Sustainable Development and Knowledge Society[1]

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Introduction

"How can we protect our descendants against ourselves?" was the question a US commission of experts headed by Gregory Benford was asked when it was assigned the task of developing a signalling and defence system to protect the American repositories for radioactive waste against accidental intruders in 1999 (Benford 1999). The challenge the commission was facing consisted of ensuring efficient protection throughout the entire, risky half−life of the substances involved, i.e. a period of ten thousand years. But how can knowledge about the dangers that repositories for radioactive waste pose be communicated over such a length of time? What must symbols look like that are still supposed to be understood ten thousand years later on? More generally, how can knowledge be objectified and established in society outside certain common contexts of action?[2] In the course of the project, it has become apparent that the usual form of societal objectification and communication of knowledge in the shape of symbols does have its weaknesses. Perhaps these weaknesses are inevitable. But this can only be revealed when alternatives have been looked for. In today's world, which is characterised by global problems and high risks, this weakness is increasingly becoming a problem, and the quest for alternatives is therefore getting more and more important. The developers of the Maya codices and the builders of Stonehenge, the Chinese Wall or the Egyptian pyramids only managed to pass on fragments of their knowledge to us. We do not know what knowledge we have therefore been denied. Neither do we know if it would have fundamentally changed our lives if we had known it. But one thing does seem certain. In today's situation, under the conditions of the modern age with the risks it has created itself and its global problems, inter and intra−generative communicability of knowledge is gaining vital importance. And this turns knowledge in its societal dimension into a crucial topic.

So far, only little research has been carried out on the societal dimension of knowledge, i.e. knowledge embedded in the structures of social systems.[3] However, the current debate on sustainable development has placed this issue on the scientific agenda for two reasons. First, the vision of sustainable development is committed to a global ethic that refers both to the relations between generations (inter−generative) and to the relations within a generation (intra−generative). "Current generations should meet their needs without compromising the ability of future generations to meet theirs" (Brundtland Report 1987). The second reason is the close intermeshing of global and local events, resulting in greater complexity. Globality is reflected on the one hand in the interaction between various causal factors and ubiquitous consequences occurring world−wide. They become apparent in global problems (e.g. reductions in biodiversity) and complex syndromes (e.g. the rural exodus). On the other hand, it is becoming increasingly difficult to locally restrict the problem solution strategies in which knowledge needs updating. This means that complexity can no longer be dealt with using old patterns. A society−wide enhancement of resonance and reflexivity is required. To achieve sustainability and to be able to react with long−term strategies to global risks such as climate change or societal cohesiveness, society must gain knowledge of itself, especially of its

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2 Anyone who has seen the ruins of Teotihuacán in Mexico will have gained an impression of how difficult it is to communicate social knowledge over several generations. However, this also applies to no lesser a degree to communication within a generation. For example, the symbol commonly used world−wide for radioactivity is not even generally understood today. In a series of tests conducted by the Benford commission of experts the question was asked why anyone would want to bury so many ship propellers. And the objection was raised that the skull and crossbones could also be mistaken for a reference to an ancient pirates' treasure rather than a warning of a life−threatening danger (Schirrmacher 2000).

3 The lack of investigating the societal dimension of knowledge can be shown in Radermacher 2001. But there are promising approaches in Luhmann 1990, Baecker 1999, Willke 2001. Baecker refers to this knowledge as "social knowledge" (1999: 78). However, he also speaks of "societal knowledge" at the same time, although he is not implying the social dimension here but the factual dimension of knowledge (71).

environmental, economic and social affairs, of the available problem solving alternatives, of the potentials of activities, and of the societal realization conditions. But how is that possible?

In this context, knowledge is becoming an increasingly big problem. On the one hand, there is talk of an exponential growth of knowledge, of its generation being accelerated, of changes in how it is communicated and of improvements in how it is evaluated. On the other hand, it is conceded that what is at issue here is not so much knowledge itself but merely the *potential* that knowledge bears. And the problem is that this potential is not, or only insufficiently, being made use of in social systems, whether it be organisations, communities, social networks or society as a whole. As a rule, social systems do not know what they know. Organisations are suffering from this insecurity in particular, for their ability to work (i.e. above all the absorption of insecurity) depends considerably on the ability to select knowledge (Ahlemeyer 2000; Baecker 1999: 69). This is why the new catchword it is hoped will solve the problem is "knowledge management", and it turns both the *cognitive*[4] and the *communicative* foundations of knowledge into a research topic.

