

SCIENCE AND TECHNOLOGY IN THE EUROPEAN PERIPHERY: SOME HISTORIOGRAPHICAL REFLECTIONS

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INTRODUCTION

In less than twenty years a number of developments have dramatically reshaped much of what was considered as common (historiographical) values among members of the established communities of historians of science and technology. The intense discussions concerning a number of theoretical issues, and the subsequent re-thinking of foundational historiographical problems, took place within a context characterized by the impressive scholarship produced by a continual increase in the number of scholars working in the history of science and technology, and also in the expanded range of themes to be studied. Relevant to this was an increase in funding, the establishment of new research centres, the availability of new academic positions, the consolidation of professional bodies, and the launching of many well-funded programs. Concomitantly, the proliferation of book series together with the access to a variety of new sources, and the implementation of a multitude of projects involving the digitalization of standard archival and bibliographical collections, all played a major role in defining the contours of the professional community of historians of science and the scope of the discipline.

During the same period major transformations took place in both the actual study and the institutional contexts of the history of science and technology in a number of countries of the European Periphery. On the whole, the developments which took place within the more established communities of historians of science and technology

have had their ‘analogue’ in the sites of the European Periphery. We have been active participants in these developments while, at the same time, we have been critically (re)assessing entrenched historiographical mentalities, ideologies of national grandeur which often dominated the choice of themes and their subsequent discussions, as well as the rhetoric of modernization which over the last decade has been the prevailing discourse which precipitated in most of the ensuing institutional reforms.

In this paper, we examine a number of issues related to our attempts at problematizing “Science and Technology in the European Periphery, from the Scientific Revolution to the 20th century”. The concept of “centre and periphery” has been employed in the history of science with different meanings and purposes, but not always clarified nor differentiated. Geographical centres and their peripheries have often been established on the basis of the cultural, economic or political predominance of the former and the subsidiary role of the latter. We think that the deterministic and static overtones of the idea of “centre and periphery” have to be questioned as well as other implicit ideas associated with the transit of scientific knowledge from one region to another. In our paper, we shall revise the different meanings of “centre and periphery” and discuss the historical images that commonly shape the study of the scientific activity in contexts regarded as peripheries, having specifically in mind their consequences when addressing “Science and technology in the European Periphery”.

In doing so, we shall try to articulate the significance of the processes of appropriation of scientific ideas, practices and techniques through the multifarious (local) cultural processes, to bring to surface the specificities of local sites which have had a decisive role in knowledge production, and to underline the decisive *active* role of all those whose intellectual, professional and, often, political interventions shaped the processes of appropriation. Furthermore, we hope to be able to raise a number of issues, which follow organically from such an approach and whose systematic examination could not be carried out within a historiography which regards the introduction of the scientific and technological ideas and practices from the centre(s) as *merely* a process of transmission. We will show the rather restricted possibilities provided by such an historiography of transmission, whose only interpretative challenge is to understand how the locals adapt to the exigencies of what is “imported” and which is, invariably, considered as “new” and “progressive”. Thus our context is that of the *active receiver*, which entails a shift from the point of view of *what has been transmitted* to the view of *how, what was received has been appropriated*.

First, we briefly analyse the received view about science and technology in European periphery. Then, we discuss some images concerning the relationship between centre and periphery that are conveyed in the great majority of works. Afterwards, we point to the various difficulties which have hampered a systematic study of the sciences and technology in the European periphery. In the second section and in the conclusions, we attempt to articulate our differences from most of the existing scholarship, by arguing in favour of shifting the emphasis on three methodological/historiographical issues: from transmission to appropriation, from the perspective of the centre to the perspective of the periphery, from the isolated study of the periphery

to the comparative assessment of developments. In the third section three different groups of examples are discussed: circulation of knowledge, communicating science and technology, and popularization of science and technology.¹

THE 'CENTRE-PERIPHERY' QUESTION IN THE HISTORIOGRAPHY OF SCIENCE

Centre and periphery are concepts which have been employed in various social sciences, with particular emphasis in economy. The terms were largely used by development economists in the 1950s and 1960s. They played an important role in Immanuel Wallerstein's model of world economy and the rise of capitalism and in various Marxist analyses of imperialism. The concepts appeared, for example, in an economic survey of Europe prepared by the United Nations.² In many studies, the centre/periphery approach involves assumed images and preconceptions: it depicts the differences in economic and political structures between the industrialized countries and the rest of the world; it considers the countries of the centre as the suppliers of capital and technology, while at the same time they also functioned as providers of tourists and absorbers of migration; it regards the peripheral countries to be mainly producers of primary resources; it emphasizes that the critical decisions pertaining to the economic prospects of the periphery have been taken in, or strongly influenced by the interests of the centre; it agrees that the lack of local innovation have forced peripheries to become importers of "new products, new technologies, new ideas" which emanated from the centres and were transferred to the periphery; finally, it argues that the success of the enterprise is strongly dependent on having as dominant political forces, those whose economic and ideological aspirations mimic their counterparts in the countries of the centre.³

Undoubtedly the dipole centre/periphery has been quite suggestive in economics, political science, and sociology. Much of the scholarship in colonial studies and in "transmission studies" concerning the introduction of the sciences and technology in the countries far away from the centres, has brought out a mass of new information and given interesting results. The bipolar distinction between centre and periphery has proved itself useful, but incapable of capturing many salient features of such a dipole. For example, often there are centres and peripheries, depending on the subject one is discussing, which can be both centre and periphery; over time, a centre may change into a periphery, and vice-versa. Finally, a single country may contain both centres and peripheries, thereby making purely national distinctions of dubious use. Despite such difficulties, such a division remains useful and suggestive, and we shall use it in this paper.

Centre and periphery have also been amply used by historians of science during the last decades.⁴ Works referring to the European periphery have appeared in mainstream journals and publications, while a huge and highly diversified second category of works has been produced by scientists or historians from the periphery in their local languages, aiming almost exclusively at audiences in the periphery.⁵ The number of publications on national history of science and technology is huge and expresses a wide spectrum of historical approaches, philosophical views, ideological orientations

and political commitments in the historiography of science. Over the years different writers (scientists, philosophers, historians, etc.) have written on this topic with different purposes and for different audiences. Some national histories were written to promote national self-esteem; in others, writers aimed to gain support for their professions or to attract young people to become interested in a career in science; often authors preferred narrow and internal disciplinary histories while others embedded their narrative of national science in more general accounts on the history of literature, technology and culture. The focus of much of this scholarship has been on the attitudes adopted by the (local) scholars when they come to deal with the new scientific ideas and practices which were imported into their local cultural environment. A large number of studies regarded the scientific ideas and practices as entities, which moved from one place to another as if they were material commodities. The notions of ‘transfer’, ‘spread’, and ‘transmission’ referred to the same object: ideas and practices which had been formulated and validated in the place of their production and, then, delivered to the rest of the world. Despite important differences and nuances in the use of these categories by the various authors, they all concur with the notion that the role of local scholars did not transcend the ‘faithful’ reproduction of what was received. There have also been historians who put great emphasis on the specific dimensions conveyed to their societies through scientific activity: science considered as a moral value and as a social prototype where technical details do not matter. The lesson to be conveyed is that the local scholars were able to conceive the emancipating message of modern science and to spread this message by means of a scientifically weak but ideologically robust campaign in favour of the new spirit.⁶

