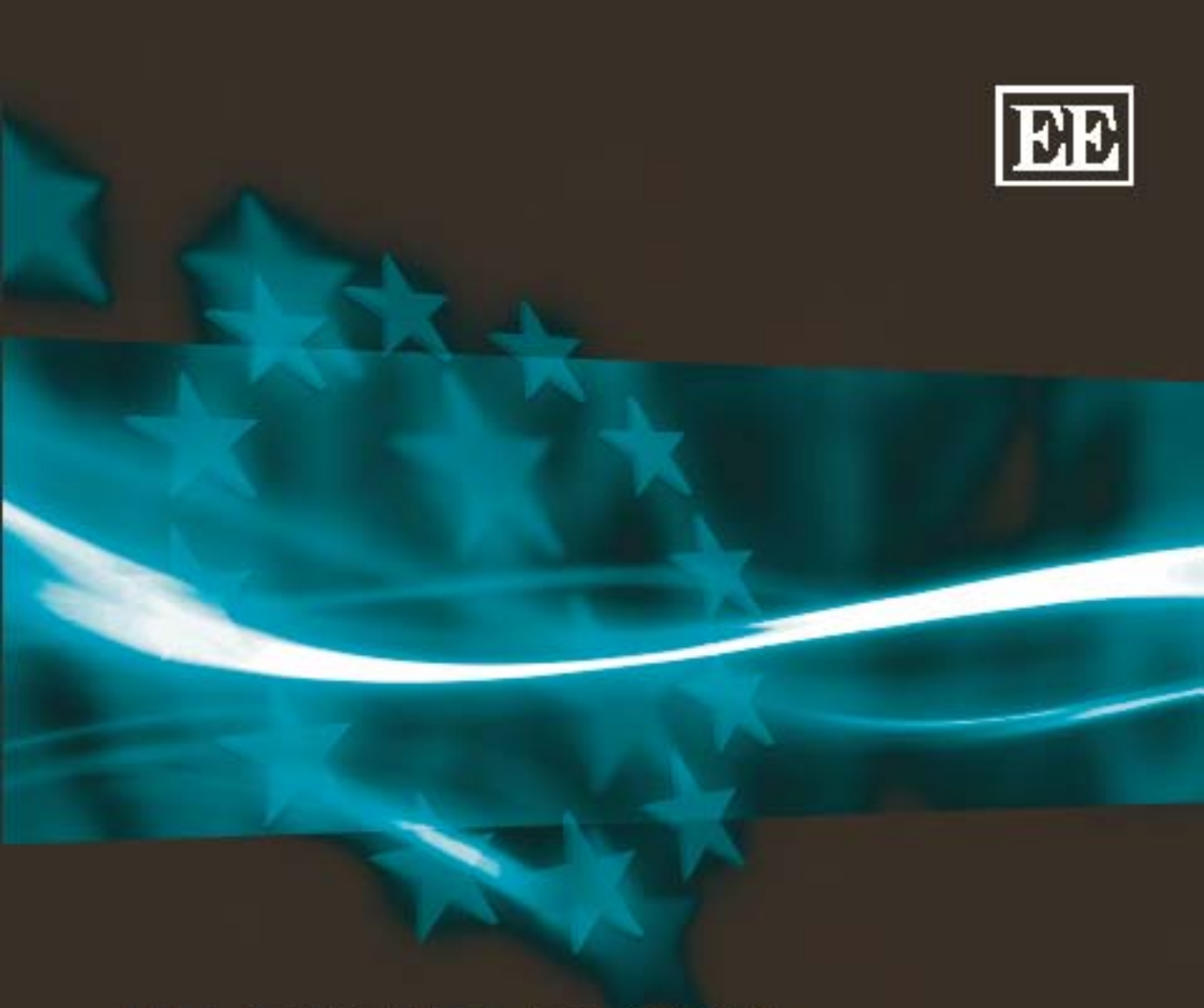

THE SOCIOLOGY OF SCIENTIFIC WORK

The Fundamental Relationship between Science and Society

Dominique Vinck

PRIME Series on Research and Innovation Policy in Europe

The Sociology of Scientific Work

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Introduction

The issues facing society today (sustainable development, health and industrial risks, new technologies, the knowledge society and so on) concern science and technology. Mad cow disease, the controversy over genetically modified organisms (GMOs), nanotechnologies, our understanding of climate change, the depletion of our natural resources, the fight against new epidemics (AIDS, bird flu and so on), and the transformation of our production systems are just some of the topics that concern the human and social sciences as well as the natural, health and engineering sciences. Researchers and lecturers in these fields are making sure that students receive thorough training in these sciences (covering the state of knowledge, methods, epistemology and so on), but also on the interrelations between 'science and society'. Indeed, these are an essential key to the dynamics of science.

