HISTORY OF SCIENCES

Issues, General Themes and Methods of History of Sciences

Science and Technology in Society

Coordinated by
Soraya Boudia
Ashveen Peerbaye

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SCIENCES

History of Sciences, Field Director – Jean-Claude Dupont

Issues, General Themes and Methods of History of Sciences, Subject Head – Stéphane Tirard

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Contents

Presentation of the "History of Sciences" Field

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The "History of Sciences" field of the *SCIENCES* collection is conceived as related, on the one hand, to the field devoted to scientific and technological disciplines and, on the other hand, to the field on epistemology. In addition to an overview of current methods and issues in the history of science, the 16 volumes offer an overview of the evolution of knowledge in mathematics, physical and natural sciences, medicine, and in the humanities and technologies, from their origins to the present day, and in the various cultural areas. It is intended both for a non-specialist audience and for scientists, for whom it provides a useful perspective on the origin and foundation of knowledge, while remaining close to current research in the history of science:

– Field director: Jean-Claude Dupont.

– Subject heads:

- "Issues, General Themes and Methods of the History of Science": Stéphane Tirard;

- "Logic and Mathematics": Sabine Rommevaux-Tani;

- "Astronomy, Physics, Chemistry and Earth Sciences": Christian Bracco;

- "Life Sciences": Jean-Claude Dupont;

- "Humanities and Social Sciences": Alexandre Escudier.

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Introduction

Science and Technology in Societies

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This book is one of the first attempts in France at offering a broad overview of an international field of research dedicated to the study of science and technology, captured in their different dimensions: STS[1]. This is internationally known as Science and Technology Studies, but the translation of the acronym into French has remained flexible, even vague; sometimes referring to "Science, technology and society" or to "Social studies of science and technology", without fully satisfying all of the researchers who see themselves as part of it. These terminological hesitations relate both to debates around the objects and approaches used, to disputed institutional uses of the results produced, and to a real difficulty in creating an interdisciplinary field that transcends the traditional organization of disciplines which is very prevalent in France. Also, in many research works and publications, the English title of the field is preferred.

This book aims to present this field, its formation, its contributions and the new perspectives that are emerging. This is a classic exercise in the academic world, but here it is coupled with another concern. The original version, written in French, is

1. Some French-language texts have presented work on certain themes or approaches in the field of STS. In particular: Pestre (2006); Bonneuil and Joly (2013). Textbooks that favor an approach through the discipline of sociology are also available. See in particular: Vinck (1995, 2007); Dubois (1999, 2001); Martin (2000); Berthelot et al. (2005).

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first and foremost aimed at a French-speaking audience, and strives to improve access to, and foster discussions on, research that is not sufficiently well known or institutionally established in France – while, surprisingly, many researchers from French institutions have made (and continue to make) crucial contributions to the international production in the field. To carry out this task, several choices were made.

The first was to stabilize a name in French for the field of STS. We have opted for "*Sciences et techniques en sociétés*" (Science and Technology in Societies), a name regularly used in recent years among researchers who see themselves as part of STS, and which seems to us to allow encompassing of the multiple forms of research developed in recent decades. This research has focused on: the material and institutional conditions for the production of knowledge and innovation; the practices of the various academic, economic and political actors involved; the modalities of circulation and reappropriation of knowledge; on relationships with knowledge, as well as on the reconfigurations brought about by science and technology in modes of existence, biographies, bodies or relationships with nature. Naming this field "Science and Technology in Societies" means recognizing that over the last two centuries, science and technology have become a powerful driving force for transformation of contemporary societies, one of the most significant forms of human activity, inseparable from social, political and economic life. They have been (and continue to be) instruments of military power, innovation and economic organization, of the governance of societies, ecosystems and bodies. They deeply permeate daily lives, mobility, nutrition, health and communication. Also, they play a central role in the globalization of flows and markets, information and energy, as well as in diagnosing the state of the planet or measuring individual and organizational performance. Science and technology thus profoundly shape our ways of life and impose themselves almost de facto on the humanities and social sciences as a central subject of study.