There are two areas in particular — reception studies and colonial studies — which have had some overlap with what we are attempting to do here; yet our undertaking is different in some fundamental ways. Reception studies are usually associated with literature, art and aesthetics and they deal with the analysis of the different reactions by the different publics in different localities. They point to the importance of receivers and their varied responses to what is being received. Not infrequently, reception is also used in the history of science.⁷ Some reception studies black-box science, focus mainly on the factors that affect the course of a more or less established science in the periphery, and examine only the alterations this science underwent in order to overcome the various constraints posed by particular environments. Various studies on transmission of science have focused on the reception of famous scientific theories, i.e., how the important scientific ideas (almost always produced by geniuses) were transmitted and accepted by the scientific community. How was Harvey’s work on the circulation of blood introduced in seventeenth-century Spain? Were early-modern Portuguese astronomers aware of Copernicus’s heliocentric theory? What books introduced Newtonian mechanics into the Greek educational system? Works which attempt to answer these questions are complemented by others where the subject matter has been Lavoisier’s chemistry, Darwin’s biology, Einstein’s relativity, etc. In the great majority of these works, what is at stake is the “intactness” of the transmitted ideas, the extent of the *faithful* reproduction of the “original” ideas. These

studies attempt to examine issues as to how faithfully the new scientific ideas (and sometimes practices) were transferred from their birthplace to the receiving environment, by enumerating the misconceptions which started to dominate as a result of the resistance by local conservative scholars and by presenting the characteristics of the enlightened local scholars who believed in the truth of science and fought to replace the existing beliefs with the new “positive” knowledge. On the whole, most of what is presented in these works is the eclectic nature of the transmitted knowledge, and the resistance by conservatives counterbalanced by the persistent efforts of the widely travelled and sometimes well-connected enlightened local scholars. The emerging picture is that of peripheries far away from the centres, whose needs oblige them to import new ideas, techniques and instruments in rather unsystematic and haphazard manners, whose conservatives are threatened by what is coming from the centres, and whose enlightened scholars are the bearers of whatever new and radical is happening in the centres. Few, if any, of these writers historicize the notion of ‘needs’, not to mention the ease with which they characterize protagonists as conservative or progressive.

More specifically, most of the historical works produced in or referring to the countries of the European periphery which examine issues concerning the introduction of modern science during the eighteenth century, move about a dipole. Each pole has been populated by groups of historians whose historiographical choices and interpretative attempts brought about tensions with somewhat ideological and nationalistic undertones. One group with strong attachment to the historiography of transmission studies for the European periphery would claim that the history of science in the eighteenth and nineteenth centuries is in effect the history of all those who had become the bearers of Enlightenment in their respective societies. These individuals are considered as the protagonists of the dissemination of natural philosophy, since these (enlightened) individuals were, literally, the bearers of Enlightenment.⁸ This group of historians whose work is woven around the themes of the ever-increasing phase difference between what was happening in the (developed) centre and their own (underdeveloped) periphery, have been challenged by a second group of authors who tried to argue that there had, indeed, been local scholars who introduced aspects of natural philosophy earlier than most people thought, and that society, as a whole, showed a degree of receptivity not properly appreciated by many of those who examine these themes. Often, the work of this group of historians who championed the causes of the unsung heroes, has been woven around themes of a rather glorious national past underplayed by many historians belonging to the first group, whose almost unconditional admiration of the centres — as has been claimed by the latter group of historians — has disguised important local ‘firsts’. The local ideologues of Westernization have been repeatedly accused for belittling local achievements, while those who accused them are incriminated by the former for underestimating the multifarious dynamics of Enlightenment. The former characterization is unavoidably schematic, but it is by no means dismissive. This scholarship has unveiled an invaluable amount of information, unearthed new archival material, examined themes

surrounding the sciences which have been traditionally snubbed by many historians, produced many biographies of little-known scholars, and initiated discussions which helped to further underline the significance of history of science and technology in the countries of the European periphery. Most importantly, this scholarship made a new generation of historians of science particularly sensitive to the constraints and limitations of such an historiography of transmission and, at the same time, forced them to re-examine these issues within the context of the *problématique* of the historiography of Enlightenment which in the last forty years has produced a number of emblematic works.⁹

“Colonial studies” is another blossoming area which has experienced deep changes since George Basalla published his famous paper on “The spread of Western science”.¹⁰ In this paper, Basalla suggested a three-stage model describing the introduction of modern science into any non-European nation. During “phase 1”, “the nonscientific society” became a source for European science (natural history, geography, astronomy, etc.). “Phase 2” is marked by a period of colonial science, characterized by its dependence on the institutions and traditions of the centre and the emergence of “colonial science” by means of those whose training, institutional setting and research interests are largely shaped by the culture of scientific centres. Finally, during “phase 3” the process of transference of modern science ends with “a struggle to achieve an independent scientific tradition”,¹¹ which implies deep changes: the overcoming of “resistance to science on the basis of philosophical and religious beliefs”,¹² the social approval of the role and place of the scientists (including funding and encouragement by the government), the development of scientific education and native scientific organizations, etc. The model, which was conceived as “a heuristic device” useful in facilitating a discussion on colonial science, then “a neglected topic in the history of science”,¹³ has encouraged various studies and empirical work. However, it is now clear that Basalla’s model has proved to be defective in many issues. During the last decades, new studies have re-evaluated the standard premises and suggested new and promising inroads into the study of colonial science.¹⁴ Some researchers have argued convincingly that what should be emphasized is the epistemologically active role of the colonies as well as the dynamic interaction between metropolis and colonies in the exchange of scientific knowledge.¹⁵ In this respect, there are many aspects in common with the study of European peripheries: colonies and peripheries should be analysed as epistemologically active; knowledge not only dynamically circulates among metropolis and colonies, but also among centres and peripheries in Europe; and last but not least, as the scholarship in neo-colonial and subaltern studies has clearly shown in the last decades, metropolis and centres have imposed an hegemonic historiographical view on colonies and peripheries.¹⁶ Therefore, new questions and new sensibilities, much closer to the view of “science from below”, appear to be progressively applied to the study of colonies and also — why not? — to the European peripheries.