In science and engineering faculties just about everywhere, social science training courses have been introduced. Sometimes, the temptation is to believe that a dash of epistemology will be enough to get across to young scientists exactly what science in action is all about. Others believe that a dose of ethics is what they need to be able to deal with society-related problems. Of course, such beliefs are by and large illusory. Obviously, some kind of philosophical training has its worth, but what our young experts also need is scientific training that will allow them to get to grips with the real socioscientific dynamics. They need to be able to understand the dynamics behind the creation of knowledge and innovation, but they also need to be able to act on these, both as professional actors and as responsible citizens.

This book provides analysis frameworks to help students and scholars to decode the stakes underlying and surrounding science and technology. It looks at different ways in which science and society interrelate (for example, the emergence of scientific disciplines, the dynamics behind innovation, technical democracy and so on), and at the main social mechanisms that drive and sustain science (institutions, organisations, exchanges between researchers, building of content, concrete practices and so on). With this manual, sociology lecturers will be able to meet the rising demands of our colleagues working in the natural and engineering sciences. Its use is also recommended for new training courses such as a Masters degree in science and technology. But it will also help to prepare future generations of sociologists to deal with the science and society questions that many have tended to leave to one side.

The objective of this manual is to provide a broad range of analysis grids, concepts, methods and various other pointers about authors, schools of thought and the underlying debates. Readers of the manual will be able to understand and

use Robert Merton's contribution to the institution of science and Bruno Latour's with respect to the construction of sociotechnical networks. Decoding the workings of scientific job markets sheds just as much light on science as examining the material-related and cognitive culture of a laboratory. Similarly, studying the role of language interactions in science in the making, or in scientific publishing practices or in the interactions between scientists and non-specialists, are all starting points for analysis that go beyond the contributions of epistemology or ethics. This manual does not aim to be erudite. Nor does it aim to set up or defend *one* overriding theory of science, based on rationalistic epistemology, relativism, constructivism, relationism, neo-institutionalism or whatever. On the contrary, it studies and documents the various processes and mechanisms at work, as these are highly useful when trying to understand the dynamics in action.

It is a question of understanding what 'doing science' really means. Simply detailing the state of knowledge, as is usually the case in teaching and TV programmes popularising science, is not enough to understand how such knowledge was created. A student's view of science based on what they learn from their lessons very often has little in common with science as it is practised. Even practical exercises rarely allow students to get a real grasp on research approaches. Students aiming to go into research discover the real face of science as they go along, as well as what they need to know to become a good researcher: methods, negotiating with colleagues, empirical know-how, science institutions and networks, writing styles and so on. History, philosophy, sociology, economics and linguistics all propose their own analyses. This manual has thus been written for future researchers too.

Any philosophical discourse that conveys *one* general and universal conception of science, as if it were the norm to be followed by all researchers, is counterproductive. On the one hand, it shrouds science in a mystery that is far from being compatible with actual scientific practices. Such discourse is therefore not very useful when it comes to providing researchers with concrete guidance in their work. Although it may stimulate thinking about science, and change the course of science, it is above all the privilege of those who have already proven their worth and can afford to wax philosophical about it. On the other hand, this general conception of science, which is pushed to the front when combating pseudo-science and irrationalism, is so far removed from concrete scientific practices that it loses all credibility. Without a philosophical representation that comes close to what can actually be observed or practised, reflexive researchers or outside observers are likely to fall into the worst type of relativism: 'if there is no universal science then it's all very much of a muchness'. The sociology of science, on the contrary, puts forward realistic analyses of scientific activity.