The second choice involved deciding against an approach presenting the major theoretical approaches or research traditions in STS (such as constructivist sociology, symbolic interactionism, actor-network theory or even the political sociology of science and technology) in favor of a presentation organized by major themes, from the most exhaustively explored to the most newly emergent. Our project was clearly to produce a work that would be a mapping of STS, reflecting the state of the art of the field since its creation and indicating the most current themes. To begin this work, we had an important resource at our disposal: the four handbooks published by the 4S (Society for Social Studies of Science), a professional association dedicated to STS created in 1975 which has seen notable international expansion in recent years (Spiegel-Rösing and de Solla Price 1977;

Jasanoff et al. 1995; Hackett et al. 2008; Felt et al. 2017). Any researcher working in the field of STS is familiar with these works. Taken as a whole, they provide an excellent overview of the evolution of STS themes and approaches, particularly in the English-speaking world, and in terms of publications in English. However, we had to face an initial constraint: the size of the work required more drastic choices than those made in the 4S handbooks. Furthermore, as the editors of the most recent edition point out: "Unlike fields with longer traditions and more thorough institutionalization, STS has no single or preferred entry point" (Felt et al. 2017, p. 24). The choices we made were thus guided by our readings, our own trajectory and our encounters in the field, as well as by the numerous debates happening in the international STS community.

We wanted to offer a work that could serve as an introduction to the field of STS for master's and doctoral students, and which would also open up and fuel discussion with researchers in the humanities and social sciences in general. This meant offering a work suitable for different audiences, presenting the production of STS at different scales, at both international and national levels, and reporting on the conditions of this production in the French context. It was important to us for the choice of contributors to reflect the diversity of approaches and positions in the field, as well as the variety of disciplinary origins, ranging from philosophy to anthropology, including history and sociology or political science. The 30 authors who participated in writing the chapters of this book represent this diversity, and their contributions made it possible to make this project a collective enterprise.

This book is made up of 12 chapters, devoted to themes as varied as: the trajectory of STS in France; laboratory studies; biomedicine; science and its audiences; the politics of expertise; risk regulation; ignorance studies; the globalization of technosciences and the decolonization of knowledge; environmental STS; soil and subsoil issues; the digital; maintenance and repair. Other themes initially chosen (particularly those addressing feminist approaches to science and technology, and studies of economic markets) ultimately failed to come to fruition. The list of thematic entries which deserve to be treated is certainly very long and needs to be enlarged in the future. Firstly, because science and technology are continually evoked in the age of the entanglement of global environmental changes, geopolitical tensions and economic crises, often in a techno-solutionist logic. The ever-renewed rise of new technologies, artificial intelligence, digital technologies, so-called "green" energies or biotechnologies helps to materially transform the world in which we live, with effects at different levels. Secondly, because the research being conducted evolves and new work explores the ongoing transformations, the debates and mobilizations they generate, and the worlds which

they participate in building. We thus hope to demonstrate the plurality and richness of the contributions and perspectives of STS.

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1

STS: French History of an (In)discipline

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1.1. Introduction

STS: a three-letter abbreviation designating both a field of public policy (*science, technology and society*) and an interdisciplinary field of science and technology studies, the English label having established itself in French-speaking countries. This is what any dictionary worthy of the name could tell us!

