by no means been satisfactorily understood yet.

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