Chapter 2
The Nexus of Knowledge and Space[1]

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Given the prospects of the Internet and other digital information systems, and the emergence of a borderless world, access to certain forms of knowledge is arguably easier and faster than ever before. Some observers (Cairncross, 1997; Knoke, 1996; Naisbitt, 1995; Negroponte, 1995; Relph, 1976; Toffler, 1980; Webber, 1964, 1973) have gone as far as to predict that advances in communication technology will lead to the death of distance, imperil locational advantages of cities, and make spatial disparities of knowledge irrelevant. Some people assume that scientific results can be generated everywhere, that "objective" scientific results are quickly accepted universally, that knowledge can be easily and rapidly disseminated throughout the world, and that everybody is able to gain access to the knowledge he or she needs. Others argue that knowledge is situated in space and time; that the generation and diffusion of knowledge is affected by the spatial context; that knowledge is built through acts of social interaction; that various types of knowledge spread at different speeds; that knowledge is not only in the heads of individuals but also represented in rules, routines, and architectures of organizations; that knowledge is reified in scientific instruments, machines, and research infrastructure; and that the various carriers of knowledge are never equally distributed in space.

Spatial disparities in knowledge, professional skills, and technology can be traced back to early human history. New communication technologies—from the creation of the first scripts to the invention of paper, the construction of the first printing machine, the innovation of the telephone, and the introduction of digital information systems—facilitated and accelerated access to freely offered and easily understandable information. They also changed the spatial division of labor, the structure and complexity of organizations, the asymmetry and spatial range of power relations, and the ways in which social systems and networks are coordinated and governed in space. But none of these inventions ever abolished spatial disparities pertaining to the production, dissemination, and use of knowledge.

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Centers of power and knowledge have shifted, but spatial disparities of knowledge have never disappeared. On the contrary, most of these communication techniques enlarged the disparities between the centers and peripheries of national or global urban systems with regard to the distribution of workplaces for highly and marginally skilled persons. The proliferation of printing, the telephone, and electronic communication devices made much of former face-to-face contact dispensable but simultaneously created a demand of new face-to-face contact. Improved communication technology "will lead to more relationships and subsequent face-to-face meetings, as long as some relationships still use face-to-face meetings" (Panayides & Kern, 2005, p. 165; see also Gaspar & Glaeser, 1998).

Many authors have predicted an unproblematic diffusion of codified knowledge through new information technologies or even a notable decrease in spatial disparities of knowledge in the context of globalization and a decline in the importance of proximity (Altvater & Mahnkopf, 1996, p. 269; Henkel & Herkommer, 2004; Machlup, 1962, p. 15; McLuhan, 1964; Radner, 1987, p. 737; Singh, 1994, p. 174; Stehr, 1994a, p. 343; 1994b; Werlen, 1997c, pp. 234, 384; Zare, 1997). However, I argue in this chapter that observers making these attempts to presume or predict the emergence of spatially ubiquitous knowledge make at least one of the following mistakes:

- They overlook the spatial consequences of the vertical division of labor, which become manifest in a spatial bifurcation of skills between centers and peripheries.
- They do not distinguish between knowledge and information and between different categories of knowledge; the distinction between codified and tacit knowledge or between individual and collective knowledge is not sufficient.
- They overlook the importance of the spatial context and spatial interactions in the generation, justification, diffusion, and application of new knowledge.
- They base their empirical evidence about the changing functions of cities on the resident population instead of on the places of work as recommended and demonstrated elsewhere (Meusburger, 1978, 1980, 1996b, 2000, 2001b).
- They disregard the findings of organization theory and underestimate the close affiliation between power and various categories of knowledge. They fail to acknowledge that a spatial system's asymmetry of power relations between center and periphery continually prompts the migration of talent and thus produces, or reproduces, spatial disparities of knowledge.
- They apply a naïve model of linear communication between the sender and receiver of information. When analyzing the process of communicating knowledge from A to B, they overemphasize the producer and codifier of knowledge and neglect the cognitive processes taking place in the receiver of information. They overlook the importance that prior knowledge has for the ability, willingness, or reluctance of potential receivers to accept and integrate certain kinds of information into their knowledge base.

- They focus on codified knowledge as a tradable commodity and fail to notice that the acquisition and application of knowledge is primarily a cognitive process.
- They undervalue the importance of the time dimension in a competitive society. Success in a competitive situation does not depend on knowledge or information per se but on having knowledge before another competitor (agent) does or on receiving information earlier than others.

Some of the standard views that mainstream neoclassical economists had on knowledge were that most of it could be codified and transformed in information, that codified knowledge was a public, tradable, and spatially very mobile commodity, that new communication and transport technologies would diminish spatial disparities of knowledge, that *homo oeconomicus* had access to the knowledge he or she needed for rational decision-making, and that spatial disparities of knowledge were only short-lived. In the last 20 to 30 years, most of these ideas have been largely discredited, not only in science studies, geography of knowledge, and actor-network theory, but also in economics, where they have been gradually replaced by concepts of bounded rationality, evolutionary economics, behavioral economics, learning organizations, new theories of the firm, and the strategic management approach (for an overview see Amin & Cohendet, 2004; Gigerenzer, 2001; Gigerenzer & Selten, 2001; Simon, 1956). The classical thinkers in sociology, too, once believed that scientific truths are generated independent of any local context. Durkheim (1899/1972) distinguished religion from science precisely in terms of the situatedness of the former and the placelessness of the latter (Gieryn, 2002c, p. 45).

In science studies, in the geographies of knowledge, science, and education, and, recently, in economics, scholars argue that new knowledge is created in particular places and contexts, often through interaction with other places and through relations within space. They do not regard spatial disparities of knowledge as short-term transitional phenomena. On the contrary, spatial disparities of knowledge are understood as a fundamental structural phenomenon of any society with a highly developed division of labor. In a dynamic and competitive society, the search for and acquisition of knowledge and skills are continuous processes that never finish. In many situations, it is not knowledge per se that counts but rather the possession of prior, specialized, unique, superior, or rare knowledge. It is a head start in generating and applying new knowledge that counts. Mainly for that reason, some kinds of knowledge are kept secret as long as possible or necessary (Brunés, 1967; Konrád & Szelényi, 1978). The fact that a considerable amount of knowledge is kept secret for a certain span of time has aroused much less interest in geography and economics than has the knowledge exchange in and between firms.

All new knowledge starts as local knowledge. Locally produced knowledge as competence of locally situated actors becomes widely disseminated knowledge only if it is shared with others, recognized by epistemic authorities of the relevant domain, and proved useful. If a scientific experiment is only successful at one place and cannot be replicated elsewhere, it gains no credibility (Collins, 1983, 1985; Gieryn,

1999; Livingstone, 2002, 2003; Shapin, 2001). A spatial context not only influences the generation of knowledge, it also strongly affects the justification, legitimation, dissemination, acceptance, interpretation, and application of knowledge. Science and the humanities are replete with examples illustrating the extremely long time it took for highly creative ideas, new research questions, methods, and theoretical concepts to be perceived and accepted by the epistemological centers of the relevant disciplines. It took 11 years until Max Planck's quantum theory was accepted by the leading physicists (Polanyi, 1985, p. 63). A spatial diffusion of knowledge does not guarantee that readers will interpret that knowledge as intended by the writer. Darwin's theory of evolution, for instance, was interpreted very differently, depending on the country in question (see Livingstone, 1987, 2003; Numbers & Stenhouse, 2001; Stenhouse, 2001). Alexander von Humboldt's work, too, was variously received from one land and period to the next (Rupke, 2005).

Some kinds of knowledge diffuse very slowly in space and arrive only at relatively few places. Among these forms are implicit knowledge, nonverbal knowledge (e.g., the competence to play piano), nonpropositional knowledge (a type of knowledge that cannot be articulated in a that-proposition, such as knowing how to understand a bodily movement; see Abel, p.14), and embedded or encultured knowledge (Blackler, 2002) arising from socialization and acculturation in specific cultural settings or shaped by stable relationships in organizational routines and interpersonal relationships. Some contents of knowledge (e.g., gene technology, nuclear energy, and interpretation of certain "historical facts") are opposed by political elites and therefore do not circulate in certain areas. In other words, the generation and diffusion of knowledge is affected by many influencing factors, and any delay or impediment in the diffusion, acceptance, and application of knowledge produces new spatial disparities of knowledge, at least temporarily.

This chapter is an examination of various relations between knowledge and space and debates some of the reasons why spatial disparities of knowledge evolve and why they are so persistent. Before discussing relations between knowledge and space and explaining some of the reasons underlying spatial disparities of knowledge, I inquire into concepts of space, place, spatiality, and spatial scales. The proper consideration of spatial concepts and space-time has crucial effects upon the way theories and understandings are articulated and developed (see Harvey, 2005, p. 100; Kröcher, 2007) and the way the nexus between knowledge and space can be explicated. I also review the significance of spatial contexts for generating, legitimizing, controlling, manipulating, and applying knowledge, especially scientific knowledge, and propose a model for the spatial diffusion of various types of knowledge. The chapter presents a brief report on the developmental paths and research interests of the geographies of science, knowledge, and education and discusses some of the key questions that are decisive for building bridges between the discourses of various disciplines.

The Significance of Spatial Patterns, Spatiality, and Spatial Contexts in Social and Behavioral Sciences

Conceptions of Space and Place

Until the 1970s many scholars of human geography and other social sciences took space for granted. Its existence was so obvious that it was not a matter of heated theoretical debates. Early concepts of space resembled more or less the notion of a confined container enclosing physical-material objects, human beings with ideas and attributes, animals, and artifacts. Searching for spatial laws, spatial factors, and purely spatial processes, devotees of quantitative geography and regional science defined their discipline as the science of the spatial and argued that the explanation of geographical patterns lay within the spatial dimension. Social aspects were widely neglected (for a critique of this position see Massey, 1985, p. 11). A severe blow to this traditional concept fell at the end of the 1960s, when some of the leading quantitative geographers declared that spatial patterns were overdetermined when it comes to the problem of inference, or the *explanation* of the manner in which spatial structures were created (see Barnes, 2004, pp. 589–590). Harvey (1969), once one of the outstanding quantitative geographers, made a radical shift away from positivism and proclaimed in 1972:

> [Geography's] quantitative revolution has run its course. [It tells us] less and less about anything of great relevance … There is a clear disparity between the sophisticated theoretical and methodological framework which we are using and our ability to say anything really meaningful about events as they unfold around us … In short, our paradigm is not coping well. (p. 6; see also Barnes, 2004)

Other critics of traditional concepts of space as a "taken-for-granted world" (Ley, 1977) drew on phenomenology and action theory. Ley claimed that geographers should not be interested only in spatial patterns of social facts and processes or in the subjective perception of places but also in the subjective constitution of the meaning of "place" (see also Werlen, 1997a, p. 647). On the basis of Heidegger's existential phenomenology, Pickles (1985) elaborated a perspective in which not "space" but rather the appropriate interpretation of human spatiality should be the aim of social geography (see Werlen, 1997a, p. 648; 1999, p. 5).

Werlen (1993, 1999), a proponent of subject-centered action theory, argued that space does not exist as a material object, or as a consistent object of empirical research. "It is … rather a formal and classificatory concept, a frame of reference for the physical components of actions and a grammalogue for problems and possibilities related to the performance of action in the physical world" (Werlen, 1993, p. 3). For him "materiality only becomes meaningful in the performance of actions with certain intentions, and under certain social and subjective conditions" (Werlen, 1993, p. 4). He insists that scientific investigation had to center on subjects, not primarily spaces, regions or spatiality. He starts from a perspective "that emphasizes subjective agency as the only source of action and hence of change, at the same

time as it stresses that the social world shapes the social actions that produce it" (Werlen, 1993, p. 3). Werlen calls for a rigorous categorical shift from "space" to "action" or from "a geography of the things" to "geographies of the subjects" and to "everyday regionalizations" (Werlen, 1993, pp. 2–4, passim). He argues that the relational concept of place is about human agency and the interplay between structure and agency (Werlen, 1993, p. 253; 1995, 1997b, c, 2004a, b).

Lefebvre (1991) sees space from the opposite perspective. For him the social relations of production have a social existence only insofar as they exist spatially; they project themselves into a space while producing it. In other words, all social relations are spatial, and all spatial relations are social (Markus, 2006, p. 321). It has recently become very fashionable in postmodern geography to relate the reassertion of space in social theory (Soja, 1980) to Lefebvre. However, Schmid (2005, p. 13) argues that the reception of Lefebvre in most cases is very superficial and full of misinterpretations.

Representatives of material semiotics have tried to "bring materiality back in and to see places as generated by the placing, arranging, and naming the spatial ordering of materials and the system of difference that they perform" (Hetherington, 1997, p. 184). In the course of the spatial turn (the discovery, or rediscovery, of the importance of space and spatiality) in the social sciences and humanities, the discussion about correct concepts of space has become even more controversial (see Kröcher, 2007; Lippuner & Lossau, 2005; Löw, 2001; Meusburger, 1999; Schlögel, 2003; Werlen, 2007).