The French history of STS, the subject of this chapter, is understood here as a reflection on the constitution of this interdisciplinary field of studies. However, the two meanings are clearly not unrelated, which is sometimes a source of ambiguity. We can in fact expect STS specialists to be competent in analyzing the relationships between science, technology and society, and to think about their organization. However, just as specialists in the sociology of religions cannot claim a monopoly over competence in religion, the skills of researchers in the field of STS cannot substitute for those of professionals in this field, starting with researchers from other disciplines. This is moreover sometimes a source of misunderstanding, even tension. The reception of STS research may be problematic when what it reveals calls into question the representations or imaginaries of scientific, associational or political actors. This is a common occurrence when using the principle of symmetry (which recommends treating all scientific and non-scientific actors in the same way in the analysis of a controversy); when establishing that scientific facts are constructed; when showing that the boundary between science and non-science is not

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self-evident, but results from boundary work; and when showing that the separation between facts and values is not as clear-cut as we think, that science is indeed part of society. While the expectations of many science professionals are on the side of a better reception (or even acceptance) of science by society, STS instead offers an analysis of scientific practice that calls for greater reflexivity. Since, in a certain way, it desacralizes scientific activity, STS can be perceived as questioning the cultural authority of science. The term "relativist" is not far away, and carries the threat that by challenging science as a source of truth, the political order will be endangered.

These tensions are also quite often found in relationships with colleagues in the social sciences. The position of the two great pioneers of STS in France, Michel Callon and Bruno Latour[1] (Callon an engineer, Latour a philosopher, both at the École des Mines for a long time), is not unusual: a good number of researchers came to STS after initial training as engineers or in the so-called "exact" sciences. Given that in France, contrary to what is observed in the United States and in various European countries, STS does not exist as a discipline, professionals in this field – especially academics – must display an institutional disciplinary affiliation; usually sociology, as well as history, political science or anthropology.

Although, for convenience, STS is sometimes presented as the sociology of science and technology, such an equivalence is hardly satisfactory. Researchers in the STS community are not quite sociologists and are not only sociologists. This difficulty in finding a place within established disciplinary frameworks is the common feature of various forms of "studies" (cultural studies, gender studies, etc.), which are defined primarily by their object, the latter serving as the basis for elaboration of concepts, approaches and data collection – in short, original ways of producing knowledge. This outside-the-margins situation is, of course, uncomfortable. Nevertheless, it is a guarantee of freedom, a source of creativity, also sometimes of boldness, which may lead to an emphasis on the rebellious nature of STS, which is certainly part of the appeal of the field (Peerbaye 2015).

One of the central concepts of STS may be used to characterize the field: that of epistemic culture, as proposed by Knorr-Cetina (1999). This concept aims to capture the different ways of producing scientific facts: not only methods and tools, but also modes of reasoning, ways of establishing proof, and relationships between theory and empirical approaches. STS is among the constructivist and generally comprehensive approaches. Four main features characterize its epistemic culture:

1. While being pioneers in the field of STS, Latour and Callon are in the top 10 of the most cited French "sociologists" in the United States (respectively, at numbers 3 and 6) (Ollion and Abbott 2015).

1) a great deal of attention paid to the diversity of ways of knowing, mainly in the scientific field, as well as beyond it (action knowledge, experiential knowledge, etc.); 2) a co-productionist approach to interactions between knowledge production and political order; 3) recognition of the central role, and the agency, of technological objects; and 4) methods often inspired by ethnographic practice (sometimes by ethnomethodology).

This chapter offers an analysis of the emergence and evolution of STS in France. Various researchers have offered related analyses, mainly focusing on the sociology of science and technology (Vinck 1995; Dubois 1999; Berthelot et al. 2005) or on the emergence or evolution of STS (Pestre 2006; Bonneuil and Joly 2013). However, a French history of STS for the entire period under consideration, from the 1960s to the present day, remains to be written. Here, we have chosen a chronological approach. The first section is devoted to the period of emergence, from the 1960s to the early 1980s. This period was marked by the importance of epistemology and the history of science, and by institutional efforts – with mixed results – to create research about research. The second period, from the 1980s to the early 2000s, saw the formation, around Michel Callon and Bruno Latour, of an approach aimed at analyzing not only science and technology, but also innovation, and more generally "hot" situations. Through such situations, we may indeed grasp society in the making, the constitution of new ontologies and the formation of new associations. The theoretical proposal structuring this work, *actor-network theory* (ANT), would not only come to dominate the French scene, but also experienced considerable international success. The 2000s saw a new wave of work. On the one hand, the objects and fields of study multiplied. On the other hand – and this is the dimension most productive of renewal – while the approaches of the previous period had privileged the flexibility, plurality and creativity of the social, it proved necessary to analyze the sociohistorical transformations of our time, to consider the lasting asymmetries of power, to think about what lasts, what subjects are not controversial, what knowledge is not produced, etc. Thus began a period marked by the necessary development of a new political economy of knowledge.

