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The Governance of Knowledge, Limited: The rising relevance of non-explicit knowledge under a new regime of distributed knowledge production

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1. Institutional and epistemological limitations of the governance of knowledge

Scientific and technological knowledge is going to become the key factor in the change of economies and in the evolution of society. The production, distribution and use of knowledge determines the competitive advantages of enterprises (Machlup 1962). It increases the innovative capacities of economies. It strengthens the power position of nation-states in the world-system. As the production of knowledge is dispersed over many places, as it is split into the use of explicit and non-explicit knowledge, and as it is divided between different institutional actors, new means and mechanisms of co-ordination are demanded beyond market and hierarchy. "Interactive networks of innovation" (Lundvall 1993) are constructed in order to get access to local knowledge and to share profit and risk of its global utilization. "Knowledge management" is created as a new field of business in order to raise the efficiency of knowledge work and to keep up with the pace of innovation. "Knowledge politics" is coming up as a new field of policy. Its aim is to establish the adequate institutional infrastructure that assures and accelerates the growth of knowledge production. If one shifts the focus from the division of labor that predominated in industrial society to the division of knowledge (Hayek 1945; Helmstädter 2000) that takes place actually, one can observe and perhaps explain the emergence of a new regime of governance. I shall call it the *regime of distributed knowledge production.*

The title of the paper „The governance of knowledge, limited" indicates two features of the actual mode of knowledge production: On the one side, the knowledge production has turned into a business. Universities and research institutes are transforming themselves into patent-holding and knowledge-selling enterprises. Firms and companies engage themselves in the business of knowledge creation and knowledge management. Scientific institutions, state agencies and industrial R&D-laboratories are knitted together to build either national innovation systems (Nelson 1993) or networks of innovation that operate between heterogeneous actors and on an international level (Freeman 1991; Powell/Koput/Smith-Doerr 1996). Their activities are co-ordinated more and more under the imperatives of economic innovation and national wealth (Foray/Freeman 1993). The first aim of this paper is to give a short outline of the *institutional changes* that are leading to a new regime of distributed knowledge production.

On the other side, limitations of the governance of knowledge become visible. They are rooted mainly in two paradoxical processes. Firstly, the heterogeneity of the enrolled actors – scientists and managers, politicians and administrators, venture capitalists and ecological activists - and the diversity of their perspectives cause problems of a successful concertation (Rammert 2000) that does not level out the creative differences between disciplines or institutional rationality standards, and that does not destroy the complementary competences of functionally specialized actors. Secondly, the specifity of knowledge to be an intangible asset and an incompletely explicable set of competences sets limits to the complete control and commercialization of knowledge. The second aim of this paper is to explore the *role of non-explicit knowledge* in the process of making a growing part of the knowledge more explicit.

The innovativeness and the economic performance of the rising science-based "knowledge societies" (Böhme/Stehr 1986) are fundamentally determined by the ways how they cope with both problems, the institutional problem of co-ordinated distributedness between heterogeneous actors and the epistemological paradox of the explication of the non-explicit knowledge.

2. The rise of a new regime of governance: distributed knowledge production under conditions of fragmentation

Knowledge has to be seen more as a competence to do something than a compact good that one can transport and store (Rammert et al. 1998: 37 pp.; Stehr 2000: 81 pp.). A scientific paper or a written patent claim are, however, packaged pieces of information; but they can only be converted into knowledge, if people or organizations know how to use them. Both aspects, the incorporated „known" and the enacted „knowing" (Dewey/Bentley 1949), belong together and should not be analyzed separately.

If we accept this pragmatic definition of knowledge, then follows that it makes a difference how the system of knowledge production is institutionalized in society. Following a widely recognized theory of societal differentiation (Luhmann 1977; Münch 1990), we can distinguish between three types of differentiation: the segmental, the hierarchical and the functional one. I assume that there exists a close interrelationship („Wahlverwandtschaft") between a type of social differentiation and a regime of knowledge production. It is not a strong causal relation, but it is supposed that particular patterns of dominant social structures favor certain means of co-ordination and suggest specific institutional answers. These institutional answers show a great variety in the beginning. But after periods of transformation, the trial-and-error process of learning is closed. A new regime of governance is established that consists of a selected set of institutions and that is characterized by the dominance of particular means of co-ordination. Dominance does not mean that the other types and means are diminishing or even disappearing. The rise of a new regime only indicates that one type of differentiation achieves the leading role in shaping society whereas the others only loose their centrality, but gain new importance for particular social units.

