Chapter 2
Knowledge and Science in Current Discussions of Globalization

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2.1 Introduction

Recent studies of global history and the history of globalization have, among many other subjects, dealt with issues of knowledge and science. In the following, some of these studies will be examined from the perspective of a history of the globalization of knowledge. From this perspective, several key questions arise. First and foremost: what role is knowledge considered to play in the concert of other factors of globalization?[1] Frequently, globalization studies place economic, political or cultural developments in the foreground. The second question is how knowledge is considered to interact with these other factors. The third question concerns the relationship between knowledge and science. How is this relationship understood in recent histories of globalization? And how can an understanding of science biased by the European tradition be overcome? The fourth question concerns the dynamics of knowledge development: how does knowledge change over long historical periods as they are covered by recent studies of globalization? These studies trace the change of economic activities, governance, trading and transport. But what do they assert about the global history of knowledge?

As the studies considered in the following do not aim primarily at a history of the globalization of knowledge or science, the aspects concerning knowledge and science have to be filtered out from the overall account and examined for their importance in the narrative as a whole. In the following, the historical studies covered in this chapter will be briefly presented. They will then be examined for the role that knowledge and science play in them. Next, the role assigned to Europe in these studies of globalization will be reviewed. Finally, the historical periodizations underlying these studies will be analyzed with a focus on the understanding of capitalism and Industrial Revolution they present.

[1] See also the introduction to this volume, chapter 1.

2.2 Major Contributions to a History of Globalization

The Birth of the Modern World by Christopher A. Bayly (2004) is one of the most celebrated works in global history of recent years.[2] Focusing on a long nineteenth century, from 1780 to 1914, the author develops his idea of global modernization. In his view, this was not initiated unilaterally by movements proceeding from Europe to other parts of the world. Rather, it constituted a phenomenon that was established by the worldwide exchange of information, the major political configurations of the colonial empires, and by politicized social movements. Christopher Bayly takes the history of science seriously, attributing to it an important place in the global history of the nineteenth and twentieth centuries.

In the reception of Bayly's work, this aspect of *The Birth of the Modern World* has, however, remained largely ignored. Next to the "major" themes of the economic reconfiguration of the world by capitalism, the great religious movements or the decimation of the indigenous population of the Americas, the aspects of Bayly's work that are related to the history of science have not been taken up in subsequent historical discussions. Neither Kenneth Pomeranz (2006) nor John McNeill (2005) mention this subject in their reading of Bayly's work. Gauri Viswanathan (2005) touches the theme in his review, dealing with Bayly's critique of Foucault's role of the state. Viswanathan also discusses the issue of non-religious systems of reason. But even in this review, the topic of science is rather neglected as part of the global modernization process. Thus, Bayly's treatment of the concept of knowledge in global processes has met with little substantial response.

In *The Birth of the Modern World*, Bayly discusses the form of history known in German as *Ideengeschichte*, and in English as "intellectual history." Traditionally, this historiography was strongly oriented toward Europe and North America. It has taken on a truly global dimension only after paying increasing attention to the history of science. Emphasizing this role of the history of science in broadening the historical perspective, Bayly points out:

> An exception to this rule is the history of science. Historians of science have recently found much more room for the dynamic role of Asians, Africans, and other non-European peoples in the creation of the hybrid bodies of learning by which global society understood the natural world. They have also been quite successful in explaining how preexisting assumptions and styles of intellectual training guided people's reactions to new scientific ideas coming to them from the West. (Bayly 2004, 285)

In this, Bayly clearly presumes that scientific knowledge comes primarily from Europe. Transported by colonial regimes, with the help of imported school systems

[2] See (Conrad 2004).

and public debate, non-Europeans had the opportunity to partake of this knowledge. In the colonies, even more strongly than in the countries of origin themselves, the sciences entered into a symbiosis with the political currents of liberalism and socialism. This symbiosis also changed the spectrum of themes covered in the individual sciences. According to Bayly, science is thus an important indicator that enables the historian to identify global debates as well as to reveal processes of change and dissemination, as will be shown in more detail below.

Similar to the definition of knowledge in the present volume, in *Verwandlung der Welt* (Transformation of the World) Jürgen Osterhammel defines knowledge as "cognitive resources that serve to resolve problems and master life situations in the real world" (Osterhammel 2009, 1105).[3] For Osterhammel, modern science, as it emerged around the mid-nineteenth century, represents a significant rupture with European origins and had a global impact. The new subjects of science, their designations and the social type of the scientist are clear signs of the rupture and of the autonomy of the corresponding social system. Another factor was the emergence of more and more specialists, who became increasingly involved with state governments and with enterprises. In Osterhammel's opinion, by the end of World War I the institutionalization of scientific knowledge had been completed in most European countries and in the United States. This geographical focus of institutionalization on areas of the so-called "West" represents for Osterhammel an undeniable fact that also a more encompassing global history would not be able to overturn (ibid. 1105–1107). In short, Osterhammel does not consider the emergence of the system of science in the West as the result of intricate historical processes of globalization, as is the case in the present volume, but rather characterizes it as a Western event of global significance. In contrast, Bayly sees the "Western" sciences as being clearly shaped by non-European experiences.

An entirely different argument is advanced by Andre Gunder Frank, who in 1998 undertook a broadly based attack on Eurocentrism, focusing partly on issues related to history of science, while his overall perspective is governed by economic issues. Since the 1970s, he had been part of the study group investigating world system theory and the expansion of European capitalism. In his study *ReOrient. Global Economy in the Asian Age*, he claims that in the worldwide capitalistic economic system no single power ever reigned supreme, nor did a hegemony ever emerge from processes of globalization. According to Frank, the same holds for European technology:

> The received Eurocentric mythology is that European technology was superior to that of Asia throughout our period from 1400 to 1800, or a least since 1500. Moreover, the conventional Eurocentric bias regarding science and technology extends to institutional forms [...]. (Frank 1998, 185)

[3] See also the introduction to this volume, chapter 1.

For this reason, he turns against two opinions frequently expressed in accounts of global history. First, according to Frank, the Scientific Revolution cannot be conceived as a prerequisite for the European Industrial Revolution, as will be discussed in more detail later. Second, a one-way transfer of knowledge from Europe to other parts of the world, by means of goods, institutions or ruling systems, never took place. Instead, the history of knowledge transfer has always been multi-directional. It began much earlier than European expansion and continued to be multi-directional, even during European colonialism and imperialism.

Walter Mignolo's *Local Histories/ Global Designs. Coloniality, Subaltern Knowledges and Border Thinking* of the year 2000 continues the tradition of relativizing Europe's role in the history of the world. He poses the question of how thinking can be decolonized and sets out on a quest to find alternative philosophical traditions to "colonial/modern" thought. In his view, this "colonial/modern" thought developed in the sixteenth century, first in Spain and then, as the center of the European world system shifted, in the Netherlands and in England, and finally, in North America (Mignolo 2000, 30). Since the Enlightenment, this "colonial/modern" philosophy, which Mignolo terms "occidentalism," became the decisive Western way of thinking. In his study, Mignolo attempts to uncover alternative and local histories, as well as other layers of knowledge and ways of thinking, and their relations to dominant occidentalism:

> So knowledge from local histories where intellectual projects are produced at the intersection of silenced and silencing languages, [...] did not receive the same attention. This situation is not trivial. It opens up a space for the multiplication of interconnected projects at the intersection of local histories and global designs, both at the 'center' and the 'periphery'. (ibid. 71)

Mignolo distinguishes two layers of global history: the first layer comprises the global history of European expansion. In the second layer, a variety of local situations persist. Mignolo sees in their manifold the potential for a new, systematic and non-hegemonial approach that he terms "border thinking."