According to Hayden (2001, p. 11451) place is "one of the trickiest words in the English language." It carries the resonance of location as well as of a position in a social hierarchy. A "sense of place" can be an aesthetic concept or can settle for local distinctiveness. A phrase like "knowing one's place" can imply power relationships or a sense of belonging or an emotional attachment to a place. Social relationships and memory are intertwined with spatial perception, with sites of memory, landmarks of triumphs and defeats, massacres, or civil rights. However, the human attachment to places is so complex that it defies simplistic explanations (see Hayden, 2001, pp. 11451–11453). One of the functions of place is gathering and holding together things, experiences, histories, and thoughts, enabling copresence and triggering or releasing memories. According to Casey (1996),

> a given place takes on the qualities of its occupants, reflecting these qualities in its own constitution and description and expressing them in its occurrence as an event: places not only are, they happen. … Places are qualified by their own contents, and qualified as well by the various ways these contents are articulated (denoted, described, discussed, narrated, and so forth) in a given culture. (pp. 27–28)

Harvey (1973, 2005) tries to bridge some of the gaps between different concepts of space. He first distinguishes between three types of space: absolute, relative, and relational.

> If we regard space as absolute it becomes a "thing in itself" with an existence independent of matter. It then possesses a structure which we can use to pigeon-hole or individuate phenomena. The view of relative space proposes that it be understood as a relationship between objects which exists only because objects exist and relate to each other. There is

> another sense in which space can be viewed as relative and I choose to call this relational space—space regarded in the manner of Leibniz, as being contained in objects in the sense that an object can be said to exist only insofar as it contains and represents within itself relationships to other objects. [Absolute space] is fixed and we record or plan events within its frame … [I]t is usually represented as a pre-existing and immovable grid amenable to standardized measurement and open to calculation. … Socially, it is the space of private property and other bounded territorial designations (such as states, administrative units, city plans and urban grids). (Harvey, 2005, p. 94)

The relative notion of space rests on Einstein's argument that all forms of measurement depended on the frame of reference of the observer (Harvey, 2005, p. 95). As for the relational view of space,

> there is no such thing as space or time outside of the processes that define them. … Processes do not occur *in* space but define their own spatial frame. The concept of space is embedded in or internal to process. This very formulation implies that, as in the case of relative space, it is impossible to disentangle space from time. We must therefore focus on the relationality of space-time rather than of space in isolation. The relational notion of space-time implies the idea of internal relations; external influences get internalized in specific processes or things through time … An event or a thing at a point in space cannot be understood by appeal to what exists only at that point. It depends on everything else going on around it. (Harvey, 2005, p. 96)

Similar arguments about the fluidity of space or the daily making of space are put forward by other authors such as Massey (1999a), Werlen (1987, 1993, 1995, 1997b), and Löw (2001). "We are constantly making and re-making the time-spaces through which we live our lives" (Massey, 1999a, pp. 22–23). Thrift (1999) summarized this issue with the following words: "Like societies, places can be made durable, but they cannot last" (p. 317). Some authors argue that it is the relational ordering of living entities and social goods, the connections between them, and the symbolic meaning of them that constitute space (Löw, 2001).

For Harvey (1973),

> space is neither absolute, relative or relational in itself, but it can become one or all simultaneously depending on the circumstances. The problem of the proper conceptualization of space is resolved through human practice with respect to it … The question 'what is space?' is therefore replaced by the question 'how is it that different human practices create and make use of different conceptualizations of space'. (p. 13)

As human beings, we are inescapably situated in all three frameworks of space simultaneously. The three concepts are in dialectical tension with each other. "Ground Zero" is an absolute space at the same time as it is relative and relational (see Harvey, 2005, pp. 98–99).

Inspired by Cassirer (1944), who distinguished between organic, perceptual, and symbolic space, and by Lefebvre (1991), Harvey (2005, pp. 101–102) works with a second categorization of space, differentiating material space (experienced space), representations of space (conceptualized space, space as conceived and represented), and spaces of representation (the lived space of sensations, the imagination, emotions, and meanings incorporated into the way people live day by day). Material space is the space of perception open to experience, physical touch and sensation. It is the world of tactile and sensual interaction with matter, the space of

experience. The abstract representation of material realities is achieved through maps, pictures, graphs, words, and other means of communication:

> The physical and material experience of spatial and temporal ordering is mediated to some degree by the way space and time are represented … The spaces and times of representation that envelop and surround us as we go about our daily lives likewise affect both our direct experiences and the way we interpret and understand representations. (Harvey, 2005, p. 102)

Combining these two categorizations of space, Harvey (2005, pp. 105, 111) draws a matrix within which points of intersection suggest different modalities of understanding the meanings of space and space-time. Although it is the dialectical relation between the categories that really counts for Harvey, each of the nine categories of space can become relevant (admittedly to a different degree) when studying the nexus between knowledge and space. Werlen (1993, 2007) certainly does not agree with Harvey's conceptualization of material space. In his view, Lefebvre's formulation "involves a double reification: the reification of space, and the reification of relations of production" (Werlen, 1993, p. 4). He opposes the assertion "that space or materiality already have a meaning in themselves, a meaning that is constitutive of social facts. Materiality only becomes meaningful in the performance of actions with certain intentions, and under certain social (and subjective) conditions" (p. 4).

It is not my intention to summarize the extensive and controversial academic debate on concepts of place, space and spatiality or structure and social action in this chapter (see Barnes, 2004; Gieryn, 2000, 2002c; Gregory, 1994; Günzel, 2006; Hard, 1999, 2002; Harvey, 1972, 1973, 2005; Hasse, 1998; Hayden, 1995, 2001; Jahnke, 2004; Klüter, 1986, 1999, 2003; Koch, 2003; Kröcher, 2007; Lefebvre, 1991; Lippuner, 2005; Lippuner & Lossau, 2005; Löw, 2001; Massey, 1999a, b, 2005; Meusburger, 1999; Pred, 1984; Relph, 1976; Sack, 1980; Schatzki, 2007; Schmid, 2005; Soja, 1980, 1985, 2003; Thrift, 1983, 1985, 1999; Tuan, 1977; Weichhart, 1996; 1999, 2003; Werlen, 1987, 1993, 1995, 1997b, c, 2004a, b, 2007). Nor is it possible to condense the debates about the constitution of "reality," on the relation between the "social" and the "material" or between structure and agency in a short paragraph.

Most authors will probably agree with one of the following definitions:

1. Space is the result (product) of social relations (Harvey, 1973; Werlen, 1987, 1993).
2. Space is the relational ordering of social goods and people (Löw, 2001).
3. Space is a means of perception, a performative act (Löw, 2001). Space is an element of social communication (Hard, 2002; Lippuner, 2005, p. 129; Werlen, 2004b).
4. Space is a semantic concept of order in which the physical-material space serves as an element of order and bears a semantic meaning (Miggelbrink, 2002, p. 344).

To me, it makes little sense to maintain that one concept (or understanding) of space or place is in principle more relevant or adequate than another. Those relative qualities

of the concepts depend on the research topic, the scale of investigation, and the nature of the phenomena under study. The meaning of place, the link between place and function—that is, between the sign and its object (Pucci, 2006, p. 169)—and the way people interpret space and orient themselves in it (Wassmann, 1998, 2003) vary across culture and time periods.

Taking into account the results of psychological experiments on unconscious perception, implicit learning, implicit memory, and automatic (uncontrolled) reactions (Merikle & Daneman, 1996, 1998; Reber, 1993), one asks whether geography of knowledge, human ecology, or action theory can ignore unconscious cognitive processes any longer. In my view, future research on the relations between environment (spatial context) and actions should also include the role of subliminal or unconscious perception, implicit learning, implicit memory, and procedural knowledge (Anderson, 1983; Merikle, 2000; Merikle & Daneman, 1996, 1998; Reber, 1993). According to Merikle (2000), "subliminal perception occurs whenever stimuli presented below the threshold or limen for awareness are found to influence thoughts, feelings, or actions. … [T]he term has been applied more generally to describe any situation in which unnoticed stimuli are perceived" (p. 497). Psychological experiments during anesthesia have shown that unconsciously perceived information can remain in the memory for a considerable time. This work suggests "that unconscious perception may have relatively long lasting impact if the perceived information is personally relevant and meaningful" (Merikle & Daneman, 1998, p. 16). According to Reber (1993), implicit learning is "the acquisition of knowledge that takes place largely independently of conscious attempts to learn and largely in the absence of explicit knowledge about what was acquired" (p. 5). Consciousness and phenomenological awareness are late arrivals on the evolutionary scene (pp. 7, 86). "Hence, consciousness and conscious control over action must have been 'built upon' … deeper and more primitive processes and structures that functioned, independently of awareness" (p. 7). According to Reber (1993) and Merikle and Daneman (1998), many psychological experiments on implicit learning have shown that people acquire complex knowledge about the world independently of conscious attempts to do so. Unconscious cognitive processes apparently tend to be more robust and basic than explicit cognitive processes (Reber, 1993, p. 18).

The findings on implicit learning are paralleled by those on implicit memory. Drawing on these experiments, Anderson (1983) distinguishes between declarative knowledge, which is knowledge that people are aware of and can articulate, and procedural knowledge, which is knowledge that guides action and decision-making but typically lies outside the scope of consciousness (see also Reber, 1993, pp. 14–17). Unconscious perception tends to lead to automatic and uncontrolled reactions; conscious perception allows individuals to modify their reactions and respond more flexibly to a situation (Merikle & Daneman, 1996, 1998). According to Reber (1993), "the study of unconscious processes generally and implicit learning specifically should be cast into an evolutionary setting" (p. 79). Allowing evolutionary biology to act as an explanatory vehicle for understanding implicit, unconscious mentation and for differentiating these covert processes from explicit, conscious processes may be provocative to some social scientists. However, there is ample

evidence (see Reber, 1993; Squire, 1986) that implicit, nonreflective, procedural, or unconscious functions (e.g., procedural memory) are, in terms of evolution, much older, more robust, and less age-dependent than explicit, reflective, declarative, or conscious functions. Infants are able to learn about their social, cultural, familial, physical, and linguistic environments without support from conscious strategies for acquisition (Reber, 1993, p. 97). Why should theoretical concepts on the relations between environment and action, on orientation in space, on local and regional identities, and on cultural memories not include consideration of the psychological and neurological research on implicit learning, implicit memory, and procedural knowledge? Why should one not ask the question of the extent to which the environment does contribute to the development of knowledge? However, arguments about the importance of implicit and explicit knowledge should avoid the "polarity fallacy" (Reber, 1993, pp. 23, 68). Implicit and explicit knowledge should not be treated as though they were completely separate and independent processes. They should instead be seen as interactive components or "as complementary and cooperative functional systems that act to provide us with information about the world within which we function" (Reber, 1993, p. 24).

Advantages of a Spatial Perspective

According to Massey (1999b), spatiality displays the "contemporaneity of difference" (p. 35). The detection, visualization, and analysis of difference are basic tools of any research:

> Space is the sphere of the possibility of the existence of multiplicity; it is the sphere in which distinct trajectories coexist; it is the sphere of the possibility of the existence of more than one voice. Without space, no multiplicity; without multiplicity, no space … Multiplicity and space are co-constitutive. (p. 28)
>
> The very possibility of any serious recognition of multiplicity and difference itself depends on a recognition of spatiality. (p. 30)
>
> In order for there to be co-existing, multiple histories, there must be space. (p. 35)

Is the new focus of social sciences on spatiality and spatial patterns a relapse into old-fashioned geodeterminism or spatial science? Not at all. In the 1960s spatial patterns were seen as a factor of explanation, and geographers were searching for spatial laws and expected causalities between spatial patterns and actions. Since the 1980s, spatial patterns in most cases no longer serve as an explanation; space is no longer a cause or determining power of human actions. Instead, spatial patterns are perceived as a primary component or focus of cognitive processes. According to Abel (2004, pp. 303–304; see also his chapter in this volume), both information and knowledge are bounded by signs and interpretations. Contents and forms of knowledge cannot be specified, nor can they exist independent of the forms, practices, and dynamics of their underlying systems of signs and interpretation. Observing, classifying, and interpreting *spatial* patterns of signs, objects, relations, flows, and processes are a key to orientation and problem-solving and a means of heuristic

exploration. Many situational analyses and decisions demand an ability to draw conclusions from positioning in space or to reconstruct a picture from a small number of signs, clues, or fragments. The ability to recognize, read, and interpret patterns is highly significant, not only for orientation and survival in an unknown or risky environment but also for daily problem-solving and research in many disciplines. Because "nature does not speak" (Ancori et al., 2000, p. 263), the stimuli and signs of the environment have to be perceived, interpreted, and categorized by the knowledgeable agent. In the course of evolution human beings had to learn how to reduce the complexity of spatially ordered signs by promptly recognizing a picture, pattern, entity, context, or gestalt. It is not the sum of a given space's objects or actors that displays social structures and processes but rather the spatial arrangement of and the relations between these objects and actors.