The term governance of knowledge should as well not be misunderstood: Knowledge production, especially scientific knowledge production or even technological innovation, cannot be guided or regulated like car production or conventional industrial production systems. The uncertainties of innovation are uncomparable higher than those of product markets. The heterogeneity of actors and the diversity of their orientations are so complex that no principle agent can appropriate the necessary information and can control the actions of all agents who come from different fields. That is why the state is not any longer seen as the central authority; even state regulation has to be divided between the government and private or semi-private agencies. New forms of divided systems of governance evolve, like the regime of „corporate governance" (Hollingsworth/Schmitter/Streeck 1994) which enrolls the most important collective actors and excludes the rest, or the „distributed governance" by "policy networks" (Marin/Mayntz 1991) where all relevant actors of a political field participate in the shaping of the output.

In the following section I shall roughly characterize the three widely acknowledged types of societal differentiation and relate them to idealized regimes of knowledge production.

Segmental differentiation is characterized by the split into many parts of the same kind and of the same status. Families, clans, and tribes are the resulting social units which dominated in archaic societies. Segmentation is a kind of homogeneous division. Clan relations and myths are the weak means of co-ordination between the homogeneous and autonomous parts. Under conditions of segmental differentiation, the same knowledge is dispersed over many places without any mechanism of coordination like exchange or central collection. Every tribe and every settlement controls its own local knowledge production. Internally, special roles like artisan or medicine man are separated; but one can

find the same stock of knowledge in every social unit. A *regime of local and dispersed knowledge production* emerged that affiliates with the segmental type of social differentiation.

Hierarchical differentiation divides the whole into parts of a different kind and with different status. It establishes a system of vertical distinction. Historical examples are stratifications between high and low classes or between center and periphery. Empires based on military forces and monotheistic religions with a missionary impetus are the strong means of co-ordination between the distinguished ranks and between the distantiated places. Under conditions of hierarchical differentiation, people start to collect the knowledge from the dispersed places, and some organizations begin to systematize and centralize the relevant knowledge. Such people were called „Mechanici", technicians and scholars. The monastery, the early universities, and the city guilds were the early places of knowledge collection and exchange. The church and later-on the state became the principal agents who controlled the knowledge production and diffusion. *A regime of universal and centered knowledge production* came up that co-evolves with the hierarchical type of social differentiation.

Modern society differs from traditional society by the predominance of *functional differentiation*. It splits society into complementary parts which are organized around different functions, but which have the same status. Spheres of actions and action-orientations are separated horizontally from each other, like the economic, the political and the scientific subsystems. They differ under the aspect of a specialized contribution to the reproduction of society. They increased their efficiency by generating a self-referential orientation following only their own code of orientation purifying it from other influences. They achieved relative autonomy from interventions from outside by establishing a system of self-organization. As the functions are indispensable and cannot be substituted by another subsystem, all functionally specialized systems are equally important. A system of horizontal division outplays the vertical system of stratification. The production and use of economic, governmental and scientific knowledge is institutionalized in these specialized spheres of society. Society looses its center and central principle of organization. Markets, mobilization of resources by state or political movements, and discourses (scientific and public) advance to equivalent means of co-ordination. Scientific knowledge production e.g. gains high institutional autonomy and self-governance; but in order to exploit it for the sake of economic innovation or military power enforcement, markets of patents and licenses and big organizations were recruited to co-ordinate the separated, but complementary innovative activities. A *regime of complementary and specialized knowledge production* belongs to the functional type of social differentiation.

But the consequences of this functional differentiation lead to unintended problems of synchronization and adjustments that some analysts call „reflexive modernization" (Beck/Giddens/Lash 1994). Other analysts conceive these changes as formations of secondary subsystems that operate to cope with the consequences of the primary subsystems. Some other diagnose them as processes of „de-differentiation" or "heterogeneization" (Weingart 1983;Tyrell 1978; Knorr Cetina 1992). I do not want to continue this debate on the basis of three types of differentiation, but I want to give it a fresh impetus. I claim the logical possibility (Schimank 1996: 151) and the empirical validity of a fourth type of social differentiation: the fragmental one.

The *fragmental differentiation* splits a heterogeneous whole into parts that are of the same kind, but of a different status or on a different level. Regional innovation networks e.g. always include nearly the same mixture of elements, like political, economic and cultural actors and institutions. But some networks are setting the bench marks, like the

Silicon Valley network of microelectronics and software industry or the Baden-Württemberg network of mechanical engineering and car production, others are imitators and followers in the global competition. The differentiation of scientific disciplines is rooted in well-defined and theory-bound fields of research. Each of them enjoys the same highly reputated status as asscertained knowledge that we call scientific truth. But when the number of mission and issue-oriented scientific research projects increases, the new type of fragmented knowledge production is coming up that is rooted in the same combinations of heterogeneous relevant knowledge. The quality is not any longer reviewed by the peers of one discipline, but by heterogeneous expert groups and epistemic cultures.