In *Les quatre parties du monde. Histoire d'une mondialisation*, Serge Gruzinski also focuses on the Spanish expansion. He discusses the Spanish sphere of influence in the sixteenth and seventeenth centuries, paying particular attention to the role of actors who created and attested to globality. His study may be characterized as a cultural history of globalization that also covers processes of knowledge exchange. Gruzinski perceives the Iberian colonial globalization as being distributed over many locations where knowledge of equal value emerged in all important domains, as is also stressed by Francisco Bethencourt (2005) in his review of the work. Gruzinski cites the example of the spread of Aristotelianism in the Spanish empire:

> The process of globalization thus did not see the light of day at a certain location of the [Spanish] monarchy. It is not bound to the Iberian

> peninsula or to the European continent, because Aristotelianism and allegorical and symbolic languages can be discovered just as well in Mexico as in Salamanca. (Gruzinski 2004, 369)

The reception of Gruzinski's book clearly concentrates on issues of knowledge. In his review, de Neymet recognizes the fundamental importance of the category of knowledge for Gruzinski's depiction of a mestizo globalization emerging in the Iberian sphere of influence (de Neymet 2005).

Gruzinski argues that the foundation of universities and other educational institutions should not be understood as expressing Westernization or occidentalism. The very production of knowledge at the University of Mexico or at the various colleges of the colonial cities shows that certain institutions of knowledge had a global character from the start. They then spread globally throughout the Iberian domains and were transformed according to local contexts. Gruzinski makes this movement of knowledge between different intellectual centers and across global and local scales especially clear using the example of Aristotelian commentaries that were written in different parts of the world.

Peter N. Stearns's study *Globalization in World History* deals with the historiography of global history and undertakes an attempt to identify future topics in global historical research. Although his emphasis is generally on economic topics, "technological, sociocultural and political forces" are not neglected (Stearns 2010, 1). Knowledge and science are not listed here, but the book makes it clear that they are considered as part of the areas of technological and sociocultural forces. The basis of Stearns's argument is that every area of human thought and activity is affected and influenced by globalization processes, even when they seem to be merely characterized by local circumstances (ibid. 2). On the first pages of his book, Stearns develops a brief definition of globalization: "Looking at globalization as the accumulation of different types of connection helps to focus the relationship of current developments to the past" (ibid. 6). Globalization history is the history of connections and relations and as such can be traced back to early history.

In an even more explicit way than Stearns, John and William McNeill establish in *The Human Web* that human history is the history of increasing connections: "A web, as we can see it, is a set of connections that link people to one another" (McNeill and McNeill 2003, 3). This history of connection building is to be understood as occurring in a broader frame of human history, as "[...] human history is an evolution from simple sameness to diversity toward complex sameness" (ibid. 322).

In this chronologically structured study, knowledge is one of the components of human history that serves as evidence for the evolution of an increasingly extended network among people. The study begins with prehistory showing that, with the exception of Australia, the bow and arrow spread throughout the world and ends with a discussion of the newest communication technologies. The authors focus on connections shaped in contexts of wars and rivalry which are reinterpreted

as moments of exchange. Relevant connections are distinguished according to whether they were directed toward the exterior of a given society or whether they emerged from the internal organizations of social entities. According to the authors, internal communication and cooperation are fundamental for explaining the superiority of one group over another (ibid. 4–5).

2.3 Knowledge and Science in Narratives of Globalization

Traditionally, science has been associated with literacy. In many of the non-European regions studied by global history, no indigenous traditions of writing existed so that in the older historiography, the knowledge there was conceived as being inferior to European knowledge. In post-colonial studies, this perspective was contested and characterized as being Eurocentric and elitist.[4] Against this background, it becomes important to trace how the individual authors define science and knowledge and how they contextualize them in different cultures.

Christopher Bayly's position on this issues can be best understood in connection with his discussion of the evolution of political thought. At the beginning of the chapter "Theory and Practice of Liberalism," dealing with colonial movements inspired by European liberalism in the nineteenth century, he introduces the topics of liberalism, revolutionary thought, liberal economic theories and theories of political systems. Bayly reconstructs how newly emerging political entities imported packages of knowledge and linked them to so-called traditional forms of knowledge. Bayly identifies this form of knowledge evolution as a way of expressing new forms of nationalism in different historical situations, as happened in the classic revolutionary states of the United States and France, but also in the context of the Meiji "Restoration" of Japan and of the Egyptian nationalist movement. More specifically, he points out:

> The intellectual leaders of these Asian and Middle Eastern movements also mixed elements from modern Western radicalism and theories of human rights with claims to defend ancient traditions of community and the honor of the land from the rising tide of global commercialization, most powerfully manifested in the Atlantic economies. (Bayly 2004, 288)

Here, Bayly represents a view of history that radically rejects a Eurocentric modernization paradigm. For Bayly, modernization has ceased to be European but rather emerged in relation to traditional ways of societal organization and political thinking. He simply declares any existing and dynamic social, political or technical phenomenon in any part of the world from the beginning of the nineteenth century to be modern. As news and information could be received worldwide, any individual standpoint unavoidably developed in relation even to distant

[4] See, for instance, (Harding 1998).

events. Bayly stands in a tradition of historiography that has broken fresh ground since the 1960s. It takes its distance from the assumption of radical revolutions and rather sees revolutionary movements as being rooted in intellectual constants (ibid. 287–288).

Bayly stresses these constants and long-term developments in historical processes with the intention of understanding the history of political theories in close connection with the history of scientific discoveries. He considers the separate study of politics and science to be misguided and simply an artifact of disciplinary specialization. This separation obscures, according to him, the close relation and interactions between political and scientific spheres. For Bayly, science occupies a special place in the world history of the nineteenth century: "... [S]cience was as influential in the mindset of the nineteenth century as religion had been during the Renaissance." (ibid. 312)

He characterizes science as an approach to reality that in many ways used to be more radical than political theories. In particular, he claims that simultaneously throughout the world science developed into a subsystem of society and increasingly became the foundation on which political power and decision-making were based. Bayly makes use of a broad concept of science that includes the natural sciences as well as sociology, history and ethnology. According to him, during the nineteenth century all subjects of knowledge underwent a similar development throughout the world and eventually became university disciplines.

For Bayly, this development from knowledge as a collection of unspecified skills to science as a societal subsystem comprised three phases. The first phase was the creation of huge pools of knowledge, such as museums and archives. He also refers to the surveying and classificatory enterprises of natural history undertaken by Linné, Goethe and Alexander von Humboldt. These European enterprises, however, were not solitary undertakings but had their counterparts in the creation of herbaria and other collections in Africa, India or China, establishing, for instance, the basis for local medical knowledge. In the second phase, individual efforts were pursued to identify unifying principles, while the third phase saw the establishment of a comprehensive evolutionary theory by Darwin and others.

The essential factor accounting for the rapid development of European sciences was the commitment of nearly all governments to invest in specialized administrative units and infrastructures that supported science, as well as in technical resources like the railroads. The precision and reliability of scientific claims associated with government institutions allowed them to enhance their legitimacy, which, in turn, led to increased investments in this system by the state (ibid. 313–315). In the course of this process, science, now established in complex institutions, became in Bayly's analysis a globally communicable achievement that turned into an instrument of persuasion relying on cultural and scientific traditions in each country (ibid. 323).