But such common perceptions cannot overshadow the structural differences between colonial studies and those about the European periphery. The study of the

sciences in the colonies presupposes a centre, in fact a well-structured centre, be it an empire or a colonial state. Many colonial features, including scientific practices and institutions, are generally subjugated to the political and ideological objectives of the ruling groups of the centre and their direct representatives in the colonies. The political relations between countries of the centre and those of the European periphery are usually different from the analogous relations of the colonies. These differences are even more pronounced when concerning the military presence and the structures of the police forces. In the colonies, there is a wide chasm between the cultural affinities of the ruling élite and those of the rest of the population, something which is not valid at all in the case of the European periphery. The structure of the political institutions of the colonies and the role of education and of scholars is dramatically different from those of the European periphery. Notwithstanding cases of scholars in the colonies with a relative autonomy with respect to the main political and ideological aspirations of colonial powers, the whole enterprise of scientific practices and technical innovations is within the well-defined context of colonial politics. Various scholars in the European periphery regard the sciences and technical innovations as an integral part of their local political, ideological, educational and even religious agendas. What eventually dominates is the result of the confluence of these agendas, of a synthesis of local cultural trends, often through procedures where gentlemanly persuasion is accompanied by violent deeds, and consensual (institutional) arrangements go hand in hand with undemocratic outbursts.

TRANSMISSION V. APPROPRIATION

Studies on science in the periphery have often employed the notions of “transfer”, “spread”, “influence”, “transmission”, “introduction”, “resistance” and “adoption”. These concepts imply a particular model for the circulation of knowledge: after being formulated in the centres, those who use these concepts consider scientific knowledge as a kind of commodity, which can be distributed by means of various intellectual networks. As a result, scientific centres and peripheries are defined on the basis of the *separation* of production from distribution and use of scientific knowledge. Ideas and techniques may not all have been transmitted in a manner which preserved their original form and full content in the centres, but what was transmitted looked very much like what was its form in the centres. Local scholars were no more than local agents who introduced (and most often fought hard for) the commodities produced in far away places. In such an approach, however, there is no room to deal with another, perhaps decisive aspect of the transmission of knowledge: that ideas and techniques are, more often than not, transformed in unexpected and sometimes startling ways when introduced in a different social and educational context. This is the reason why we prefer to reorient the discussion of all the issues related to the transmission of ideas and techniques from the centres to the European periphery in terms of their *appropriation* by the multifarious cultural traditions of a specific local site during a particular period of its history through the conscious strategies devised by local scholars.¹⁷

A historiography of appropriation allows us to examine systematically the particular forms of the fusion of aspects of the science and technology with local traditions, and the specific forms of resistance encountered by these new ideas and techniques; the extent to which such expressions and resistances displayed local characteristics; the procedures through which the new ways of dealing with nature were made legitimate; the commonalities and differences between methods developed by scholars at the periphery for handling these issues and those of their colleagues in the central countries of Western Europe; the role of new scientific ideas, texts and popular scientific writings in forming the rhetoric of modernization and national identity; the prevailing mode of scientific discourse among local scholars; the relation between political power and scientific culture; the social agendas, educational policies and (in certain loci) the research policies of scientists and scholars; the shifts in ideological and political allegiances brought about as the landscape of social hierarchy changed; the consensus and tensions as disciplinary boundaries formed, especially as reflected in the establishment of new university chairs; and the ideological undertones of the disputes, and their cognitive content. As a result, what emerges from this is a richer and more complex picture of how science and technology were integrated in the European Periphery.

Emphasis on appropriation obliges one to examine the dynamics and the conditions under which the emergence of legitimizing spaces for the new ideas and practices become possible.¹⁸ The problem is relatively simple in cases where we are confronted with well-discerned and clearly defined spaces such as universities, academies, museums, and cafés. But in many instances in the countries of the periphery, one may not be able even to find such spaces. So, where shall we direct our attention? Understanding the formation of such legitimizing spaces cannot be achieved independently from understanding the ways resistance has been expressed. Resistance is expressed because there is something at stake, be it cognitive, ideological, or political, and also because spaces already legitimized in the knowledge producing process, feel the threat of invasion. Thus, the emergence of specific sites as legitimizing spaces is closely associated with the character of the resistance to the new ideas and techniques and the ways such resistance is counteracted. Furthermore, the exclusive emphasis on understanding the formation and function of social institutions such as, for example, patronage and the academies, is inadequate in understanding the processes of appropriation. In some cases, peripheral societies lack these institutions, and, as we will show in the third part of this paper, scientific travels or teaching and popularizing science became a major source of legitimization for peripheral scientists. The lack of an institutional framework where the activities involving the dissemination of science and technology would be under continuous scrutiny made often ideological, social, and political considerations the dominant criteria for the realization of scholars' aspirations. Thus, in trying to discern the emergence of the multiple spaces of appropriation, or equivalently, in bringing out the multiplicity of legitimizing spaces, professional strategies and personal agendas become inescapably significant dimensions of these studies. Furthermore, one can

discern among scholars a spectrum of multiple practices of appropriation, such as the management of novelties; the attempts to incorporate science in the rhetoric of modernization; the ways to make the new ideas become coherent with local educational values, philosophical beliefs and religious traditions; the efforts to articulate and, subsequently, meet local utilitarian needs; the aims of popularization; and the kind of relations resulting from patronage, travels and networking. The appropriation of scientific ideas and practices in the periphery is, above all, a knowledge-producing process. It is a process which helps us comprehend the particularities (and often the idiosyncratic characteristics) of a number of discourses developed by local scholars. In the following paragraphs, we shall analyse the practices of appropriation by paying attention to three issues: the circulation of knowledge and scientific travels, textbooks and scientific teaching, and the popularization of science.

APPROPRIATING SCIENCE AND TECHNOLOGY IN THE EUROPEAN PERIPHERY

1. *Circulation of Knowledge*

It has been argued that during the past decades the emphasis on the local, that is, on “science in context”, has obliterated the concern for circulation, that is, for “knowledge in transit”, despite the implicit assumption that science travels.¹⁹ Circulation of knowledge has been taken as a kind of mediating process, from the local to the global, or from a multiple, varied and contingent knowledge to universal knowledge. The circulation of ideas and practices, depending first and foremost on people, is a fundamental component in the consolidation of scientific and technological cultures.²⁰ Whether correspondence, books, manuscripts, or instruments are exchanged, people are either directly or indirectly involved in this process. In all instances, travel becomes a particularly decisive means of fostering communication between sites, which are specific nodes in more or less extended networks. Despite a multitude of historical studies on scientific and technological travelling, only a few have addressed travels involving people from the European peripheries. In this context, travelling can not only be used to help in clarifying the processes of appropriation of scientific ideas, instruments, practices and of technological expertise, but it can also assess similarities and differences in the perceptions of science and technology in some countries of the European peripheries. Thus, travel becomes a conceptual tool to disclose the aspects of the dynamics of science and technology which are often dismissed in the literature of the history of science and technology.²¹

In general, most travellers perceived their target destinations as centres, and their travels were then the means of getting acquainted with the tools of modernization, and of striving to eliminate scientific and technological asymmetries. However, this relationship should be considered as bi-directional: scholars from the periphery chose to be influenced by scholars from the centre, even though “peripheral” agents also influenced the “central” characters in certain ways. Cultural contingencies and social variability acted as constraints to be taken into consideration in the articulation of the

types of discourses produced by historical actors. Thus the concept of networking emerges as an alternative to the opposing concepts usually taken for granted such as centres and peripheries. Networks are extended, more or less hierarchical and fluid structures, which represent the mediation of ideas, practices and instruments in between more or less faraway nodes, with their relative importance evolving dynamically in time. Nodes may represent individuals or instruments or structures such as institutions, thus, travelling may be regarded as a particularly interesting means of fostering communication between nodes.