1.2. The difficult constitution of "research on research", between institutional control and academic conformism

1.2.1. *The emergence of STS on the margins of the humanities and social sciences*

In an article published in 1987 in *Social Studies of Science*, Geoffrey Bowker and Bruno Latour present the specifics of the emerging field of (social) studies of science in France (Bowker and Latour 1987). This paper may be interpreted as a

performative exercise in boundary work (Gieryn 1983), contributing to the establishment of the field. Addressing the readers of this flagship journal of STS, the authors take knowledge of this field in the English-speaking world for granted, and endeavor to define the particularities of the French situation. The argument is simple enough. The study of science and technology *in society*, which constitutes the distinctive characteristic of this field, which emerged in the 1970s[2], is foreign to the French tradition, both for sociologists who, like Pierre Bourdieu, consider that science stands outside of society, and for historians, notably the Annales school, for whom science is outside of history. The authors emphasize the lasting and profound influence of the great French specialists in epistemology and the history of science who, like Gaston Bachelard, Alexandre Koyré or Georges Canguilhem, held a position that was both anti-empiricist and anti-materialist, opposing the rationality of the scientific approach to the irrationality of opinion, and who generally favored an internalist approach to science[3]. According to Bowker and Latour (1987, p. 723), Alexandre Koyré "vaccinated a generation of French historians against social explanations of science: by making them accept the influence of philosophy and theology on science, he prevented infection from the influence of society". This intellectual heritage would explain, according to the two authors, a critical attitude toward Anglophone STS and its iconic approaches, starting with the Edinburgh school's strong program for the study of controversies (Bloor 1976)[4].

Bowker and Latour further argue that Michel Foucault's work has only an apparent proximity to the field of *science studies.* While Foucault's contribution to a constructivist approach to knowledge and to the analysis of knowledge/power relations is essential, both authors consider that he was not interested in experimental sciences and that society for him plays a marginal role, as compared to the importance of the genealogy of ideas[5]. On the other hand, the work of Michel Serres is considered a major source of inspiration: "Michel Serres is the only one to

2. The first specialized society, the Society for Social Studies of Science ("4S"), was founded in the United States in 1975.

3. For a more nuanced view of the complexity of the links between the French tradition and the English-speaking tradition, see Simons' (2017) analysis of the reception of the work of Thomas Kuhn, among which *The Structure of Scientific Revolutions* (published in 1962) is often presented as a precursor of STS, because it makes the link between the internal and external analysis of science.

4. For a critique of the "strong program" that calls for taking cognitive activities seriously and not "desacralizing" science, see Isambert (1985).

5. The essential contribution of Foucault's knowledge–power association is nevertheless recognized in other texts, for example, in Callon and Latour (1990, p. 17): "[Foucault's] lesson is general: […] knowledge about society is produced at the same time as society; it circulates from the social sciences to the actors, and it is in the ambivalence of this process that what we can agree to call 'power' is born." As Quet (2015) observes, it is significant that this remark on Foucault was added in the second edition of the work, in 1990.

contribute to a rethinking of science, of discourse and, in many ways, of society" (Bowker and Latour 1987, p. 730)[6].