For Osterhammel, educational institutions are important factors of global history. Only during the nineteenth century did school curricula develop into the

form of systematically structured courses of instruction implemented by public and private institutions. In Prussia, whose educational system became a model for other states, schools were part of the state ideology and played an important role in transmitting the official ethics of the state. In colonial regions, only a very limited number of European schools were established. In Algeria under French rule, an educational dualism of French schools and Koran schools prevailed. In China, Japan and the Ottoman Empire, the adoption of European forms of knowledge transmission was intensely discussed around 1900, but were realized only to a limited degree. It was predominantly Western, especially missionary organizations, that implemented schools recognized by Europeans as valid educational institutions (Osterhammel 2009, 1129–1130):

> The schoolification of society was a European-North American program of the early nineteenth century, which over time was elevated to a goal of state policy worldwide (ibid. 1131).

According to Osterhammel, this approach assumed a programmatic character when states recognized that educational policy was instrumental in asserting their own claims to power in three areas of society: in the socialization of the state population; in its political formation; and in the storage and propagation of knowledge (ibid. 1131).

Over the course of the nineteenth century, European universities achieved a new quality. While in many other countries outside of Europe, institutions of higher education often took the form of academies or professional schools, in the West universities became sites of research and even of new political thinking. According to Osterhammel, well into the twentieth century, non-European institutions diverged widely in quality; their performance was hampered by the limited spectrum of subjects taught, the lack of a complete academic curriculum, and a staff often selected more on the basis of colonial power hierarchies than achievement. Osterhammel stresses, however, that there were also non-European institutions such as the University of Istanbul founded in 1900, the University of Tokyo founded at the end of the 1870s and the Academia Sinica founded in 1928, which broke with conventional educational institutions in their countries and significantly contributed to science—as measured against their European models (ibid. 1132–1139).

Osterhammel also considers the development of universities within Europe, starting with the establishment of the German research university. This became a model that was adopted in England, France and, towards the end of the nineteenth century, also in the United States and Japan. The context of this development was competition among rival nations (ibid. 1142–1146).

Turning to the broader issue of knowledge, Osterhammel discusses the situation of the "world languages" in the nineteenth century, tracing their diffusion, forms of usage and stability. He regards language as an important medium for knowledge transfer and examines for the Ottoman Empire, China and Japan the

close connection between the adoption of European languages and the introduction of European knowledge. He compares the openness that made these innovations possible to the considerable resistance of European educational systems with regard to the exclusion of non-European languages and subjects from their curricula. He ascribes an important emancipatory role to the spread of colonial languages—even in their creole and pidgin forms—since they not only served colonialist purposes but also enabled individuals to pursue their personal goals (ibid. 1112–1115).

The concentration on the nineteenth century unavoidably emphasizes the developed European schooling and academic systems that Osterhammel considers as being superior to non-European educational systems. For him, science is an essentially European concept that becomes globalized over the course of the nineteenth century. But he also recognizes other facets of the globalization of knowledge, in particular, its increasing diversification as well as the role of non-European knowledge in other domains.

Stearns approaches the issue of knowledge diffusion and scientific practice with an entirely different emphasis, reflecting on the role played by individuals. He emphasizes that, in the transfer of knowledge, contexts and convergences are much more important than single actors. He cites the examples of bronze smelting, the compass, gunpowder and, somewhat surprisingly, of the printing press in Europe. For Stearns, the individual "inventor" always stands in a long line of tradition. He leaves the question of the relation between science and new technology largely open and mainly speaks generically only about knowledge. Only when he deals with the second half of the twentieth century does his grid become finer when he discusses, for instance, the way laboratories collaborate with each other to conduct research on global epidemics (Stearns 2010, 149).

In Stearns's understanding, knowledge emerges over longer periods of time and through long enduring connections. One of the systems transporting knowledge is religion. Contacts between religions, as well as the propagation and mixing of religions, were especially important in the period of European expansion (ibid. 77). Nevertheless, in the actual globalization of the twentieth century, religions are losing importance as agents of the globalization process; instead of developing a common language they highlight their mutual differences. This common language has instead been created by science with its collaborations and cooperation in laboratories, and even more so by the global language of the global culture of consumption (ibid. 150–153).

In contrast to other studies that point to the increasing centralization of the world, John and William McNeill pursue another view of history, emphasizing a persistent pluricentrism: over the course of the centuries, the world has been permanently transformed into a tight network of connections. Consequently, any multiplicity of languages, lifestyles, manners of dress or political and legal systems that may have existed is being replaced by a few, globally asserted norms. During this process, a world emerged with a comprehensive information infrastructure,

characterized by constant competition, along with a continual process of mutual perception, urbanization and migration that led to a reduction in cultural varieties. This process is taking place while systems that are already globalized penetrate traditional ones. Nevertheless, John and William McNeill stress their assumption of a pluricentrical world by pointing out that in history no hegemonial center ever existed. In a world assembled by a global network, they observe the emergence of counter-religions and counter-systems—for example as competing ideologies—that embody and pursue global multiplicity (McNeill and McNeill 2003, 270–274).

This development is not restricted to politics, culture or economics: over the course of the twentieth century, science has seemingly become a monolithic system in which the same scientific doctrines are taught in the same way throughout the world. The point of departure for this development was the formation of disciplines during the nineteenth century. John and William McNeill nevertheless claim that science, like all other social systems, is ultimately characterized by pluricentrism. To justify this view, they point to the fact that science is by no means limited to universities and research laboratories. For one thing, it has entered into a close partnership with the development of technology, where it becomes substantially application-oriented and immersed in an industrial context. What is more, science at the same time represents a kind of countermovement, because—at least in the authors' liberal view—it has adopted some of the moral authority of religions (ibid. 277–279). Science today is embedded within the economically defined model of competing companies. Here, economic knowledge and application-oriented science are highly dependent on each other; each is governed by the mechanisms of the global systems of economics and science.

Walter Mignolo stresses the distinction between science as it was shaped by European determination in the colonial and modern era, on the one hand, and non-European knowledge viewed from the perspective of "subaltern studies," on the other. These subaltern studies were first employed by Indian historians to describe actors and agency in Indian colonial history from below, that is, from the perspective of the lower social strata of colonial society. Taking up the concept of subaltern studies, Mignolo claims that individuals and groups opposing colonial regimes existed throughout the world, creating forms of knowledge that he characterizes as "border knowledge" since it served to break up the boundaries set by colonial and modern science (Mignolo 2000, 11–12).

"Border knowledge" refers quite generally to archives and movements of knowledge directed against occidentalism. Mignolo is less interested in institutions or in the question of whether one tradition of knowledge was more important than another. He rather concentrates on broader cultural issues such as language, clothing and pop culture. It remains an open question whether the promise that border knowledge holds as an alternative knowledge system to "Western" science can actually be fulfilled. For Mignolo, knowledge and science are in any case situated in two largely separate spheres communicating with each other only in a relationship of politically determined historical correspondence.