Fragmentation is a kind of division that combines heterogeneous elements. It shares the feature to combine different types of knowledge with the segmental one, but it differs from it under the aspect that its mix of heterogeneous knowledge consists out of fragments of a once systematized and functionally specialized knowledge. Elements of all kinds of knowledge are recombined. The fragmental differentiation differs from the functional one radically under the aspect that the purified separation is given up in favor of heterogeneity and reflexivity. Functionally specialized institutions and purified scientific disciplines remain important factors on the back stage of fragmented society, but they are loosing their privilege to act on the front stage where network forms of organization and transdisciplinary epistemic and expert cultures take over the prominent roles. The *regime of heterogeneously distributed knowledge production* rises in close relation to the type of fragmental differentiation.

SOCIETAL DIFFERENTIATION	DISTINCTIVE FEATURES	MEANS OF CO-ORDINATION	REGIME OF KNOWLEDGE PROD
Segmental	dispersed, homogeneous division	clans myths	local and dispersed know. prod.
Hierarchical	concentrated, vertical division	empire religion	universal and centered know. prod.
Functional	separated, horizontal division	market media science	complementary and specialized know. prod.
Fragmental	combined, heterogeneous division	networks epistemic cultures	heterogeneous and distributed know. prod.

Figure 1: Types of societal differentiation and regimes of knowledge production

If we have once accepted the new idea that a fourth type of social differentiation can be deduced theoretically, then a lot of empirical studies in the fields of neo-institutionalism and of science and technology studies can be seen under a new perspective. They describe the emergence of this new type of social differentiation and the development of the new regime of heterogeneously distributed knowledge production.

The „network form of organization“ was discovered as a particular mechanism of co-ordination besides hierarchy and market (Powell 1990).

- „Idea-Innovation networks“ were described as the principle agents of knowledge production and innovation (Hage/Hollingsworth 2000).
- A post-Schumpeterian mode of „reflexive innovation“ that is based on heterogeneous and interactive networks of innovation was distinguished from two modern ones that are based on Schumpeterian inventive entrepreneurs and on big state, big science or big business bureaucracies. This network form of organization was identified as the adequate institutional mechanism to synchronize the different tempi of innovation between the scientific, economic and political system (Rammert 1999; 2000).
- A „mode 2“ of a transdisciplinary and reflexive production of scientific knowledge was claimed to develop besides the mode 1 of normal disciplinary knowledge production. One of its characteristics is the integration of political and moral knowledge into the scientific knowledge production (Gibbons et al. 1994; Nowotny et al. 2001).
- Hybrid „actor-networks“ were described as the relevant unit and socio-technical association whereby scientific facts and technological artifacts are constructed. The boarder-lines between human and nonhuman entities and between the humanities, social sciences and technosciences were deconstructed (Latour 1994; Callon 1993).
- „Epistemic cultures“ were said to shape the scientific knowledge production, not a set of purified disciplinary knowledge. An epistemic culture encompasses scientific and non-scientific practices and objects (Knorr Cetina 1999).
- „Distributed cognition“ was the phenomenon that Ed Hutchins discovered when he observed knowledge production for the sake of ship navigation. It was not the functionally specialized or centrally organized knowledge that was relevant during the break-down of the automatic navigation system. It was a kind of natural distributed process that consists of accommodating practices (Hutchins 1996).

One may doubt whether all these empirical phenomena and these new categories of description really designate the emergence of a qualitatively new type of knowledge production (e.g. Weingart 1997). But one cannot deny the current changes of practices, discourses and institutional rearrangement in the process of knowledge production. Under which aspects do they differ from the standard model of knowledge production in functionally differentiated modern societies, and especially, what are the implications concerning the governance of knowledge?

1. The specialization of disciplinary and subdisciplinary knowledge production has multiplicated the research fields with the consequence that besides new specialties and interdisciplinary cooperation new fields of technoscience emerge that are under the aspect of cognitive integration only loosely coupled and remain heterogeneous, like robotics or nano technology e.g. They are more strongly coupled by sharing certain practices of borderline-activities and a “pidgin”-type of communication (Galison 1996; Meister 2002).
2. The complexity of the research objects is highly increased by the expansion of the aspects one is interested in, e.g. sustainable technical systems of energy production instead of efficient energy production, or by the enlargement of the perspective, e.g. from narrow weather forecasting to complex climate research (Stehr/von Storch 1999).
3. The integration of hardware and software products into situations of work and communication enforces the rise of research fields that develop transdisciplinary

models and methods to grasp the hybridity of the research object, e.g. in high tech workplace studies (Button 1993, Star 1996) or in socionics (Malsch 1998; 2001).

It is not a really new phenomenon, especially in the engineering sciences, that the objects of research are *complex* under the aspect of elements and relations, *heterogeneous* under the aspect of included disciplinary perspectives, and *hybrid* under the aspect of kinds of focussed objects. But it seems to me that the knowledge production that crosses the traditional disciplinary borders actually gains a predominant role, like in neurological computing, nanotechnology, genetically engineering, or robotics. The knowledge situation can better be described to be in the *state of a loosely coupled distributedness* than in the state of a functional or even a hierarchical integratedness. It is far beyond the phase of finalization (Böhme/van den Daele/Weingart 1976). It looks more like a puzzle of disciplinary knowledge fragments.