Information perceived by humans is always fragmentary and ambiguous, so it can be interpreted in different ways. Because the search for information cannot go on indefinitely and because an excess of information could even detract from knowledge, humans are constrained by limitations on time, experience, resources, cognitive abilities, attention, and motivation when making inferences about unknown features of their world (see Gigerenzer, 2001). Simon (1956, pp. 129–130) pointed out that there are two sides to bounded rationality: the "cognitive limitations" and, as the title of the article states, the "structure of environments." Gigerenzer (2001) elaborated this notion and stated elsewhere that humans "do not need to wait until all knowledge is acquired and all truth is known … Adaptive solutions can be found with little knowledge" (Gigerenzer & Selten, 2001, p. 10) if the solutions have to work only in a specific environment. Humans are not supposed to be able to explain the world but to find ways to attain their goals successfully. Interpreting spatial patterns of a given environment helps one understand or describe a situation and recognize ways to solve a problem. For Gigerenzer (2001), ecological rationality is a basic tool of decision-making:

> The notions of psychological plausibility and ecological rationality suggest two routes to the study of bounded rationality. The quest for psychological plausibility suggests looking into the mind, that is, taking account of what we know about cognition and emotion in order to understand decisions and behavior. Ecological rationality, in contrast, suggests looking outside the mind, at the structure of environments, to understand what is inside the mind. These research strategies are complementary, like digging a tunnel from two sides. (p. 39)

He points out that the "rationality" of domain-specific heuristics does not lie in optimization, omniscience, or consistency. Their success is rather in their "degree of adaptation to the structure of environments both physical and social" (p. 38).

This ecological rationality clearly depends to a large extent on the ability to grasp and interpret patterns and entities. It is well known from research on optical illusions that the brains we humans have supplement incomplete information with the help of earlier experiences, prior knowledge, preconceptions, or expectations of behavior (Merikle & Daneman, 1996, 1998; Perrig et al., 1993; Schwan, 2003). The structures we recognize in such patterns and the conclusions we draw from them depend on our prior knowledge, or *Vorverständnis* (Gadamer, 1987a, b, 1960),

which means more than cognitive capabilities. It also includes earlier learning processes and experiences, intuition, situational expectations, and the symbolic significance we assign to positioning, goods, buildings, or spatial configurations. Prior knowledge can be defined as a cognitive structure of relationships between signs, events, actions, experiences, memories, and emotions that is possible to retrieve and superimpose on subsequent activities. Choo (1996) used a similar definition for his term "historical knowledge." This retrieval can happen as an unconscious event (e.g., recognition of a face or building), as routines based on former learning processes (e.g., the riding of a bicycle), or as an intentional, conscious act.

A medical doctor has learned how to interpret the image of X-rays. A geomorphologist has been trained to interpret the sequence, stratification, thickness, and spatial arrangement of different types of sediments and remains of organic material in order to gain an insight into climatic conditions and geomorphic processes that took place ten thousand years ago. An archaeologist's task is to reconstruct social structures, power relations, burial rites, and spatial interaction by interpreting the spatial position of stones, ceramics, bones, and other artifacts. To a human geographer thematic maps can serve as a very powerful means of representing, visualizing, and interpreting social structures and processes. Analyzing and interpreting the spatial variation of social indicators on a thematic map is an important heuristic method and can reveal socioeconomic structures, processes, and factors of influence not to be recognized by applying aspatial approaches. However, persons untrained in the relevant discipline might not recognize any structures at all or might not be able to interpret them. Many aspects of society, culture, and economic activity cannot be perceived, described, and explained adequately if the spatial dimension is ignored. The consequences of disregarding the spatial dimension of social structures, indicators, relations, and processes are as adverse as those of neglecting the time dimension or history of social phenomena. Various lines of argument support this assertion. First, both in traditional and modern societies, authority structures, representations of power, distinctiveness, and differences in rank or status are to a large degree spatially exhibited through ordering, positioning, demarcation, exclusion, and elevation. Canter (1991) explained this phenomenon convincingly by pointing out the need for social rules in all human societies (see also Maran, 2006, p. 12). The significance of spatiality for social hierarchies and social relations is also supported by the fact that social ranking is frequently described with spatial metaphors and terminology such as *center*, *periphery*, *top*, *marginal*, *upper* and *lower* class, *insider* and *outsider*, *segregation*, or *distance*.

Space is a means of intervention that controls, manipulates, or otherwise influences the activities of individuals and social systems (see, for example, Feldman, 1997, p. 944; Foucault, 1972, 1980; Townley, 1993). Categorizing, organizing, and commanding space and controlling the spatial arrangement of persons, objects, resources, and relations are very effective devices for governing social systems and manipulating people. "The capacity to dominate and control people or things comes through the geographic location, built-form, and symbolic meanings of a place" (Gieryn, 2000, p. 475). "Space is both the medium and the message of domination and subordination … It tells you where you are and it puts you there" (Keith & Pile,

1993, p. 37). Architectural space constitutes one of the key elements of the symbolism of power. "Social practice always takes place in an environment mirroring the microcosm of social and cultural norms of a given society at a certain time" (Maran, 2006, p. 12). The architecture of even the earliest temples, palaces, and cities distinguished between inside and outside, between the private and public sectors, between holy districts and profane ones, and between areas for upper classes and those for lower classes.

Choreographing space through recurring rituals and ceremonies and through vertical elevation and horizontal distances serves the visualization and confirmation of status, dignity, and prestige (Hölscher, 2006; Weddigen, 2006). It helps a community to recognize, practice and memorize social structures; to strengthen the awareness of hierarchies and dichotomies between us and them, inside and outside, and good and evil; and to reinforce memories and beliefs. In his *Book of Ceremonies* (written about 1488, published in 1516), Piccolomini (1965) devotes an entire chapter to the complex of admittance to and exclusion from the papal chapel. The place of each member of the Curia assembled on the other side of the marble *cancellata* (the place of the pope) was determined by his duties and privileges, all of which were minutely described (see also Weddigen, 2006, p. 272).

"Hardly any other artifact is as closely linked to the human body as architecture" (Juwig, 2006, p. 207). Places, built environments and other materialized spatial structures enable, guide, and constrain action, they arrange patterns of face-to-face interaction that constitute network formation and collective action. They stabilize social life; give structure to social institutions, durability to social networks, and persistence to behavioral patterns (Gieryn, 2002c, p. 35); and facilitate sociality, which may provide the serendipity for new knowledge encounters (Amin & Cohendet, 2004, p. 67). Built environments embody and secure otherwise intangible cultural norms, identities, memories, and values. Built places give material form to the ineffable or invisible, providing a durable legible architectural aide-mémoire (Gieryn, 2000, pp. 473, 481). According to Rapoport (1982), Hölscher (2006), and Maran (2006, p. 12), the built environment can be looked upon as a teaching medium. "Once learned, [the built environment] becomes a mnemonic device reminding us of appropriate behavior" (Rapoport, 1982, p. 67). In the fields of social geography and human ecology, however, controversy abounds regarding the ways in which sociomaterial things can act on humans. One should always bear in mind that the significance of the built environment and architecture "reveals itself only in combination with people and their agency" (Maran, 2006, p. 13) and, as I would like to add, in combination with their prior knowledge, experience, motives, and expectations. Experts in geography, archaeology, and other comparable disciplines are in the position of a detective. In most cases they cannot observe agency; they derive their limited information about social interaction and social structures from surviving clues and objects whose spatial pattern and former meanings they are specially trained to decode and reconstruct.

A second line of reasoning that buttresses the assertion about the negative consequences of disregarding the spatial dimension is that places, monuments, architecture, and built environments are associated with events, histories, biographical

experiences, and practices. On the basis of their symbolic meaning, performative spaces create identities, loyalties, and social connectivity; build memories; evoke emotions; and influence feelings. Connerton (1989), Wright (2006), and others argue that the process of remembering in a social sense requires the bodily practice of commemoration in the form of ritual performances. Buildings, courts, mortuary facilities, and streets "facilitate commemorative performance by reproducing and producing social relations" (Wright, 2006, p. 50). Place attachment results from interactive and culturally shared processes of endowing buildings, neighborhoods, or cities with an emotional and symbolic meaning or moral judgment. In cognitive processes, places can function as mnemonic aids, as triggers for emotions and memories, as "spatial anchors for historical traditions" (Foote et al., 2000, p. 305), or as "contextual memory" (Chun & Jiang, 2003). Like icons of power, mnemonic places (Zerubavel, 1997) are specifically designed and constructed to evoke memories, embody histories, and focus the attention of the public on certain objects and interpretations. The more unintentional or unconscious these learning processes are, the more efficient the manipulation of knowledge is.

A third group of arguments proposes that different spatial contexts, environments, and infrastructures offer dissimilar challenges and incentives for learning, research, and problem-solving. "Knowledge cannot be regarded independently from the process through which it is obtained" (Ancori et al., 2000, p. 281). "Intellectual production is always materialized through human bodies, and non-human objects … Scientists are not faceless organs of scientific rationality, but real people with particular kinds of bodies, histories, skills and interests that make a difference to the kind of knowledge produced" (Barnes, 2004, p. 570). New ideas emerge from social practice, and practice is always undertaken in particular places (Shapin, 1998). "Intellectual inquiry is not the view from nowhere, but the view from somewhere" (Barnes, 2004, p. 568; see also Shapin, 1998). Different places present distinct opportunities of learning and pressures of adapting. They set off different cognitive processes and motivations, induce different discourses, questions, and answers and foster different experiments, practices, and engagements.

Places of discovery can have an impact on scientific results. In various disciplines the process of discovery is not based on formal logic alone; it does not require specific logical methods. Instead, it may involve historical, psychological, and sociological reasoning and research (Hoyningen-Huene, 1987, p. 505). A number of disciplines sample their data in the field, in archives, or in museums. The processes through which they attain their knowledge are highly place dependent (see Wenger, 1998). Different scientific institutions, laboratories, museums, or other places offer different opportunities of learning. They are confronted by different degrees of competition and critique and provide access to different scientific instruments, infrastructure, and resources essential for research. Different departments are integrated into distinct international networks, alliances, and loyalties. They recruit their research staff and visiting scholars from different cultural areas and scientific backgrounds (Jöns, 2003, 2007; Meusburger, 1990; Weick, 1995).

They offer different prospects and risks, and their scholars differ in their scientific biographies, experience, and reputation. Places vary with regard to social control, limitation of research (e.g., stem cells), and the significance of political correctness. The reputation of a research institution may crumble when the alliances and networks associated with a certain theoretical approach falter (Barnes, 2004, p. 588). Different research institutions have different "styles of scientific reasoning" (Hacking, 1985, 2002). For Hacking a style of reasoning connotes both the historiocultural nature of intellectual projects and their particular nature based upon specialized vocabularies, logics, practices, and forms of explanation. The Japanese notion of *ba* (field) also belongs to this concept. Contrary to kinship, *ba* is a shared space of relationships and mutual commitments built at the place of work. *Ba* is a place in which knowledge is shared, created, and utilized. It is a shared context in cognition and action (Nonaka, 1994; Nonaka & Takeuchi, 1995; Nonaka et al., 2000, p. 8).

The acceptance and reputation of scientific results depend, to a large degree, on where they were generated and verified (Knorr-Cetina, 1992, 1999; Livingstone, 2003; Shapin, 2001; Withers, 2002, 2004). The platform on which scientific results are first presented is often of more importance for their fast spatial diffusion than is the quality or originality of the findings. According to Noteboom (2000) all forms of thought develop out of active interaction with the physical and social environment. In this context scientific practice can be regarded as a process of building networks between actors, resources, things, objects, infrastructures, and social interests (Jöns, 2006, p. 563). If it is accepted that people know and understand through the practice of acting and that acting is always context dependent (Amin & Cohendet, 2004, p. 64), then all forms of learning can be seen as contextual. In geographies of knowledge and in evolutionary economics and organization theory, the external environment of the social system is seen as the driving force that shapes the core competencies, learning processes, and architecture of social systems (see Amin & Cohendet, 2004, p. 57; Geser, 1983; Meusburger, 1998; Mintzberg, 1979). Reviewing the relevant literature in economics of knowledge, Amin and Cohendet (2004) draw the conclusion "that the powers of context—spatial and temporal—should be placed at the center of any theorization of knowledge formation" (p. 86).

Another advantage of using the spatial dimension for perceiving and displaying social phenomena, structures, and processes lies in the fact that space can be represented and visualized on various scales. Each spatial scale (i.e., level of aggregation and generalization) exposes different structures and patterns not visible or not clearly perceivable on other scales. An overload of information on the microscale may blur patterns that are quite clear at the meso- or macroscale where information is reduced to the most important elements. Each scale enables distinctive insights, heuristic assumptions, and interpretations hardly possible on another scale. Different scales put forward different research questions and may call for different theoretical approaches. Maps of various scales may function as "knowledge mediaries" or "active knowledge actants" (Amin & Cohendet, 2004, p. 71).

How Is It Possible that Sociomaterial Things Positioned in Space Act upon Humans?