Parts of Serge Gruzinski's book *Les quatre parties du monde* can be read as a kind of response to Mignolo. In contrast to Mignolo, Gruzinski conceives Spanish colonialism not as overwriting distant continents with occidentalism, but rather as the creation of a space in which global communication became possible, vividly illustrated by the propagation of literature (Gruzinski 2004, 55–59) and of printing workshops (ibid. 62). The space to which Gruzinski refers of global communication opened up by colonialism becomes particularly visible when he traces how knowledge recorded in the colonies was utilized in Europe. He discusses its intellectual and commercial impact on European countries (ibid. 62–69), on the one hand, and reconstructs the processes by which knowledge was adapted in Mexico, Peru and the Philippines, on the other. Gruzinski points to a global space of mutual perception: events that took place on one continent were received, written down or immortalized in images shortly thereafter in another part of the world. The assassination of Henry IV in Paris in 1610 was described some months later in a diary written by a Mexican mestizo. Similarly, the naval battle of Lepanto, where the Spaniards fought against the Ottomans, soon appeared as a motive on a Japanese screen (ibid. 14–19).

Gruzinski cares less about the difference between science and knowledge. He defines science as the efforts toward systematization that were recorded throughout the globalized Spanish Empire from the sixteenth century on. What matters to him is the framework in which knowledge could emerge. He investigates the sites and the people through which it came into being as well as the reception that this emerging knowledge received. On the one hand, colonial global knowledge is based directly on the "Ancients," that is, on Homer, Aristotle, Ptolemy and other ancient scholars and philosophers. On the other hand, their works constitute the framework for structuring the genuinely different knowledge about the newly discovered worlds outside of Europe. Referring to this formative role of the ancient knowledge, Gruzinski explains the references to Plato and Ptolemy integrated by Diego Muñoz de Camargo in his *Relaciones geográficas*, as well as André Álvares de Almada's need to classify Africans as cannibals (ibid. 204–205). Such texts saw a worldwide circulation and thus constituted the foundation for every form of discourse and classification undertaken in the colonial world.

Knowledge was collected and classified in natural histories, herbaria and compendia of navigation maps. Since experience played a central role in these works, indigenous people or mestizos in the colonial areas could contribute significantly to European knowledge on the basis of their own experiences. Experience and the claim of having seen what is described or depicted became an increasingly important argument in its own right and legitimized new knowledge (ibid. 211). For Gruzinski, knowledge and science are intimately related. He also stresses that knowledge was not only represented by texts, but also recorded in images. He refers, for instance, to frescos created by indigenous artists in Mexican monasteries, which not only represented a blend of artistic techniques, but also integrated knowledge from Europe, Asia and America.

2.4 Revisiting Europe from a Global Perspective

Since Dipesh Chakrabarty in 1992 called for a provincializing of Europe, most global historians endeavor to avoid the impression of Eurocentric argumentation. In view of the colonial and imperial, and then of the international political and economic dominance of the "West," historians face a great challenge. One solution to this historiographic challenge is to enlarge the temporal focus and to emphasize the historical eras before European colonialism, because then European dominance in the areas of economics, the organization of politics, and the production of knowledge did not exist.

Another argumentative strategy is to draw attention to local non-European processes that changed European knowledge systems, even in the heyday of colonialism and imperialism. Marshall Sahlins has shown, for example, that the development of capitalism was different in China, Hawaii and Vancouver Island (Sahlins 2000). This in turn then raises the question of whether this development took place in the same way in the heartlands of industrialization: in Manchester, Lille, Philadelphia and Essen. In a certain sense, capitalism is comparable to the global development of knowledge, as both are dynamic and complex systems.

A third historiographical current responding to the challenge of post-colonial critique emphasizes the role of constant negotiations among different groups. It recognizes the asymmetry created by European dominance, but insists on the idea that power and knowledge are in flux due to these ongoing negotiations. All of these historical accounts, like the contributions to the present volume, stress the role of local contexts and point to events and circumstances of global history that had hitherto been neglected by the dominant narratives.

According to Christopher Bayly, the superiority of science and its larger historical tradition have been propagated in Europe at least since the beginning of the nineteenth century. But he also emphasizes that debates about science and its history did not just take place in Europe and that science was part of many societies worldwide. As a result, a global communicative space emerged over the course of the nineteenth century in which science was an independent subsystem. He presents arguments against a European origin of science, as they were brought forward in India and the Arab world, pointing to the autonomy of the scientific traditions of these regions and their achievements (Bayly 2004, 317).

Bayly pursues the debate about the "origin" of science up to the end of the twentieth century, arguing that what ultimately counts historically is not the provenance of a scientific insight, but its application. Accordingly, he focuses on the various societal environments in which science was performed. In particular, the environments of European and North American industries provided opportunities and ideas that shaped the further development of science because they offered multifarious areas of application. For Bayly, the appeal of earning economic benefits by way of scientific and technological inventions prevailed over any idealist expectations associated with science. He notes that in the nineteenth century Eu-

rope had started with certain "advantages" because its dynamics resulted from a politically and economically fragmented landscape that had developed over centuries. A high number of territories competed intensely with each other and were thus compelled to constantly innovate their technology as well as their methods of organization, especially in warfare. Bayly believes that the fact that European societies from the the eighteenth century on were highly technologized and militarily oriented may have situated them to offer more stimuli to Asian states than could have happened in reverse, since the latter enjoyed conditions of relative peace (Bayly 2004, 80–81).

In order to correct the unilateral image of a European dominated nineteenth century, Bayly pays special attention to those institutions in non-European countries that worked in a systematic and application-oriented manner comparable to the European situation. He considers the examples of the Ottoman Empire's School of Languages and of the emerging scientific community in Japan. He mentions, in particular, the role of seismology in Japan and the transfer of medical knowledge from the West to Japan, China, the Arab world and India. For him, this knowledge transfer is indicative of the openness of these knowledge systems to external influences and to their awareness that their own history had involved borrowing components of knowledge from various sources.

Political reasons and in particular a situation of global competition and rising nationalism could lead however to a closure of knowledge systems with regard to each other. In the Islamic regions and in Africa, for instance, Bayly identifies "hybrid systems" in which traditional and Western treatments existed and developed in parallel; they were highly competitive and always concerned with their demarcation (ibid. 318–320). According to Bayly, this was a worldwide development. While some of these "hybrid systems" can be traced back to European origins, their unfolding can only be understood as taking place in reaction to local contexts. The global development of science must also be seen in this context. Europe was no exception. Science with its characteristic specialization and standardization emerged at the same time in many regions of the world and had to struggle everywhere with "traditional" approaches in fields like medicine, agriculture and small industry. This struggle was comparable to any other process in which new knowledge was generated and had to compete with existing traditions. There was hence no a priori reason to expect that science would enjoy higher acceptance than any other new knowledge (ibid. 320–322). European expansion and the spread of science did not in fact lead to a complete and sudden rejection of knowledge prevalent in the colonized countries. For the most part, this knowledge was merely recontextualized and so placed within a new global consciousness from which it drew its meaning and had to prove itself.