The article concludes with a characterization of French-style STS, identifying four main features. Firstly, the French academic space does not include the equivalent of English-speaking STS. Nevertheless, several fields of research are closely related, in sociology of science, history of science and history of technology. Secondly, work on the social study of science is mainly located in engineering schools (Conservatoire national des arts et métiers (CNAM), École nationale supérieure des mines, École nationale des ponts et chaussées) and at the École des hautes études en sciences sociales (EHESS), in exceptional cases in the university context (as in the case of GERSULP in Strasbourg). Thirdly, if we take this wide scope into account, the number of researchers is rather high (in comparison with the English-speaking world), but weak structuring and tenuous links between centers of research and training explain the strong atomization and low visibility of the work. Finally, while in English-speaking countries, STS has developed in close relation with social movements, in France it remains in the shadow of the state and its control[7].

1.2.2. *Institutional initiatives with mixed results*

With this last point, the authors correctly adopt a reflexive stance toward the conditions of existence of this research in society. However, this analysis leaves out the institutional investments which, since the 1960s, have led to support for research into the science of science. Indeed, the need for research on science policies gradually became apparent in the 1960s, especially under the influence of the increasing prominence of this theme in English-speaking countries. Jean-Jacques Salomon, appointed to the science policy department of the Organization for Economic Co-operation and Development (OECD), brought this to the attention of the authorities of the National Center for Scientific Research (CNRS) and the Délégation générale à la recherche scientifique et technique (DGRST) (Vilkas 2015). Awareness of the issues of "research on research" led to the establishment of

6. Nevertheless, the reader will search in vain for the substantial content of this contribution, as the article does not go beyond a summary characterization: "What [Serres] seeks to do is to find the structure that articulates a particular religious, scientific or literary system, and to show how it works" (Bowker and Latour 1987, p. 731).

7. Bowker and Latour formulate a "Ben David" hypothesis: the state finances research, but it must keep a distance from politics; technocrats (seen as bearers of the general interest) are in a mediating position. "[T]alking of power and/in/of science is simply unthinkable. For an attack on (universal) science is an attack on the state" (Bowker and Latour 1987, p. 740).

the Parex (for Paris-Sussex) project[8], launched in 1970 to promote Franco-British collaboration in the social studies of science[9], with the main leaders being, on the French side, Gérard Lemaine assisted by Bernard-Pierre Lécuyer and, on the British side, Roy MacLeod and Michael Mulkay. Lemaine would participate in the creation of the Group for Studies and Research on Science at the EHESS, and carry out a series of Mertonian-inspired research[10] on the emergence of new disciplines and on the division of labor in laboratories. At the CNRS headquarters, during the tenure of Hubert Curien (1969–1973), Robert Chabbal, then scientific director for physical sciences, led a monthly seminar entitled "Research Policy". It then became a question of better understanding science policies, methods of organizing research and processes of emergence of new scientific fields. In the 1970s, the CNRS supported a "research on research" program through the financing of programmed thematic actions.

The sociology of science benefited quite largely from this support and would gain visibility with the multiplication of empirical studies. In his overview of "The Sociology of Science in France", published in 1979, Gérard Lemaine identifies five major areas of study and some of their principal actors:

> 1) the sociology of social sciences (B.P. Lécuyer, M. Pollak, V. Karady); 2) the popularization and dissemination of scientific knowledge (S. Moscovici, P. Roqueplo); 3) the scientific field, research strategies and consensus (P. Bourdieu, M. Callon, G. Lemaine, B. Matalon); 4) the study of scientific groups and laboratories (G. Darmon, B. Latour, B. Jurdant); 5) industrial research, applied science, sociology of technology (T. Shinn) (Dubois and Schultz 2015).

In 1979, the CNRS social sciences department launched a five-year program called Science–Technology–Society (STS) (Vilkas 2015). Calls for projects were launched between 1980 and 1983. These concerned three main themes: "the productions of science; relationships between science and technology; the creative power specific to technology". Eighty-five projects were funded (including 25 in history and sociology), involving more than 100 researchers. After several years, the results of this program were mixed. It was criticized for trying to cover too wide an area, leading to difficulties in structuring a field of research with blurred boundaries and an uncertain identity.