Material environments which provide cultural meaning (e.g., in the form of action settings) can order social relationships and the course of activities. The symbolic meaning of a place or action setting determines what is regarded as appropriate behavior (see Weichhart, 2003). Conduct tolerated backstage or in private may not be appropriate or permissible in public. It depends on the categorization and demarcation of places and areas whether individual action (e.g., spraying graffiti or parking a car) or collective action (e.g., a demonstration) is illegal and how the police respond to it. It goes without saying that action settings (such as a mosque, synagogue, a chemist's laboratory, or a cinema) do not *determine* the behavior of people. Rather, they prompt people to act in a particular way that is appropriate for the cultural significance of the place. People knowing which behavior is appropriate, permitted, tolerated, desired, or disapproved of in a particular action setting behave in a certain way. Individuals who are not aware of the symbolic or cultural significance of an action setting do not behave in accordance with the expectations.

Do places or built environments have an impact on action per se, apart from their symbolic meaning and apart from powerful people or organizations occupying them? Or is it only their symbolic meanings that influence human action? How do sociomaterial things positioned in space act upon humans? These questions are part of an intense debate in a number of disciplines. Diverse answers are offered by actor-network theory (Jöns, 2003, 2006, p. 563; Latour, 1987), human ecology (Weichhart, 2003), symbolic action theory (Boesch, 1991), science studies (Gans, 2002; Gieryn, 2000, 2001, 2002a, c; Goss, 1988; Livingstone, 2003; Withers, 2002, 2004), and subject-centered action theory (Werlen, 1993, 1995, 1997b). Authors following the traditional path of sociology do not acknowledge the agentic capacity of material realities. Durkheim's classical notion that the social cannot be explained by the material and that "the truths of science are independent of any local context" (Durkheim, 1899/1972; Gieryn, 2002c, p. 45) is still widely accepted in sociology. However, Durkheim himself used spatial disparities as an analytical tool in his book on suicide (Durkheim, 1897/1997). Advocates of actor-network theory and modern science studies have no difficulties with regarding built environments as constitutive — along with governance structures, legal processes, and workplace organization (Gieryn, 2002a, p. 343).

As Gieryn (2002c, pp. 37–38) has elaborated in detail, Giddens (1984a, b) is disinclined to ascribe autonomous agency to built environments and instead makes them a function of interpretations and uses by knowledgeable humans. He is reluctant to allow that buildings or spatial structures may preempt or preclude the agent's conscious apprehension, interpretation, or mobilization and that they can structure practices without necessarily requiring actors' cognizant involvement. Giddens supports the idea that "location is only socially relevant—and this is crucial—when filtered through frames of reference that orient individuals' conduct" (see preface in Werlen, 1993, p. xv). Werlen is equally unwilling to attribute agency to material

objects. He accepts the constraining character of material artifacts, but maintains that such objects are "always and only constituted and reconstituted through subjective agency" (Werlen, 1993, p. 199). Bourdieu (1989) does not share Giddens's reluctance. For him, buildings become "objectified history: systems of classification, hierarchies, and oppositions inscribed in the durability of wood, mud, and brick" (Gieryn, 2002c, p. 39; see also Bourdieu, 1981, pp. 305–306). Gieryn (2002a) summarized the debate in sociology as follows:

> Once upon a time, sociologists thought that the effects of "the social" (political or economic interests, power, face-sheet attributes, discursive forms, etc.) on scientists' legitimate beliefs about the natural world were limited to the institutional contexts for problem choice, data collection, experimentation, publication, funding, or peer review. The content of what would become scientific truth was determined by the given reality of the natural world; social factors just introduced error or governed the pace at which nature revealed its secrets. Then came revolution number one: scientific truth became a social construction, and the race was on how to show how the content of scientific claims was substantially (completely?) affected by power, interests, discourse.… The "natural world" itself dissolved into so many representations or accounts, and reality became the upshot of persuasion and negotiation (losing its force as a cause of belief). Then came revolution number two, inspired by the slow realization that it didn't make sense to leave reality out of truth making. But "nature" was brought back in not as antipode to "the social" (as it was at the beginning) but as part of it. Nowadays, … social things and natural things have autonomous force in shaping scientists' beliefs and practices. "Given reality" has an effect on the content of claims and theories, but only as that stuff is suspended in vast networks of circulation, along with people, meanings, political interests, economic power, and too many other things to list. Neither nonhuman physical reality nor human social reality can be privileged as an explanation or cause of what scientists believe or write. (p. 341)

For sociologists of science, the era of human or social omnipotence is over. Posthumanist sociology (Latour, 2001; Knorr-Cetina, 2001; Pickering, 1995) redistributes agency among diverse causal powers—human, material, social, ideational (Gieryn, 2002a, p. 342). Recently, sociology has become interested in the "significance of material culture in social life" (Gieryn, 2000, p. 465). Social processes (difference, power, inequality, collective action) happen *through* the material forms that humans design, build, use, and protest (Gieryn, 2000; Habraken, 1998). The culturally reproduced images of places are arbitrary in their social construction but real in their consequences—for what people do consciously or routinely (Gieryn, 2000, p. 473). As with any generalization, there are always some exceptions to the main trend. Werlen drew my attention to Linde (1972), who recognized the relevance of "real things" for sociology long before it became fashionable.

Allen (1977), Galison (1997, 1999), Gieryn (2002c), Knorr-Cetina (1992), Livingstone (2003), and others have tried to answer the question of whether and why architectural layouts of offices and laboratories do have effects on the generation of scientific results and the performance of scientists. Empirical evidence from many studies suggests that the architecture of buildings and the floor plan of laboratories have effects on patterns of social interaction among scientists, on casual face-to-face contact and chance encounters among those scientists working on different projects or in different teams (Gieryn, 2002c, pp. 46–47). "Arrangements of space inside research laboratories reproduce the divisions of labor and even

status hierarchies among a discipline's practitioners" (p. 47). But as physical environments can express social meaning by acting as a system of signs, they matter for science in a semiotic sense as well (Hillier & Hanson, 1984, p. 8). When new scientific fields emerge, the architecture of laboratories has to be changed. "Campus buildings originally designed to house biology here, chemistry there, and physics down the street now become impediments to biotechnical research that demands practitioners, skills, and equipment from all three disciplines" (Gieryn, 2002c, p. 50).

When Did Scientific Interest in the Spatiality of Science, Knowledge, and Education Evolve?

Scientific and political interest in spatial disparities of knowledge (literacy, research, educational attainment, educational infrastructure, and professional skills) harks back to the first decades of the 19th century. It was the time when social reformers in France and the United Kingdom believed that poverty, crime, and alcoholism were caused by ignorance and a lack of moral education and when relations between knowledge and economic performance were discovered. In the 19th century, scholars in the social survey movement studied social and spatial disparities of illiteracy, the availability and quality of schools, the skills and salaries of teachers, the availability of books in households, and the educational attainment of children (see Furet & Ozouf, 1977; Heffernan, 1988, 1989; Meusburger, 1998, pp. 191–198). In 1826, C. Dupin gave a lecture about the interrelation between the population's educational achievement and economic well-being. In 1827, he published the *Carte figurative de l'instruction populaire de la France*, a map that depicted large regional disparities in educational attainment between northern and southern France. The tables that were added to that document compared the educational attainment, the number of patents for inventions, and the membership in the *Académie Française*, with various economic indicators suggesting a correlation between educational achievement and economic performance. To my knowledge, the first map of spatial disparities of education on a global scale was published by Alexander von Humboldt on the topic of *geistige Bildung* (intellectual and spiritual culture) (Berghaus, 1838–1848/2004, p. 143). Fletcher (1849) published a map on "Ignorance in England and Wales" (reprinted in Hoyler, 1996, p. 188).

In the decades thereafter, academics in the social sciences and the humanities were occasionally interested in the relations between knowledge, space, and place. Since the 1960s, however, research on spatial disparities of knowledge, science, technology, and education has increased remarkably in a number of disciplines. The geography of knowledge and education emerged in German speaking-countries in the early 1960s (Geipel, 1965, 1968, 1969, 1971). Some of the main research issues of geography of education between 1965 and 2007 were spatial disparities of educational achievement (Geipel, 1971; Meusburger, 1980), location criteria and catchment areas of educational institutions (Kramer, 1993), the spatial distribution of jobs for

the highly and marginally educated work forces, the relation between the hierarchy of a national urban system and the educational achievement of the workforce (Meusburger, 1978, 1980, 1996b, 2000, 2001b), the relation between spatial mobility and educational achievement (Meusburger, 1980), ethnicity and educational achievement (Frantz, 1994; Freytag, 2003; Gamerith, 2006; Meusburger, 1996a), spatial disparities in the feminization of the teaching profession (Schmude, 1988), provenance, and the careers and mobility of scientists (Beaverstock, 1996; Jöns, 2003; Meusburger, 1990; Weick, 1995). Research reports about the geography of education have been presented by Meusburger (1976, 1980, 1998, 2001a), and Butler & Hamnett (2007).

In the 1960s and 1970s studies on the diffusion of information, the role of face-to-face contact, and the location of offices and headquarters contributed substantially to knowledge about why jobs of highly skilled decision-makers and experts tend toward spatial concentration and clustering (Goddard, 1971; Goddard & Morris, 1976; Goddard & Pye, 1977; Hägerstrand, 1966; Hägerstrand & Kuklinski, 1971; Meusburger, 1978, 1980; Pred, 1973; Thorngren, 1970; Törnqvist, 1968, 1970; Westaway, 1974). Seminal influence on economic geography came from the theory of human capital (Schultz, 1960, 1963) and from research on innovations and innovative firms (Feldman, 1994; Feldman & Florida, 1994; Kline & Rosenberg, 1986; Lundvall, 1988; Sternberg, 2007) and inventions (Nelson, 1959a, b, 1962), which have been seen as the most important sources of competitive advantage and as the driving force of economic development since Schumpeter (1912). They were followed by studies on the role of institutions in regional development (Camagni, 1991; Maskell & Malmberg, 1999; Storper, 1995; Storper & Venables, 2004), the relations between technology and economic development (Malecki, 1980, 1997, 2000), learning economies, regions and cities (Gertler, 2003; Lundvall, 1997; Maskell & Malmberg, 1999; Matthiesen, 2004; Morgan, 1997), collective learning (Capello, 1999; Keeble & Wilkinson, 1999; Lawson & Lorenz, 1999; Stam & Wever, 2003), learning organizations (Maskell & Malmberg, 1999), knowledge creation (Ibert, 2007), knowledge-creating companies (Nonaka, 1994; Nonaka & Takeuchi, 1995), and industrial clusters (Malmberg & Maskell, 2002; for an overview see Bathelt et al., 2004).

Another line of research on knowledge and power was the role of travel accounts and geographical imaginations in the production of imperial knowledge (Gregory, 1994, 1998, 2000; Pratt, 1992) and the relationship between power and knowledge in the conduct of former and present colonialism (Gregory, 2004).

The geography of science, which has developed since the early 1980s mainly in the United Kingdom and the United States (Livingstone, 1987, 1995, 2000, 2002, 2003; Naylor, 2002, 2005a, b; Ophir & Shapin, 1991; Powell, 2007; Shapin, 1988, 1991; Shapin & Schaffer, 1985; Withers, 2002, 2004), had epistemic roots other than the geography of knowledge and education. The notion that place matters in the production of scientific knowledge began to take shape in the 1930s, when Fleck (1935/1980) pointed out that the question of what is regarded as "scientific fact" depends on *Denkstilen* (styles of thinking) and *Denkkollektiven* (collectives of thinkers) or *Denkgemeinschaften* (communities of thinkers). "Even

the simplest act of observation is conditioned by thinking style and is, hence, tied to a community of thinkers" (Fleck, 1935/1980, p. 129).[2] Hayek (1937, 1945) distinguished between context-specific knowledge, which he called knowledge of the particular circumstances of time and place, and knowledge of general rules, which he called scientific knowledge. Kuhn (1962) elaborated similar ideas. In the 1970s a number of historians and sociologists of science questioned whether there was an inherent universality of scientific content. They argued that knowledge reflects various social interests of those who propose it (Bloor, 1976), that science is a particular kind of social practice, that scientific results are socially constructed (Latour, 1987; Latour & Wolgar, 1979), and that they reflect unequal relations of power and uneven distribution of resources (Barnes, 1998, p. 205; Jöns, 2006, p. 562). In this debate Latour (1987) reminded the scientific community that "the proof race [of the sciences] is so expensive that only a few people, nations, institutions, or professions are able to sustain it, this means that the production of facts and artifacts will not occur everywhere and for free, but will occur only at restricted places at particular times" (p. 179). His concept of cycles of accumulation in scientific centers of calculation describes the way in which certain places can become centers that dominate the periphery: "At every run of this accumulation cycle, more elements are gathered in the center … at every run the asymmetry between the foreigners and the natives grows" (p. 179). "Systematic knowledge is never free of context and prescriptive assumptions. Hence, each group will make knowledge claims according to its interests and strategic goals. Integration of knowledge is based on rhetoric, persuasion skills, and power rather than established rules of discovering the truth" (Renn, 2001, p. 13651). As soon as it was accepted by most social scientists that the generation of scientific knowledge is situated in time and space and that truth about natural reality is influenced by the social environment (Haraway, 1988; Knorr-Cetina, 1992, 1999; Kuhn, 1962; Latour, 1987; Schaffer, 1991; Shapin, 1998; Shapin & Schaffer, 1985), new research questions about the meaning of space within the process of knowledge production arose and paved the way for a geography of science (Jöns, 2006, p. 561; Livingstone, 2003).