What are the consequences of this fragmental distributedness for knowledge politics? The role of disciplinary knowledge production has to be maintained because one needs the inputs of the disciplinary stock of knowledge and repertoire of methods. But the disciplines loose their overall structuring force; new forms of co-evolution, shared testbeds and meta-languages of communication (Galison 1996) are developing and substituting the strict control of disciplinary theory. Knowledge policy has to foster the development of innovation networks. It should control the balances within and the access to them by heterogeneous, even oppositional actors. It should encourage the participation on each level, e.g. by interactive workshops between experts and citizens, by organized mediation between industrial, political and scientific groups, or by establishing networks of cooperation or platforms of communication that enhance the institutional learning between science, economy and polity.

4. The acceleration of the tempo of knowledge production has limited the co-ordinative capacities of the linear-sequential model of innovation. The standard model produced certainty by connecting the stages of inception, invention, production and diffusion consecutively. The different activities from the idea-creation to the marketing of knowledge are now organized in several functionally specialized arenas (Hage/Hollingsworth 2000), and they are performed at the same time like in parallel computing prodesses, not one after the other.
5. The acceleration is closely connected with the differentiation of spheres and arenas. This interrelationship causes problems of synchronization between the different tempi (Rammert 2000). Discontinuity instead of continuity dominates. Continuity can only be acquired by permanent and parallel interactions between the diverse actors and agencies on several levels.

What are the consequences of this discontinuity and simultaneity for knowledge policy? Different tempi of development have to be recognized in the different institutional fields in order to keep open the time-horizons, e.g. a fifty-years-cycle for the reorganization of disciplinary knowledge, a fifteen-years-cycle for transdisciplinary research fields or a five-year-cycle for domains of product innovation or a one-year-cycle for marketing-knowledge. A good governance would avoid rigid time schedules and would not force all under a unified time regulation that equalizes what should be different. The governance of knowledge means under these conditions „making happening, not making strictly“. The role of knowledge policy should be to maintain the space for different time-horizons and to

construct continuity by permanent and parallel interactions on several levels by the means of mediation, not by the techniques of dictating.

6. The multiplication of agents who take part in the knowledge production leads to new role requirements and to fragmental units that reproduce the same set of competences at every place, e.g. universities supplement their traditional research and teaching competences with new management, fund-raising and start-up competences, whereas business enterprises develop scientific education and research competences besides their management and venture competences.
7. The pluralization of actors‘ perspectives and of institutional contexts raises severe problems of co-ordination and quality control. Under the conditions of functional differentiation, the interfaces between science, industry and government could be managed with the help of highly standardized procedures and hierarchically organized advisory groups. But under the conditions of distributed and fragmented knowledge production, new forms of mediation and interactive networking are coming up, e.g. mediation has established as a new profession; consultance concerning knowledge production, knowledge management and knowledge politics have grown to a successful industry; the task of initiating and moderating networks of knowledge production has become a quite visible concern of state agencies.

What are the consequences of this multiplication of agents and pluralization of perspectives for knowledge politics? As the bulk of knowledge is bigger than at any time before, as the frames, places and the portals of knowing are growing like „mille plateaux“ (Deleuze/Guattari), the established mechanism of integration, like curricular education, public opinion and mass communication, are not sufficient. Governance of knowledge that takes place under these conditions of proliferous growth of knowledge production and under conditions of a fragmented public is challenged to aim at both, the maintenance of the creative diversity of actors, opinions and perspectives as well as the institutionalization of codes, cultural models and procedures that enable processes of collective learning (Rammert 2002).

3. The limits of explication and the rising relevance of non-explicit knowledge

All societies construct themselves in distinguishing some practices and parts of knowledge and giving them an exclusive meaning. Premodern societies used myths, rituals and monuments to express their systems of relevances. Modern societies can be characterized by making more and more explicit the tacit and traditional knowledge. They privilege explicit knowledge in comparison to all types of non-explicit knowledge. They are more interested in the production of new than in the circulation of old knowledge.

What are the most eminent fields in modern society where knowledge is made explicit? It is the field of science where technological experiences and practical knowledge are transformed into scientific laws. It is the field of economy where commercial intuition and rules of thumb are cast into the calculus of profit and loss accounts. It is the field of law and legislation where moral rules and political priorities are made explicit in the process of codification. Finally, it is the field of complex organizations where a written and formalized form is given to the tasks and duties of its members. Rational science, capitalist economy,

positive law, and complex bureaucracy are the resultant modern institutions which can be characterized by their high grade of expliciteness.