1. When does a Society know something?

In scientific literature today, it is still common to define social knowledge as a "possibility". Stehr refers to knowledge as an "action resource", and speaks of it as the possibility to "get something going" (Stehr 1994). Already in the 20th of the last century the sociologist Max Weber pointed out that increases in knowledge no means "an increasing general knowledge of living conditions" but "knowledge of or trust in being able to acquire this knowledge at any time if one wants to (...)" (Weber 1973: 594). But how does the possibility of knowing something become real knowledge?

Unlike with individual knowledge, the most important quality characteristic of social knowledge is that it needs to be communicated in order to have an impact, no matter what that impact may be. And this is precisely where the problem lies. For in their day−to−day actions, social systems have to decide what communicative knowledge they want to resort to, what data they intend to process and what information they wish to draw conclusions from (Baecker 1999:69). They have to make decisions on accepting and turning down communication offers. Moreover, they have to decide what knowledge they wish to introduce into the process of communication and what they do not.

Every attempt to communicate knowledge involves a twofold transformation. First of all, knowledge has to be turned into information. And then, someone has to transform this information into new action knowledge. This is the eye of a needle that social knowledge has to go through. With regard to selection required here, Luhmann distinguishes between three steps. First, information is generated, second, a suitable medium of utterance needs to be selected, and third, the information has to be understood. Provided that the conditions mentioned are fulfilled, Luhmann calls this three−step selection process "communication". Although the resulting product can be referred to as a "condensation of observations" (Luhmann 1990: 123), this still does not solve the problem of "fluidity and contextual intensity" (Willke 2001: 79). In this theoretical framework Willke regards communication referring to common contexts of experience as the indispensible prerequisite for the development of social knowledge. Only when information has been integrated into a "community of practice" of immediate and interactive common experiencing can "collective knowledge" be formed (Willke 2001: 90).

2. Sustainable Criteria for Institutional Innovations: Enhancement of Resonance and Reflexivity

Sustainable development can only be achieved via a far−reaching modification in the life−styles of people, via fundamental changes in dominant production and consumption patterns and via a re−orientation of planning and decision−making processes. Regarding the issue of how such far−reaching transformation can be possible, debates focus on institutional innovation. Both in sociology and in political science and economics, institutions are seen as an option to control individual or collective behaviour. This is already picked out as a central theme in the final document of the 1992 Rio Conference (Agenda 21 1992; Jörissen 1999).

[4] as has already been the case in Artificial Intelligence and the sociology of knowledge

Jörissen et al. describe five basic principles for the institutional innovations required of which I would only like to refer to the two most general ones in the following: 1. enhancing resonance and 2. enhancing reflectivity.

Resonance describes the property of social systems to perceive changes in their natural or social environment and respond to them. How they respond depends on various conditions inherent in the system. What is crucial is the degree to which the interference signals, perturbations (Maturana 1990) or irritations (Luhmann 1995) are perceived by society or the social subsystems and are turned into an object of internal considerations and changes in behaviour of their own. The advantage of this self−referential type of resonance generation is that the respective system responds swiftly (and usually inevitably[5]). The disadvantage here is that this only occurs in a highly selective and one−sided way. This means that not all problems can be dealt with in this way and that the mode of response of the individual systems might well be problematic for society as a whole. In connection with strategies for a sustainable development, a further characteristic of modern societies therefore becomes important that we refer to as reflexivity (Jörissen et al. 1999: 160pp.).

Reflexivity is a central category in the current debate on how to achieve sustainable development. Lash calls it a "condition for the continuation of modernisation" (Lash 1996: 199). With reflexivity we refer to the consideration of the consequences of actions of a social subsystem, an organisation or a person for other areas of society, organisations or persons. Reflexivity implies that these consequences are already anticipated before the actions are performed. Here, the issue is not merely that of delimiting other actors or social systems from each other but also encompasses the thematic borders (Jörissen et al. 1999: 163pp.). One example of attempts to enhance reflexivity in science is the approaches to combine certain global problems as complexes of syndromes (Schellnhuber & Wenzel 1998). Although it is possible to assign the problems themselves to various spheres (e.g. the atmosphere, the biosphere or the anthrosphere), they can only be understood if they are regarded in their mutual relations, which is then expressed in so−called syndromes (e.g. in the so−called Sahel Syndrome or the Favela Syndrome). In this way, one−sided assessments that often focus on certain problematic areas of individual dimensions (of an ecological economic or social nature) can be avoided, while integrated problem solutions can be attempted.