Throughout the ages, travel has had different aims and purposes. For instance, during the eighteenth century, scholars and men of science travelling from the European peripheries to the centres sought to participate in the Republic of Letters. Such was the case of the Portuguese *estrangeirado* Correia da Serra, who after spending his youth in Italy, returned to Portugal but soon after travelled to England and France, in order to look for congenial intellectual environments in which his botanical ideas could flourish.²² On the contrary, Greek scholars of the eighteenth century who lived in the Ottoman Empire, did not actually travel “abroad”, but they visited places inhabited by Greek-speaking populations or Greek communities, extending from Macedonia to Padua and from Venice to Leipzig. It appears that many of them were interested in participating in the many discussions focused around a number of fundamental issues of what came to be known as Newtonianism.²³

The nineteenth century re-contextualized the idea of travel in the framework of a growing professionalization and specialization in the sciences. Travelling, like travellers, was reshaped, and evolved into a more professional and specialized endeavour. Such was the case of the travels of the Catalan textile workers, which were funded by the Catalan Trade Board, the Spanish Junta General de Comercio y Moneda, or by private firms. They headed mainly towards France where historical agents aimed at learning new skills of their trade.²⁴ Travellers had various motives, which influenced the choices made during their journeys as well as the results they obtained. In some cases, they were part of an institutional framework or were sponsored by different types of institutions; in others they travelled by their own initiative and at their own expense, including the cases in which there were simply no local organized structures supporting their wanderings. While the Spanish *pensionados* travelled abroad sponsored by private, local or national institutions, having well-defined targets, the Portuguese *estrangeirados* were seldom sponsored by state or official institutions and never funded by private ones.²⁵

As far as results are concerned, institutionally financed travels resulted in official reports, which, however, had varied impacts depending on the characteristics of the recipient culture. In some cases these reports provided the basis for the implementation of new policies and economic initiatives; in others their impact was reduced despite the efforts of local élites willing to promote change.²⁶ After the last quarter of the nineteenth century, scientists who eventually acquired university positions travelled extensively. Many acquired their specialties in prestigious centres, and used their contacts to send their associates and students there. Of immense importance were

the various attempts to establish new disciplines in the peripheries, at universities or outside. Especially in the case of the social sciences and humanities, where none of the initiatives unfolded without intense reactions, there were initially attempts to “copy the centre” which eventually evolved into more intricate and amazingly varied strategies of legitimating and establishing the new disciplines. The presence of prestigious scholars from the centre, the emphasis on the publication through the translations of standard books, teaching rather than research, and the study of local themes which were politically and ideologically uncontroversial, were some of the means used for the further entrenchment of the new disciplines.²⁷

2. Communicating Science and Technology

Most existing scholarship elaborates on a particular typology of the scholar-scientist of the periphery: compared to colleagues in the centre who create knowledge, the latter is perceived primarily as an agent whose role is to communicate “ready knowledge” received from the centres through popularization and/or education. Such an approach exists in the antipodes of what we wish to convey in this paper. Scientific teaching in the peripheries cannot be considered as an act of passive transmission of knowledge, but as one of the instances in which scientific knowledge is appropriated. Moreover, since in various European localities there has never been a Newton, nor a Lavoisier, nor a Darwin, the everyday task of science teachers and professors has been particularly relevant in the communication of science. Furthermore, the educational agenda of scholars played a rather decisive role, since the appropriation of the sciences was almost exclusively carried out within educational institutions and often in reference to the issues pertaining to education. Such a variance with respect to the norms of the European centres has often been ascribed to an uneven scientific competence, or a “watering down” of science at the periphery. Such an interpretation is rather difficult to be argued for, if one’s context is the “receiving culture”, instead of an approach that is almost wholly determined by an exclusive emphasis on the notion of transmission.

The focus on teaching practices in the scientific peripheries can shed light on how skills and material culture are transferred and appropriated in both the experimental and the theoretical sciences. Teachers and students are active agents in creating scientific knowledge, and teaching becomes a multidirectional activity that implies a strong interaction of all participants. Scientific teaching, much like in the centres, is an activity located at the intersection between scientific knowledge and pedagogical views that have always come under strong social, political, and ideological pressures.²⁸ Scientific education encourages the circulation of knowledge not only among individuals and groups of the same society, but also from one geographical context to another. When moving from centre to periphery (or from periphery to centre), textbooks and other pedagogical resources are introduced in new social, political and ideological contexts, so that practices of adaptation and transformation are commonly developed to fit them to new settings. When scientific ideas through educational models are introduced and appropriated in the periphery, it is often the

case that local actors reinvent them, bringing to the fore the non-linear interactions between the different forces and historical actors who participate in the moulding of scientific education.

Scientific textbooks can offer hints about this intricate space, because they are located in a crucial crossroads among the multiple and diverse factors and actors that shape educational practices. Authors with particular backgrounds write scientific textbooks which are produced by printers using different technological means and sold by publishers and booksellers in specific technical, economic and commercial contexts. Moreover, textbooks are read and used by a great variety of audiences with different aims, expectations and reading practices. By analysing this particular variety of historical actors, and paying attention to a broad range of almost unknown sources, one can examine issues which would be rather difficult to study otherwise: the different and selective appropriation of scientific novelties in educational practices; the topography of scientific disciplines; their changing identities and interrelationships; the emergence of research schools in the periphery; the role of translators and the consequences of translations; the images and didactical uses of experiments and paper tools in classrooms; and the configuration of genres of scientific literature in the periphery.²⁹

Textbooks are also closely associated with the emergence and consolidation of scientific disciplines since they serve to stabilize shared knowledge and practices in a research field. Textbooks are uncontroversial vehicles of “normal science” and they “define the legitimate problems and methods of a research field”.³⁰ Historians of science, on the whole, agree with this view. Of course, the identity of a scientific discipline is far from being static — it is frequently defined (and redefined) through research articles and popular treatises, public lectures and textbooks. But the formation of the identity of disciplines is also influenced by the adopted pedagogical methods and the translation of textbooks. In this context, local teachers and audiences played an often unacknowledged but rather important role in legitimizing the cognitive autonomy and, at times, the institutional expression of the new disciplines. The study of textbooks in the scientific periphery provides us with clues about the changing relationship between disciplines such as physics and chemistry, biology and medicine, astronomy and mathematics, or the emergence of new fields such as biochemistry, molecular biology, and quantum chemistry. Furthermore, the analysis of textbooks can unveil how scientific communities perceive “scientific revolutions” and how textbook writers accommodate the novelties in their pedagogical works.³¹