If we accept the diagnosis that we are approaching now a type of society that is based on the axis of knowledge production, then the modern imperative of making knowledge explicit is expected to be amplified and intensified:

(1) Scientific knowledge penetrates all fields of praxis and has reached the status of the first productive force.
(2) The economical production, appropriation and evaluation of scientific knowledge requires a rise in explicity: time schedules and project formats become more fine-grained, cost and quality evaluations are introduced everywhere, and patent claims are applied for more widely and have to be expressed more precisely.
(3) The distribution of knowledge producing activities that includes many and different agents demands explicit rules of exchange, standards of cooperation and codes of sharing risks and profits between the agents of a network.
(4) The computerization of work and communication presupposes the existence and formulation of explicit rules and explicit models of the organization, its goals and its quality standards.

But in spite of this strong imperative of explication I assume that the relevance of non-explicit knowledge will rise under the regime of distributed knowledge production. The limits of explication which already became visible under the regime of modern industrial production will be enforced. An unlimited process of making knowledge explicit will threat the balances and the scope of collective learning under the highly sensible regime of distributed knowledge production.

3.1 Non-explicit knowledge in science and technology

Science seems to be the empire of explicitness. But we have learnt by science studies that scientific knowledge is based on non-explicit knowledge. Ludwik Fleck (1935) has demonstrated that scientific statements, assumptions about the effects of instruments, and interpretations of empirical observations are deeply embedded in the „thought style“ of a thought collective. It is this group-bound and incorporated knowledge that Michael Polanyi later on defined as „tacit knowledge“ and with reference to that Thomas Kuhn coined the famous term „paradigm“. This statement does not mean that science has always remained an art, as some post-modern thinkers assume, but that the advantages of modern science are necessarily interwoven with non-explicit knowledge. Polanyi expresses the paradoxical relation between implicit and explicit knowledge more sharply. He states that the process of formalization of all knowledge that does not exclude any element of implicit knowledge does destroy itself (Polanyi 1985: 27).

Modern sciences incorporate more and more technical instruments (Joerges/Shinn 2001). They change towards „experimental systems“ (Rheinberger 1997) where implicit skills and explicit knowledge are closely interwoven with the „epistemological objects“. Harry Collins (1974) had already demonstrated that the published explicit physical and technological knowledge is not sufficient, if one wants to replicate a successful experiment at another scientific laboratory. You need a person who was a member of the scientific research group or who shared the practices of the group for a while as a visitor. The TEA Laser Set study emphasizes the necessity of shared collective experiences and of

incorporated knowledge. Even in the most explicit science of mathematics, the proving and the formal examination of proofs with and without the help of computers is based on background knowledge of the mathematical culture that cannot be spoken out and be made completely explicit (Heintz 2000: 175).

If we accept the changes towards distributed knowledge production as described in the second part, then we must expect a rising consciousness of the tacit and implicit aspects of knowledge. Inter- and transdisciplinary cooperation cannot be performed by following algorithmic rules; but an enculturation process is required whereby the heterogeneous participants learn to know the tacit knowledge of the others, where they develop a shared language, and where they found a new community of practices. There is, however, also a strong force to make explicit more and more of the tacit assumptions in the process of scientification, but the tuning between and the concertation of the different disciplinary packages of explicit knowledge needs a space where new tacit and collectively incorporated knowledge may grow.

3.2 Non-explicit knowledge in the economy

Modern economy is said to be based on rational choices between goods the values and costs of which can be made explicit. But especially in the field of innovation and technological choices it is evident that decisions are following more likely rules of thumb and organizational search routines than explicit rational calculations (Nelson/Winter 1982).

Under the regime of distributed knowledge production, the conditions of temporal planing and of cost calculation are worsening. A „circle of uncertainties“ is coming up (Rammert 2002: 169) that limits the explicit calculation of risks and benefits. Enterprises try to cope with these uncertainties by building strategic alliances or by sharing knowledge and risks. As the success of an innovation is dependent on a growing bulk of environmental influences, e.g. whether a politicy of deregulation is introduced, whether norms of safety are increased, whether accidents happen or whether values and life styles change, it is only one strategy to intensify and expand the research function in order to make all of this uncertainties explicit and calculable. Another strategy of firms is to ask for all kinds of expert knowledge and to integrate it into the strategic planning. But both activities, the evaluation of the many, but different knowledge packages and the assessment of its weight in a dynamic model of future developments, can only be based on the tacit knowledge of “insiders” and on experiences of a mixed group of experts at the end. The method of a dynamic and collective scenario development tries to combine the use of explicit indicators and the implicit knowledge of a heterogeneous team of experts.