According to Osterhammel, a global consciousness provides a framework that encourages the capability of societies to engage in self-diagnostics with regard to their current situation. In his view, the nineteenth century was "a period of enhanced self-reflection" (Osterhammel 2009, 1279). The sciences in general, and

disciplines such as history or sociology in particular, served as instruments that enabled simultaneously occurring phenomena to be diagnosed in an interwoven global context. Obviously, the issue of self-reflection is not limited to the domain of science, but rather raises the more general question of what modernity means and whether it could mean something different in different cultural contexts. In this regard, Osterhammel observes that such self-reflection hardly took place before 1900:

> Indeed it is difficult to find independent and distinctive Indian, Chinese, Middle Eastern-Islamic or African paths for the period between around 1800 and 1900, which provided a counterpart of their own to the hegemonial Western European model of modernity. Such differentiations did not become noticeable until after the turn of the century, initially more in terms of intellectual history than structure. (ibid. 1279–1281)

Two formulations by Osterhammel are interesting in this context: first he claims that "colonialism and globalization [created] cosmopolitan orders of language" (ibid. 1116). Yet, according to his understanding, expansion, disseminations or mixtures are not motors of globalization and perhaps not even indicators, but mere consequences. The second interesting formulation is connected with the reforms of writing undertaken in many countries with the goal of bringing elite language and the vernacular closer together. Osterhammel denies that these projects reflected "a direct imitation" of Europe (ibid. 1117). These projects are rather to be explained as a consequence of the given "national" situation. Osterhammel covers alphabetization and literacy comprehensively. He interprets these topics as belonging to the competition among nations for modernity, described in terms of the rising rates of literacy in the population. In this competition, the northern European states, the United States and Japan came out ahead of, for instance, Mexico or China. Osterhammel discusses at length what he considers to be missed educational opportunities in the nineteenth century in these countries (ibid. 1125–1127).

Osterhammel argues that curricula and research topics as they were shaped by newly created national institutions were largely immune to the influence of non-European experiences. Instead, they developed their own research agendas and methods independently of such influences. However, some of their research results were translated and thus reached non-European scholars as well. This transmission happened not by chance, but rather in response to specific demands for new knowledge emerging among growing scientific communities, for instance, in China and Japan. This transmission was hampered by considerable obstacles, however, in particular by the cultural connotations of key scientific concepts. Osterhammel concludes:

> More than ever before and more than since, say, the mid-twentieth century, in the long nineteenth century the flow of knowledge around the world was a path down a one-way street." (ibid. 1151)

As a consequence of the Western habit of ignoring or rejecting knowledge recorded elsewhere, the European sciences took on a hegemonial status. This status was reinforced by the growing professionalization of the sciences in Europe and the formation and differentiation of disciplines that gave rise to scientific achievements serving as milestones for global science over long periods of time (ibid. 1147–1156). Such claims may seem to suggest that Osterhammel is merely rolling out a new edition of a Eurocentric historical account. Yet, the author actually attempts to straddle the two main currents of global history without coming down as either a "diffusionist" or an "evolutionist." Osterhammel works in both directions: as we have seen, while university models were diffused, the development of national languages emphasized each country's own character.

Gunder Frank takes a position opposite to that of Osterhammel: He rigorously denies that anything like a "European technology" even exists. After all, Europe has always been dependent on external influences. Even the innovations developed during the colonial period were based on a mutual, albeit asymmetrical, exchange of knowledge (Frank 1998, 204). In the picture he draws of the world prior to 1800, Frank emphasizes the economic features. According to him, China represented the most powerful economic sphere of influence, followed by Japan and India, with Europe lagging well behind. In any event, these are the four main global players of his account, which neglects Africa and Latin America and leaves North America somewhat surprisingly in the background. Frank also denies the existence of any long-term hegemony. For him, neither the use of gunpowder for firearms, nor the construction of ships, nor the invention of the printing press or of mechanized textile production, nor innovations of metallurgy or of other areas of mining and transport constitute the basis for any enduring superiority of one political-economic system over another. He rather traces temporary phenomena of dominance lasting for limited periods of time and covering only restricted geographic spaces. According to Frank, these cannot be explained in terms of knowledge, but always depend on economic circumstances (ibid. 193–203):

> That is, technological progress here *and* there, even more than institutional forms, is a function of world economic 'development' much more than it is of regional, national, local, let alone specificities. (ibid. 186)

Walter Mignolo's goal is to provide a common theoretical and epistemological basis for the flows of politics, ideas and knowledge in the world system of border knowledge that is at the center of his analysis. Border knowledge consists in demarcation, in opposition, and in a process of separation from occidentalism. Mignolo connects his broad theoretical approach with the dependency theory developed in Latin America. Dependency theory analyzes why and how Latin

American economies were for a long time unable to disengage themselves from power relations as well as from societal and economic structures inherited from the colonial period. For Mignolo, this theory provides an example of how colonial and modern thought can be overcome with the aim to put an end to the Latin American states' imitation of Europe (Mignolo 2000, 54).

According to Mignolo, capitalist and colonial domination continue to persist. They are opposed by processes of detachment which Mignolo believes to constitute an ongoing political project. These processes of detachment do not simply correspond to reactions to the colonial world, but are composed of both older and more recent layers of collective experience and thinking (ibid. 50). For Mignolo, the capitalist world system proceeding from Europe, Europe's colonial dominance and the system of knowledge developing through Europe's experience abroad cannot be divorced from each other. They determine the economic and scientific system of thought to such a degree that, even in the aftermath of the colonial and modern epochs, an alternative system of thought can be achieved only under one condition. Such an alternative system has to rely necessarily on those traditions of thought that did interact with the systemic colonial dominance, but that nevertheless remained recognizable as independent traditions and striving themselves to mutate into new systems:

> The reordering of the geopolitics of knowledge manifests itself in two different but complementary directions: 1. the critique of the subalternization from the perspective of subaltern knowledge [...]; and 2. the emergence of border thinking [...] as a new epistemological modality at the intersection of Western and the diversity of categories that were suppressed under occidentalism (as an affirmation of Greco-Roman tradition as the locus of enunciation in the sixteenth and seventeenth centuries), Orientalism (as an objectification of the locus of the enunciated as 'Otherness'), and area studies (as an objectification of the 'Third World,' as producer of cultures but not of knowledge). (ibid. 95)

In this sense, global connections play a central role for Mignolo. They explain the dominance of the colonial and modern system and also harbor the potential for the creation of alternative systems. In contrast to occidentalism, the alternative systems do not aspire to hegemony, but are always countermovements and third paths, based on multi-local substantiations and are thus oriented toward the dissolution of fixed blocs (ibid. 95).

Instead of trying to filter Europe out of global processes, Serge Gruzinski advocates integrating Europe into the world events of the seventeenth century. There is no denying that Spain, as a part of Europe, spread throughout the world, and that there were strong tendencies to centralize knowledge. But the Iberian peninsula was by no means the node through which all threads of knowledge ran. In contrast to Mignolo, Gruzinski does not assume that occidentalization can be equated with the development of hegemony. He makes this clear by using the

example of Aristotelianism, which for Gruzinski could not achieve any hegemony in the non-European world but remained simply one conceptual framework among others.

It was Europe that suffered because of the dominance of Aristotelianism: there it prevented any significant influence of non-European knowledge on science. By dint of the export of Aristotelianism as a knowledge system comprising books, professors, the mastery of the Latin and Greek languages, as well as the foundation of new monasteries and universities in Spanish America, Europe believed to have achieved hegemony with regard to any other form of knowledge. In Mexico, Aristotle was taught as early as 1553 in a local Dominican monastery, that is, even before the university was founded. The Thomistic interpretation of Aristotle's work played an important role in Iberian globalization. As a consequence, the Aristotelian *Organon* became the foundation for all studies at the colonial universities. Since the Iberian social context of reception was similar to that in Europe, scholars in the colonies did not develop different interpretations from those familiar in the colonial homeland. This is also why Western philosophy did not receive any new impulses from the colonies (Gruzinski 2004, 340–332). So far, Gruzinski's account represents a typical narrative of the expansion of European knowledge to another continent.

