DYNAMICS OF MODER
COMMUNICATION

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DYNAMICS OF MODERN COMMUNICATION

The Shaping and Impact of New Communication Technologies

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Preface

The idea of a technologically determined communication revolution with far reaching social consequences has been a recurrent theme in both elite and popular discourse for 30 years or more. Current excitement over Internet and the, so-called, Information Superhighway is merely the latest version of a hype previously attached to cable, the personal computer, satellites and videotext. The failure of each successive technology to deliver on the revolutionary claims made for it by policy-makers and business people does not appear to undermine this deep-seated faith in technological determinism.

This is not to say, however, that technology does not matter. While predictions as to the extent of change may be exaggerated and as to its nature, wrong, technology does, nonetheless, have effects which are not merely random, and technological choices have at times to be consciously made by both businesses and policy-makers. As a result a growing body of work has developed in economics, sociology and policy studies which attempts to understand how technologies develop, why some paths of technological development are followed rather than others and how and why technologies are adopted and used in societies – often in ways that are very different from those the designers and promoters of the technology imagined. Broadly, this line of research tries to replace a simple, a-historical and uni-causal technological determinism, which incorporates a stress on progress and inevitability, and thus predictability – technology as fate, with a historically based study of technological development and its impact as part of a complex economic, social and cultural process of change. Technology both shapes and is shaped by social processes whose very complexity makes the outcomes highly unpredictable.

This book comes out of this tradition. It is an important book which will be of unique value to students of communication because it combines original historical research on the development of communications technology and its social adoption since the late eighteenth century with an analysis based upon the best recent work in the sociology of technological innovation and social use. There are in this book two key messages for both students and policy-makers. First, that the early development of a technology is far from being scientifically determined but is one of struggle and controversy between different potential technological solutions and different visions of future use. Secondly, that the successful social adoption of a technology involves a process of learning and adaption on the part of users which itself shapes the technological solution adopted and determines its social impact.

Because the history Flichy is telling starts in France and the author is French there is a danger that Anglo-Saxon readers, more familiar with such histories told from an Anglo-American perspective, will be tempted to reject the book as being irrelevant to their concerns. This would be a mistake. The analytical approach being taken is essentially historical. It is concerned to explain technological development, adoption and impact as concretely socially situated in the context of a set of related economic, social, cultural and political determinants. Thus the history of each successive development in communications technology and its adoption has to be told where it actually took place. Thus because the story starts in France the book starts there too. As the story moves first to Britain and later to the United States they become successively the focus of the account. The history of technology may be increasingly a global history but technological development has passed and still passes through national and regional levels on its path to global adoption. That passage marks its development and is part of that process of social learning and adaption which we still too often mistakenly think of as the 'impact' of technology.

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Introduction

Over the past 20 years numerous authors have expressed their enthusiasm for the so-called communication revolution (cable TV, satellites, the VCR, videotext, microcomputers etc.). Their writings evoke a blend of technological and social utopia, extolling the abundant supply of television offering live broadcasts of events throughout the world, telematics providing access to the accumulated knowledge of a universal encyclopaedia, or mobile telephones enabling modern-day nomads to be 'switched on' constantly. These new technologies have indeed modified relationships between the public and private spheres, radically changing the organization of work, and transforming the functioning of democracy.

Most of these texts devoted to the new information and communication technologies give the impression that machines for communicating are a late twentieth-century invention. By contrast, this book will take a more objective standpoint, looking at contemporary tools from 'when old technologies were new' – to borrow Carolyn Marvin's expression (Marvin, 1988). Most of its subject matter is therefore situated in 'that long nineteenth century' described by Maurice Agulhon as stretching from the French Revolution to the 1950s. We are thereby able to examine 'the originality of a singular historical cycle, rather than the banality of a perpetual transition to the present' (Agulhon, 1988: 11). Indeed, the nineteenth century saw the birth of those machines on which today's communication systems are based: the telegraph and then the telephone, photography, the gramophone, the motion picture and radio. Contemporary technologies (satellite TV or mobile telephones, for example) should not be studied outside of this historical context.

Whereas the history of all these communication systems has already been written, few authors have looked at the links which existed between each of them. Numerous inventors worked successively on different types of devices and in each period the functions of communication took on a specific form manifested in the various media. A comparative analysis of the different communication devices is therefore particularly fruitful.

A new medium is never the fully fledged product of its inventor's fertile brain. The contribution of many researchers is required before a viable result can emerge from the different possible hypotheses and the combination of numerous preliminary micro-inventions. Historians often tend, in retrospect, to compose a harmonious picture in which each inventor's contribution appears indispensable to the final product. Yet, a detailed genealogy of these inventions brings to light a less consensual situation.

Innovations often grow from violent controversy: technological debates (is an electromechanical or an electronic solution better?); quarrels over technical usage (are Hertzian waves to be used in experiments only, or also for transmitting information?); controversy over social uses (should the phonograph be an office machine or a family tool?); and conflicts concerning the final marketing of the product (how should the user pay for the radio, by subscription or through advertising?).

My goal is to study these different controversies and the ways in which they were settled. While the inventors' skills in gaining support for their devices were of considerable importance, one also has to consider more long-term technological and social developments. In the technological domain, two basic systems were diffused during the nineteenth and twentieth centuries: electricity and electronics. Progress in these two scientifico-technical fields was to be a determining factor in the invention of communication machines. However, since this question has already been covered by the history of technology, it seems unnecessary for us to discuss it in detail here.

'An innovation', wrote Fernand Braudel, 'is conditional upon the social force on which it is based and which necessitates it' (Braudel, 1979: 477). The role of these 'social forces' in the invention of communication machines has enjoyed relatively little attention and is therefore one of the main focuses of this book. Particular emphasis is placed on the following four social movements: the birth of the modern state at the end of the eighteenth century; the development of the stock market during the 1850s; the transformation of private life with the appearance of the Victorian family; and, finally, the individualism of the late twentieth century.

Numerous historical works on the subject all but ignore the uses to which technologies are put; in fact, they implicitly assume that the utilization of machines is a natural result of their technical characteristics. In contrast, certain sociological studies of technology focus solely on the diffusion of a tool and tend to consider it as a 'black box'. The aim of this book is precisely to articulate these two contrasting traditions. The history of an invention is that of a series of technological and social developments, together with interactions between the two spheres. A new communications system is only established at the end of a long process in which each stage warrants attention. When a technical (or scientific) device shifts from one sphere to another, we can consider it captured, in both a military and hydrological sense of the word. When considered in the former sense, the strategies used to seize the technical device should be studied. In the latter sense, the metaphor is that of the flow of water in geological strata, from one river basin into another. The phenomenon appears in unexpected, although not random, places.