Major stimuli for a spatial turn in science studies originated partly with those historians and sociologists of science who shifted their research focus from problems of truth and validity to issues surrounding the credibility of and trust in scientific experiments and the circulation of scientific results (Ophir & Shapin, 1991; Schaffer, 1991; Shapin, 2001). The spatial turn was also facilitated by researchers who switched from producing laboratory ethnographies that focused on the local aspects of science practice to viewing the laboratory as cultural space (Naylor, 2002, 2005a, b; Schaffer, 1998; Shapin & Schaffer, 1985). According to Powell (2007), "due to a concern for the credibility of truth-claims

[2] Auch das einfachste Beobachten [ist] denkstilbedingt, also an eine Denkgemeinschaft gebunden.

and truth-claimants, science studies *necessarily* had to confront questions of spatiality" (p. 310).

Naylor (2005b, p. 3) distinguishes between three geographies of science. The first one is the microgeography of science focusing on the spaces (e.g., laboratories) in which scientists have done their work. The second one is a consideration of science and its contexts, including the city, the region, and the nation. The third geography is focused on a more general and abstract concept of the relation between science and the public sphere. National censuses, national academies of science, ordnance surveys, and other enterprises have been used to construct national identity and unity (Naylor, 2005b, p. 8).

Shapin (1988, p. 373) showed how, in the 17th century, the siting of knowledge-making practices contributed to the credibility of experiments. Truth-claims of scientific experiments needed spaces such as laboratories where witnessing was to occur and could be guaranteed by a community of respected scholars. Other sites of knowledge generation and legitimation were museums, archives, lecture halls, botany gardens, and selected field sites. Such sites acted as "truth spots" (Gieryn, 2002b) facilitating experiments and practices, bringing certain actors together and excluding others, and legitimating results (for detailed discussions see Gieryn, 2002a, b, c; Knorr-Cetina, 1992; Livingstone, 2003; Naylor, 2005a, b; Ophir & Shapin, 1991; Powell, 2007; Schaffer, 1998; Shapin, 1988, 1991; Shapin & Schaffer, 1985).

Geographers of science are interested in all steps of the generation, dissemination, and application of knowledge. They study the settings in which scientific experiments and studies were carried out and the places where scientific knowledge was generated, displayed, and legitimated. According to Livingstone (2003), science "is a human enterprise situated in time and space, … scientific knowledge bears the imprints of its location" (p. 13). He has pointed out that "space matters in the conduct of scientific inquiry" (Livingstone, 2002, p. 8) and that "in different spaces different kinds of science are practiced" (Livingstone, 2003, p. 15). He has described distinctive geographies of writing and reception (p. 29), showing that the generation of knowledge requires a spatial context other than the showing of experiments and that the legitimation of scientific results, in turn, calls for other locations:

> A gulf thus opens up between what was called the "trying" of an experiment and the "showing" of an experiment … The shift from "trying" to "showing," from delving to demonstrating … is a spatial manifestation of the move from the context of scientific discovery to the context of justification. (p. 24)

The distinction between the context of discovery and the context of justification reaches back to the mid-19th century (for details see Hoyningen-Huene, 1987, pp. 502–503) and was already a central theme of the *Wiener Kreis* (Carnap et al., 1929), of Popper (1934), and other authors. Hoyningen-Huene (1987, p. 508) suggests a differentiation that is at least threefold. In the first phase a theoretical idea, a hypothesis, or a theory sketch is "generated." This process may be initiated by a challenge, a problem to be solved, a discourse, or the crossing of disciplinary borders. In the second phase the plausibility of the idea is assessed. Finally, the

elaborated idea may be subjected to critical testing and, if it is successful, it may be "accepted." The criteria or communal cognitive values involved in this testing vary both in the spatial and the temporal dimensions.

Other important stimuli came from psychology in the 1980s, when learning and creativity were no longer regarded as mere cognitive processes of individuals but as something influenced by interaction with social and cultural contexts and artifacts, especially by participation in cultural activities. As soon as psychologists saw the learning of individuals in relation to social systems, contexts, networks, interactions, and social practices, as soon as it was accepted that action settings, situations, or a system's environment can influence the creation, diffusion, and application of new knowledge, social and environmental psychologists had built a bridge to human geography.

In economics the boom in publications on the role of knowledge in economic performance, on learning organizations, on the formation and distribution of knowledge in firms, on knowledge formation in clusters, on innovative milieus and other issues started mainly in the 1990s (Aydalot, 1986; Aydalot & Keeble, 1991; Camagni, 1991, 1995; Christensen & Drejer, 2005; Lam, 2000; Lorenzen & Maskell, 2004; Maillat et al., 1993), although many classics (e.g., A. Smith, S. Mill, L. Stein, L. Walras, A. Marshall, J. Schumpeter, S. Kuznets, and F. Hayek) had pointed out that knowledge and innovations are the key driving force of economic development (for details see Meusburger, 1998, pp. 81–96; Nelson, 1959a, b, 1962; Nelson & Winter, 1977). According to Amin and Cohendet (2004, p. 17) traditional economists had to overcome at least four theoretical obstacles before knowledge could become central in economic theory. They had to (a) abandon the "vision of knowledge as a simple stock resulting from the accumulation of information in a linear process," (b) shed "the hypothesis that any form of knowledge can be made codifiable," (c) give up "the vision that knowledge is limited to individuals", and (d) "the idea that knowledge is limited to something that people 'possess'." I add, that they had also to accept that place and spatiality matter.

Reading the literature on networks and clusters, one gets the impression that many authors take it for granted that networks and clusters contribute almost automatically to the generation of knowledge (see Bathelt & Glückler, 2000; Bathelt et al., 2004; Lo, 2003; Schamp & Lo, 2003). My view is that networks and clusters per se have no positive effects on the generation of knowledge, they can even detract from the generation and transfer of important knowledge. Whether networks generate new knowledge depends on who belongs to the network, how much expertise the network comprises, which interests the members of the network pursue, and how links are added and removed. A proper understanding of most networks requires that analysts characterize the assembly process that generated them, that they increase their knowledge about the structure of collaboration and about the ways in which people form alliances (Barabási, 2005, p. 640).

Forces and Processes Generating and Reproducing Spatial Disparities of Knowledge

Power, Knowledge, and the Organization of Space

Among the primary causes of spatial disparities of knowledge, the most prominent are the division of labor, the growth of complex social systems, the emergence of hierarchies, and the asymmetry of power relations in social systems. The vertical division of labor implies that a profession or activity (e.g., the production of a shoe or machine) formerly performed by a single person is broken down into various activities carried out by many individuals with different levels of skills and decision-making authority. Some lines of routine work become deskilled and need less training. Other activities (e.g., research, design, and marketing) require high-level, time-consuming training and call for specialized expertise and skills. The bifurcation of skills means that jobs of highly skilled professionals and high-ranking decision-makers shift to the top levels of an organization's hierarchy, whereas low-skill routine activities in production and administration are predominantly located at the lower levels of the hierarchy. In the spatial dimension this process leads to the emergence of centers and peripheries of different ranks. Positions of power and authority and highly skilled experts show a strong tendency toward spatial concentration in a few centers, whereas low-skill routine activities coordinated and controlled by external decision-makers show a trend toward dispersion and decentralization (Meusburger, 1996b, 1998, 2000, 2001b).

Any invention or new technique that facilitates indirect communication over large distances also enlarges the potential for a spatial division of labor, improves the opportunities of governing and coordinating large organizations in space, intensifies the coalition between knowledge and power, encourages the growth of cities, and reinforces the disparities of knowledge between the center and the periphery. Since the close coalition between knowledge and power and their dialectical relationship may be regarded as the main reason for the long persistence and continuous reproduction of spatial disparities of socioeconomic structures, the questions arise as to why knowledge and power depend on each other, why they mutually transform each other (Brown, 1993, p. 154), and why their top ranks tend toward spatial proximity.

The importance of power to the production and dissemination of certain types of knowledge can hardly be overestimated. Since early history, it has been in the interest of those in power to control or influence institutions of knowledge production. Also "in modern societies the ability to facilitate or suppress knowledge is in large part what makes one party more powerful than another" (Flyvbjerg, 1998, p. 36). Political and cultural elites fake documents, invent "facts" (e.g., the existence of weapons of mass destruction in Iraq) and construct historical memories that legitimate their actions and provide national or regional identities. The ways we know history are determined more by contemporary concerns of those in power than by history itself (Williams, 1973, p. 9).

In order to obtain power and preserve it for notable periods of time in an uncertain, risky, and dynamic social environment, a social system has to be successful in achieving (and redefining) its goals and has to retain its ability to learn and adapt to a dynamic environment. In a dynamic and competitive society, the acquisition of knowledge and skills is a process that never reaches completion. The skills and knowledge needed for the key functions of a social system striving for success (i.e., survival) will always be scarce and expensive. The larger the uncertainties, the greater the social demand to *anticipate* prospective events and future developments or to reveal a hidden truth. This pressure leads to emergence of oracles, dream readers, priests, advisors, experts, intellectuals, and think tanks, which derive their privileges and status from their claim to know better or earlier than the majority of people or to represent a link to the mysterious and unrevealed.

The relation between knowledge and power has been discussed intensely by a large number of philosophers and social scientists (Foucault, 1972, 1980; Konrád & Szelényi, 1978; Mann, 1986; Meusburger, 1998; Nietzsche, 1888; Stehr, 1994a, b; Weber, 1978). If rulers of empires or high-ranking decision-makers of large social systems want to maintain their power, survive competition, preserve their legitimacy, and impose their view of the world, they need the support of two types of experts. First, they depend on the analytical skills and professional competence of experts of analytical knowledge. Second, they need the support or assent of the representatives of orientation knowledge, which was called *Heilswissen* by Scheler (1926), to legitimate their power. With regard to the single actor, it is clear that both categories are strongly interrelated and influence each other. However, on the level of organizations, a clear functional differentiation and specialization can be observed. Experts of analytical knowledge have other tasks, need different training and skills, and use other methods than experts of orientation knowledge do (Meusburger, 2005).

Analytical knowledge, scientific knowledge, competence, and proficiency are needed in order to analyze a situation as precisely as possible and to offer solutions to problems that have to be solved. Experts are persons who, by objective standards and over time, consistently show superior and outstanding performance in typical activities of a particular domain (Gruber, 2001). The gaining of expertise is usually characterized cognitively "as a process of enhancing one's competence in a target domain by accumulating experience of problem solving, understanding, and task performance in that domain" (Hatano & Oura, 2001, pp. 3173–3174). Experts are needed and paid to predict the likely consequences of actions, to anticipate potential opportunities and risks and to give advice on how to cope with uncertainties. They are supposed to reduce complexity and offer more certainty in a risky environment than a layperson is able to do. They are required to anticipate, perceive, and understand new developments and offer solutions to new-found problems and challenges. They are expected to interpret signs and patterns of change that are not understood by most people. As expertise is action-orientated advice, it should be free of errors. The role of an expert involves that person's trustworthiness, accountability, and credibility. "Trusting becomes the crucial strategy to deal with an uncertain, unpredictable, and uncontrollable future" (Sztompka, 2001, p. 15913; see also Sztompka, 1999).

Because "bodies of expert knowledge … are widely taken as the touchstone of truth in our culture" (Shapin, 2001, p. 15926), credibility is the most important asset of an expert. The relation between the expert and the layperson but also that between experts of various domains can be described as "epistemic dependency" (Jones, 2001, p. 15917). Incompetence, ignorance, and lack of experience are important factors leading to the collapse of social systems or to the decline of centers. Therefore, those in power depend on the analytical capabilities and competence of experts.

However, it is not sufficient just to acquire power; power has also to be legitimated. Rulers achieve the legitimization of their power mainly from representatives of orientation knowledge. In earlier times they were prophets or oracles; later they were priests, intellectuals, editors, propaganda departments, novelists, and artists. Orientation knowledge provides a point of reference, declares what is good or evil, bestows identity and forms the glue that keeps a social system together. Representatives of orientation knowledge are trained and experienced in the art of influencing, convincing, and manipulating people. Their task is not to analyze a "real situation" or to search for truth or "objective facts" but rather to sustain the internal cohesion and motivation of their social system, to create beliefs and collective memories, to mobilize loyalty, to justify actions, and to make moral judgments.

Through the mechanism of moral exclusion, the dichotomy between "good" and "evil" is equated with "us" and "them." The specialists of orientation knowledge are responsible for depicting their "own side" as representative of moral values, justice, peace, and human rights, as acting upon God's wishes or being "God's own country" (Weinberg, 1935). The opposing side is demonized as an aggressor, a barbaric enemy, a danger to peace, a power of darkness, an axis of evil, or a war criminal (Jewett & Lawrence, 2003; Lawrence & Jewett, 2002; Wunder, 2006). The mechanism of moral exclusion is not a modern invention; it has been used since ancient times (Assmann, 2000; Meusburger, 2005; Wunder, 2005). In most cases, moral exclusion was combined with spatial exclusion. The enemy or barbarian was outside, or had to be excluded from the community.