3.3 Non-explicit knowledge, the state and governance

Modern states are based on explicit constitutional rules and administrational laws. For a long time, they were conceived as the central agency of regulation. Specialized ministerial administrations defined the explicit legal frameworks of financial, economic or science and technology policies. But policy studies could demonstrate that a formulated political program or a legal framework gains the intended consequences, only if the conditions of its implementation, especially the interests and the experiences of the different collective actors in the field, are acknowledged (Mayntz 1993). New forms of governance were

tested, like corporate governance, that divided governance between state authorities and private associations (Hollingsworth, Schmitter, Streeck 1994).

When the actors who participate are growing, when the knowledge that is needed for formulating regulatory policies is radically distributed between the heterogeneous individual and collective actors, and when high technologies emerge with rapidity, then all kinds of knowledge that was up to that time certain become quickly obsolete. The new knowledge that is up to then highly needed gets the status of a rare, risky and transitory good. Under these difficult conditions of distributed knowledge production, a kind of co-ordination mechanism is required that achieves both: It must maintain the diversity of actors and of their different knowledge perspectives, and at the same time, it has to create a culture of trust and cooperation that allows a kind of "distributed governance" that refers to explicit rules and to the implicit cultural model or „hidden curriculum" (Rammert 2002). We can observe a rise of procedures of mediation and the growth of interactive networks of innovation that integrate not only heterogeneous participants, but include even dissenting groups. These pluralist and democratic forms of network organization appears to become the new institutional answers to the problems of distributed governance.

3.4 Non-explicit knowledge and complex organizations

Bureaucracies as a prototype of formal organizations are defined by written rules and explicit procedures of rational operation, especially by the criterion of explicit membership (Weber 1921/1968). Empirical organization research, however, has demonstrated that informal rules, myths of rationality (DiMaggio/Powell 1983) and power that is based on knowledge about relevant zones of uncertainty (Crozier/Friedberg 1980) determine the course of organizational development more likely than explicit goals.

The complexity of organizations is actually raised under two aspects: internally, by the introduction of the new information and communication technologies (Sproull/Kiesler; Orlikowski) that doubles, virtualizes and reorganizes tasks and interactions, and externally, by the increasing mass of actors and aspects that influence its performance from outside. New situations of a „distributed co-operation" (Rammert, Braun, Meister) emerge and replace the Fordist work organization that is based on a functionally specialized division of work and the Tayloristic work organization that is mainly shaped by a hierarchical division of work planning and performance. Co-operation and interaction at high tech workplaces is characterized by a high grade of agency of physical and software tools, by a high grade of diversity of skills and competences and by a low grade of overall formalization. Governance is assured by pieces of explicit standards, routines, „boundary objects" and other borderline activities that mediate between the different knowledge cultures (Galison 1997; Star/Griesemer 1989).

The interactive networking between firms and the heterogeneous networking between organizations from different institutional backgrounds threat to dissolve the explicit boundaries between organizations and institutional spheres. In the radically distributed world of virtual enterprises e.g. the clear-cut role and loyalty of an engineer is diffused by his cooperation in a development department that is commonly shared between two competing enterprises and by his participation in a governance committee where norms of self-regulation are negotiated between industry, administration and political representatives. It will be not a question of formal job descriptions, but of organizational culture and tacit dimensions of management whether this engineer will share the fresh attained knowledge with his original organization or uses it for influencing the governance committee or takes

personal advantage and sells it as a free consultant. The interminglement of expertise knowledge and of loyalties increases under conditions of distributed knowledge production and favors the rise of a flourishing consultance industry.

Finally, the considerations and findings of this section demonstrated that neither explicit knowledge will loose its relevance or even diminish under the regime of distributed knowledge production, nor that non-explicit knowledge is step by step disappearing. There is no zero-sum-game between explicit and non-explicit knowledge; both kinds of knowledge can grow and gain more relevance at the same time. There is one strong tendency in knowledge society to raise the level of explication in all fields when it is confronted with the rise of material complexity, when it has to cope with the growing discontinuity in the course of innovation, and when it has to integrate the increasing diversity of actors and their perspectives. Additionally, the employment of computer technologies and the progress of telecommunication strengthen the tendency to make knowledge more explicit. But the traditional limits of explication which were demonstrated at the fields of science, economy, state policy and organization of work, do not disappear. There is another strong tendency to take care of the non-explicit knowledge. It gains rising relevance under the regime of distributed knowledge production. Non-explicit knowledge is a necessary condition

- for the creation and diffusion of scientific facts and technological artifacts in a growing multidisciplinary landscape,
- for pushing the technological innovation in times of high uncertainties,
- for the policy-regulation when the central authority of the state and when the certainty and disposability of knowledge are fading, and
- for the management of organizations which cross the borders towards virtual enterprises and network cooperation.

4. A plead for a policy of knowledge diversity and collective learning

In industrial society, the division of work produced an explosion of productivity. Big complex organizations and markets became the central institutional mechanisms of co-ordination. A regime of complementary and specialized differentiation of activities and institutional spheres was established to cope with the problems of raising the efficiency of and regulating the relationship between the production, distribution and use of industrial goods. Policies of efficiency raising and economic growth were the adequate means on the road to a converging welfare society.