This book therefore analyses the development of communication machines by taking into account the major technological and social movements in which they were situated. My twofold ambition led me to reflect upon the origins of different communication systems (the semaphore telegraph, the electric telegraph, photography, the phonograph, the telephone, the radio, motion picture and television), while simultaneously examining

their technological and social contexts. I have started at the dawn of the industrial era, with the semaphore telegraph – the first reliable communication device in permanent use – and look at three periods, each corresponding to different types of research work: that of the researcher working alone, that of the small private laboratory and that of the large research centre. The first period (1790–1870) includes the birth of electricity, the concept of a network and the recording of images; it was one of controversy between state-controlled and market-controlled communication. During the second period (1870–1930) another controversy arose between professional and domestic or family use of communication devices. Research on electricity was pursued and Hertzian waves were discovered. The third period (1930 to the present) is that of electronics and the move from family communication to individual communication.

Although all the examples presented in this book[1] belong to the general field of communication (excluding writing), I have nevertheless favoured those which have hitherto received the least attention: telecommunications (telegraph and telephone) and sound technologies (the gramophone and radio). Each study is situated in the country in which the relevant communication device was developed in its established form (France, the UK or the USA, respectively).

Note

1 The original versions of some of these monographs have already been presented in seminars and have been published. However, the corresponding chapters of this book have been rearranged to a large extent.

'L'imaginaire collectif des ingénieurs : le cas des machines à communiquer', *Réseaux*, no. 36, CNET, Issy, 1989.

'L'historien et le sociologue face à la technique : le cas des machines sonores', *Réseaux*, no. 46–7, CNET, Issy, 1991.

'Nécessité sociale et innovation : du télégraphe d'Etat au télégraphe commercial', in François du Castel, Pierre Chambat and Pierre Musso (eds), *L'Ordre communicationnel II* (records of a research seminar 1988–89), La Documentation française, Paris, 1991.

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PART I
FROM STATE-CONTROLLED COMMUNICATION TO MARKET-CONTROLLED COMMUNICATION (1790–1870)

Introduction

Historians of the industrial revolution have noted that in eighteenth-century England no clear-cut distinction was made between science and technology. Scientists were fascinated by the technological progress made in industry, and technicians took a keen interest in scientific papers. For example, James Watt, one of the pioneers of the steam engine, was a mechanic at Glasgow University and cooperated with both renowned chemists like Black and influential entrepreneurs like Boulton (Musson and Robinson, 1969). In France, the *Encyclopédie* or the *Description des arts et des métiers*, published by the *Académie des sciences*, attempted to draw up an index of all scientific and technological knowledge. The close link between science and technology developed peculiar features in that country with the advent of a new player: the state engineer. The *ancien régime's* policy of establishing institutions for training its engineers (today's *grandes écoles*) was systemized by the Convention when it created the *Ecole polytechnique*. During the Revolution and the Empire, scientists and state engineers worked together in close cooperation.

Thus, scientists in the eighteenth and early nineteenth centuries were well aware of technological developments. In England this link with technology was achieved essentially through industry, while in France it was provided by the state. Constant exchange existed between scientists working alone in their offices or private laboratories, and their colleagues both at home and abroad. Some kept in close contact and compared their work in the large scientific institutions of the day: the *Académie des sciences* in Paris or the Royal Society in London.

In the field of long-distance communication by electricity, studied in this section, the exchange between scientists was all the more important since research remained confined to individual scientists' private laboratories for decades, without resulting in operational uses. Technological progress was thus the result of comparison with peers' work, and of the incorporation of discoveries on electricity.

How did research on long-distance communication move out of these laboratories? Historically, the first case was that of the semaphore telegraph

discussed in Chapter 1, which took on a new social meaning with the French Revolution and the constitution of the modern state. In Chapter 2, I look again at the development of the basic principles of a telecommunications network as defined at the time, and examine the progress of research on electricity. Chapter 3 studies the articulation between the new (electric) telegraph and a new social use: the transmission of financial and commercial information.

Reference

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1

State-controlled Communication: the Semaphore Telegraph

The idea of long-distance communication appeared in scientifico-utopian literature of the seventeenth and eighteenth centuries. Father Strada, in his *Prolusiones Academicae* of 1616, suggested that 'lovers separated by the severity of their families turn to account the sympathy manifested for each other through two compass needles' to communicate (Cazenoble, 1981: 96–7). The aim of this 'magnetic action'[1] was less to transmit messages than to communicate thoughts or feelings. Long-distance communication was thus telepathic, and the first technical description of a device for transmitting signals by semaphore, presented by the English scientist Robert Hooke in 1684, was entitled 'Method for *making your thoughts* known far away' (Gerspach, 1860: 48, italic added). Several years later, in 1690, the French physicist Guillaume Amontons conducted a first experiment in semaphoric communication in the Luxembourg Gardens. Fontenelle described the device as follows: 'The secret consisted of placing in several consecutive posts persons who, having perceived through a telescope certain signals from the preceding post, transmitted them to the following ones, and so forth' (Gerspach, 1860: 49). In the eighteenth century, several inventors were to perform similar experiments which were hardly more successful and none of which led to an effective device for long-distance communication.

The use for telepathic or telegraphic devices envisaged by literature of that period was primarily that of romantic communication. At the beginning of the nineteenth century a writer in the very serious *Mechanics Magazine* (24 November 1827) suggested that by means of semaphores 'a lover might . . . conspicuously *signalize* his devotion to the fair one of his heart; and the pining mistress might learn from the expanded *arms* of the telegraph how soon she should be restored to the arms of her betrothed' (Wilson, 1976: 71).

Romantic communication was similarly to appropriate another medium in the eighteenth century – the 'string telephone'. This device was also described by Robert Hooke in 1667: 'By using a taut string, I was able to instantaneously transmit the sound over a long distance.' Later, it would often be called the lovers' telephone. In the eighteenth century, long-distance communication devices, whether real or imaginary, were thus for a romantic use. But romantic communication is by nature impulsive, secret and exclusive, and therefore contrary to the idea of a permanent infrastructure. There were two configurations which suited it: the 'string telephone' which allowed for secret communication in a public place (etchings of that period show lovers

communicating from one side of a public square to another) and telepathy.

Thus the semaphore telegraph – known and tested from the end of the seventeenth century – was not developed for a century, for lack of an appropriate social structure capable not only of imagining the advantages of long-distance communication, but also of backing the construction of a permanent network. It was first in France with the Revolution and the creation of the modern state that a social agent prepared to take on the establishment of a permanent infrastructure appeared.[2] I shall therefore closely examine the birth of the semaphore telegraph in France, before briefly presenting the development of this medium in other countries.

Communication of Enlightenment Thought

Convincing the Convention

At the start of the Revolution, Claude Chappe was a young physicist who performed several experiments with electricity, of which the results were published in the *Journal de Physique*. In 1790, he defined a new technological project: 'to give the government the means to transmit its orders over a long distance in the shortest time possible' (Chappe, 1840: xii). He was to try several solutions (electricity and sound) but finally visual signs with the aid of a lens seemed to him the most effective system.