In a conflict, the representatives of orientation knowledge define whether a person is a terrorist or a freedom fighter, a hero or a war criminal. Their tasks might include supporting the propaganda of their government or party, glorifying or demonizing historic events, manipulating or censoring media, falsifying documents, or constructing new "collective memories." The party who succeeds in imposing their definitions, interpretations, and memories is already well on the way to winning the conflict. Therefore, opponents do everything they can to achieve hegemony in the interpretation of texts, the definition and explanation of historical facts, the construction of narratives, and the use of images and symbols.

In periods of conflict, however, it is not easy to keep a balance between the two categories of knowledge. Orientation knowledge can cloud perception, prevent a realistic assessment of situations, foster prejudice and chauvinism, and lead to decisions that trigger damaging consequences for the stability of the social system. More than a few governments, political parties, and organizations have failed to

reach their goals because they took their own propaganda and myths as reality and were no longer able to evaluate a situation and foresee the consequences of their actions.

The Architecture of Social Systems and the Location of Knowledge

The survival chances, competitiveness, or success of large and complex organizations depend to a large extent on the questions of how competence, expertise, and high-level decision-making authority are allocated within the social system, how formal hierarchies and communication structures are ordered, and how spatially allotted specialized knowledge is coordinated. In this context, the term *hierarchy* is not defined as a top-to-bottom chain of command in which all levels differ from each other in their degrees of authority and privileges. Instead, hierarchy is defined as a functional differentiation of a complex system. Once an organization attains a certain size and complexity, it cannot exist without adopting hierarchic structures of communication, information-processing, and decision-making. According to Simon (1962) and Reber (1993, 75) "evolutionary useful" systems are virtually always hierarchical. The main purpose of a hierarchy is to reduce complexity and uncertainty, to increase the number of information channels to the environment, and to improve the organization's ability to acquire, transfer, and exploit knowledge effectively.

Ultimately, an organization can compensate for only a certain amount of incompetence, so it acts in its own interest when it fills the key positions of information-processing, decision-making, planning, coordination, and control with knowledgeable and skilled persons. In particular, those positions and subsystems that are constantly confronted with high degrees of uncertainty and whose decisions have enduring consequences for the entire system require highly skilled and experienced decision-makers. In social systems knowledge, skills, and experience have the same function as redundancy in technical systems. They reduce uncertainty and enhance survival chances in a dynamic and risky environment.

Because important or valuable knowledge is always scarce, the first crucial question is where to locate scarce knowledge, important skills, and high levels of decision-making within the architecture of an organization. The architecture of a social system (its structure of information-processing, formal communication, and decision-making), is not a matter of deliberate choice. The optimal architecture of an organization depends on the goals of the organization; the degree of uncertainty confronting it; the constancy or instability of its environment; the system's autonomy, size, and complexity, and the available instruments and channels of information-processing (Geser, 1983; Meusburger, 1980, 1998; Mintzberg, 1979). In systems with stable goals and low degrees of uncertainty, decision-making, problem-solving, research, development, and planning shift to the upper levels of the system's hierarchy, with the lower levels predominantly retaining routine activities and jobs for

marginally skilled workers. This arrangement is typical of a bureaucratic organization. In systems dealing with a dynamic and complex environment and with constantly changing, unpredictable, one-time transactions, decentralization of competence and authority within the organization is more effective than such centralization (Mintzberg, 1979).

The second question is where to locate scarce knowledge, important skills, and high-ranking decision-making in the spatial dimension. Most large and complex social systems are not autonomous and free in their choice of where to locate their highest levels of authority, decision-making, and knowledge production. From the viewpoint of organization theory, it is again primarily the degree of uncertainty with which a decision-maker must cope that decides the optimal location of a position. The fiercer the competition and the greater the uncertainty about the consequences of far-reaching decisions, about future developments, and about the correctness of methods and objectives, the more necessary it is to have frequent, spontaneous, face-to-face contact with knowledgeable, well-informed, high-ranking decision-makers and highly skilled specialists of *other* organizations and other domains.

Uncertainty can be temporarily reduced through constant and prompt acquisition of specialized knowledge of important innovations, future technical and economic developments, and probable societal changes. Continuous acquisition of new knowledge and early access to crucial information make it possible to adapt quickly to new situations and to cope with new challenges. Early information and new knowledge about important developments are no guarantee for successful actions; indeed, they tend to provoke new questions and new uncertainties. But a continuous search for information and knowledge increases a social system's transparency, predictability, efficiency, and competitiveness, at least for a while.

This kind of crucial information is not presented in the Internet, business reports, press conferences, public data bases, or scientific journals. It is first revealed by rumors, through nonverbal communication in informal meetings, and in small fragments that have to be pieced together like a puzzle by the attentive observer. Few centers or nodes of network-building offer potential for high-ranking, spontaneous, face-to-face contact with top decision-makers of other institutions. Gaining access to informal interest groups, prestigious clubs, and powerful networks offering this kind of early, exclusive, and valuable knowledge is a matter of mutual trust. If trust is not founded on kinship, it has to be earned and maintained by frequent face-to-face contact, conditioning of moods and sentiments through rituals, affinity of interests, empathy, and a record of mutually useful performance (Brown, 1993; Glückler & Armbrüster, 2003). Trustworthiness can also be achieved by membership in prestigious institutions, by living or working at the "right" address or by belonging to networks of high reputation. Trust in the reliability of partners and in the superior knowledge of experts is an indispensable prerequisite for coping with an uncertain, unpredictable, and uncontrollable future (Sztompka, 2001, p. 15913). Mutual trust cannot be established by telecommunication. The generation of trust is tied to places. It develops by common practice, symbolic acts, ceremonials, and rituals that require copresence in certain secluded or distinguished places.

It is not only the functional role of face-to-face contact but also the symbolic meaning and reputation of a place that attract high-level decision-makers, intellectuals, and other successful knowledge producers. Authenticity, credibility, accountability, and trustworthiness are in many cases associated with the symbolic meaning of certain places or territories. HipHop musicians (Mager, 2007) are not the only people who derive their authenticity, credibility, and reputation partly from the places they are associated with or belong to; so do bankers, lawyers, scientists, actors, and members of other professions. Places are a kind of acronym of the complexity of a social system, historical event, or economic structure. Acronyms help individuals cope with the overload of information they are exposed to. Since the information-processing capabilities of an individual are limited and because that person cannot check and process all the detailed information needed for successful action, people constantly work with simplifications, generalizations, and cognitive reductions. Symbols or names of places stand for complex institutions, situations, and actions. Harvard stands for a prestigious university with thousands of prominent scholars and students. New York's 47th street is a symbol for expertise and reputation in the trade of diamonds. Zürs and Davos stand for expensive jet-set skiing; Hollywood, for media power. Other places may be associated with war crimes, torture, or danger.

Each large and complex organization displays its asymmetric power relationships, its functional division of labor, and its structures of decision-making and coordination in a spatial hierarchy of places. The center or core of a social system, economic sector, or scientific discipline is defined as the place where the highest degree of authority is located (Gottmann, 1980; Meusburger, 1980, 2000, 2001b). Centrality is the spatial manifestation of power, authority, and prestige. In early civilizations, the center was a sacred place where the connection with superhuman beings was initiated. Sages and priests were assembled at the center of power or presented themselves as the center of the social system. By virtue of their connection with their gods, forebears, or other superhuman beings, they claimed preeminence with regard to authority, knowledge, and competence and represented divine and ancestral will in everyday life. Similar ritualistic constructions of centers exist in modern societies as well.

A center is the nodal point of interaction and communication from where the elements of a social or spatial system are governed, coordinated, and controlled (Strassoldo, 1980). A center is a point of reference and orientation. It collects and distributes resources and sets the rules, norms, and standards for the members of the system. A center legitimates knowledge. It offers more diverse and wide-ranging knowledge sources, early access to crucial information, and a higher potential for high-level face-to-face contact than less important places. Centers derive some of their attractiveness through their national and global connectivity with other centers of knowledge and power. Through the business connections of big corporations and institutions, centers are able to absorb vastly diverse kinds of knowledge from elsewhere and profit from a wide range of information channels. The concentration of expertise and high-level decision-making, the high degree of connectivity and the consistent generation of new knowledge imbue centers with a special

"buzz" (Storper & Venables, 2004) or atmosphere (Böhme, 1998). In economic geography, the term *buzz* initially referred to "the information and communication ecology created by face-to-face contacts, copresence and colocation of people and firms within the same industry and place or region" (Bathelt et al., 2004, p. 38). Contrary to most industrial clusters, the information and communication ecology of high-ranking urban centers is characterized by a large diversity of industries, institutions, cultures, and knowledge bases.

The term *center* or *core* also has a psychological meaning. It is associated with social attributes such as power, authority, dominance, prestige, access to resources, attractiveness, and influence. Most experts, scientists, and intellectuals are fascinated by domain-specific authority or centrality, want to concern themselves with the essentials of existence, and strive for influence and recognition. They are convinced that they have something important to convey to humanity, that their capabilities are needed by society, and that they can offer solutions to important problems. Being associated with a high-ranking center endows experts with prestige and influence. Proximity to power increases their chances of influencing important decision-makers. Someone at the periphery is seen as an "outsider"; he or she has less influence, fewer resources, and less prestige. That person may also be marginalized. Centers act like magnets for highly skilled professionals, experts, scientists, artists, and intellectuals striving for prestige, influence, or success. Because centers and peripheries are socially constructed and because space is a product of relations and interactions and is always "in a process of becoming … never finished … never closed" (Massey, 1999b, p. 28), the rank, significance, and locations of centers and peripheries change over time. In some cases (nomadic tribe, army in war) the location of the center moves constantly.

The recent discussion of face-to-face contact has four weaknesses. First, many authors (e.g., Amin & Cohendet, 2004; Bathelt et al., 2004; Storper & Venables, 2004) do not distinguish between orientation contacts, planning contacts, and routine contacts as was suggested earlier by Goddard (1971), Goddard and Morris (1976), Goddard and Pye (1977), Hohenstein (1971), and Meusburger (1980). From the theoretical point of view, it is not advantageous for the face-to-face contacts of sales girls or clerks to be lumped together in the same category as those of top managers or scientists. Face-to-face contacts of orientation need other locations of learning and have other spatial interactions than face-to-face contacts of planning or routine work. Routine face-to-face contact can be more easily replaced by letters or electronic communication than is the case with face-to-face contact of orientation.

Second, the need for interagent face-to-face contact and the relevance of proximity undergo a kind of life cycle during the relationship of the people involved. In the first phase, when interactions have to be established and the degree of uncertainty is high, face-to-face contact may be extremely important. When the agents come to trust each other, much face-to-face contact can be replaced by electronic communication, and proximity loses importance.

This lack of distinction between types of contact, levels of management and expertise, and degrees of uncertainty has led to the third weakness, an overemphasis

of proximity and clusters in what is know as "new regionalism" (see also Kröcher, 2007, pp. 57–61). There is no general "proximity imperative" (Lagendijk, 2001, p. 146) in human geography. The questions are: proximity to whom, to which purpose, and for which reasons? Need for proximity to reduce transport costs (e.g., within production and supply chains of industrial clusters) should be distinguished from need for proximity to learn from and imitate successful agents and competitors (so as to reduce uncertainty). It should also be distinguished from a need for proximity to benefit for symbolic reasons (e.g., to gain reputation and trust by belonging to a center of authority). If an organization is highly autonomous (e.g., as a global market leader) and enjoys a stable environment with little or no competition (e.g., public administration), or if it can enhance its reputation in ways other than identification with centers of domain-specific authority, then proximity to other institutions is almost irrelevant.

The fourth problematic trend in the research on clusters and industrial districts is the overemphasis on homogeneous business cultures and on in-group relations between persons, companies, and institutions already known to each other (either as a supplier or a competitor) and in more or less regular mutual communication. According to Porter (2001) "clusters are geographic concentrations of interconnected companies, specialized suppliers, and service providers, firms in related industries; and associated institutions … in particular fields that compete but also cooperate" (p. 144). Creativity hardly develops in homogeneous business cultures. It emerges by drawing analogies from completely different domains that previously had nothing to do with one another. Creativity is very often based on transgressing boundaries. Combinatorial creativity requires a rich store of knowledge and the ability to form links between many different types of knowledge.