While some lecturers are afraid that the sociology of science is going to scare away their students because of the less edifying image of science that it portrays, others recommend that young researchers study it. Owing to its realistic approach, these students will become better researchers able to understand and act within the scientific world. This manual may lead some students to drop the idealistic views that had led them to pursue a career in science, while it will spark

others' passion for research and the way it works. It will help the latter to adopt a more lucid approach: science and technology pose problems of an ethical, political, economic and social nature. Neither the mystifying myth of rationalism nor radical and sceptical relativism are likely to help solve these.

As well as providing scientific and sociological training, this book is for anybody interested in the knowledge society: the growing scientific controversy and the issue of expertise are prime examples of this public concern. The book outlines a series of approaches designed to shed light on the relationship between science and society.

The Turns Taken by the Sociology of Science

This manual describes different ways of studying science, but it is neither a history of ideas nor a sociological work on the sociology of science. The relationship between, for example, sociological analyses and the social engagement of their authors will only be touched on in passing.[1] Taking the sociology of science as a subject of sociological study[2] will be for another project. This kind of analysis, based on the health economy in Great Britain for example (Ashmore et al., 1989), shows how interesting it is to report on the building of research programmes, the involvement of researchers in the media, the development of instruments designed for action and the insertion of young people in society's institutions.

Approaches in the sociology of science have become increasingly diversified. The development of this field is based on ongoing *dialogue* with other social science disciplines. Philosophers have pondered over the nature of this great development over the last centuries. They have attempted to explain it by examining scientific reasoning and the intrinsic normativity of science. Historians have traced the evolution of ideas and instruments. Economists have explored the links between science and economic dynamics. The analyses performed by these various disciplines compete and contrast with each other. There are also academic quarrels within disciplines: in the philosophy of science (rationalism versus realism), psychology (different cognitive theories), economics (the neoclassical versus the evolutionist approach) and history (the inside history of ideas versus the social history of science). Furthermore, several developments in the sociology of science can only be understood by referring to the philosophy of science or to exchanges with the economics of innovation.

Nor is there any consensus as to the best way of going about the sociology of science. The diversity of approaches helps to enliven and enrich scientific production in the field. Several authors have published articles or works on its so-called 'turns': 'social turn', 'cognitive turn' (Fuller et al., 1989), 'semiotic turn' (Lenoir, 1994), 'the turn to technology' (Woolgar, 1991), 'the practice turn' (Schatzki et al., 2000) or 'One more turn after the social turn' (Latour, 1996) or Pinch's pointed criticism (1993) at the thinker Woolgar: 'Turn, turn, and turn again: The Woolgar formula'. One might also talk about the 'normative turn', in reference to the growing number of committees focusing on ethics and fighting scientific fraud.

Using the idea of a turning point is often rhetorical. The aim is either to speak out about an approach that has gone adrift or back in time (rationalist or cognitivist theories, sociological reductionism or the impasse of reflexivity), or to convince people that a major change has occurred (semiotic turn, pragmatic turn and so on). Different periods have seen different movements emerging. However, the main schools behind the structuring of the field are still active. They refer to the following representations of science:

- Science as a **social institution producing rational knowledge**: science is different from the rest of society. Its actors are scientists, critical producers of true statements, whose behaviour is governed by norms and the goal of their institution: ever-progressing knowledge.
- Science as an **exchange system**: scientific activity is geared towards nature for some and society for others. The actors are rivals, driven by the promise of rewards, by the build-up of credit or credibility or by the position that they can attain. They become rational thanks to the exchange system and the fierceness of competition.
- Science as a **reflection of local cultures and societies**: scientific activity and output are explained by social factors. Scientific activity is guided by the interests of scientists and the social groups to which they belong. The goals of science are imposed from outside. The stability of knowledge comes from the production of local social consensus.
- Science as a set of **contingent sociotechnical practices**: scientific work is linked to multiple elements (incorporated tacit knowledge, instruments, materials and so on) and results in various types of output and notably publications. The actors work in laboratories and keep up relations with society. Scientific dynamics depend on circumstances and local cognitive and material culture.
- Science as a **construction of distributed research collectives and sociotechnical networks**: scientific work consists in linking heterogeneous elements in order to produce robust entities (instruments, statements and so on). Alignment and reconfiguration mechanisms are central; they lead to relatively dense and wide-reaching actor-networks where the classic distinctions between nature and society do not apply.