Chappe soon realized that he required the assistance of the National Assembly[3] to develop his system. The first message which he transmitted, during his first experiment in the Sarthe on 2 March 1791, a year before presenting his memorandum to the Assembly, was as follows: 'The National Assembly will reward experiments which are useful to the public.' An analysis of his letters and reports presented to the Convention show us how Chappe and the commissaires[4] who supported him obtained approval from the political authorities.

In the petition which he presented on 22 March 1792 to the Legislative Assembly, Claude Chappe insisted that his system be put to use, claiming it to be 'a sure means of establishing correspondence so that the legislative body may send its orders to our borders and receive a reply during the same session' (Gerspach, 1860: 57–8). Two years later (31 August 1794), several months after the first telegraph line had been installed, the use imagined by Chappe was to become a reality:

> *Carnot* [*going up to the tribune*]: Here is the telegraphic message which we have just received. Condé is restored to the Republic. Surrender was at six o'clock this morning.
> *Gossuin*: . . . Condé is restored to the Republic; let us change its name to Nord-Libre.
> *Cambon*: I request that this decree be sent to Nord-Libre by telegraph.
> *Granet*: I request that at the same time as you inform Condé, by telegraph, of its new name, you also inform the fine army of the North that it remains worthy of the homeland.

Later in the session, the chairman read out the following note by Chappe: 'I hereby announce, citizen-chairman, that the decrees of the National Convention . . . have been transmitted to Lille; I received the signal by telegraph.'[5]

We shall see that it was with regard to military news that Chappe's project to govern in 'almost real time' materialized. Gilbert Romme, who was to be made responsible by the Legislative Assembly and then by the Convention for assessing Chappe's proposition on behalf of the Committee of Public Education,[6] was to take advantage of this military demand.

On 12 March 1793, the representative of the Convention in Belgium asked for a regular service of dispatch riders to be organized, so as to have continual contact with the armies. Romme, who was preparing his report on the telegraph, suggested replacing the dispatch riders with Chappe's telegraph.[7] On 1 April, he presented his report to the Convention on behalf of the Committees of Public Education and War.[8] The only use he mentioned was military. The same was true for the Lakanal Report presented on 26 July 1793 to give an account of the experiments proposed by Romme on 1 April and decreed by the Convention.[9] These two reports also insisted on the reliability of Chappe's system and on its capacity to ensure the confidentiality of correspondence.

'The main idea behind the adoption of the telegraph was thus entirely military. Chappe, the Convention and the Committee of Public Safety saw telegraphs, before all else, as instruments of war' (Gerspach, 1860: 334). For Edouard Gerspach, as for most historians of the semaphore telegraph, the conclusion was clear: Chappe succeeded where others had failed, by making use of the demand from the War Department. Indeed, he enjoyed constant support from the Committee of Public Safety in 1793–94 (expropriation, requisitioning of equipment, etc.), and the first telegraphic line was set up in the framework of a war economy.

It was not the first time in the history of the eighteenth century that France was at war. Guillaume Amontons developed his system during the war of the Augsbourg League, and the political authorities took no interest in it. I think that in fact the decision to construct the system was not purely military. In a letter addressed to Lakanal by Chappe, and written after the first experiment had been conducted before the Convention, the latter said of his project's opponents:

> How could they not have been struck by the ingenious idea which you developed yesterday at the Committee [of Public Education] and of which I had not thought? The establishment of the telegraph is, in effect, the best answer to those publicists who think that France is too spread out to form a Republic. The telegraph shortens distances, uniting a huge nation on one single point. (Guillaume, 1891: 7)

On 17 August 1794 Barère (a member of the Committee of Public Safety) informed the Convention of the telegraphic transmission of news on the capture of Quesnoy. He declared: 'By this invention distances between places disappear in a sense. . . it is a means which tends to consolidate the unity of the Republic by the intimate and sudden contact which it gives to all parties.'[10]

The use of the telegraph to ensure national coherence was described by Rabaut-Pommier. He employed the image of instant national mobilization:

> And if in times of peace allied despots wanted to invade our territory, the war cry 'To arms!' would become a decree and would sound throughout the Republic; citizens would leave their occupations to seize their arms, and numerous armies formed suddenly would confront the surprised enemy with barriers which it would not be able to surmount.[11]

Rabaut-Pommier, moreover, had the start of the telegraph line installed on the roof of the Unity Tower of the National Palace (the Tuileries).

A new conception of space

Chappe's innovation was in keeping with an ideological context which went well beyond the targeted uses (military and political) of the device. The Revolution was a period of restructuring the national domain. From July 1789 (when Chappe began to think about his system), the National Assembly debated a new administrative partitioning of France. Thouret imagined a rectangular division, Barère proposed one which would create equal populations. Either way, it was a question of putting an end to regional peculiarities and enforcing national unity by creating divisions based on territorial and demographic equality.

For Barère, the aim of this partitioning was to 'remove all memories of history, all prejudice resulting from the community of interests or origins. Everything must be new in France and we want to date [time] only from today' (Ozouf, 1984: 33). Finally, a partition which mainly took natural borders into account was adopted at the beginning of 1790. This partition into *départements* has scarcely changed for two centuries.

As Mona Ozouf notes, centralization already present under the *ancien régime* 'was worsened further by the link created during the Revolution between the French nation and universal values; peculiarity seemed henceforth not only a hindrance to the national spirit, but also an obstacle to the formation of a universal and generic man' (Ozouf, 1984: 27).

The unity of this homogeneous space had to be constantly strengthened. The telegraph was well suited to the dynamics of territorial coherence. We can thus understand the dispatch published by *Le Moniteur universel* of 6 January 1798 indicating that, thanks to work undertaken by Chappe, Strasbourg could communicate with Paris in 36 minutes. The *Moniteur* also published on 2 September 1794 Chappe's dispatch concerning the capture of Condé (see above). It was signed 'Chappe, engineer-geographer'; what could seem to be a misprint (geographer for telegrapher) was, in fact, a slip of the pen which well illustrated the fact that Chappe's system was part of a reorganization of the national domain.

While the telegraph was well suited to revolutionary rhetoric, it also had a symbolic existence on an architectural level. The dispatch from Strasbourg shows us that 'the telegraphic machine was to replace the cathedral belltower.' As for its installation on the roof of the Tuileries, Rabaut-Pommier

tells us that 'these constructions will add to the external decoration of the National Palace. By an optical illusion, the poles for supporting the gallery of the telegraph will disappear, so that it will appear to be suspended and without a support'.[12] Thus the scientific works of the Enlightenment were to replace the symbols of royal and religious power. But to celebrate the cult of Reason, science was readily transformed into magic!