This road of convergence was shattered by new challenges which resulted from the oil crisis, the limits of growth, and by the microelectronic, bio-genetical and internet revolution. We are living now in a time of fermentation. Different modes of production and different regimes are developing side by side, sometimes in cooperation, sometimes in conflict with each other. There is no doubt about the new tendency that the production, distribution and use of knowledge has gained central importance for our society. In analogy to the division of work in industrial society, a parallel process – the division of knowledge – can be observed in actual society. We argued that this division of knowledge produces a growing mass of heterogeneous types of knowledge. It is produced at different places. But knowledge is a good of a different kind than cars or electronic circuits. It is intangible. Information can easily be distributed and copied, if they are once developed and packaged. Knowledge, however, grows only in actions and interactions. If knowledge production is

dispersed over many places, if it is distributed between many different actors, and if it is split between heterogeneous perspectives, a policy of its accumulation, unification, standardization and modularization seems to be rational according to the experiences with the industrial and economic processes. But it risks the destruction of those aspects which lend knowledge its particular worth: the richness of aspects and the relational character of knowledge will be lost.

The worth of knowledge rises, the more it is used and the more different are the aspects under which it is used, whereas the use of tangible goods lowers its worth by consumption. Therefore, a smart knowledge policy should encourage the diversity of actors and perspectives. It should cultivate the differences in and between the communities of practice. It should enable the criss-crossing between different disciplines of knowledge. And it should keep open spaces and places where collective learning between heterogenous actors can take place. A policy of quantitative knowledge growth should be complemented by a qualitative policy of knowledge diversity.

References

Beck, U., Giddens, A., Lash, S. (1994). Reflexive Modernization. Cambridge, Polity Press.

Böhme, G., van den Daele, W., Weingart, P. (1976). "Finalization in Science." Social Science Information **15**: 307-330.

Böhme, G., Stehr, N. (eds) (1986). The Knowledge Society. Dordrecht, Reidel.

Button, G., (Hg.) (1993). Technology in Working Order. Studies of Work, Interaction, and Technology. London, Routledge.

Callon, M. (1993). Variety and Irreversability in Networks of Technique Conception and Adoption. Technology and the Wealth of Nations. C. Foray, Freeman, C. (eds). London, Pinter**:** 232-268.

Collins, H. M. (1974). "The TEA Set: Tacit Knowledge and Scientific Networks." Science Studies **4**: 165-186.

Crozier, M., Friedberg, D. (eds) (1980). Actors and Systems. The Politics of Collective Action. Chicago, University of Chicago Press.

Dewey, J., Bentley, A. (1949). Knowing and the Known. Boston, Reacon Press.

DiMaggio, P., Powell, W. (1983). "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields." American Sociological Review **48**: 147-160.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, P. (1994). The New Production of Knowledge. The Dynamics of Science and Research in Contemporary Societies. London, SAGE.

Fleck, L. (1935). Genesis and Development of a Scientific Fact. Chicago, University of Chicago Press.

Foray, D., Freeman, C. (eds) (1993). Technology and the Wealth of Nations. London, OECD.

Galison, P. (1996). Computer simulations and the trading zone. The Disunity of Science: Boundaries, contexts, and power. P. Galison, Stump, D. (eds). Stanford, Stanford University Press**:** 118-157.

Galison, P. (1997). Image and Logic: A material culture of microphysics. Chicago, University of Chicago Press.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, P. (1994). The New Production of Knowledge. The Dynamics of Science and Research in Contemporary Societies. London, SAGE.

Grundmann, R., Stehr, N. (1997). "Klima und Gesellschaft, soziologische Klassiker und Außenseiter." Soziale Welt **47**: 85-100.

Hage, J., Hollingsworth, R. (2000). "A Strategy for Analysis of Idea Innovation Networks and Institutions." Organization Studies 21: 971-1004.

Hayek, F. A. (1945). "The Use of Knowledge in Society." American Economic Review 35(4): 519-530.

Heintz, B. (2000). Die Innenwelt der Mathematik. Zur Kultur und Praxis einer beweisenden Disziplin. Wien, Springer.

Helmstädter, E. (2000). "Wissensteilung." Graue Reihe des Instituts Arbeit und Technik, Gelsenkirchen: 2000-2012.

Hollingsworth, R., Schmitter, P. Streeck, W. (1994). Governing Capitalist Economies. New York, Oxford University Press.

Hutchins, E. (1996). Cognition in the Wild. Cambridge, MA, MIT Press.