Some research schools have emerged alongside the use of new scientific instruments or new scientific practices. Studies on the scientific peripheries may provide new resources to examine the problems associated with the replication of experiments, the standardization of measures, new scientific instruments, or the spread of new instruments, scientific models and paper tools. The analysis of how “tacit knowledge” circulates in the scientific periphery or how communication networks are established in peripheral communities underlines the role of the spread of new instruments, and the emergence of unforeseen new uses and meanings that are created in the contexts

of appropriation. The new uses of scientific instruments in the periphery are generally moulded within the social, political and intellectual contexts in which they are appropriated, as well as by the pedagogical setting in which the new device, model or diagram is taught to a new generation of scholars.³²

Textbooks and pedagogical practices are also ingredients in the emergence of research schools in the scientific periphery. One of the key processes in forming a research school is by the transfer of theoretical and practical knowledge from a master to a pupil. Higher education centres provide shared curricula and training programs which produce common styles of thinking or similar experimental skills for a large group of students. The development of research schools also depended on other forms of the transmission of scientific knowledge, such as an apprenticeship with older and charismatic scientists, the collaboration with colleagues, departmental seminars, or informal discussions at the laboratory bench. In this sense, local textbooks and peripheral teaching institutions might contribute to the emergence of a peculiar culture of precision or a common *ouillage mentale*. The study of research schools in the scientific periphery can bring into the forefront a bulk of forgotten autobiographical documents (lecture notes, familiar letters and other sources) and provide a more multifaceted picture, for example, of how local educational settings produced particular subcultures of scientific practice.³³

Many historians nowadays acknowledge that the practices of translation are frequent not only in the periphery, but also in the scientific centres. In the European periphery, translations comprise a substantial part of the process of production of scientific books. In many histories of the sciences, the study of translation is employed, if at all, as a bibliometric indicator of the success of a book. The interventionist role of translators has been largely neglected in spite of the evident and substantial changes they often introduce in the books. By introducing notes, additions and new titles and structures, translators have played a significant role in forming the identities of popular books. These changes and amendments often offer data about their intended audiences and, perhaps, help us understand why some translations have become best-sellers with multiple editions in a local context, while the same books intended for the same type of audience had a totally different trajectory in different settings. The changes of meaning and the processes of cultural relocation associated with translations have rarely been taken into account by historians of science who study the sciences in the European periphery. Studies on translation offer information about *who translated what* and *for whom, when* and *why*. The study of these issues can only help to articulate the multiple and constrained creativity of translators, the different types of translators (casual, erudite, professional, vocational, conjectural, etc.) and their different views about what must be regarded as a “good translation”.³⁴

Textbooks are examples of a genre of scientific literature, thus their writing implies assumptions and (more or less) stable conventions, which are shared by readers, publishers and authors about what is (and what should be) a textbook. These assumptions and conventions are, however, locally dependent and change over time. For example, eighteenth-century textbooks might not be easily distinguishable from encyclopaedias

and popular science books.³⁵ Historical actors always negotiate boundaries separating genres and conventions, so their salient characteristics are locally and historically dependent. The study of scientific journals, dictionaries, encyclopaedias, popular science books, textbooks, etc. in the scientific periphery can offer new insights on the emergence of new literary genres in science and their relationships, changes and redefinitions over time and from one place to another.

3. *Popularization of Science and Technology*

Recent discussions concerning the historiography of popularization have shown the ambiguities of the concept of popularization. More flexible concepts, such as “science communication strategies”, “knowledge in transit” or “expository science” have been suggested as possible alternatives.³⁶ It has been convincingly argued that the practices and sites of popularization can tell us a lot about the particularities of specific local contexts, and they should be carefully analysed in case studies of the European periphery.³⁷ Are there international strategies of popularization — exhibitions, theatres, popular magazines, books — which acted historically as standard patterns everywhere, or perhaps were any of these practices “different” in any specific local contexts? For instance, how can we compare — in terms of science and technology — international exhibitions such as those of London, Cork, Copenhagen and Lisbon? Was the Urania scientific theatre the same in Berlin as in Budapest? Were Flammarion’s books appropriated in the same manner when published in different peripheral countries? And once in a specific peripheral context, how did the different social classes appropriate these popular scientific products?³⁸

Furthermore, teaching and popularization practices in the periphery are excellent examples of knowledge in transit and they tell us a lot about the features of a specific local context. The study of these processes includes the study of the local actors involved in teaching and popularizing science, their international connections and the character of their particular enterprise in the periphery. In many cases, their teaching and popularizing activities were closely connected. The criteria for choosing a scientific subject to be popularized in conjunction with strategies and agendas of publishers and booksellers and the implicit epistemological attitudes of the intended audiences provide interesting insights for reconstructing specific practices of appropriation. The study of these issues has recently become possible due to the voluminous primary sources devoted to popular science that can be found in any archive, library or antiquarian bookshops in the periphery.³⁹

Two short comments about the popularization of science and technology in the European periphery are in order. First, the dominating presence of amateurs. Local scholars who were considered as professionals — medical doctors in the eighteenth century, or chemistry and physics university professors in the nineteenth — devoted part of their efforts to establishing close collaborations with local amateurs, even in the twentieth century. In turn, amateurs often established specific alliances with emerging professionals. This also applies to what was considered as a scientific periodical in the periphery, which had a rather ambiguous role, it often being in

the fringes between popular and expert knowledge. Secondly, popular science was often used by local scholars in order to draw a strategy of professionalization or legitimization of specific theories and viewpoints, and even disciplines. Under the banner of the utilitarian virtues of science to be applied to arts and manufactures, academies, agricultural societies, libraries, and clubs used to organize frequent open sessions that gathered a large range of audiences, and the speakers did not draw a clear distinction between expert and lay accounts. In this sense, popular science was a significant part of the rhetoric of modernity. However, in some cases, the tension between useful science *versus* science for leisure seems to be at the heart of many controversies, and perhaps the strong emphasis on utility made the public image of science particularly vulnerable in the periphery.⁴⁰

CONCLUSIONS: EUROPEAN PERIPHERY AS A PERSPECTIVE

In discussing a number of issues revolving around science and technology in the European periphery, we have shown the inherent historiographical limitations of two of the main presuppositions most widely used by the great majority of those who have studied these problems: that ideas and practices were *transmitted* from the centre to the periphery, and that such transmissions took place from an “active” community of scholars in the centre to the “passive” receivers of the periphery. If we were to talk in terms of the ultimate aim of our paper, this would be to move away from thinking in terms of dipoles, which are implicit in the common usage of the centre–periphery dichotomy. All the more so, since there certainly are value judgements intrinsic to the dipole itself. Such values may imply that what is happening in the centre is “better”, “superior”, or even “progressive”. These are highly problematic values, which may be trapping us into methodologies and historiographical choices, leading to deadlocks and vicious circles. If intrinsic to the specific model of centre and periphery are some value judgements, and if these judgements are quite decisive in forming aspects of the methodologies we develop for the study of these issues, then, perhaps, these methodologies have limitations which may not allow the systematic treatment of a number of questions.