Cultural Hegemony, Cultural Areas, and Clashes of Orientation Knowledge

Epistemic hegemony is a means of domination and a capacity to control and manipulate people (Brown, 1993, pp. 154, 164). The filtering of information and the manipulation of attention are effective tools for exercising power. Long-term hegemonic filtering or manipulation of information clearly creates areas where certain topics or contents of knowledge prevail while others are suppressed or criticized. One can easily define areas of political prejudice, barefaced lying, cultural and historical ignorance, bigotry and racism, and flourishing conspiracy theories. Cultural hegemony is an attempt to determine which religions, ideologies, values, traditions, collective memories, narratives, and interpretations of historical events should be accepted or tolerated in its area of influence and which should be rejected. In extreme cases power rests on the principle of *cuius regio eius religio* ("whose the region, his the religion"), the proviso by which the religion of the sovereign is automatically that of all the subjects as well. Political, economic, and cultural elites produce public sentiments and stereotypes with the help of media,

educational institutions, and other channels of communication and invent traditions and historical memories that legitimate their actions and support national or regional identities. Governments try hard to preserve the image of the good country. "Behavior inconsistent with the defensive, clean, law-abiding, faithful, and humble stance demanded by the stereotype must be denied or hidden" (Jewett & Lawrence, 2003, p. 231). Conflicts are often portrayed as a dichotomy between good versus evil, a fight between right versus wrong, human dignity and freedom versus tyranny and oppression (for details see Jewett & Lawrence, 2003; Lawrence & Jewett, 2002; Meusburger, 2007). In some cases elites go so far as to maintain that their nation has a manifest destiny (Weinberg, 1935), that it is God's own country, or that it has God's chosen people. If "the enemy is demonic and the saints are perfectly pure, no matter what they may do in battle" (Jewett & Lawrence, 2003, p. 222), any aggression and torture seems to be justified.

The relations between culture and behavior as well as between knowledge and action are ambiguous and heavily disputed. However, most authors would agree that culture shapes aspirations, stereotypes, understanding, ways of learning, frames of interpretation, and collective memories. Epistemological cultural relativism goes so far as to claim that culture determines what we humans know and how we know it. According to Herskovits (1948), reality is perceived through the spectacles of culture. He asserts that all human experience of the physical world as well as of society is culturally mediated. In his theory, all perceptions, evaluations, and judgments are a function of the cultural system to which one belongs (Harouel, 2001, p. 3181).

If knowledge can be understood as adequately justified true interpretation based on and determined by a system of signs and interpretation (Abel, 1999, pp. 304–310; see also his chapter in this volume), then it can easily be manipulated if those in power are successful in changing the system of signs and interpretation. In disputes the distinction between opinion, belief, and knowledge becomes blurred and irrelevant. Believing is as effective a disposition or capacity to act as knowing is. Subjectively binding beliefs suffice for action; a person who believes in something is prepared to accept the consequences for his or her actions (for more details see Abel, 2004, pp. 161–169).

Media, schools, museums, and other cultural institutions are deployed by power elites to generate, disseminate, and support a particular set of beliefs and orientation knowledge and to transmit their culture and collective memories from one generation to the next. Cultural institutions are supposed to enforce collective beliefs (memories that support the ideology and goals of the dominant political elite) and to ignore or suppress other narratives. Striking examples are national centennial celebrations of revolutions, civil wars, and, in immigrant nations such as the United States or Australia, glorious formative moments that often ignore the history of natives and various immigrant groups (see Spillman, 1998).

Because cultural knowledge is created through practices, interaction, and social control at particular places, schools are not only a place of instruction or formal education. They are also a site and context where social relations evolve and where identities, self-awareness, goals, beliefs, attitudes, cultural preferences, discourses,

stereotypes, and social inequalities are produced or reproduced and where parents, teachers, and other role models interact. In multiethnic states, schools have been considered the main instrument in educating "backward" or "uncivilized" ethnic minorities. If the state authority or a dominant political party controls the contents of textbooks or the recruitment of teachers, it can direct students' attention to certain issues, divert it from others, eliminate a large number of possible interpretations, and destroy ethnic self-confidence of minorities. However, this attempt is resisted by people belonging to other cultures and subcultures with contradicting memories and interpretations of the world. In order to secure the survival of their culture, ethnic or religious minorities strive to organize learning opportunities for their young (Hatano & Takahashi, 2001, p. 3041). This response is one of the reasons why the public school system in multiethnic states has often been a focal point of power struggles, an arena where cultural conflicts and clashes of knowledge are the most intense (Frantz, 1994; Freytag, 2003; Gamerith, 2006; Meusburger, 1996a, 2003; Tomiak, 1991; Trueba, 1989). In modern society hegemony is not necessarily expressed by suppression or censorship but a shift of public attention to certain issues.

Most clashes of knowledge have a spatial dimension, at least for a certain span of time. Cultural space is defined as an area or set of places in which certain kinds of orientation knowledge are considered true or correct by the power elites or the majority of the resident population and where the collective orientation knowledge is bolstered and legitimated by traditions, practices, and cultural artifacts. The extent, visibility, degree of homogeneity, and consistency of cultural areas vary over time. They partly depend on the ability of elites to control collective memories, organize consent and support among followers, construct and interpret "realities," influence collective knowledge and actions, mobilize solidarity and a sense of belonging, and mark places or territories with their cultural artifacts (e.g., signs, flags, monuments, street names, and styles of architecture). The purpose of such activity is to guide the collective knowledge and memory of the respective population in a certain direction and to erase other events from the memory of future generations. Throughout history, changes of ruling dynasties or political systems have coincided with iconoclashes (Foote et al., 2000; Hoyler & Jöns, 2005; King, 1997; Latour, 2002).

Apart from science studies and geography of religion, very few human geographers have discussed the spatial dimension and spatiality of orientation knowledge or ideology. One of them is Sahr (2006), who identified in Brazil a hierarchical space of traditional Roman Catholicism, a communitarian and syncretic space of rural ideologies, an individualistic approach of Protestantism, a rhizomatic space of Afro-Brazilian religions, and a fluid space of Amerindian religions, all of them partly counteracting, through social actions, the imposed modernist development ideology of the nation-state.

When dealing with cultural space, one must avoid the "territorial trap" (Agnew, 1999). The territorial trap is entered into when it is assumed that all actors within a culturally defined area behave in a similar way or follow the same norms. It would be wrong to assume that culturally defined space, for example, is devoid of opposition,

divergent behavior, conflicts, social differentiation, or social change. It is important to emphasize that the concept of culture does not imply homogeneity in cultural consciousness or practice within an ethnic group, cultural category, or area. Each ethnic group and cultural area has its internal differentiation and conflicts, its elites and subcultures. Culture is not a stable system of signs and interpretations but rather a process and place in constant motion, where meaning and situated identities connected to ethnicity, language, or religion are continuously created and performed (Bellwood, 2001; Wunder, 2005). Members of ethnic or cultural groups continuously borrow and adopt new cultural forms and alter their identities through contact-induced learning. Being rooted in a culture does not mean immunity against new ideas, norms, or practices. Instead, it suggests that agency and intentionality are bounded by a certain tradition of meanings and values that differ from that of other cultures. The assertion that hegemonic manipulation of information creates cultural areas never means that the whole population is thinking or acting in a certain way. However, mapping and interpreting the *spatial* distribution of ideas (e.g., Darwinism, enlightenment, creationism), performances (e.g., Mozart's itineraries and the career paths and mobility of scientists), and artifacts (e.g., the distribution of baroque churches in Europe) or analyzing *spatial* disparities in the predominance of narratives, norms, opinions, or public discourses as represented in media or opinion polls can be an important heuristic device in the research processes of the humanities and social sciences. How many people orient their actions to these narratives and norms is another question altogether. Culturally defined spaces or spatial arrangements of cultural artifacts are not something fixed or self-contained. They are constantly changing, negotiated, and contested.

Spatial Diffusion and Mobility of Knowledge: An Attempt to Construct a More Realistic Communication Model

The most efficient way to transfer rare or specialized knowledge from place A to place B is through the migration of those people who dispose of that knowledge. However, they will only be as successful in place B as in place A if they find comparable conditions in B. All other attempts at knowledge transfer, such as the sending of texts, construction plans, instruments, and machines are no guarantee that the knowledge is fully understood or accepted by the receivers. Striking evidence of this notion was witnessed at the end of World War II, when the American, Russian, and British Forces were eager to obtain the most advanced technological and scientific information Germany had to offer. The U.S. Commerce Department's Office of Technical Services addressed the industries of the United States with the following words: "[Y]our government is offering you a chance to share in the war's reparations—reparations in the form of technological information— … in all fields of industry and research [including] testing methods, chemical research, new products, new materials, production methods, and plant development" (as cited in

Gimbel, 1990, p. 57). According to Gimbel (1990), 4,994 Allied investigators in Germany microfilmed millions of pages of patent applications, construction plans, and research results. However, as the Office of Technical Services had to admit in December 1947, "it has been to our experience that the worthwhile developments cannot be exploited successfully or without considerable expense unless the German technicians familiar with all the details of such developments are brought to this country" (as cited in Gimbel, 1990, p. 57). Finally, 765 leading German scientists and engineers were brought to the United States in Operation Paperclip, and 350 rocket technicians in Operation Overcast. Other scientists were taken to the Soviet Union.

The process of knowledge transfer from person X (producer of knowledge or sender of information) in place A to person Y (recipient or potential user of information) in place B is a very challenging and complex research issue. The speed at which new knowledge diffuses through a spatial system depends on many factors. Just a few of them are the type of knowledge, its usefulness to power, its relevance for economic competition, the institution within which the new knowledge is produced, the competence of the producer in articulating or codifying his knowledge, the interest of the producer (inventor) in sharing his or her knowledge, the prior knowledge necessary to understand the substance of new information, the availability of technology necessary for the production and application of knowledge, and the inclination to accept and use the knowledge.

Following the example of Arrow (1962), Machlup (1962), Nelson (1959a, b), and others, an entire generation of economists treated scientific and technological knowledge as information (for more detailed discussion see Ancori et al., 2000, p. 256; Cowan et al., 2000, p. 221). Some social scientists and philosophers (e.g., Spinner, 1994) did so as well. Most economists recognize the existence of tacit knowledge but restrict their analysis to codified knowledge, which, in their opinion, can be reduced to information that is easily transferable to other decision agents. Ancori et al. (2000) explained why the codification of knowledge is a major concern of economists and why they find it difficult to give up their claim that there is almost no difference between codified knowledge and information. To be treated as an economic good with discernible and measurable characteristics, knowledge must be put into a form that can be exchanged, and that form is information. This view has been challenged not only by sociologists of science (Callon et al., 1999; Collins, 1983, 1985; Stehr & Meja, 2005), geography (Livingstone, 1995, 2005; Meusburger, 1998), and philosophy (Abel, 2004) but recently also by economists (Amin & Cohendet, 2004; Ancori et al., 2000; Cohendet & Meyer-Krahmer, 2001; Dosi & Marengo, 1994; Pavitt, 1998).

The diffusion of knowledge cannot be reduced to the mere transmission of information. Unlike information, which is very mobile and can spread all over the world in seconds, knowledge is rooted in persons, institutions, routines, and regional cultures. From the viewpoint of the producer of new knowledge or *sender* of a message, the boundary between information and knowledge might become blurred. In regard to the recipient of a message, the difference between knowledge and information becomes quite distinct. As soon as spatial dissemination of knowledge

becomes an issue, a distinction between knowledge and information and between different types of knowledge becomes indispensable.

However, it is not sufficient to distinguish between tacit and codified knowledge (Polanyi, 1958) or between declarative and procedural knowledge (Anderson, 1983). The terms *tacit* and *codified* knowledge can be accepted as the opposite ends of a continuum, but these categories are fluid. It is not possible to draw a generally valid line between tacit and codified knowledge. What is tacit knowledge for one person or at one point in time can be perfectly explicit for other actors or at some other time. Knowledge may remain tacit just because the emitter and receiver have no knowledge about how to exchange knowledge (Ancori et al., 2000, pp. 273–274; Baumard, 1999; Collins, 2001). Some authors view codified and tacit knowledge as essentially complementary because all forms of codified knowledge require tacit knowledge to be useful (Ancori et al., 2000, p. 257). Cowan et al. (2000, p. 213) criticized "that the terminology and meaning of 'tacitness' in the economics literature [have] drifted far from its original epistemological and psychological moorings [and have] become unproductively amorphous." Some authors confuse tacit knowledge with nonverbal knowledge. According to Abel "tacit knowledge means those aspects of knowing that are implicit in situations of perceiving, speaking, thinking and acting, but are not made explicit, are not disclosed at [the] surface" (Abel, 2004, p. 322; see also his chapter in this book). Tacit knowledge must be distinguished from nonverbal knowledge (e.g., the competence at playing the violin) that cannot be articulated by using linguistic expressions. Although the concept of tacit knowledge is widely discussed (see Ancori et al., 2000; Baumard, 1999; Collins, 2001; Cowan et al., 2000; Gertler, 2003; Lam, 2000; Polanyi, 1967, 1985; Reber, 1993), most publications do not distinguish between implicit and nonverbal knowledge but rather treat them synonymously.

In mainstream economics, too much emphasis has been put on the producer and codifier of knowledge. It is important to keep in mind that successful codification does not imply automatically that the codified knowledge will be widely disseminated. From the viewpoint of geography, increased emphasis should be put on the recipients of information and on the factors that influence the communication process between the producers of knowledge (senders of information) and the receivers of information. The quality and accuracy of codifying knowledge is only one side of the coin. The other side is that of the cognitive abilities, orientation knowledge, interests, motivation, attention, emotions, and prejudices of the recipients of information. The producers and transmitters of knowledge have limited influence on the extent to which their knowledge is accepted or interpreted elsewhere. A certain type or content of knowledge may be perfectly codified in equations, published in international journals, and well understood by 50 to 100 theoretical physicists, but the rest of the world population may just not have acquired the prior knowledge necessary to read and understand the mathematical equations and apply them to its benefit. Therefore, I question the assumption shared by Fujita et al. (1999), Maskell and Malmberg (1999), and many others that the more codified the knowledge involved, the more mobile it is and that knowledge, once codified, is almost instantly available to all firms at zero cost regardless of their location.