Then, however, Gruzinski develops his argument in a surprising direction. He claims that this belief in European superiority was actually part of a European self-deception in the early modern period. Key to this self-deception was what Gruzinski calls the "Aristotelian bubble" (ibid. 355), that is, the Aristotelian scholastic legacy which largely determined the way in which any knowledge and experience were interpreted; interpretations departing from this dominant view were persecuted (ibid. 245–256). With a few exceptions, this Aristotelian bubble made Europeans largely blind to the innovations and the new knowledge produced in the colonial sphere that went far beyond the scope of Aristotelian teachings. Gruzinski discusses attempts by Europeans to integrate non-European knowledge, such as the reception of Chinese nautical knowledge by Bernardino de Escalante or of Chinese medical knowledge by Juan González de Mendoza. He notes, however, that characteristically, such alien knowledge later fell into oblivion (ibid. 350–355).

In conclusion, at the beginning of Iberian globalization, various knowledge traditions coexisted in relative autonomy with respect to each other. According to Gruzinski, however, this autonomy was gradually undermined by the export of thought systems like Aristotelianism, by translation activities, by the spread of publishing ventures and, more generally, by the global diffusion of knowledge overcoming geographical separations.

Peter Stearns sees hegemonial situations emerging, for instance, from trade and shipbuilding. In general, in the literature on globalization, shipbuilding is mentioned frequently since ships are highly technical products which could be used for conquest and expansion. Furthermore, shipbuilding was an important medium for the exchange and the accumulation of knowledge. Through war and

expansion, technical knowledge passed from one side to the other, at least as long as it could be matched with existing technical and epistemic concepts.

Stearns analyzes hybridization processes associated with trade and shipbuilding. Through Arab trade, two different techniques of shipbuilding spread in the Indian Ocean, namely the Arabic and the Malay-Chinese traditions. He shows how a specialized terminology of shipbuilding spread over large distances (Stearns 2010, 36–37, 60–61). He also discusses the role of trade relations for the spread of the compass from China, via the Arab world, all the way to thirteenth-century Europe, as well as for the spread of the astrolabe and the cartographic and narrative descriptions of geography (ibid. 38–39).

The spread of knowledge is not at the focus of Stearns' interest however. He rather uses the occurrence of similar technologies in different locations as evidence for the existence of intensive trade relations that must have been responsible for the exchange of these technologies (ibid. 44). As it turned out, eventually Europeans benefited more than others from this exchange. Thus, Portuguese shipbuilders produced results superior to those of their Arab forerunners once they equipped their newly-built ships with cannons.

Stearns deals not only with the question of which area of knowledge might bear potential for a hegemonic position. He is also interested in intercultural histories of knowledge such as the history of the concept of zero and the history of firearms. In particular, he shows how the concept of zero emerged and was spread as the result of an adaptation of knowledge in various historical situations. He emphasizes the non-linear and even controversial character of its history. In parts of India, the concept was rejected and once it arrived in Europe, a considerable length of time passed before it generally prevailed. Yet, it had scarcely entered the European chambers of commerce before it was carried, by way of European expansion, to other continents where it soon became firmly established (ibid. 47). Several centuries later, a similar intercultural development eventually led to the dominance of firearms in fifteenth-century Europe (ibid. 58–59). Stearns gives further examples that show how European superiority depended on external influences and, in particular, how the resulting superior technology became decisive for European dominance and how it finally led, from ca. 1850, to true globalization.

2.5 Capitalism and Industrial Revolution as Controversial Milestones of Globalization

In the history of the last centuries, the economic system of "capitalism" played such a central role that also studies of global history focusing on issues other than economic can hardly avoid taking its historical development as a reference for periodization. Similarly, industrialization as a new mode of production established since the end of the eighteenth century became a central historiographical category for globalization studies. Capitalism and industrialization were traditionally considered to be merely European historical processes that achieved a certain impact

in other parts of the world. The works of Immanuel Wallerstein and Eric Hobsbawm widened the perspective on these crucial developments to a global scale, insisting on the worldwide network of interconnections that made them possible, although Europe continues to play a central role in their narratives. Their works in fact constitute the first steps toward a history of capitalism and industrialization emphasizing the dependency of these processes on the relations between Europe and other parts of the world. This explains why their pioneering contributions have become standard references for any history of globalization.

By outlining a global history of capitalism, Wallerstein suggested a modified reading of European colonialism. He considers the development of European capitalism as a process in its own right, which only initially depended on European political expansion. This economic development extended over a large period of time and correlated core regions, peripheries and semi-peripheries into a single world system. The European global economy was distinguished from other economic systems by creating "a single division of labor but multiple polities and cultures" (Wallerstein 1979, 6). This European global economy was based not primarily on colonial and imperial hegemony, nor was it determined by individual actors, nations or governments. Rather, the economic system was the arena in which these actors and powers could play their roles.

The European global economy in fact distinguishes itself from other economic systems by the high degree of connectivity between its participants. Once the pre-Spanish economic systems of America had been incorporated into this European system through colonial conquests, a global European economic system emerged, whose core region shifted, by the mid-seventeenth century, from the Iberian peninsula toward Flanders and England. But even apart from political conquests, the European world system expanded and involved ever more regions, such as, for example, the Ottoman empire (Wallerstein et al. 1987).

The Industrial Revolution is generally seen as an important step in the development of capitalism. Eric Hobsbawm designates this developmental step, which began around 1800, as "capitalist industrialization" in order to distinguish it from more traditional modes of production. He situates the Industrial Revolution within a context of various social and technological developments. These are not restricted to England, let alone to Europe. According to Hobsbawm, capitalist industrialization "was part of a larger network of economic relationships, which included several "advanced" areas, some of which were also areas of potential or aspiring industrialization [...]" (Hobsbawm 1999, 13). Wallerstein and Hobsbawm have transformed the issues of capitalism and industrialization into themes of a global historiography. They thus prepared the ground for more specific historical studies investigating the global connectivity associated with social and economic processes.

In the tradition of this economic historiography, Christopher A. Bayly identifies historical milestones associated with economic changes. He claims that societies all over the world changed in multilayered global processes, moving from proto-globalization through archaic globalization toward modern globalization.

The latter was prepared by what he calls "industrious revolutions," taking up a notion introduced by Jan de Vries. Bayly follows the development of modern globalization through "the great acceleration" of imperialism, nationalism and liberalism up to 1914. A key theme of his work is the development of networks comprising a "multitude of centers, a global history of connections and interconnections" (Bayly 2004, 44–46; 451–467).

A new perspective that he introduces in his study concerns the role of changes in the labor process over the course of the nineteenth century, which he claims to be more fundamental than changes in production processes as they are highlighted by the term "Industrial Revolution." Bayly employs instead the concept of *industrious revolutions*, introduced in the singular by Jan de Vries for developments in North-West Europe between 1650 and 1850 (DeVries 1994, 49–55). For the nineteenth century, Bayly traces instead how workflows changed all over the world and how work itself became an appreciated value.

According to Bayly, the industrious revolutions did not have their exclusive origin in Europe, but rather constitute an important example of how distributed processes became globally integrated. The industrious revolutions were based on a co-evolution of labor and knowledge about how the goals of production could be achieved in an economically more effective manner. These revolutions became the prerequisite for the emergence of new economic systems, forms of religious organization and of science as social systems in their own right. Thus, while science may have been temporarily closely associated with industrialization, it emerged on a global scale as a social system that carries no specifically European traits. In contrast to Gunder Frank, who argues that the emergence of science, the development of technology and industrialization should not be conceived as interdependent processes, Bayly advocates a radical application of the globalization paradigm. According to this paradigm, any development is mediated by a worldwide interplay of processes, thus constituting globalization in the first place. He thus opposes previous historiographies which considered developments as rather taking place in a chronological sequence.