One becomes conscious of a much richer and, certainly, less naïve picture of the science and technology at the European Periphery, if, as we have argued in this paper, one studies these problems from the point of view of a locality whose *active* scholars have been articulating *strategies of appropriation* of ideas and practices. The regions of the European Periphery do not appear to be the receivers of the watered down versions of what was created in the centres, nor were they inhabited by some kind of idiosyncratic automatons who would follow instructions of what to do with the received ideas and technologies. Simply put, the establishment of new ideas, theories and practices was not only the result of overcoming local resistances, but, more importantly, these were adopted and appropriated within local cultural, ideological and political frameworks, and often expressed through discourses containing a number of novelties.

In order to study these strategies of appropriation and the ensuing practices,

historians have to pay more attention to cultural affinities, dispositions for adoption, and resistances. In many cases, local scholars formed their discourses by trying to comprehend such affinities of their local culture for the new ideas, worldviews and even techniques. They did their best to take advantage of social and cultural dispositions for adoption, and in equally significant manners, they tried to take into account the potent proclivities to resistance, ever present as part of the very same society and culture which instantiate the dispositions for adoption. While forming their discourses, local scholars were particularly sensitive to the kinds of resistances they will meet, and hence, such potentialities had to be taken care of by these scholars before making public what they were attempting to do. Hence, potent proclivities rather than actual resistances turned out to be quite decisive in forming discourses.

The previous discussion shows that the concepts of “centre and periphery” convey different meanings: geographical, cultural, economic, political, etc. We have argued that the use of the geographical image alone conveys a static and deterministic idea of the issues discussed in the paper. However, European periphery and centres involve dynamic relationships, whose main features can substantially change, so sites regarded as periphery in the past can be perceived as centres in the future. Moreover, European Periphery is more than a geographical and cultural context: European Periphery is also an *historiographical standpoint*. Starting from the periphery (or, better, *standing* on the periphery) might offer a clearer view over the intricate ideological constructs which accompany the establishment of science and technology, and at the same time, unveil the socio-political dimensions of the sciences in the European periphery. It is often the case that what appears as a coherent whole of ideas or well articulated practices when it is seen from the point of view of the centre, is entirely disassembled when it reaches the European periphery and becomes an issue of intense philosophical and political debate. In the European periphery, an “imported” framework of ideas and practices does not necessarily bring about the consensual stability that had been achieved in the centre. Quite the contrary: what is introduced can produce rather dynamic instabilities, which entail the possibility of examining these processes in terms of appropriation rather than of transmission. Within this approach, a large amount of unexplored sources can be analysed through the study of the means and modalities of appropriation, thereby shedding light and enriching current historiography of science. In particular, studies focusing on travels, forms of scientific practice and teaching, scientific controversies and on ways of communicating science in the European periphery, have raised interesting questions, and provided clues to the re-examination of historical and historiographical issues. These sources when analysed from the perspective of appropriation constitute an additional resource available to the historian of science interested in understanding the cultural relevance of science to society in multiple contexts and different historical periods.

It should also be stated that in examining the sciences and technology in the European periphery, our long-term aim, notwithstanding serious asymmetries among the different peripheries, is to try to articulate the various similarities which might help us in the conceptualization of the notion of European Periphery which would transcend

the centre–periphery dipole.⁴¹ Of considerable weight in such an approach has been the emphasis on the political rather than the social in the criteria for choosing to appropriate a particular theory or practice; of the personal networking (as opposed to institutional backing); of the immediate applications (as a kind of quick-fix); of the fluidity of institutional structures; of the blurring of dichotomies (the same individual performing different tasks usually associated with the scientist, teacher or popularizer); and of the rhetoric of modernization. These considerations have been as valid for Enlightenment as for the Industrial Revolution, and for incidents in the nineteenth and twentieth centuries. By raising such issues, while using analytical tools and historiographical concepts stemming from mainstream international historiography of science, we hope to be able to (re-)examine some old themes, to pose new questions, and enrich the hegemonic historical accounts, traditionally being articulated with the model of centre and periphery and at the same time to critically challenge these accounts.

It should, finally, be mentioned that our enterprise has a quasi-political purpose. Greece, Portugal and Spain have had long periods of undemocratic and dictatorial governments, and it is only within the last thirty years that social institutions have acquired the degree of stability characterizing modern European societies. Within this period the universities have gone through deep and lasting changes and the humanities and social sciences have been blooming to a degree that no one could have imagined a generation earlier. Though the distortions of the past still make their presence felt, at the same time a very large number of younger scholars are dynamically involved in the intricate procedures of drawing and consolidating disciplinary boundaries for many subject matters while defining the identity of the relevant scientific communities. Membership of the European Union has undoubtedly accelerated these processes, and at the same time, has put on the agenda all the complex issues resulting from the relationship of the local to the “European”. Between the uncritical Europeanization of everything so dear to the messiahs of the Unified Europe, and the ideology of those who react to such a spectre and entrench themselves in the dubious legitimacy of notions like the intrinsic incompatibility of the various localities in Europe, there is, we believe, a third way — with the danger of parochialism always looming large — and whose repercussions in the historiography of science and technology we attempted to outline in this paper.