Joerges, B., Shinn, T. (2001). Instrumentation. Between science, state, and industry. Dordrecht, Kluwer.
Knorr Cetina, K. (1992). "Zur Unterkomplexität der Differenzierungstheorie: Empirische Anfragen an die Systemtheorie." Zeitschrift für Soziologie 21(6): 406-419.
Knorr Cetina, K. (1999). Epistemic Cultures. Cambridge, Harvard U. P.
Latour, B. (1994). "On Technical Mediation: The Messenger Lectures on the Evolution of Civilization." Common Knowledge 3(2): 29-64.
Luhmann, N. (1977). "Differentiation of Society." Canadian Journal of Sociology 2: 29-53.
Lundvall, B.-A. (1993). User-Producer Relationships, National Systems of Innovation and Internationalization. Technology and the Wealth of Nations. D. Foray, Freeman, C. London, OECD**:** 277-300.
Machlup, F. (1962). The Production und Distribution of Knowledge in the United States. Princeton, Princeton U. P.
Malsch, T. (2001). "Naming the Unnamable: Socionics or the Sociological Turn of/to Distributed Artificial Intelligence." Autonomous Agents and Multi-Agent Systems **4**: 155-186.
Malsch, T., (Hg.) (1998). Sozionik: Soziologische Ansichten zur künstlichen Sozialität. Berlin, Sigma.
Marin, B., Mayntz, R. (1991). Policy Networks. Frankfurt/M., Campus.
Mayntz, R. (1993). Networks, Issues, and Games: Multiorganizational Interactions in the Restructuring of a National Research System. Games in Hierarchies and Networks. F. W. Scharpf. Frankfurt/M., Campus**:** 189-209.
Münch, R. (1990). Differentiation, Rationalization, Interpenetration: The Emergence of Modern Society. Differentiation Theory and Social Change. Comparative and Historical Perspectives. J. Alexander, Colony, P. (eds). New York, Columbia University Press**:** 441-464.
Nelson, R., (ed.) (1993). National Innovation Systems: A Comparative Analysis. Oxford, Oxford University Press.
Nowotny, H., et al. (2001). Re-thinking Science: Knowledge production in an age of uncertainties. Cambridge, Polity Press.
Orlikowski, W., Walsham, G., Jones, M., de Gross, J. (eds) (1996). Information Technology and Changes in Organizational Work. London, Chapmann & Hall.
Polany, M. (1985). Implizites Wissen. Frankfurt/M., Suhrkamp.
Powell, W. (1990). "Neither Market, Nor Hierarchy: Network Forms of Organization." Research in Organization Behavior 12: 295-336.
Powell, W., Koput, K., Smith-Doerr, L. (1996). "Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology." Administrative Science Quarterly 41(1): 116-145.
Rammert, W., Schlese, M., Wagner, G., Wehner, J., Weingarten, R. (1998). Wissensmaschinen („Knowledge Machines“). Frankfurt/M., Campus.
Rammert, W. (1999). "Inquiry into Innovation - A Pragmatist's Conception of Technological Change (unpublished paper)." Madison: University of Wisconsin.
Rammert, W. (2000). "Ritardando and Accelerando in Reflexive Innovation, or How Networks Synchronise the Tempi of Technological Innovation." Working Paper TUTS-WP-7-2000, Technical University Berlin.
Rammert, W. (2002). The Cultural Shaping of Technology and the Politics of Technodiversity. Social Shaping, Guiding Policy. R. Williamson, Sörensen, K. (eds). Edinburgh, Edgar Elger Press.
Rheinberger, H.-J. (1997). Toward a History of Epistemic Things. Synthesizing Proteins in the Test Tube. Stanford, Stanford University Press.
Schimank, U. (1996). Theorien gesellschaftlicher Differenzierung. Opladen, Leske & Budrich.
Star, S. L., Griesemer, J. R. (1989). "Institutional Ecology: "Translations" and Coherence: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939." Social Studies of Science 19: 387-420.
Star, S. L. (1996). Working together: Symbolic Interactionism, activity theory, and information systems. Cognition and Communication of will. Y. Engström, Biddhton, D. (eds). Cambridge, Cambridge University Press.
Stehr, N., von Storch, H. (1999). Klima - Wetter - Mensch. München, Beck.
Stehr, N. (2000). Die Zerbrechlichkeit moderner Gesellschaften. Weilerswist, Velbrück.
Tyrell, H. (1978). "Anfragen an die Theorie der gesellschaftlichen Differenzierung." Zeitschrift für Soziologie **7**: 175-193.
Weber, M. (1921, 1968). Economy and Society. Three volumes. Totowa, N. Y., Bedminster Press.
Weingart, P. (1983). "Verwissenschaftlichung der Gesellschaft - Politisierung der Wissenschaft." Zeitschrift für Soziologie 12(3): 225-241.
Weingart, P. (1997). "From "Finalization" to "Mode 2": old wine in new bottles." Social Science Information 36(4): 591-613.