The sociology of science generally switches from a study where the social aspect is seen as the central concept around which explanations are organised to other approaches where social causality is overridden by the focus on the material nature of things. The notion of science, viewed as a distinct entity, is rethought as a heterogeneous and distributed whole. Thus, the sociology of science has evolved from a sociology of scientists to a sociology of scientific knowledge, to social studies in science and technology and to an anthropology of science, technology and society.

These different analytical stances lead us to some relatively local approaches to scientific activity. Nevertheless, any globalising thinking about the relationship

between science and society is rare. The sociology of science rarely raises this kind of question at the macroscopic level, even if there are calls for sociology to shed itself of some of its positivism (dissection of scientific work) in order to put forward new landscapes re-injecting new meaning into all this activity and making it possible to assess it.

Notes

1 Merton's defence of the autonomy of science in a period when the world was full of totalitarian regimes or the relativist sociologists' fight against the hegemony of physics.
2 Little work has been devoted to the sociology of the social sciences, with the exception of Deutsch et al. (1986) and Halliday and Janowitz (1992), who show that the divides between specialities are much deeper than the barriers between disciplines. There have been few efforts to draw up any theoretical summaries.

Recommended Reading

Jasanoff, S., Markle, G., Peterson, J. and Pinch, T. (eds) (1995), *Handbook of Science and Technology Studies*, London: Sage.

References

Ashmore, M., Mulkay, M. and Pinch, T. (1989), *Health and Efficiency*: *A Sociology of Health Economics*, Milton Keynes: Open University Press.

Deutsch, K., Markovits, A. and Platt, J. (1986), *Advances in the Social Sciences 1900–1980*, Lanham, MD: University Press of America.

Fuller, S., De Mey, M., Shinn, T. and Woolgar, S. (eds) (1989), 'The cognitive turn. Sociological and psychological perspectives on science', in *Sociology of the Sciences Yearbook*, Vol. 13, Dordrecht: Kluwer.

Halliday, T. and Janowitz, M. (1992), *Sociology and its Publics: The Forms and Fates of Disciplinary Organization*, Chicago, IL: University of Chicago Press.

Latour, B. (1996), *Aramis, or the Love of Technology*, Cambridge, MA: Harvard University Press.

Lenoir, T. (1994), 'Was the last turn in the right turn? The semiotic turn and A.J. Greimas', *Configurations*, **1**, 119–36.

Pinch, T. (1993), 'Turn, turn, and turn again: the Woolgar formula', *Science, Technology, and Human Values*, **18**, 511–22.

Schatzki, T., Knorr-Cetina, K. and von Savigny, E. (eds) (2000), *The Practice Turn in Contemporary Theory*, London: Routledge & Kegan Paul.

Woolgar, S. (1991), 'The turn to technology in social studies of science', *Science, Technology, and Human Values*, **16**, 20–50.

1 Science and society: a complex relationship

Science would appear to stand out from other social activities. This phenomenon has kept thinkers pondering, notably those striving to understand society and its transformations. Indeed, heads were being scratched well before the sociology of knowledge and the sociology of the sciences actually came into being. In this first chapter, we shall overview the analytical work of several classical authors (Comte, Condorcet, Marx and so on), who studied the relationship between science and society and, in particular, the conditions behind the presence and development of science in society. We shall study the analysis put forward by one of the first sociologists of science, Merton, who explored the relationship between Puritanism and the role of the scientist. Then, referring to the work of Ben-David, we shall look at the process according to which science emerged as a distinct social activity. Finally, we shall concentrate on the mechanisms behind the organisation and governance of the sciences in society. The question of the relationship between science and society shall be looked at again in Chapter 4 when we study the production of scientific knowledge.

Emergence of a Distinct Social Activity

In this first part, we shall see how science emerges as a social phenomenon, how the social role of the scientist is institutionalised according to the values of society, how the scientific community becomes independent of society, how the laboratory emerges as an institution and disciplines are established within society.