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1. The discussion and conclusions of this paper are mostly grounded in our experience as members of the group STEP (Science and Technology in the European Periphery). STEP is a multi-national research group focused on the study of processes and models of circulation of scientific and technological knowledge between European centres and peripheries from the sixteenth to the twentieth century. STEP was founded in May 1999, in Barcelona, and gathers researchers and university teachers from Belgium, Denmark, Finland, Greece, Hungary, Italy, Portugal, Russia, Spain, Sweden, Turkey, etc. STEP organizes thematic meetings to be held biannually. Besides the foundational meeting in Barcelona, four more thematic meetings have taken place in Lisbon, Portugal (Scientific travels); Aegina, Greece (Scientific and technological textbooks); Aarhus, Denmark (Traditions and realities of national historiographies of science); and Mahon, Spain (Scientific and technological popularization in the European periphery). Many of the examples employed in this paper come from these meetings.
2. N. Despicht, "'Centre' and 'periphery' in Europe", in J. de Bandt, P. Mandi and D. Seers (eds), *European studies in development: New trends in European development studies* (London and Basingstoke, 1980), 38–41, p. 38.
3. P. Selwyn, "Some thoughts on cores and peripheries", in D. Seers, B. Schaffer and M. L. Kiljumen (eds), *Underdeveloped Europe: Studies in core-periphery relations* (Hassocks, 1979), 37–39; and Edward Shils, *Centre and periphery: Essays in macrosociology* (Chicago and London, 1975). Shils argued that "Society has a centre.... The central zone, is not as such, a spatially located phenomenon.... Its centrality has, however, nothing to do with geometry and little with geography. The centre, or the central zone, is a phenomenon of the realm of values and beliefs" (p. 3). See the recent discussion by Peter Burke, "Centres and peripheries", in *History and social theory*, 2nd edn (Cambridge, 2005), 82–88. Other examples are the work on Portuguese economic history by Miriam Halpern Pereira, Villaverde Cabral, Jaime Reis and more recently sociologists such as Boaventura Sousa Santos, João Arriscado Nunes and Eduarda Gonçalves: they all presuppose and discuss different hierarchical spaces from centres to peripheries, semi-peripheries, and ultra-peripheries. See, for example: João Arriscado Nunes and Maria Eduarda Gonçalves (eds), *Enteados de Galileu? A semiperiferia no sistema mundial da ciência* (Porto, 2001); Boaventura de Sousa Santos (ed.), *Globalização: Fatalidade ou utopia?* (Porto, 2001). The idea of "semi-peripheries" has also been employed by other historians of science. See X. Polanco (ed.), *Naissance et développement de la science-monde: Production et reproduction des communautés scientifiques en Europe et en Amérique Latine* (Paris, 1990).
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5. For a review of this extensive historiography see R. G. A. Dolby, “The transmission of science”, *History of science*, xv (1977), 1–43. For modern reviews see A. Lafuente, A. Elena and M. L. Ortega (eds), *Mundialización de la ciencia y cultura nacional* (Madrid, 1993). There is an important “bibliometric” literature revised by D. Edge, “Quantitative measures of communication in science: A critical review”, *History of science*, xvii (1979), 102–34. See, also, the analysis by Jorge Cañizares-Esquerro, “Iberian science in the Renaissance: Ignored how much longer?”, *Perspectives on science*, xii (2004), 86–124. Cañizares shows that the neglect of Iberian contributions to the Scientific Revolution goes back to the Protestant Reformation and the Enlightenment. He also offers an interesting review of the literature.
6. A special issue of the journal *Nuncius* devoted to national historiographies of science is now under preparation by a group of STEP members. It will cover ‘peripheral’ countries such as Greece, Portugal, and Spain, among others.
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10. G. Basalla, “The spread of Western science”, *Science*, clvi (1967), 611–22.
11. Basalla, *op. cit.* (ref. 10), 611.
12. Basalla, *op. cit.* (ref. 10), 617.
13. Basalla, *op. cit.* (ref. 10), 611.
14. See Lafuente *et al.* (eds), *op. cit.* (ref. 5), which includes, for instance, a paper by Roy McLeod discussing Basalla’s point of view: “The worldwide diffusion of science”, 735–7. It also includes a chapter by Basalla himself revisiting his famous paper: “The spread of Western science revisited”, 599–603. Main changes can be identified simply by going through the following books: Nathan Reingold and Marc Rothenberg (eds), *Scientific colonialism: A cross-cultural comparison* (Washington, DC, 1987); Roy McLeod and Deepak Kumar (eds), *Technology at the Raj: Western technology and technical transfers to India 1700–1947* (New Delhi, 1995); and Roy McLeod (ed.), *Nature and empire: Science and the colonial enterprise (Osiris, n.s., xv (2000))*.
15. “Looking back, the diffusionist perspective, the centre–periphery model, and the strong program

of imperial science have proved insufficiently accommodating to the sources and discoveries of recent research.” Cf. McLeod, *Nature and empire* (ref. 14), 5. Some of the new approaches cited by McLeod are: Anthony Padgen, *European encounters with the New World: From the Renaissance to Romanticism* (New Haven, 1993); P. Petitjean, C. Jami and A. M. Moulin (eds), *Science and empires: Historical studies about scientific development and European expansion* (Dordrecht, 1990); and Michel Patty, “Comparative history of modern science and the context of dependency”, *Science, technology and society*, iv (1999), 171–203. Another example is Robert Iliffe, “Foreign bodies: Travel, empire and the early Royal Society of London. Part 1: Englishmen on tour. Part 2: The land of experimental knowledge”, *Canadian journal of history*, xxxiii (1998), 357–85; xxxiv (1999), 24–50. For a recent review see “Focus: Colonial science”, *Isis*, xcvi (2005), 52–87, which includes introduction by Londa Schiebinger, “Forum introduction: The European colonial science complex”; and papers by Mark Harrison, “Science and the British empire”; Jorge Cañizares-Esguerra, “Iberian colonial science” (the paper focuses on Spain with scarce allusions to Portugal); Steven J. Harris, “Jesuit scientific activity in the overseas missions, 1540–1773”; and Michael A. Osborne, “Science and the French empire”. It is also the case that in what relates to technology the issues pertaining to innovation and reliable knowledge have to be taken into consideration in order to further elucidate the relationship between the (colonizing) centre and the (colonized) periphery.

16. This is a strong point in Edward W. Said, *Orientalism* (London, 1978 (1st English edn)), and also in Ranajit Guha, *History at the limit of world history* (New York, 2002). Guha is the leader of the subaltern studies group in India, which has notably contributed to the historiographical revision of colonial science. In his words: “The noise of world-history and its statist concerns has made historiography insensitive to the sighs and whispers of everyday life ... the events and sentiments which inform the prose of the world remain unacknowledged” (p. 73); “We [indigenous historians in India] work within the paradigm it [world-history] has constructed for us, therefore far too close and committed to it to realize the need for challenge and change” (p. 5). See also Dhruv Raina, *Images and contexts: The historiography of science and modernity in India* (Oxford, 2003); and David Arnold, “Europe, technology, and colonialism in the twentieth century”, *History and technology*, xxi (2005), 85–106.
17. While the concept of appropriation has been used in the history of science for many years (see for example A. I. Sabra, “The appropriation and subsequent naturalization of Greek science in medieval Islam: A preliminary statement”, *History of science*, xxv (1987), 223–43), we use the concept of appropriation in a novel way, firstly, when contrasting ‘appropriation’ with ‘transmission’, and, secondly, when studying the possibilities for using it for the sciences as a term denoting the “point of view of the receivers”, “the transformation of knowledge”, etc. On the other hand, the concept of appropriation and the notion of the active receiver has been around for a long time, in the history of art, literature, and anthropology. It has been extensively used to analyse the active role of the public in cultural phenomena of communication and reception by French authors such as M. Foucault, M. de Certeau, P. Ricoeur and R. Chartier. See especially Roger Chartier, “Culture as appropriation: Popular cultural uses in early modern France”, in Steven L. Kaplan (ed.), *Understanding popular culture: Europe from the Middle Ages to the nineteenth century* (Amsterdam, 1984), 229–53. In that context ‘popular culture’ might have some analogies with ‘periphery’ in terms of appropriation from below. For a recent overview, see Peter Burke, *History* (ref. 3), 101–4. In what relates to the uses of appropriation in art studies see M. Baxandall, *Patterns of intention: On the historical explanation of pictures* (New Haven, 1985), especially pp. 58–62. In order to stress the new perspective Baxandall lists a number of notions which can be used only within such a framework: “Draw on, resort to, avail oneself of, appropriate from, have recourse to, adapt, misunderstand, refer to, pick up, take on, engage with, react to, quote, differentiate oneself from, assimilate oneself to, align oneself with, copy, address, paraphrase, absorb, make a variation on, revive, continue, remodel, ape, modulate, travesty, parody, extract

from, distort, attend to, resist, simplify, reconstitute, elaborate on, develop, face up to, master, subvert, perpetuate, reduce, promote, respond to, transform, tackle ...” (p. 59).