The symbolic rather than functional aspect of Chappe's machine had been noted by the German scholar Bergstrasser, the author of several works on the telegraph:

> I fear that the French use their telegraph for nothing other than a political goal; it is used to entertain the Parisians who, their eyes forever riveted to the machine, say 'It's working, it's not working'. They take advantage of this to attract the attention of Europe and so to imperceptibly attain their objective. (Chappe, 1840: 148)

New conception of time

In the second version of his report, Lakanal defined the telegraph as follows: 'It shortens distances. A rapid messenger of thought, which it seems to rival in speed' (Lakanal, 1795: 3). Chappe had, moreover, at first wanted to call his machine a 'tachygraph' ('who writes fast'). In his report to the Assembly, as in those of Romme and Lakanal, the rapidity of transmission was one of the main points of the argument, and very precise transmission times were quoted. For Rabaut-Pommier, 'a decree could be transmitted to the ends [of the Republic] half an hour after being issued, proclaimed forthwith and executed the same day.' Thus, at any place in the nation, the same events could be lived simultaneously.

Bonaparte was one of the first to understand the political value of this new medium. On the evening of the *coup d'état* of *18 brumaire an VIII* (9 November 1799) he had the following dispatch sent by all the telegraphic lines: 'The Legislative Corps has just been transferred to Saint-Cloud by virtue of articles 102 and 103 of the Constitution; the General Bonaparte is named commander of the armed forces of Paris. Everything is perfectly calm and the citizens are content.'

Two days later, Chappe submitted a new dispatch to the Consuls: 'The Legislative Corps has named a three-member *Consulat* to replace the *Directoire*. . .',[13] followed by names and details on the nomination of a legislative commission. The Consuls had the following sentence added: 'Paris is satisfied and public funds have increased by 25 per cent' (Belloc, 1888).

This new telegraphic time, which permitted an almost instantaneous dissemination of information, was in keeping with the revolution of time that members of the National Convention, and particularly Romme (the main author of this reform of the First French Republic), wanted to undertake. When Romme was preparing his report on the telegraph, he chaired a working group on the reform of the calendar with the cooperation of scientists like Lagrange and Monge. Romme wanted to break away from the *ancien régime*, start a new era, make the 'republican calendar' an instrument of ideological

struggle against Christianity. These aspects of reform are well known. What is less known is the desire to introduce a rational division of time: months equal to 30 days (plus a special unit of five days), decades, instead of weeks which 'did not divide exactly neither the months, nor the year, nor the lunations', and, in particular, use of the decimal system to divide the day into 10 hours and the hours into tenths and hundredths.

Reform of the calendar was linked to that of weights and measures, although the principle of the latter reform was accepted by the Constituent Assembly. On 21 December 1792 the Committee of Public Education designated a single commission to prepare the two reforms.[14] 'You have undertaken', declared Romme during the presentation of his project:

> one of the most important operations for the progress of the arts and human minds and which could only succeed in a time of revolution. That is, making diversity, incoherence and inexactitude of weights and measures which continually hinder industry and trade, disappear; and taking, even for measuring the ground, the unique and invariable type of all new measures. The arts and history, for which time is a necessary element or instrument, also require new measures of duration, similarly rid of the errors which credulity and superstitious routine conveyed from centuries of ignorance through to us. (Romme, 1793: 1)

As Bronislaw Baczko notes, 'reform of the calendar was in keeping with the framework of a vast enterprise of rationalization which would affect social life as a whole' (Baczko, 1978: 217).

New measures

In 1789 the metrological situation was truly chaotic (Kula, 1984).[15] Different objects were measured with different units; some were in paces, others in cubits or in feet. Certain measures had no physical objectivity, and land was measured according to the number of days' work (in Bourges, for example, an acre was equivalent to 16 days' harvesting). Furthermore, measures varied from one parish to another. At certain markets two or three systems of weights were used simultaneously for measuring wheat. Royal authorities repeatedly tried, in vain, to unify the system of weights and measures. In fact, local metrological particularism was part and parcel of the privileges of the nobility who could always take advantage of it to increase taxes, generally paid in kind. Metrological unification was a significant claim in registers of grievances, but it was only with the upheaval of the Revolution that this was to be realized. As Kula notes, such unification 'was impossible without the Night of 4 August, without the Declaration of Human Rights. Metric reform, the abstract and nationalist work of a few academics, could only become a social reality with the abolition of feudal privileges and the proclamation of equality of all before the law' (Kula, 1984: 210).

Such reform was to be modelled by the rationalism of the Enlightenment. The demands in the registers of grievances were for an end to metrological arbitrariness and for local unification. The academics responsible for implementing this reform, and particularly Condorcet, wanted to give it a universal character and a natural base. Condorcet, as secretary of the

Academy of Sciences, wrote in his report to the National Assembly in March 1791:

> The Academy has tried to exclude any arbitrary condition, anything which could hint of the influence of a particular French interest or a national bias. In short, it wished that if the principles and details of this operation were to be passed to posterity, it would be impossible to guess by which nation it had been ordained and executed. (Kula, 1984: 225)

That is why the Assembly took a quarter of the earth's meridian as the basis of the new metric system.

Under the Convention, reform – like the telegraph – seemed intended more to strengthen national unity. In his report presented on behalf of the Committee of Public Education at the Convention *le 11 vantôse an III*, Prieur de la Côte-d'Or indicated: 'Unity of the Republic demands that there be unity in weights and measures, as there is unity in currency, unity in language, unity in legislation, unity in the government, and unity of interest in defending oneself against outside enemies and for marching together to all kinds of prosperity' (Kula, 1984: 223).

The Enlightenment intellectuals' desire for unification was also at the centre of numerous reform projects for schools examined by the revolutionaries. Condorcet, Romme and Lakanal were the authors of such projects, as were Arbogast and Daunou (the two *commissaires* responsible with Lakanal for supervising Chappe's first experiments). Lakanal wrote in his Report on the establishment of *écoles normales*[16] in October 1794: the springhead of the Enlightenment, 'so pure, so abundant since it will start with the first men of the Republic, of all kinds, and will overflow from reservoir to reservoir, will spread from one sphere to another in all France, without losing any of its purity in its course' (Julia, 1988: 206). His hydraulic comparison was possibly inspired by a machine he had to evaluate for the Committee of Public Education but, whatever the case, this model of diffusion by relays is exactly that of the telegraph.

A universal language

All these reforms in space, time and systems of measures had the same justification: rationality, simplicity, universality. The universal vocation of the Revolution expressed by Lakanal, who spoke of 'the Republic which by its huge population and the genius of its inhabitants is destined to become the teaching nation of Europe', led some to envisage a universal language. This was notably the case with Condorcet, from whom Romme took his main educational ideas (Galante-Garonne, 1971).[17]

The project of a universal language developed by Condorcet was fairly close to that of Leibniz. It was a matter of discovering the intellectual operations at the base of all reasoning. This project was initially applied to the sciences but its ambition was broader, since it was essentially a linguistic analysis of knowledge (Granger, 1954: 197–219). Other revolutionary intellectuals wanted to construct an artificial universal language, an Esperanto

before its time. Delournel, for example, presented a 'universal language project' to the Convention in 1795.