Science as a Social Phenomenon

The idea of science is often associated with that of a world apart, different from society. Our perception of science is still pervaded by an image of the isolated scientist, excitedly working on things beyond comprehension, or that of the genius, incarnated by Albert Einstein. Science comes across as a mysterious activity and scientists as strange beings. There seems to be a rift between the sciences and other forms of knowledge.

Indeed, for a long time, thinkers like *Condorcet* (1743–94) suggested that the emergence of science was a specific social and historical phenomenon, with the knowledge system being dependent on the structure of society.

For *Auguste Comte* (1798–1857), the human mind and every branch of

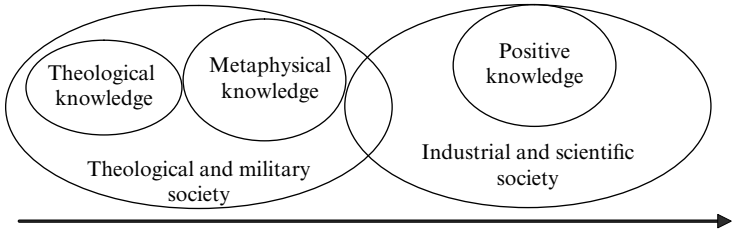

Figure 1.1 *Evolution of the nature of knowledge and the type of society*

knowledge pass through three states: theological, metaphysical and positive (Figure 1.1). In the theological state, natural phenomena can be explained by forces or beings similar to humans: gods, spirits, ancestors, demons and so on. In the metaphysical state, they are explained by great causes and abstract entities such as Nature. However, in the positive science state, the human being observes phenomena and sets up laws to establish links between them, hence abandoning the search for absolute causes. Scientific disciplines such as mathematics, physics and chemistry were the first to enter this positive state because the phenomena with which they are concerned are easier to think about. Scientific disciplines that are interested in more complex objects such as social phenomena entered the realm of positive thinking at a later, although ineluctable, date. In the positive state, scientists are able to impose their verdicts on the ignorant. These states correspond to the evolutionary stages of societies: theological and military society for the first two, and industrial and scientific society for the third. Science is thus a social and historical phenomenon linked to a specific form of social organisation in which labour is organised, in factories, in order to maximise yield and not according to custom. Moving into this stage of society supposes a dual revolution, one that is both social and intellectual and which represents a radical break in tradition.

Karl Marx (1818–83) also established a link between a social system state and a knowledge system state. For Marx, science is a historically dated phenomenon, linked to the capitalist production mode.

The Scientific Role as a Byproduct of Social Values

In the 1920–30 period, the sociologist Robert K. Merton (1910–2003) queried the cultural and historical origins of the scientific community. He described science as a sphere of social and cognitive activity that is different from other forms of activity and belief. He characterised the social climate that fostered its emergence, as well as the technical conditions that made it necessary. According to Merton, science is an autonomous sphere of activity, able to resist external influences; it defends and champions the principles of independence, discipline and pure rationality.

Merton founded his analysis on the study of the origins of the scientific community in seventeenth-century England. He analysed the biographies of the members of the British elite, the activity of the Royal Society (founded in 1645) and various works, inventions and publications. He underlined the significant growth in technical knowledge, skills and machinery in the mining, metallurgy,

shipbuilding and weapons industries from 1620 onwards. Merton specifically focused on the values, beliefs and feelings that marked this period of rapid development in science and technology.

Performing a quantitative study of the changes in career choices of the English social elite, he observed an evolution: in the first half of the seventeenth century, the 'science' and 'medicine and surgery' categories became increasingly popular. The elite turned more readily towards science than to the army or navy, or to the arts (painting, sculpture, music, poetry and prose), education, historiography, religion, scholastic knowledge, law or politics. According to Merton, this phenomenon could be explained by the enhanced value of the social role of the scientist and by a form of social recognition of science as an activity. At the time, there was a convergence of values between those of English Puritanism (interest in earthly things, discipline, condemning of idleness, free examination and distancing with respect to traditions and utilitarianism), and those arising from naturalist philosophy and experimental science.[1] These values, which placed experience at the top of the hierarchy of forms of knowledge, influenced the founders of the Royal Society. They permeated the Baconian movement (as of 1640) and were embedded in scientific education. The convictions at that time, with respect to man's mission to the relief of man's estate, converged towards the idea of a better understanding and control of nature. The idea of a natural science, studying the order and regularities of nature, was associated with the virtues of a new profession dedicated to it. For Merton, the growth of science as a distinct sphere of activity and the emergence of a new professional role in society could be explained less by the incoming flow of new knowledge than by the trend in social values and by the attempts of the members of the Royal Society to justify the ways of science before God. The Puritan values, combining rationalism and empiricism, fostered scientific method and gave a new lease of life to the empirical science that had been decried in the Middle Ages.