Sustainable development points to the need to make knowledge generated at a particular point or level in society available to society as a whole. The difficulty here is that its production and use are separate, which results in a fundamental difference between knowledge and lack of knowledge in problem solving situations. Knowledge that is generated in certain contexts is required at another localisation of other contexts (but with similar problems). Often, the potential use of knowledge initially remains concealed from the actors generating it. Although one can make assumptions, one will still not know where and when. What also remains concealed, now albeit from another angle, is whether knowledge required to solve certain problems may have already been acquired in other situations. And here too, the statement applies that one can assume it but does not know where and when. The conclusion to be drawn from this state of affairs is that society does not know what it knows.[6]

Basically, there is nothing new about this problem. Historically, society always found a way out with hierarchies. Social systems had their defined selection rules. In accordance with their hierarchical level, they knew whom they could get the required (i.e. appropriately pre−selected according to its specific function) knowledge from, and they knew whom they had to pass knowledge processed on this basis on to. Another type of knowledge processing is only relatively young, having emerged with the development of bourgeois society, i.e. just under 250 years ago. It is oriented on the concept of the public and does not work hierarchically. The science system has developed a special type in which scientific discourses that are above all based on texts emerge in thematically focused networks of mutual observation.[7] However − and this is

[5] Which does not mean that it always responds in a predictable way.

[6] For organisations Luhmann quotes Karl E. Weik: "An organization can never know what it thinks or wants until it sees what it does." (Luhmann 1990: 186).

[7] However, what is special about the scientific system is not that it produces especially true knowledge (which it indeed does too), but that it always has to formulate knowledge within a relation to non−knowledge. Knowledge has to face critical questions from which research requirements are deduced and on the basis of which applications for third−party funding are formulated. Merton once called this "co−formulation of specific non−knowledge" "organised scepticism" (Luhmann 1995: 177p).

the crucial point − all these forms have collapsed in the course of the information technology revolution (which nobody really believed in but which has occurred nonetheless). Even if it were desirable, knowledge processing would not be able to resort to the old patterns. But what new ones are there?

One crucial point will be that of networking knowledge (Castells 2000) (Messner 1995; Stefik 1999). Sustainable development is a particularly good example of how communication and action contexts that are networked world−wide are emerging owing to the close link between local action and global consequences or, vice versa, global problems and local consequences. Generating, processing and communicating knowledge no longer follows the old patterns of industrial society (above all the hierarchical modes of establishing and distributing knowledge). Over the last few years, network structures have come to the fore more and more (examples are the UN’s "Sustainable Development Networking Programme" <SDNP>, the "Global Development Network", in which both government and non−governmental organisations are involved, regional networks covering issues of the Local Agenda 21 as well as a number of self−help networks). Networks are to make knowledge on problems and problem solution strategies that has been generated individually and in a decentralised way available to society and enable it to flow into concrete decision−making processes wherever these may be in progress in the world. Networks are becoming means and forms of designing a sustainable society.

3. Information and communications technology access: the example of "City Traffic"

One illustrative example of the mutual networking of autonomous systems is the modern traffic system in conurbations. With this example, the question can be formulated more accurately as to the degree to which the employment of information and communications technology can contribute to understanding the emergence of knowledge in social networks.

The traffic system in conurbations is a highly complex socio−technical system with a wide range of influential factors (motorists, public passenger transport, cyclists, city traffic guidance systems, traffic lights etc.). Small local changes can have a considerable impact on the system as a whole (chaos effects). Within just a few minutes, an accident in a busy crossroads or a lane blockage can cause considerable irritation to the system as a whole in a conurbation. As a rule, owing to the general contingence of the system, any forecast on how individual road−users will act in a situation is only possible for the region immediately affected and over a very limited period. A forecast on the behaviour of the system as a whole would only be possible under three conditions: First, a sufficient amount of empirically established figures relating to similar situations would have to be available, second, the other nodal points at which bifurcation may occur in the overall system would have to be observed, and third, these up−to−date observations would constantly have to be compared with the stored empirically established figures.