Themes such as these were adopted by an intellectual movement called the Ideologists (of which Daunou was a member), which prevailed at the time of the *Directoire* and the *Consulat*. Some of them considered changing the language. For Lancelin, 'the uniform division of the French territory, uniformity of legislation and administration for all *Départements*, and finally the establishment and introduction of a uniform system of weights and measures for the entire Republic are new steps towards this goal' – a general analysis of ideas.[18] His project 'did not only seek to determine the common foundations of all languages; [it] was also animated by the dream of finding the lost universal language whose restoration would ensure perfect communication, the true base of understanding and social communication' (Branca, 1982: 59–66).

Such universal language utopias are a reflection of the concrete difficulties which the revolutionaries experienced in trying to get their political message across. The Directoire of the Corrèze (*département*) indicated, for example, that 'the translator from the Juillac canton did not have the accent of the other cantons which differed more or less, particularly at a distance of seven or eight leagues' (de Certeau et al. 1975: 162). In the face of such linguistic fragmentation, a means of communication had to be found to constitute a public sphere. Thus Pierre Bernardeau wrote to Abbé Grégoire: 'The knowledge I have of the country surrounding me made me think of translating, into the most common language out of all the jargon of its inhabitants, the blessed Declaration of Human Rights.'[19]

Such projects for a universal language soon proved to be impractical. Reforms envisaged were rather relative to vocabulary and spelling, and a principle for the multiplication of words was sought. For Degérando, French multiplied meanings rather than words: 'The language therefore suffers from the vice of extreme indetermination with the result that men living in the same country and using the same words, often understand one another as little as if they were talking in a foreign language.'[20] It was thus a question of rationalizing the construction of vocabulary. Furthermore, the reform of spelling, like that of weights and measures, was to allow for the definition of a rational system, so that the sounds of words could be noted in a universal fashion, and the use of the language standardized. 'It was necessary to try to have a single elocution in a single and indivisible Republic.'[21] In the end the universal language was simply the diffusion of French across the Republic as a whole. Like the reform of weights and measures, which in 1790 Talleyrand had envisaged could be led jointly with England so as to be truly universal, it became national and Jacobin.

In January 1794 (when Chappe was building his first telegraphic line), Grégoire and Barère presented a report to the Convention which concluded with the necessity of making French compulsory in all public acts. But as Renée Balibar indicates, the real linguistic revolution was less the diffusion of French as opposed to patois, than that of writing 'the Republican language'. This language, considered 'universal' in the nation, was 'founded on the grammaticization of the French language and appeared explicitly as the expression of popular sovereignty. [It represented] the condition of "communication" between citizens and with the State, in the debates of assemblies, the reports of commissions, the laws, and in the organization of the new school system' (Balibar, 1988).

Ignace Chappe, who was the ideologist of the family,[22] related their project to the idea of a universal language. 'We were strangely wrong' he wrote:

> in saying that the telegraphic language was a universal language or a plausible language as Leibniz conceived it. This philosopher wanted to introduce a new method of reasoning founded on formulae similar to those used in algebra . . . but they could only be universal for rules of logic and they would not have served to indicate . . . The telegraph thus only writes languages which are already formulated; but its language becomes almost universal in that it indicates combinations of numbers instead of words, and that the manner of expressing these numbers is generally known and can be applied to the words which compose all dictionaries. His aim is not to find a language which is *easy to learn without a dictionary* (Leibniz's expression in his letter to M. Renard) but to find the means to express many things with few signs. (Chappe, 1840: 135–6)

Numerous innovators

All these utopian conceptions of space, time and communication were produced not only by the intelligentsia and politicians but also by unknown persons who sent letters to the Convention or the Committee of Public Education. Some of this literature is still accessible today in the French national archives. From 1792 to 1798 there was one invention project per year for a long-distance communication system. Some of these projects were completely impracticable, such as Julien Chapus' cannon-ball mail, whereby a letter introduced into a cannon-ball was shot from cannon to cannon in a relay system.[23] Some were very rudimentary, such as that of Labarthe which coded messages by means of cannon shots.[24] Others, such as Bréguet's and Bethencourt's systems, proposed alternatives for semaphore telegraphs.

My intention in this chapter is, however, not to write a technical history of telegraphic inventions, but a history of the representations of the technology. The amateur inventors of this period are of interest to me because of their discourse. The idea of instant communication was part of the utopianism of the era. Favre discovered a system which permitted 'the transmission in a few seconds of a mind's image from one end of the Republic to another', but he was careful not to reveal his method.[25] A 'citizen of Angely-Boutonne' sent two notes, one on the telegraph, the other on 'Directions on the French Calendar', preceded by 'Reflection on chronology in relation to the people's freedom'.[26]

This twofold interest in the revolutionary calendar[27] and communication was also to be found in Morin's memorandum. He proposed a system of phonetic writing 'which gives an accurate image of speech' and 'reduces it to its most basic simplicity'. He hoped to 'make France and all peoples of the earth enjoy this great advantage which should contribute to the progress of the Enlightenment and make French a language of communication with all

peoples'.[28] To illustrate his phonetic writing he used the example of the republican calendar. Morin, steeped in Enlightenment ideology, was so convinced that one needed only a little simplicity and universality to understand nature, that he described in a second note another discovery: the 'mechanism of nature', the matrix of all sciences.

All these scholarly or spontaneous representations of space, time, measurement systems and communication constitute the prevailing outlook in which Chappe was able to develop his innovation. He was not content to convince the military lobby of the Convention alone. Moreover, his project was adopted by Romme and Lakanal not only because it was reliable (it was not unique in this respect) but because it was in keeping with the new perception of space and time which had appeared under the Revolution. Chappe's advantage over Amontons was that he proposed a project which corresponded to the way of thinking of his era.

If we look further at this idea of correspondence between a technology and an outlook, we see that the semaphore telegraph did not correspond to any significant technological development. It was situated in a technological paradigm which had been stable for the preceding two centuries. One could therefore consider at one level that we are dealing with a latent innovation which the movement of ideas resulting from the Revolution had allowed. Yet, the histories of the telegraph, the calendar and systems of measurement reveal an interpenetration between technological and social dimensions.

Chappe was a product of the Enlightenment and the Revolution. In his account to the Legislative Assembly, he stated:

> The most difficult obstacle to conquer will be the spirit of prevention, with which creators of projects are normally received. I would never have been able to get beyond the fear of being associated with them, had I not been supported by the persuasion that every French citizen owes to his country, now more than ever, the tribute which he believes will be useful to it.

Two years later, Barère gave his reply in his speech to the Convention:

> In spite of the Enlightenment which characterizes the end of the eighteenth century, modern inventions are not shielded from the ridiculous accusations which also struck brilliant ideas in other centuries. It is up to the legislators to stop the clamours of ignorance or the agitation of curiosity; it is for the National Convention to encourage the arts and sciences.