8. The Science Policy Research Unit (SPRU) had recently been created there by the economist, Christopher Freeman.
9. The Parex project then extended to other European countries. It foreshadowed the European Association for the Study of Science and Technology (EASST).
10. Robert Merton, founder of the American sociology of science, was one of the instigators of the break between an approach to science through institutions and a cognitive approach.

These findings are in line with those of Bowker and Latour. Despite fairly substantial support for research, the existence of this field remains problematic given the variety of disciplines involved and the absence of a unifying program. The organization of access to university careers is also a determining factor. Since recruitment in universities and research organizations is organized by disciplinary sections, STS specialists do not have autonomy and are considered part of institutionally recognized disciplinary fields (mainly sociology, history and philosophy of science, political science).

1.3. An iconoclastic conception of science for thinking differently about society

1.3.1. *The invention of actor-network theory*

In this general context, the Center for the Sociology of Innovation (CSI) of the École nationale supérieure des mines de Paris would play an essential role in the establishment of French-style STS. Created in 1967 by Lucien Karpik, it was joined the same year by Michel Callon, a young graduate of this school. Bruno Latour would leave Jean-Jacques Salomon and CNAM to join the CSI in 1982. The CSI was first recognized internationally, before becoming established in France. Indeed, Callon, Latour and their colleagues were involved from the outset in the Anglophone field of STS: they would in turn be presidents of the 4S; Latour's first works would first be published in English; they would have very early structuring collaborations with English-speaking colleagues, Callon with John Law and Latour with Steve Woolgar, and would be regularly welcomed in US universities.

From the mid-1970s onward, Latour made a major contribution to the debates in the emerging field of STS. *Laboratory Life*, co-written with Steve Woolgar and published in 1979, renewed the genre of science studies, by analyzing the construction of scientific facts using an ethnographic method inspired by the practices of ethnomethodology (Peerbaye and Vinck, in this work). This book was also the herald of a very fruitful research program. Latour borrows from David Bloor the principle of symmetry, which prescribes studying the successes and failures of science in the same way, without taking for granted the way in which history has separated the victors from the vanquished. He extends this principle by proposing to deal with nature and society in the same terms:

> The fieldwork that we will present here is therefore doubly symmetrical: it applies to the true as well as to the false, it strives to rework both the construction of nature and the construction of society (Latour and Woolgar 1979, p. 22).

These initial works laid the foundations of ANT, whose international recognition was both the cause and the consequence of its success. While the study of science and innovation was the crucible of this theory, its scope is much more general. As Latour (2007) wrote, the issue is nothing more or less than rebuilding sociology on new foundations. In a recent text, he explains how focusing analysis on changes ("hot situations", as Callon would say) was essential for the design of this theory (Latour 2010). ANT (Actor-Network Theory) integrates the traditional argument of social network theories (Burt, etc.) or interactionist theories (Goffman, etc.), according to which actors are determined by the networks of relations in which they are involved. However, it goes beyond this by recognizing the agency of non-human actors, in application of the principle of generalized symmetry.

Thus, the study of science is associated with that of innovation, as these are the situations in which new ontologies and new associations appear. The CSI is thus also a center for research on innovation. This essential distinguishing feature in the field of STS relates at the same time to the theoretical concepts being developed and the contexts of realization; that is, an interdisciplinary team in an engineering school and in a close relationship with public and private actors in research and innovation. The initial theoretical inspiration came from Serres' work on translation[11]. Callon, Latour and their colleagues, notably John Law, founded their sociological approach on this notion, defining it firstly as an act of association between two entities, which allows one of them to speak or act in the name of another. We therefore speak of a sociology of associations. Networks are built through chains of translation, an elementary four-stage operation (problematization, interest, enrollment, mobilization), constitutive of the actors (human and non-human) involved (Callon 1984). As Hennion (2015) indicates, the scope of ANT is measured by a series of reversals between objects and relations: action makes the actor, *interessement* makes the interest, and relation makes the object. ANT is thus a general theory of action characterized by radical relationism.