Frank, on the other hand, emphasizes the autonomy of economic, political and scientific developments in Asia which remained unnoticed for centuries by Europeans. He also denies that the rapid development of capitalism and the industrialization in Europe represented singular historical events. He rather claims that the Chinese form of economy was equally successful. In his view, the global economic system emerged over centuries as the result of an interplay between different regional economic systems. With regard to the European development, he stresses that "any such Western rise must have been *within* the world economy itself" (Frank 1998, 334). Effectively, he turns the view of an alleged European singularity and superiority upside down by claiming that one has to interpret the entire complex of capitalism, industrialization and technical progress in Europe as ultimately resulting from Europe's success in learning to stand on the shoulders of the Asian economies.

With a focus on Great Britain, Jürgen Osterhammel introduces a periodization for global history. He regards the decades between 1770 and 1830 as a "global saddle period," marked by the Industrial Revolution. It comprises the development of wage labor from 1820 on, the deployment of fossil fuels and the massive spread of steam engines (Osterhammel 2009, 108). This global saddle period is followed by the "Victorian globalization" lasting until 1890. It is characterized by imperialism, the emancipation of white settler societies in North and South America, nationalism, the importance of civil liberties and the rise of the middle class. With regard to the global character of the contemporary intellectual history, Osterhammel takes a cautious stance because, as he writes, too little is known about the individual "contacts and relations of exchange between the individual civilizations [...] from non-occidental contexts" (ibid. 108-109).

Osterhammel distinguishes between industrialization and the Industrial Revolution, two terms often used synonymously in historiography. For him, industrialization is characterized by slow growth; it is not necessarily coupled to capitalism or accompanied by a major impact on society. The Industrial Revolution, on the other hand, distinguishes itself by its far-reaching effects on society and its global impact. The prerequisites for the emergence of the Industrial Revolution existed only in Great Britain. Among the conditions favoring the Industrial Revolution were a large demand for bulk goods, a well-developed international trade and an elaborated scientific tradition and great technological experience.

The British economic context in fact also favored a second scientific revolution in which, in contrast to earlier epochs of history, "the waves of innovation did not break off or peter out" (ibid. 918). Osterhammel describes the cumulative character of this process of innovation, which he considers to be a unique characteristic of Great Britain, by referring to a "*normalization* of technical innovations." In his view, it results from a particular interplay of already existing and systematically produced new knowledge. The development of new technologies for converting energy, for instance, was furthered and accompanied by the capability of formulating physical models of such conversion processes. For Osterhammel, the nineteenth century was, in fact, a period in which social and scientific progress were both closely linked with each other, as well as with the issue of energy conversion, in particular from fossil fuels (ibid. 928–930).

Also Walter Mignolo sees close parallels in the development of politics, capitalist economy and epistemology when he traces the expansion of Spain during the sixteenth century. He claims, in particular, that this historical development shaped modern philosophy and, more generally, modern thinking with effects lasting until today. The starting point of this development was the global challenge with which the Spanish monarchy was confronted as a consequence of the expansion of Iberian powers to America and other parts of the world. Through this expansion, Spain assumed a central position and became a mediator largely determining the epistemological framework for interpreting the new, global world (Mignolo 2000, 56).

As a response to this challenge, epistemic strategies were developed to integrate the new experiences into the existing complexes of politics, faith and power. Thus, under the auspices of Spain's Catholic monarchy, a self-contained epistemological system was established that excluded any claims to scientific validity coming from the outside and that continued to bend and twist anything not in accordance with it (ibid. 4–5). This system which Mignolo designates as "occidentalism" indeed remained in power long after the demise of the period properly labeled as colonialism (ibid. 53). In particular, this system entered into a close, functional relationship with the expanding capitalistic world system. Following Aníbal Quijano, Mignolo sees close parallels between the relation of owner and property in capitalism and the epistemic subject-object relation (ibid. 60), and more generally between the development of global capitalism and that of knowledge systems.

Also Serge Gruzinski is convinced that the globalization of knowledge was deeply shaped by capitalism. But he widens the economic perspective to include the circulation of luxury goods, in particular, in the sixteenth century. Luxury goods, marvels and curiosities traded in Europe since the Middle Ages were recognized on all continents as gifts and became objects of global consciousness and worldwide trade (Gruzinski 2004, 43–47). For Gruzinski, genuine globalization means assimilation, a central topic of his studies. The traded "exotic" luxury goods were assimilated by economic processes and incorporated into a social value system from which a new form of economy emerged. Through these assimilation processes, new stocks of knowledge were built up that could have hardly emerged in the world prior to Iberian expansion, with its mostly autonomous knowledge traditions.

> The connection between one or the other world is not limited to the translation of indigenous issues into an Iberian language and to European codes. However, the connectivity would be imperfect without the further inclusion of an indigenization or an Africanization of European issues. (ibid. 242–243)

Peter Stearns broadens the discussion about capitalism and Industrial Revolution by emphasizing the importance of transport and communication for the history of globalization in a long-term perspective. Accordingly, he takes a close look at the spaces of communication and trade before 1500. According to Stearns, wide ranging connections emerged as early as the Bronze Age. During this period, the transfer of knowledge occurred on the basis of certain goods that had become objects of desire in places other than their regions of origin. This interest in objects, but also in production methods such as metal smelting techniques, stimulated a search for knowledge and learning that also motivated mobility. In antiquity, for instance, scholars visited other cities and countries because they were interested in their local knowledge. Greeks went to Egypt and Chinese scholars visited India. Some were seeking mathematical knowledge, others were interested in religious

matters. In any case, knowledge became something like a material good. Through this mobility of scholars, as well as by way of the exchange of manuscripts, contacts emerged, many of which proved enduring (Stearns 2010, 9–10).

For the period after antiquity, Stearns closely follows the development of trade and language as vehicles of a "proto-globalization." He emphasizes the importance of relationship-building in the expanded Mediterranean area and attributes a significant role to the Arabs and their culture of trade. For Stearns, trading is in fact the true motor of the Arab expansion that transported not only goods but also their language. Thus Arabic became the lingua franca of the Mediterranean and of the Indian Ocean. In the Arab world, a wide-ranging network of intellectual centers emerged with close relationships between each other. Scholars were able to travel back and forth, exchanging religious or legal knowledge, because travel was considered to be safe (ibid. 32–36).

For the Middle Ages, Stearns shows that the diffusion of knowledge was closely linked to that of the objects to which the knowledge referred. He discusses, in particular, the examples of silk and porcelain. Although the knowledge of their production was protected by political entities, it was nevertheless distributed ever further through trade (ibid. 36). The period between ca. 1500 and the Industrial Revolution saw important developments of transportation technologies, leading to an increase of both loading capacity and speed. The invention of the printing press with movable type in Europe became a key element of increased and accelerated communication, although this was not the purpose of its invention (ibid. 63).