In order to better understand the complexity of the communication process between person X in place A and person Y in place B, I propose a communication model pertaining to only a small selection of processes intervening between the producer of knowledge (the sender of information) and the receiver of information (Fig. 2.1). Depending on the type of knowledge and the topic under investigation, this model could and should be greatly elaborated and amended by a number of further issues, such as the questions of how knowledge is legitimated, how individual knowledge becomes collective knowledge, how knowledge is transformed into routines and organizational structures, and how the communication process is influenced by an organization's size and hierarchy.

The communication process displayed in Fig. 2.1 consists of nine stages: (a) the willingness of person X to share his or her knowledge with others, (b) the ability of person X to verbalize and codify that knowledge, (c) the degree of attention, reputation, and visibility of the platform where the information is presented, (d) the code in which a message is written, (e) the communication channel used for transmission, (f) the chances of a recipient to receive the information, (g) the ability of the receiver to read the used code, (h) the prior knowledge of the receiver to understand the information and integrate it into his or her knowledge base, and (i) the willingness

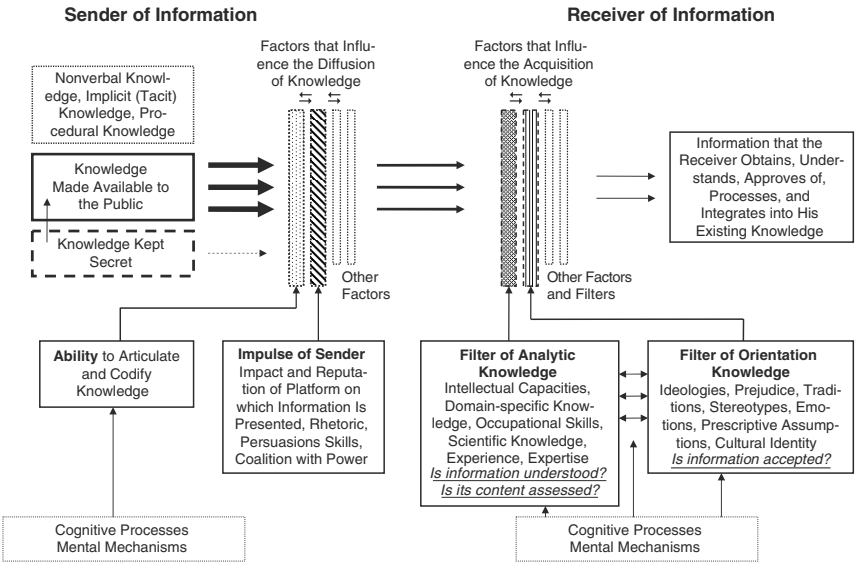

Fig. 2.1 "Factors influencing the transfer of knowledge between persons at different places" (P. Meusburger. With permission)

of the receiver to accept the new information. Each stage of the communication process has a high degree of actor-, community- and place-dependent contingency and acts like a filter, letting some information pass and withholding or transforming other information. At each step and place of the communication process, there can be misunderstandings, distortions, misrepresentations, and loss of information that may result in further spatial disparities of knowledge.

Any visualized model runs the risk of being misunderstood as a description of static relations and mechanistic interactions. In reality, these processes and steps of communication are not arranged sequentially as depicted in Fig. 2.1. They must be conceived of as interactive learning loops that incorporate agents, individual and collective capabilities, work practices, spatial and organizational contexts, resources, and strategic visions. The terms *prior knowledge*, *analytical knowledge*, and *orientation knowledge* are not understood as a static knowledge base but rather as a knowledge base subject to a continuous process of change. Prior knowledge is not something people possess; it is something they constantly develop.

As two filters, the receiver's analytical knowledge and orientation knowledge should not be viewed as separate and unconnected. They are related to each other and influence each other in many ways. Orientation knowledge may motivate a person or social system to acquire new scientific knowledge, but it can also distort perception, weaken analytical judgment, and prevent the scientific investigation of topics—with possibly unpleasant results. The acquisition of new analytical or scientific knowledge may contribute to the revision of prejudice, stereotypes, and ideologies.

The first step in a communication process concerns the question of whether a producer of new knowledge is *willing* to share his or her knowledge. Knowledge that improves chances and competitiveness, promises high profits, or constitutes the role of an expert is in many cases kept secret as long as possible. In many situations it may be an advantage to leave competitors or opponents uncertain about one's goals and actions. A new bargain is normally made public only after it has been signed. Some scientific results may be shared only after they have been patented. The act of keeping knowledge secret, or restricting access to it, has a long tradition. Many religions have holy knowledge that priests or shamans pass on only to chosen successors or have temple precincts and sanctums that only priests are allowed to enter. Worldwide, billions of dollars are spent to prevent industrial or military espionage.

The second question affecting the communication is whether a producer of knowledge is *able* to codify his or her knowledge to express it in language, signs, and gestures or to transform it into physical objects (e.g., scientific instruments). Each person knows more than he or she is able to articulate to someone else. The producer of knowledge has to transform ideas and matter into language or signs "in order to generate comprehensible and well-communicable scientific claims about much more complex phenomena" (Jöns, 2006, p. 570). During each transformation from matter to sign, there is not only a loss of multiplicity, particularity, locality, and materiality but also a gain of standardization, compatibility, relative universality, and immateriality (see Jöns, 2006, p. 571; Latour, 1999, pp. 70–71).

Different producers of knowledge are proficient in different codes. Some of the codes are understood by a large number of people; others, by only a few. A manuscript published in Estonian has far fewer potential readers than a publication in English. However, the message in Estonian may be much more important or deserve a wider distribution than that in English.

The third factor that can enhance or confine dispersion of knowledge concerns the platforms where new knowledge is presented. Experts, scientists, professionals, and artists require a platform of attention that puts them in the spotlight and guarantees their presence in the relevant media. Different platforms send impulses of varying strength, have dissimilar reputation, visibility, and audibility and achieve unequal attention. Because human memory and information-processing capacities are limited, attention is selective and limited (Franck, 1998). The selectivity in perception determines what is learned and kept in memory and what is excluded. Judgment of significance is neither impartial nor spatially invariant; it is an instrument for exercising power. Considering today's flood of information, the contents of a message or its usefulness for society are often less important for its wide diffusion than the platform on which it is presented. The locality where new knowledge is proclaimed determines to a large extent the relevance, visibility, and credibility of the knowledge claims and the attention of the media. Channels of transmission (e.g., books, journals, radio, TV, Internet, and congresses) differ in their reach, credibility, and effectiveness.

On the side of the receiver, incoming information has to pass at least two filters before it is processed. In this context, the term *filter* is a metaphor for various cognitive processes and factors that influence the selectivity of perception, the evaluation and interpretation of incoming information, and the conversion of knowledge into practice. The fact that somebody has access to a piece of information does not mean that he or she is interested in it; understands its meaning; reflects upon it; recognizes its far-reaching implications; can associatively link the piece of information with his or her existing structure of knowledge; or accepts the information as relevant, valid, or credible. The perception, interpretation, evaluation, and acceptance of information requires more or less extensive or specialized prior knowledge, which cannot be transferred easily from one person to the next.

The first filter consists of domain-specific knowledge and expertise, the familiarity with codes (foreign languages, mathematical equations), and various cognitive abilities, such as the skills of analyzing problems or evaluating situations. This filter decides whether the recipient is able to find, read, and understand the message; evaluate the importance of the information correctly; integrate it into his or her knowledge base; and transform the knowledge into action. Prior knowledge is also indispensable when it comes to coping with the increasing overload of information. The learning processes necessary for acquiring this type of prior knowledge may require notable amounts of time and money. Publications of molecular biology or high-frequency physics are available worldwide after they have been published. However, persons who have not completed years of study in the subject have little or no use for the available information. Some types of scientific knowledge cannot be simply transferred from A to B; they must be replicated in B with expensive

experiments in sophisticated laboratories (see also Callon et al., 1999; Collins, 1983, 1985).

The second filter on the side of the recipient of information falls into the category of orientation knowledge. It may consist of religious and ideological convictions; a set of dispositions, prejudices, and stereotypes inculcated in childhood; emotions; national myths; political legends; loyalty to a community; cultural traditions; and so on. This filter determines whether a new piece of information is compatible with the recipient's values and identity. Orientation knowledge decides whether new information is emotionally accepted or rejected. Information may be rejected because it questions the recipient's own cultural identity, integrity, or convictions or because it shatters collective memories, historical myths, or the reputation of the institution a person belongs to.

Both filters on the receiver's side are embedded in contexts and influenced by social processes, the selectivity of communication, interpersonal interaction, social control, circular mobility, value systems, and many other factors. The effects of these filters and others are the most important reason why the dissemination of certain categories and contents of knowledge are limited to certain places and areas and to cultural, religious, and political contexts. The effects also explain why those categories and contents of knowledge circulate only within and between particular areas with similar preconditions and bypass others. The spatial distribution and spatial mobility of those people who can read the relevant codes (e.g., a foreign language or a mathematical equation), who have the prior knowledge to understand the codified message, and who have access to the communication channels and resources needed to apply the codified knowledge deserve much more scientific interest (Jöns, 2007). One can extend the model by including additional factors of influence and filters; by describing institutional, cultural, and political contexts in which the individuals process information; by distinguishing between a language form, a picture form, and an action form of knowledge, as Abel suggests in this book; and by focusing more on the signointerpretational practices. In Abel's view "contents of knowledge and forms of knowledge *cannot* exist independent of the forms, practices, and dynamics of the underlying representational, interpretational, and sign system" (p. 15 in this volume). These signointerpretational practices greatly vary in the spatial dimension and could also be integrated into the model.

With regard to the outcome of the communication process between person X in place A and person Y in place B, as described in this model, knowledge can be differentiated into at least five categories, distinguishable by the speed and places of their diffusion:

1. Knowledge that is kept secret as long as possible or necessary in order to gain a competitive advantage.
2. Knowledge that is widely disseminated in the interest of its producer, though a number of barriers may impede its diffusion (e.g., a sender's difficulty expressing his or her knowledge in language, signs, gestures, or performance, or insufficient attention attracted by the platform on which the knowledge is presented).

3. Knowledge that is successfully codified and publicly available but understood, processed, and applied only by a relatively small epistemic community with the prior knowledge necessary to read the code (e.g., foreign language or mathematical equation) in order to comprehend the message or replicate the experiment.
4. Knowledge that is successfully codified, well documented, open to the public, and well understood by the addressees but not accepted or adopted by a distinct group of recipients for emotional or ideological reasons.
5. "Common knowledge" that is easily articulated and disseminated, easily acquirable, promptly understood, and relatively conflict free, making it the only one of these five categories of knowledge that is as mobile in space and as ubiquitously distributed as hypothesized in traditional economics.

It goes without saying that combinations of these five types also exist.

Conclusion—The Knowledge-Transfer Paradox

The neoclassic contention that codified knowledge is highly mobile may now be refuted in social and economic sciences, but it is still en vogue in research policy and regional policy. Even prestigious scientists, such as R. N. Zare, former chairman of the U.S. National Science Board and currently professor at Stanford University, hold the view that knowledge is ubiquitously available. "This is an age of 'knowledge and distributed intelligence,' in which knowledge is available to anyone, located anywhere, at any time" (Zare, 1997, p. 1047). However, a closer look at those disciplines dealing with knowledge proves the opposite. The issues of sending, receiving, and processing information and of generating and transferring knowledge are studied by anthropologists, archaeologists, brain researchers, computer scientists, economists, geographers, historians, linguists, neuroscientists, philosophers, psychologists, sociologists, and scholars in other disciplines as well. If codified knowledge were really as mobile as some observers maintain, and if knowledge really did diffuse through barter exchange among pairs of agents in communication networks as some economists still assume (e.g., Cowan & Jonard, 2004), why does it take 10 to 20 years or even longer for important scientific results and theoretical concepts to move from one discipline to the next even when they are located in the same university town?

An answer might lie in what I propose to call "the knowledge-transfer paradox." It refers to the fact that some of the scholars who act on the assumption that codified knowledge is very mobile in space and accessible to anyone have not the faintest idea of what other disciplines, epistemic communities, or languages contribute to their own research topic. Even some of the most reputed scientific journals accept manuscripts whose authors were unaware that work on their topic, idea, or concept had been published 10, 20, or 30 years earlier by other scholars in another language or another discipline. In this chapter, however, I have outlined some of the ways in which easy access to information neither guarantees the acceptance and application of available knowledge nor eradicates spatial disparities of knowledge.

Clearly, the study of knowledge production and knowledge transfer as a social construction and a context-dependent practice remains to become "one of the most vibrant and exciting areas of research in the social sciences and humanities" (Thrift et al., 1995, p. 1).

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