11. The genealogy of the sociology of translation has not been subject to systematic work. It is therefore difficult to make an inventory of intellectual influences. In the collection of "foundational texts" of the sociology of translation (Akrich et al. 2006), the choice to publish the translation of one of the only articles co-signed by Callon and Latour, "Is the Great Leviathan Being Tamed?" (Callon and Latour 1981) and the absence of Callon's article on scallops (Callon 1984) certainly marks the desire to signify co-production of this theory. In his retrospective analysis, Hennion (2015) supports the thesis of complementarity between Callon, an engineer by training, and Latour, a qualified philosophy academic, and of their respective influences. I recommend the very beautiful and moving testimony written by Michel Callon in homage to his colleague and friend Bruno Latour, published in February 2023 in the online journal, *AOC*, "Working with Bruno Latour on a Daily Basis".

While Latour developed the metaphysical aspects of this theory (notably the questioning of the great divides – between culture and nature, between facts and values, between science and society, etc.), Callon concentrated on formalisms and instrumental aspects. In the early 1980s, he developed original scientometric approaches, contributing to the invention of Leximap software, based on a network construction algorithm using the frequencies of co-occurrences of terms (this type of algorithm was later used by Internet search engines) (Callon et al. 1986, 1993). At the end of the 1980s, in a strategy of alliance with economists of innovation, he proposed a formalization of ANT, leading him to enrich its conceptualization (the notion of punctuality, in particular) and to introduce the notions of heterogeneity and irreversibility into the dynamics of sociotechnical networks (Callon 1990).

In his iconic article, Callon (1984) constructed the theory of translation by taking the example of Ifremer's work on scallops in the bay of Saint-Brieuc. Ultimately, according to him, it is the scallops that "decide" not to anchor themselves. The "mobilization" of broader populations by the initial "spokespeople" did not work. The "obligatory passage points" were bypassed. The approach seriously takes the agency of technical or biological entities – here, the recalcitrance of scallops – that are conceptualized as actants. It would come under fire from critics of the social construction of technology, who adhere to an extension of Bloor's "strong program". This disagreement gave rise to particularly lively exchanges, notably with Harry Collins and Steven Yearley, who criticized Callon and Latour for giving the last word to scientists and engineers[12]. Indeed, contrary to the supporters of the strong program, from the ANT perspective, it is not necessarily society that has the last word. On the one hand, society is made up of constantly evolving arrangements. On the other hand, the trials to which statements are subjected in the construction of scientific facts reinforce the latter's robustness, so that, sometimes, certain facts become indisputable. In this, despite the criticisms of rationalists, proponents of ANT are not relativists. They are both constructivists and realists.

1.3.2. *Science and innovations as society in the making*

The other side of the complementarity between science studies and innovation refers more to elements of context and choices of object. Callon's early work focused on research in large companies, electric vehicles and fuel cells; that of Madeleine Akrich on the design and distribution of photovoltaic lighting kits in several developing countries (Akrich 1994). In 1988, Akrich, Callon and Latour published "À quoi tient le succès des innovations ?" in the management journal

12. On the so-called epistemological chicken controversy, see Callon and Latour (1992) and Collins and Yearley (1992).

Gérer et comprendre (Akrich et al. (2006)). In 1992, Latour published *Aramis or the Love of Technology*, a symmetric analysis of the failure of a major project of technological innovation, in which technological objects are endowed with agency (Latour 1996). At the CSI in the 1980s and 1990s, innovation studies were numerous, as were research policy studies; notably, the work of Philippe Larédo, Philippe Mustar and Dominique Vinck. Thus, a set of tools was designed, often within the framework of contractual research, for the management of innovation, research policies, analysis of controversies, description of research activities and socio-technical transformations.