On this basis forecasts could then be made that would also make successful control interventions feasible. And it would by no means be necessary for the available repertoire to exceed the usual measures. It ranges from the employment of traffic policemen through modified traffic light switching, changes in directions of travel, modifications of lanes, announcements on indicator boards to electronic traffic guidance systems. The basic difficulty is that of contingence in the behaviour of all participants. All guidance is self−guidance that is influenced by the social availability of knowledge.

In a pilot project that the Fraunhofer Institute for Autonomous intelligent Systems (Sankt Augustin) is currently running with the City of Bonn, it has been possible to identify or create such ideal conditions (City−Traffic 2001). The City of Bonn is one of the towns in Germany in which almost all important crossroads with traffic lights are equipped with sensors capable of reporting the respective traffic situation to the city traffic guidance system. As a rule, these observations enable a relatively swift response to changed situations. However up to now − and this is important − such a response was normally restricted to a *certain location.* So far, a reflection in the sense described above that would also consider the behaviour of the system as a whole has not been possible. Any attempt to accomplish this would have presupposed co−ordinating communication the complexity of which would have been impossible to deal with.

This is where the option of microsimulation comes in. The information technology challenge here is that of networking local information and linking up stored data with the data of events established by the sensors.

Among other things, this coupling enables forecasts to be made from the angle of individual road−users. For example, a road−user who still has to see to something downtown can have the parking situation in one of Bonn's car−park garages in an hour's time calculated. On the basis of data referring to past situations and current parameter adjustments (e.g. the state of the weather, snow or rain, current events, e.g. a football match or a political demonstration), forecasts can be made here that go beyond the usual attempts made so far.

Most simulation concepts used nowadays are not capable of providing a highly detailed blanket coverage of a respective region. When models are formed, many aspects have to be treated in a strongly abstract way.

- Individual vehicles cannot be simulated, so that medium flows of traffic are used.
- The real behaviour of light signal systems cannot be modelled true to their function over an entire area. Instead, typical switching behaviour or simple traffic queue models are used.
- The geometry of real roads, involving, for example, filter lanes, can only be considered in a small number of cases.

Simplifications of this kind strongly restrict the ability of the simulation results to yield forecasts, so that a large number of interesting problems cannot be simulated closely enough to reality. Only a precise micro−simulation in which the individual vehicles can be modelled in numbers that would be typical of large cities can change this situation. The geometry of real roads − for instance the length of filter lanes and the position and function of sensors − can be modelled in an artificial reality, and decision−making behaviour can be tried out. This enables the consequences of different alternatives for action to be anticipated on the basis of a microscopic description.

Nowadays, the use of cluster computers and modern agent software allows for such technical modelling. In a traffic simulation of the kind currently being realised in the AiS' "City−Traffic" project, this means that the system can model real traffic movements true to scale and function, in real−time and covering an entire area on the basis of several thousand software agents. So

- individual, technically different vehicles and different types of drivers can be simulated,
- light signal systems and the geometry of roads are modelled true to scale and function,
- the flow of individual vehicles is gained from sensor data of real traffic and can be co−ordinated in real−time.[8]

The system is a hybrid comprising real−time coupled traffic monitoring /guidance technology and micro−based simulation. The artificial reality that is created enables a holistic treatment of the relevant aspects of urban mobility. In addition to traffic guidance technology, this also covers management of the light signal systems and parking space and can simultaneously be used as a citizen's information system.

Here, simulation is not one of the usual abstractions but a detailed (simulated) approach to the world. The simulation enables different observers' perspectives to be taken up. By fading out or changing a respective parameter, the user of the simulation model can observe a (simulated) observer, i.e. realise a sort of observation of second order on the basis of assumed observation points. Of course these arrangements are also simplifications. Nevertheless, a much greater number of relevant details can be considered than would be the case with classic models. Karl E. Weick's sceptical statement that social systems cannot know what is happening if they have not been doing it could be refuted at this point.

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8 After two minutes of computer time, a forecast can be made in this way that covers a period of 20 minutes.

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