Merton's conclusions, which were similar to those of Max Weber regarding the growth of capitalism in Germany, led to the idea that the development of science is conditioned by an emphasis on the religious value of certain activities. This did not immediately lead to the institutionalisation of science, still considered an esoteric activity that was potentially dangerous for those in power and whose practical use had not yet been proven. The emphasis on religious values created favourable conditions for the development of science and the new social role of the scientist. This theory is opposed to the common idea according to which the recognition of science in society comes from its ability to solve problems. This is not at all the case; the appearance of modern science can be explained by the social values that psychologically restrict individuals. The social role of the scientist is defined by a set of behavioural norms.

The Scientific Community as the Fruit of Autonomisation

The social role of the scientist emerged simultaneously in France and Italy. The sociologist Joseph Ben-David (1920–86), in *The Scientist's Role in Society* (1971),

suggests studying the history of universities in order to understand the phenomenon and the speed at which this new social role spread outside of England. In fact, scientific training was already organised in Universities independently of the powers of Royalty and the Church. Sometimes academics formed corporate bodies with their own working rules. In Paris, the university had several hundred lecturers. As secular scholars, working inside a medieval university, their role was to search for truth and criticise the ideas of their peers, while their behaviour was controlled by their intellectual community. The scholar's social role came into being without being attached to any form of power. Scholars were able to compare and contrast their ideas because they were not absorbed by the need to constantly justify their role in society. With the university, erudition had become a rightful vocation and occupation. In this social space, dedicated to education, the practice of debating and querying fostered the right conditions for autonomous research. In this way, philosophers were able to gain independence from religious authorities. The new scientists used this autonomous university structure to reproduce the same kind of system while being careful to underline their difference with respect to the philosophers. They set up informal meetings and private lessons (notably at the Collège Royal de France), and this eventually led to the establishment of scientific academies.

In Italy, scholars formed alliances with artists and engineers and strove to solve problems by combining knowledge of classical texts, practical experience and explanations of the principles at work in various phenomena: perspective in architecture, dynamics in machinery, anatomy and so on. They served as an intellectual and social resource for artists and engineers. They were also admitted to the princely courts. Between the fifteenth and seventeenth centuries, groups of scholars travelled across Europe looking for settings to match their ideal of society. They saw experimental philosophy as a means of increasing their knowledge of man and nature. The coming together of the interests of these groups and those of their hosts can explain the emergence and recognition of their social role (Box 1.1). This role consisted in studying nature using mathematics, measurement and experimentation, rather than interpreting texts in order to study divine or human ways. This is how the science academies came into being at the beginning of the seventeenth century, in particular the Academia Dei Lincei (1603) and the Academia del Cimento (1651).

It has to be said that the English revolution occupies a specific place in the history of science. It led to the merging of scientism and puritan religious values and beliefs. This merging provided a legitimate basis for the recognition of science, its role in society and its value. For the first time, the role of the scientist was institutionalised as a distinct social role making ongoing research possible. From an individual and self-taught activity, experimental science was transformed into a recognised and collective activity. The creation of the Royal Society in England (1662), followed by the Académie des sciences in France (1666), were part of this movement to institutionalise science. Scientists appeared to the rest of society as a homogeneous community, governed by rules (a normative structure) and an internal social control system. They demanded that their role and autonomy in

society be recognised. Their use of mathematics helped them to stand out from other intellectuals and their doctrine-based approaches, as well as dilettantes and charlatans. The scientific community was built up outside the universities, which were still highly influenced by traditional disciplines. Nevertheless, having no specific institutional reproductive mechanism, the community still had to depend on these universities.