Concerning controversies, here again an original position was taken. On the one hand, as we have seen, CSI researchers extended the strong program's principle of symmetry by proposing a principle of generalized symmetry. On the other hand, the focus on socio-technical controversies, the subject of Callon (1981), suggested not limiting ourselves to the scientific controversies that are at the heart of many works in social and cultural studies of science. Callon highlights the need to acquire the tools for analyzing controversies around scientific and technical issues in society: "What do we know about the mechanisms through which families of so-called technical problems are defined, solutions are developed and then negotiated, and certain choices are imposed which become increasingly irreversible? Nothing, or almost nothing" (Callon 1981, 2006, p. 136). Here too, we find a strong indicator of the CSI's broad positioning, and we can highlight the pioneering character of these analyses when we consider the increasing frequency and importance of socio-technical controversies from the 1980s.

The positioning of the CSI is therefore quite unique, both in the French space of social sciences and in relation to the English-speaking approach of STS[13]. A new look at science, a pillar of modernity, was essential to examine the construction of society in a very original way, breaking with the great intellectual traditions so important in the structuring of the French space of social sciences. This iconoclastic vision of science was the crucible of a new theory of the social, ANT, which then influenced different fields of research: in sociology (of culture, media, economics),

13. We will not insist here on the role played by Callon and Latour in disseminating international STS research with the magazine *Pandore* at the end of the 1970s. Conceived as a forum for debates on science and technology in society, *Pandore* would be published regularly between 1978 and 1983, reaching an audience of nearly a thousand readers. Systematic analysis of the magazine by Quet (2009) reflects the intensity and liveliness of the debates in which Bruno Latour participated very actively. Very early on, Callon and Latour positioned themselves in favor of what would be called, from the late 1990s, "technical democracy". Philippe Roqueplo was also a very active participant in this debate on technical democracy in the 1970s. In the 1990s, he was involved in debates on the role of scientific expertise and in organizing the first citizens' conference on GMOs in 1998.

in political science, in management science, in geography, etc. In this sense, the term "new sociology of science", often used to name this approach, is reductive.

The influence of the CSI has long overshadowed other approaches to research with an interest in science and technology. This position certainly explains the intensity of the criticisms that have been addressed to it, with many actors positioning themselves for or against it, both in a generally fruitful intellectual game as well as in a game of positioning. This is probably one of the reasons why Latour was one of the targets of the "science wars" launched in 1996 with the Alan Sokal hoax. Latour, a relativist? No, a relationist!

1.4. The new wave: moving beyond the paradigm of action

Although a narrow focus on CSI and ANT allows us to account for the major specificities of French STS from the early 1970s to the late 1990s, the dynamics of this field are more widely distributed and more protean from the turn of the millennium. As the field was still weakly institutionalized, the influence of STS stemmed from the circulation of ideas and concepts and from hybridizations with other fields. Consider, for example, the way in which STS's sociology of controversies was taken up by the pragmatic sociology approach to constitute a sociology of trials of strength which influenced many areas of the social sciences (Lemieux 2007). Courses in the sociology of controversies gradually become established in most engineering schools. Consider also the influence of STS on the emergence of the branch of sociology which approaches public policy through its instruments (Lascoumes and Le Galès 2004), or even the revival of economic sociology (Callon on market arrangements). We might also cite the works related to the GIS "Collective risks and crisis situations", which examined the transformation of relationships between the state, science, technology and the different stakeholders where the ambivalence of science (both a source of progress and threats) is widely in evidence, and also the numerous works in the social sciences of medicine.

This influence of STS through pollination and cross-fertilization does not mean that the field has not undergone institutional changes. Several initiatives marked this period. Around the Alexandre-Koyré Center in the mid-2000s, a group of researchers and teacher–researchers from the Center for the History of Science at La Villette[14] created a postgraduate course (masters 1 and 2) in HSTS – History of

14. The *Centre de recherche en histoire des sciences et des techniques* (Center for Research in the History of Science and Technology (created in 1986 under the joint supervision of the CNRS and the Cité des sciences de l'industrie)) brought together researchers such as Dominique Pestre, Bernadette Bensaude-Vincent, Yves Cohen and Delphine Gardey who