While other scholars would characterize these developments as the beginning of globalization, Stearns places its true inception around 1850. He agrees that the fundamental elements emerged around 1500 and were improved in the subsequent period (ibid. 87–93). But he stresses that, during the long nineteenth century, the speed of transport and communication significantly increased, as did the capacity to transport bulk quantities over large distances (ibid. 93). He sees trade and war as the most important motors for the further development of the corresponding technologies. However, the accelerated globalization was not limited to developing means of ever faster and more efficient transport, or to the greater speed at which innovation took place. For Stearns, the key to the true inception of globalization was the quicker diffusion of these innovations which now occurred within a few decades or even within just a few years (ibid. 106). He summarizes:

> Technology breakthroughs in transportation and communication alike, new approaches to global health issues and the massive acceleration of technology diffusion, really new areas of global interaction in culture and politics, and crucial commitments from key nations like Japan—the list of fundamental innovations is substantial, and might easily justify the idea that the post-1850 period is indeed the crucible of modern globalization. (ibid. 122)

Stearns is of course aware of the problems associated with a strict periodization in globalization history. Regional differences, differences between urban and rural zones or the various forms of interaction between the local and the global in fact challenge any specific temporal framework (ibid. 125–127, 150).

William and John McNeill also deal with global history in a long-term perspective. They focus on Europe and the special position it achieved in the long development from antiquity via the Scientific to the Industrial Revolution. Their story begins with the routes that had connected distant regions such as Mesopotamia and China as early as the first century BCE (McNeill and McNeill 2003, 65). They stress the particularities of ancient Greece and its pluricentric political and religious organizations, as well as the role of Aristotelianism for the further development of knowledge (ibid. 73–74). Steady cultural contacts stimulated the transfer of knowledge and fostered the development of technologies in areas such as navigation, war, astronomy and physics (ibid. 189). The authors thus identify an "Old World Web" of far-reaching connections, but also refer to epidemics as a complementary unifying force since they entailed significant consequences for political communities all over the world (ibid. 78–79).

The Arab expansion was accompanied by the spread and accumulation of knowledge which was eventually institutionalized in madrasas. Sciences in the Arab world flourished until well into the fifteenth century and beyond. Important contributions to mathematics, astronomy and medicine were achieved in this period, some of them with challenging consequences for religious knowledge. The authors nevertheless locate the Scientific Revolution in Europe, between the sixteenth and eighteenth centuries. Here, against the background of a political fragmentation that encouraged competition, modern science emerged as a system supported by the institutional framework of universities and was based on a well-established tradition of flows of information and fields of scholarship (ibid. 186–188). This European Scientific Revolution created important conditions for the further development of a globally connected humanity.

Even more than the Scientific Revolution, according to the authors, it was the Industrial Revolution that changed human history. The use of fossil fuels turned out to be essential for the development of worldwide connections and the formation of the modern world. The Industrial Revolution had its origins in England where a number of favorable conditions prevailed, such as the introduction of new technologies, but also the utilization of previously unexploited land and an advantageous political situation. The authors trace the unfolding of the Industrial Revolution through various stages. At first, innovations were mainly introduced by practitioners and entrepreneurs. Only in the final stages did science play a fundamental role in the development of new technologies. Eventually, the Industrial Revolution also had far-reaching consequences on local industrial sectors outside of Europe. The cotton industries in India, Bangladesh and Iran, for example, were unable to compete with the British industry. In these parts of the world, modes of

industrial production were only developed after European machinery was imported (ibid. 230–237).

In conclusion, as John and William McNeill consider a long time span of human history, they keep sight of the connectedness of different parts of the world, a connectedness that persisted for centuries and that can be considered as being the quintessence of globalization. Because of its fundamental implications for all parts of the world, however, the Industrial Revolution emerges as the single most important historical process shaping this globalization.

2.6 Summary

While all of the authors considered here are evidently aware of the important role of knowledge and science in the history of globalization, only for Walter Mignolo and Serge Gruzinski do they form an essential part of their narratives. As we have seen, for Mignolo epistemology plays a decisive role while Gruzinski emphasizes the exchange of knowledge. For the other authors, economic developments and political histories form the backbone of their reconstructions.

Authors with entirely different outlooks nevertheless agree on the fact that certain key periods existed that fundamentally changed the further history of the world. In Osterhammel's *Verwandlung der Welt*, this period is around 1850, while in Gruzinski's *Les quatre parties du monde* the period around 1600 marks a crossroads in history.

All of the authors agree not only on the importance of knowledge and science, but also on the role of global connections in constituting globalization. They conceptualize these connections, however, in somewhat different terms. For Christopher Bayly, they are embodied in spaces of intensive debates, such as those on liberalism, socialism, science and the late colonial situation; for John and William McNeill they are part of an ever-growing network; for Mignolo they take the form of different epistemic systems that were formed during colonialism; for Gruzinski, the essential process consists in the mixing of cultures and people; and for Peter N. Stearns, these connections intensify over centuries and are built up by forms of communication and mutual observation, as well as by the exchange of knowledge between systems, institutions and actors.

As we have seen, the question of Europe's uniqueness is studied intensively in all of these works. The most prominent theme that connects Europe with another continent consists in the exchange between Europe and Asia, especially China. Bayly and Frank stress the mutual interaction between both continents, while the one-way nature of knowledge transfer from Europe to Asia prevails in Osterhammel's account. In practically all of the studies considered, Europe is seen as a special place characterized by diversity, where a persisting competitive situation became the motor for the development of knowledge, science and technical innovation. This competitive situation was due to the permanent confrontation between

political units, but also to the rivalry and constant exchange between institutions of learning, such as the universities, as is emphasized by Osterhammel.

According to Mignolo, a North-South divide of Europe was the cause of an epistemological decline in the Mediterranean countries, with industrialization affecting only a few of the Middle and Northern European regions, as Bayly, Osterhammel and Stearns all point out. At the same time, Osterhammel and Gruzinski emphasize in their works how Europe resisted the influence of non-European knowledge, partly because it was, for most Europeans, difficult to assimilate to their own systems of knowledge. In the seventeenth century, Europe lived in an Aristotelian bubble and, in the nineteenth century, in imperialistic arrogance.

Most studies identify trade, economy and production processes, but also religion, language and politics as important vehicles of knowledge. They also notice how systems of knowledge, carried by these vehicles, are developing into sub-structures of the expanding world system. They furthermore suggest to conceive such systems of knowledge in terms of models, world orders and narrative metaphors taken from political and economic history. Finally, the studies follow the historical changes and developments of these systems of knowledge, alongside those of the objects of knowledge. Some, such as Bayly's and McNeill's accounts, propose stage models of knowledge development, favoring scientific knowledge as a superior form of knowledge, while others, such as Serge Gruzinski's account, consider catalogs and collections, for instance, as an autonomous form of science and not simply as precursors to its developed Western form.

The relation between knowledge and science constitutes, more generally speaking, a challenging problem for globalization studies that is not always confronted in an explicit manner. The way this problem is dealt with depends, of course, also on the temporal focus of a historical study, given the obvious differences between pre-modern and modern types of knowledge organization. It is also related to the controversial questions of when globalization began and what role Europe played in it. While Europe's role remains crucial, all authors make considerable efforts to pay attention to other continents. Clearly, what is still missing are, as Osterhammel remarks, studies of exchange processes between non-European historical entities, for instance, between Asia and Africa. Addressing the question of the relation between knowledge and science is often circumvented by considering institutions as the real objects of investigation or by applying a modern notion of science to earlier periods.

Another challenging problem emerging from the available accounts is the historical understanding of the relation between the Scientific Revolution and the Industrial Revolution, as well as of the relation between capitalism and industrialization. What role did knowledge and science play in these processes and their interconnections? And vice versa, how should we conceptualize knowledge and science in order to arrive at a better historical understanding of these developments? Further research on these questions will help not only to achieve a more symmetrical global history of knowledge, without glossing over differences of power, or over

the confrontations and wars that are also part of the global history of knowledge. It will also help to address some of the issues with which current globalization confronts us.

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