In different European countries, the scientific community under construction also claimed to be neutral and autonomous. It carefully selected its members so as to increase this autonomy further and partially isolated itself from other institutions, notably the universities, which it criticised. The community built itself up by excluding amateurs. The academies became the arenas of public debate where scientists reviewed scientific work. Furthermore, the scientific community gained the support of various authorities, depending on the country, and set itself up as an international and autonomous community.

Box 1.1 *Several key notions put forward by Ben-David*

Role: what is expected of an individual, a group or an institution acting as a unit of all systems making up society.

Reference group: a group holding specific expectations and sanctioning the behaviour of its members. The group grants its members retribution in the form of a *status* within the group. Members' motivation to fulfil their role depends on the retributions granted to them by the group. When members are subject to expectations and retributions emanating from other systems, they are faced with a *role conflict*. An agent can nevertheless *combine roles* and, hence, make innovation possible.

The Move from the Charismatic Scientific Revolution System to the Institution of Laboratories and Disciplines

In the eighteenth century, science was practised here, there and everywhere: in the academies, in the royal courts, in a few universities in the north of Europe and in individuals' homes. It developed around charismatic leaders, but lacked organisation. It experienced bouts of renewed esteem and bursts of creative activity, according to religious and philosophical fashions, but was not organised so that young people could be trained; it lacked continuity. Given this context, the appearance of new theories in physics and chemistry, combining experimentation and mathematics, did nothing to change the social structure of science.

In the nineteenth century, science was returned to the midst of the universities for contingent, political reasons rather than scientific reasons. There was a movement to regenerate the universities. The protagonists of this movement, both philosophers and scientists, attempted to set up professional training for the benefit of the state. In France, as in Germany, they deplored the universities'

backwardness and the authoritarian criticism that they practised. Being associated with oppressive institutions, the sciences in France were attacked by revolutionaries. At the start of the Revolution, the pure sciences and mathematics were considered as antisocial and aristocratic, before being reinstated as part of a philosophy based on the idea of Progress. The French *École Polytechnique* and *École normale supérieure* created within this context were part of this new type of academy in which the nation's scientific elite joined forces with the most outstanding scientists in order to dispense cutting-edge professional training in which science played a major role. Following the theories of Antoine Lavoisier and Pierre-Simon Laplace, which reflected the ideal of a perfect merging of mathematical theory and empirical data, defended by the academy, professors of science dispensed with knowledge that carried just as much weight as Latin grammar. Scientific education was recognised, but this did not automatically lead to training in research. Research remained within the academies (where scientific discussions took place) and private laboratories. Scientists helped each other in order to safeguard the academy of science. Science seemed to embody perfection, which was something that was so far lacking in biology and the social sciences. Classical physics was seen as a model and doubt was shed on any research that did not comply with this model.

In Germany, civil servants and philosophers joined forces to create the new Berlin University. It was designed as a grand academy, where creative scholars came together but where science was relegated to a minor role. This was because the philosophers thought they had already gathered together everything that deserved to be known into a philosophy of nature. In France, as in Germany, nobody seemed to be concerned with organising research.

However, the ambition to transform the Berlin University into the centre of German intellectual life (in the wake of political and military defeat due to the Napoleonic invasions) motivated other German states to reform their universities. Teaching became a political priority (the *Gymnasium* teachers had to be trained), and primacy was given to the faculty of philosophy (which included literature and science) over the other faculties (theology, law and medicine). The country's universities did not want to lag behind and offered professorships to attract the best young scholars while the slow economic development drew many gifted students to university careers. Alongside the laboratories, designed as supportive educational structures for teaching physiology and pharmacology, the seminars organised by the universities to improve their students' skills became places of research and experimental scientific practice. However, such practices were still considered to be beneath the universities. Rivalry led to laboratories being created in order to attract students rather than for research as an end in itself. Towards 1825, a network of laboratories within the universities emerged, although this was not in itself one of the objectives for science. Without necessarily having any scholars of great genius, this research organisation, composed of competing laboratories, led to some tangible results and a high level of scientific productivity, exceeding that of France. In around 1860, the scientific disciplines practised in these laboratories