Chappe was thus persuaded that he was participating in the progress of the Enlightenment. On the other hand, earlier inventions were considered as mere curiosities.[29]

State communication

Diffusion of innovation

Diffusion of the telegraph was largely related to that of the republican calendar and the metric system. All three seem to have resulted from the

Revolution and they spread with the movements of the French armies. The telegraph was to be extended towards northern Italy (Turin–Milan–Venice then Trieste) and Flanders (Antwerp–Amsterdam and Brussels).

Diffusion of Chappe's telegraph, in particular, was linked to the extension of the Republic. It was only implanted in those territories annexed by France and in certain sister republics. Kula notes that in other European countries, conquered later by Napoleon, it was not republics but kingdoms which were created, and no attempt was made to introduce the metric system. 'The time of exporting the republican régime, the metric system [I could add Chappe's system], in short, the Revolution, had already passed' (Kula, 1984: 206). In 1814, the Italian and Flemish parts of the telegraphic lines were closed, as pro-French Europe abandoned the metric system.

The republican calendar was abandoned in 1806 after 12 years. In retrospect, it seems hardly surprising that the most purely ideological reform did not survive the Revolution. We should not forget that, as Kula (1984) has demonstrated so well, there was also considerable resistance to the metric system. If the registers of grievances requested the unification of weights and measures, it was more a question of harmonization on a local level than creation of an abstract universal measure which used the decimal system. The 'Republican' system of measures was as ideologically weighted as were the calendar and the telegraph.

The reason for the calendar's failure has been clearly explained by Baczko. While there existed considerable diversity of weights and measures, the Christian world had unified its measurement of time on the Gregorian calendar. The need for universality was thus far less obvious. Similarly, the English who had unified their system of measures were hardly interested in the metric system. The latter was finally to be adopted in Italy, in Germany and in Russia (along with the Gregorian calendar) at the time of the 1917 Revolution.

Baczko concluded his research on the Enlightenment utopia by indicating that social imagination 'goes through "heated" phases characterized by a particularly intense exchange between the "real" and "fantasy", by a greater pressure by the imaginary on daily living, by explosions of passions and desires. This is notably the case of revolutionary crises' (Baczko, 1978: 218). We recall the May 1968 slogan in France: 'Let's indulge in wishful thinking';[30] that intensity of desire, that force of social imagination, was one of the conditions for the birth of the telegraph. It was common to Chappe and other inventors of the telegraph alike. While Chappe triumphed thanks to the reliability of his system, he did not hesitate to use ideological arguments to fight his most serious competitors. He thus wrote to the Convention, attacking Bréguet's and Bethencourt's projects: 'Irrespective of the perfection of their machine, the government must not permit that the telegraph, born French, passes to posterity disfigured by the rags of foreign livery.'[31] Indeed, Bethencourt was Spanish!

The Chappe brothers worked not only on the technical, but also on the social and political aspects of their invention. This was shown notably by the

fact that their system survived changes of régime, from the Convention to the July Monarchy. In 1832, during his retirement, Abraham Chappe alerted the Minister of the Interior to the necessity for laying the legal foundations of the telegraphic monopoly. According to Antoine Lefébure, this intervention played a decisive role in the preparation of the 1837 Act (Lefébure, 1984: 11–21).

Use of the telegraph

There was of course a discrepancy between society's idea of the telegraph and its effective uses. Rabaut-Pommier declared in 1795: 'One day, when peace permits the perfecting of useful inventions, the telegraph applied to trade, physics, politics, even agriculture, will multiply means of communication and make them more useful by their speed. The author of this fortunate invention has already used it to warn of storms.'[32] In fact, the extension of the telegraph's use outside the military field was very limited. In 1799, Chappe suggested to the *Directoire* using the telegraph for transmitting exchange rates and announcing the arrival of ships in ports. In 1801, under the *Consulat*, he renewed his proposition by extending it to the diffusion of national lottery results and the transmission of an official information bulletin approved by the First Consul. Only the lottery project was accepted. Several historians see in this the refusal by the state to open its communication networks to the private sector. It was, however, not the only reason; these projects necessitated the extension of the network towards ports, while the First Consul had just cut the telegraphic services' budget by a third (Gerspach, 1860: 29–31).

Other reasons for the failure of attempts to extend the use of the telegraph are to be found in the lack of demand. The industrial revolution was still in its infancy in France and the demand for rapid transmission of industrial and commercial information was limited. During the Revolution and the Empire, uses of the telegraph were essentially military; under the *Restauration* they were rather for the police.[33] Abraham Chappe described in a letter of 23 August 1832 the role of the telegraph after the Empire:

> [telegraphic lines] carry to the centre of government, at the speed of thought, all political feeling . . . This communication verifies all administrative reports, it gives more unity of action . . . When the government has to be ready to defend itself against attacks, when each minute must be efficiently used . . . a similar means must be considered, rightly, as one of the most powerful administrative means and one of the most worthy of interest. The telegraph is thus an element of power and order.[34]

The construction of lines was most often linked to a specific request related to current events. The first Paris–Lille line was built under the Convention for communicating with the army in the North. The *Directoire* requested the installation of the Strasbourg line to be able to communicate with its plenipotentiaries during the Rastadt Congress. Napoleon, to improve his communication with Italy, wanted to build the Lyons–Milan line in 15 days. After the Russian campaign, he also requested the urgent construction of a

Strasbourg–Mayence line. Under the *Restauration* a Paris–Bayonne line was similarly built in preparation for the Spanish expedition of 1823.

Such principles for building the network did not allow for an effective response to the development of the military/police demand. In 1829, wanting to argue for the construction of a coherent network, Abraham and René Chappe recalled that news of Napoleon's landing in the Juan gulf in 1815 did not reach Lyons until three days later, and from there a telegram was sent to Paris (Chappe and Chappe, 1829). The Lyons–Toulon line was to be built only in 1821.

Other European networks

In other countries the semaphore telegraph was also being developed according to the demands of military activity.[35] The British Admiralty built telegraphic lines between London and four coastal ports in 1796 and 1808. In 1814, these lines were closed. Similarly, in The Netherlands a telegraph was built in 1831 during the Belgian War of Independence and was closed as soon as the war ended. Except in France, the installation of a permanent transmission device for the needs of the state was developed later. Britain installed a network of semaphores in the 1820s for the Admiralty's needs. It is interesting to note that the Admiralty closed the lines which served during the Napoleonic wars and declared in 1816 to Ronalds, an inventor of the electric telegraph, 'telegraphs of any kind are now totally unnecessary, and no other than the one now in use will be adopted' (Wilson, 1976: 33). Yet it had a new semaphore system built to cover the same areas (Deal, Portsmouth and Plymouth) with slightly different alignments.