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19. James E. Secord, “Knowledge in transit”, *Isis*, xlv (2004), 654–72; Norton Wise, “Keynote address”, introductory talk at *HoST Annual Workshop “The circulation of science and technology: Places, travels and landscapes”*, 5–6 June 2006, Lisbon, published as “What can circulation explain? The case of Helmholtz’s frog-drawing-machine in Berlin”, *HoST*, i (2007), 13–71, <http://www.johost.eu>. Many inspiring concepts (“centres of calculation”, “immutable mobiles”, etc.) were introduced by B. Latour in his famous *Science in action: How to follow scientists and engineers through society* (Cambridge, MA, 1987), although some, like “immutable mobiles” as “intact” objects that do not change in any transit, rest in stark contrast to our argument.
20. For the circulation of technology, and especially for the recent emphasis on the active role of users rather than innovators in the process of appropriation of technology, see David Edgerton, *The shock of the old: Technology and global history since 1900* (London, 2006); *idem*, “From innovation to use: Ten (eclectic) theses on the history of technology”, *History and technology*, xvi (1999), 1–26; *idem*, “Creole technologies and global histories: Rethinking how things travel in space and time”, *HoST*, i (2007), 73–110, <http://www.johost.eu>; and Nelly Oudshoorn and Trevor Pinch (eds), *How users matter: The co-construction of users and technologies* (Cambridge, MA, 2003).
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29. Bertomeu-Sánchez *et al.* (eds), *op. cit.* (ref. 28).
 30. T. S. Kuhn, *The structure of scientific revolutions*, 2nd edn (Chicago, 1970), 10. Besides Olesko, “Science pedagogy” (ref. 28), see also D. Kaiser (ed.), *Pedagogy and the practice of science: Historical and contemporary perspective* (Cambridge, 2005).
 31. See four case studies on the chemical revolution in the scientific periphery: Ana Carneiro, Maria Paula Diogo and Ana Simões, “Communicating the new chemistry in eighteenth-century Portugal: Seabra’s *Elementos de Chimica*”, in Bertomeu-Sánchez *et al.* (eds), *op. cit.* (ref. 28), 671–92; José Ramón Bertomeu-Sánchez and Antonio García-Belmar, “Pedro Gutiérrez Bueno’s textbooks: Audiences, teaching practices and the Chemical Revolution”, *ibid.*, 693–712; Raffaella Selligardi, “Views of chemistry and chemical theories: A comparison of two university textbooks in early nineteenth-century Bologna”, *ibid.*, 713–38; and Anja Skaar Jacobsen, “Propagating dynamical science in the periphery of German Naturphilosophie: H. C. Ørsted’s Romantic research school”, *ibid.*, 739–60.
 32. For a very interesting discussion on the spread of a “paper tool” see D. Kaiser, K. Ito and K. Hall, “Spreading the tools of theory: Feynman diagrams in the USA, Japan and the Soviet Union”, *Social studies of science*, xxxiv (2004), 879–922. On the transfer of technical skills, see A. Lundgren, “The transfer of chemical knowledge: The case of chemical technology and its textbooks”, in Bertomeu-Sánchez *et al.*, *op. cit.* (ref. 28), 761–78. For a critical review of some of these issues, see K. Olesko, “Tacit knowledge and school formation”, *Osiris*, n.s., viii (1997), 16–29, and the introduction and papers included in Bertomeu-Sánchez *et al.* (eds), *op. cit.* (ref. 28).
 33. Some examples of research schools in the scientific periphery are discussed in Santesmases and Muñoz, *op. cit.* (ref. 4); I. Amaral, “The emergence of new scientific disciplines in Portuguese medicine: Marck Athias’s histophysiology research school, Lisbon (1897–1946)”, *Annals of science*, lviii (2006), 85–110; and Nieto-Galan, “Free radicals” (ref. 27).
 34. On this topic, see I. Gouzevitch, “The editorial policy as a mirror of Petrine reforms: Textbooks for engineers and their translators in early eighteenth century Russia”, in Bertomeu-Sánchez *et al.* (eds), *op. cit.* (ref. 28), 841–62; and G. Petrou, “Translation studies and the history of science: The Greek textbooks of the eighteenth century”, *ibid.*, 823–40. See also N. Rupke, “Translation studies in the history of science: The example of ‘Vestiges’”, *The British journal for the history of science*, xxxiii (2000), 209–22, and S. L. Montgomery, *Science in translation: Movements of knowledge through cultures and time* (Chicago and London, 2000).
 35. Gabor Palló, “The Encyclopaedia as textbook: The first Hungarian textbook”, in Bertomeu-Sánchez *et al.* (eds), *op. cit.* (ref. 28), 779–99. For a general overview on this topic, see R. Yeo, *Encyclopaedic visions: Scientific dictionaries and Enlightenment culture* (Cambridge, 2001).
 36. See Secord, *op. cit.* (ref. 19), and T. Shinn and R. Whitley (eds), *Expository science: Forms and functions of popularization* (Boston, 1985). For additional bibliography and a broader discussion, see Faidra Papanelopoulou, Agustí Nieto-Galan and Enrique Perdiguerro (eds), *Popularizing science and technology in the European Periphery, 1800–2000* (Aldershot, forthcoming 2008).
 37. R. Cooter and S. Pumfrey, “Separate spheres and public places: Reflections on the history of science popularization and science in popular culture”, *History of science*, xxxii (1994), 237–67.
 38. The issues at stake were discussed in several papers presented at the 5th STEP meeting, 1–3 June 2006 (Mahon, Spain). Some will be included in Papanelopoulou *et al.* (eds), *op. cit.* (ref. 36). Such is the case, for example, with P. Simón Castel, “Ganot’s textbooks of physics: Translation, the making of the book and the transit of knowledge”; and G. Vanpaemel and B. Van Tiggelen, “Science for the people: The Belgian *Encyclopédie populaire* and the constitution of a national science movement”.
 39. Besides the mentioned collective volumes, a recent relevant STEP project on comparative history is

“Science and technology in the press: Impressions at the beginning of the twentieth century”. It brings together research teams from Spain, Greece, Portugal and Denmark. See the papers presented at the 5th STEP meeting: Ana Simões, Conceição Tavares, Ana Carneiro and Maria Paula Diogo, “Newspapers’ views on science and technology: Impressions from Portugal at the beginning of the twentieth century”; Hans Henrik Hjermitsev and Casper Andersen, “Newspapers’ views on science and technology in Denmark”; Matiana González, Néstor Herrán, Enric Piriz, Núria Perez and Agustí Nieto-Galan, “Science at the fin de siècle in Barcelona”; and Eirini Mergoupi–Savaidou, Spyros Tzokas, and Faidra Papanelopoulou, “National identity and progress in the popular accounts of science and technology in the Greek press 1900–1914”.

40. See Papanelopoulou *et al.* (eds), *op. cit.* (ref. 36) for further discussion and bibliography.
41. An overview of the advantages and drawbacks of comparative history approaches is presented in the well-known paper by Lewis Pyenson, “Comparative history of science”, *History of science*, xl (2002), 1–33.