Some historians, such as Jeffrey Kieve (1973), are surprised by the Admiralty's lack of insight when it failed to grasp the opportunities offered at that time by the electric telegraph. I think, on the contrary, that it proves the real demand for a permanent communication system. The semaphore telegraph, already running smoothly, seemed to the Admiralty more reliable than an electric telegraph still in its infancy.[36]

It was only in the 1830s that the other European states built telegraphic links. In 1832 Prussia built a Berlin–Coblenz line and Sweden installed a network around Stockholm. In 1839, Russia established a line between St Petersburg and Warsaw. In Spain, a real network was installed: Madrid–Irun in 1845 and then, from Madrid, links with Barcelona, Valencia and Cadiz. These networks were, however, short-lived. The English network was to be replaced by the electric telegraph in 1847, while on the Continent the transformation was to take place later, in the 1850s.[37]

All these telegraphs belonged to the state and were managed by the military (England, Prussia) or by state civil engineers (Spain, Sweden). They were instruments intended to strengthen national unity and consolidate the power of the state. For Prussia, the telegraph which crossed the independent states of central Germany constituted in the strict sense a link between the two parts of the country (the Rhineland and Eastern Prussia). For Russia, the

Warsaw line enabled it to consolidate its annexation of Poland. In Spain, the construction of the telegraph came in a period when the monarchy had to fight the Republicans and Carlists. In Sweden, the main function of the network was to ensure communication between the continent and the islands. These different networks were to retain their national character. The Spanish Irun line, for example, ended just a few miles from the French (Béhobie) line; yet, in spite of this proximity, they were never connected.

Operation of the semaphore telegraph would have lasted around half a century. The seeds of this system's technical potential had existed since the seventeenth century, but the telegraph became a reality only because it accorded with a major change in attitudes: that of the French Revolution prepared by the Enlightenment. A French utopia seemed at the time of the Revolution that of universality; redividing space evenly, measuring it with a new unit based on nature, counting time in a new way, creating a universal language so as to ensure perfect communication.

The universality of 1789 was rapidly reduced to the French nation. The Revolution created the modern nation-state, a nation where citizens all had the same rights, a state where territorial units all enjoyed equal status. In order to guarantee its coherence and unity, this nation-state needed a system of rapid communication, and behind the transformation of outlook it generated a demand for such a system. Under the Revolution and the Empire, this demand was essentially military; under the *Restauration*, it also became that of other sectors of the state apparatus, notably the police.

This association between the telegraph and the creation of the nation-state was not solely French; it was equally present in other European countries. But if the semaphore telegraph was largely associated with France, to the point where numerous histories of telecommunications ignore the English, German or Spanish systems, this is undoubtedly because it was created by a Frenchman during the Revolution and because the idea of a nation-state was largely a product of the revolutionary model. In conquering Europe, under the pretext of awakening liberty, the republican and then imperial armies were to arouse national sentiment in Prussia, Spain and Russia (Gusdorf, 1987).

Impossible trade communication

In 1836 an affair of telegraphic fraud sparked off debate again on the use of this means of communication. Two bankers from Bordeaux had bribed a telegraph employee to add signals to official dispatches. This system permitted them to be informed of the development of the rate of government stocks before the arrival of the press which was sent by post. The device was rather rudimentary and made this affair seem incredible. To avoid transmission errors, inevitable in Chappe's system, each dispatch was decoded half-way by the director of the local office in Tours. The message was then retransmitted to Bordeaux. The pirates introduced additional signals after Tours, indicating

stock market developments. To inform their 'stooges' carrying out the operation, the fraudsters sent them, by post from Paris, white or grey gloves depending on whether the rate of the stocks was going up or down. The fraud lasted for two years. When it was discovered, the protagonists were detained for trial but then released. Since the state telegraphic monopoly was not defined by law, they could not be convicted.

From de facto *to* de jure *monopoly*

The two Bordeaux bankers were not the first to discover the value of information in the establishment of stock market rates. Under the *Restauration*, the Rothschilds had already set up a system of private mail which permitted them to know, before anyone else, the main political events and rates on other markets. Thus the 'assassination of the Duke of Berry, in February 1829, was known in Frankfurt by the House of Rothschild well before everyone else. It then made necessary arrangements and only announced the news after having sent its mail and its orders' (Gille, 1959: 262). Regarding French intervention in Spain, the Prime Minister Villèle noted in his mémoires: 'The Rothschild mail again caused our government funds to rise. It is spreading the rumour that there will be no intervention. Misleading increases which prepare new fluctuations in prices and high losses tell me nothing good'(quoted in Gille, 1959: 262).

Those bankers who did not have the means to set up private postal systems across Europe also thought of using the telegraph, and other clandestine operations took place between Paris and Lyons. At the start of 1832, Alexandre Ferrier launched a subscription to constitute the capital of a private telegraph company which was to link the main European towns.[38] He envisaged an essentially commercial use. His telegraph offered 'the immense advantage of having an idea, at a glance, of all the markets, of being present at all the stock markets and giving their operations more supply at the same time than safety stock' (Ferrier, 1832). The demand for stock market information in the provinces rose sharply in the 1820s. According to Bertrand Gille (1959: 178), it was at this time that people in the provinces began subscribing on a large scale for government stock.

Ferrier obtained the support of Casimir-Perier (President of the Council and Minister of the Interior), who wrote to him: 'I have seen in this question of public usefulness, progress in civilization which promises real advantages for industry, and I am pleased to be able to encourage it with my approval.'[39] Ferrier could similarly give about 40 deputies as a reference: liberals of the (left-wing constitutional monarchy) movement's party like Laffitte, LaFayette or Odilon Barrot, bankers like Benjamin Delessert, jurists, and so forth. He also assured his future subscribers of 'the approval of the traders consulted on the utility of the project'. He was finally surrounded by the advice of several lawyers who concluded that, without a law on the telegraph 'the powerless administration will have to respect the property rights and freedom of industry'.[40]

In the full assurance of this support, Ferrier built a Paris–Rouen line and prepared the installation of a national network. He was convinced that he would obtain government backing, and wrote to several prefects asking them to indicate 'trustworthy persons whom he could appoint as managers of the lines he was to create'.[41] Negotiations were moreover initiated with the Minister of the Interior to study possible cooperation.[42] Then in June 1833, the administration broke off the negotiations and decided to have a law voted on telegraphic monopoly.[43]

This about-turn by the political authorities is interesting. At first the position of the liberal business bourgeoisie (Casimir-Perier, Laffitte) prevailed, then finally a position of affirmation of the state monopoly was adopted in the bill which was voted by Parliament in 1837. Furthermore, the opponents of the bill in the Chamber of Deputies, as in the *Chambre des Pairs* (the Upper House), were fewer than the petitioners in 1832.

The defenders of private use of the telegraph presented two options: either the creation of private lines, or the opening of state lines to the public. Vatimesnil, with the aid of a post/telegraph comparison, summarized these two options very well:

> The post office monopoly of mail can be justified, firstly because it is a source of government revenue, and secondly because it does not disadvantage private persons, since the administration undertakes to have their dispatches transported. On the contrary, state monopoly of telecommunications earns nothing for the government and would rather harm citizens' interests by preventing them from using this mode of correspondence which is so rapid, and consequently so fitted to imparting a new activity to trade relations. For matters to be otherwise, it would be necessary for the government to establish telegraphs on all important communication lines and put them at the service of private persons, in return for a charge fixed by the law.[44]

The two options envisaged corresponded to the two forms of liberalism – political or economic. Political argument maintained that state monopoly over use could be envisaged only under a despotic government, while the conquest of freedom guaranteed by the revolution of July 1830 implied the possibility for citizens to communicate in all possible ways. From an economic viewpoint, the state could not confiscate for its own use technology required for economic activity.[45]

To support their argument, the liberals referred to the press which was not a government monopoly, affirming: 'A law on telegraphs, like a law on the press, must be limited to regulating the use and curbing abuse.'[46] Nevertheless, during debate on the 1837 law, the opposition fought less against a state monopoly than in favour of private use. It thus took the suggestions of the Count of Montureux who in April 1830 had published in a Montpellier journal, 'reflections on the possibility of making the telegraph a branch of government revenue and facilitating commercial operations by putting this means of correspondence at the disposal of merchants'.

The liberal thesis, which seemed strong in 1831, was largely in the minority in the vote on the 1837 law which provided for a prison sentence for 'whosoever transmits, without authorization, signals from one place to

another'. Debate on this law is essential for an understanding of how French society in the 1830s perceived communication. There were two opposed communication projects: that of free communication necessary for the development of a market economy, and that of state communication where 'the telegraph is an indispensable complement of our governmental centralization'.[47] This vision of communication has often been presented as thoroughly reactionary, as the last outburst before the liberalization of the 1850s. Such an analysis is, however, content to gather a few speeches in its favour and misunderstands the conceptions of the July Monarchy. The debate must, on the contrary, be studied in all it richness.

Justifications for the law presented by the Minister of the Interior Adrien de Gasparin and the two rapporteurs of the Chamber of Deputies and the *Chambre des Pairs*, Joseph-Marie Portalis and the Duke of Plaisance, were based on their ideas of non-governmental use of communication. They saw two possible uses: political agitation and stock market speculation. The fear of insurrection was not only a fantasy of the Minister of the Interior, the July Monarchy had been confronted right up till 1835 by a series of social movements of considerable magnitude both in Paris and in the provinces, notably in Lyons. The authorities could thus legitimately fear that the telegraph might become an instrument in the hands of conspirators. As for its stock market use, it was seen by many deputies as a means of 'immoral and spoliatory speculation'.[48] The deputy Fulchiron could thus declare: 'Until now I have never seen telegraphic lines established by private persons with good intentions'; they serve to 'establish a brigandage, so as to rob those who do not have news of the Paris Bourse'. This scorn for financial activity and, more broadly, for economics was shared by most of the political class under the July Monarchy.[49]

Fear of insurrection, lack of interest in the economy, refusal to liberalize telegraphic communication, appear easily understandable. But the defenders of the bill could not stop at that; they faced genuine opposition. A large number of deputies supported Ferrier's project, so their refusal had to be more thoroughly argued. They therefore attempted to prove that the telegraph could not be included in the Post Office. The argument ran as follows: the mail could transport a considerable number of dispatches all arriving at the same time, so that it was difficult to manipulate information. A letter could be contradicted by another one which arrived at the same time. 'But the telegraph does not lend itself to such freedom, that equality, that simultaneous action. In itself it excludes such competition and the telegraph is, necessarily, a monopoly.'[50] At the time it was not feasible to install several competing lines. The economic difficulties of the Paris–Rouen line built by Ferrier confirmed Gasparin's thesis: if a single private line seemed hardly profitable, this was even more true for a second line.

The monopolistic aspect of the telegraph was due mainly to the conditions of transmission. Potential traffic on a line was limited and nothing guaranteed that a dispatch sent half an hour or an hour after another one would arrive the same day.[51] 'Will the first one not enjoy an immense, exorbitant,

inadmissible privilege?'[52] All these monopolistic tendencies meant that 'the lines would certainly fall into the hands of parties . . . or into those of the richest speculators who would thus remove any chance of success from the least opulent merchants and thereby obtain an exclusive privilege to the poorest merchants' detriment.'[53] The Rothschild's private mail system shows that this latter hypothesis was altogether realistic.

To preclude 'a monopoly in the service of private interests, of commercial, jealous, exclusive, demanding interests using their immense advantage to crush rivals, without any doubt to speculate',[54] the only solution was state control. Thus Gasparin could affirm, 'without paradox, that the only way of preventing the telegraphic monopoly' was 'to attribute it to the government'.[55]

In short, one finds the same governmental and centralized conception of the telegraph which had taken shape under the Empire and the *Restauration*, but the conception of monopoly had changed. It was no longer a police and military instrument which found its own legitimacy within itself, but an instrument of general interest. The Duke of Plaisance envisaged the government being responsible for diffusing stock market information and thus guaranteeing its objectivity. Private use implied certain operating conditions for a telegraphic correspondence service: the obligation to accept all dispatches irrespective of their origin, by following the order of registration, at a moderate tariff. It was because Gasparin considered that the semaphore telegraph could not meet these conditions that he would not allow it to be applied to private use. His argument was of a socio-technical nature. The July Monarchy was certainly not inclined to liberalize the telegraph, but the limits of the semaphore technique strengthened it in its opposition.

This law closed a socio-technical cycle, that which associated the Chappe telegraph with the state. The association was finally broken during the following 10 years, giving birth to a new socio-technical entity: electric commercial telegraphic communication.

The liberal telegraph

The English situation was radically different. In the liberal British view, regulation of society was largely guaranteed by the market. Communication infrastructures were part of private initiative, and in the second half of the eighteenth century there was an increase in the number of canals and roads with turnpikes constructed on this principle.

Private initiative also manifested itself in respect of the telegraph. A royal act in 1825 devoted to the improvement of Liverpool Harbour authorized the dock administrators 'to establish a rapid means of communication between Liverpool and Wales, to warn fitters and merchants of the arrival of ships'. Two years later, a telegraphic line was opened, and run by Watson. The *Shipping and Mercantile Gazette* of 4 January 1842 assessed this telegraphic link and emphasized its efficiency and 'the commercial significance of this communication mode'. From 1839 to 1842, Watson opened four other lines, to Hull, London, Southampton and Dartmouth.

Even though it owned its own lines (see above), the Admiralty also used Watson's telegraph (Wilson, 1976: 68-93) which had received the support of the East India company and Lloyd's. If we can believe the account of a contemporary, J. Humphery, this telegraphic link offered great benefits to ship-owners since certain boats could spend several weeks blocked by cross-winds, unable to sail up the Thames (Wilson, 1976: 93). The risks of maritime transport had consequences on the availability of goods and the movement of prices. David Landes recalls that:

> traders and bankers of nineteenth-century London and Paris waited eagerly for the first word of sails off Land's End or l'Ouessant bringing golden cargoes from the Pacific. The amounts involved were a tiny fraction of debts outstanding in the money and securities markets; but they made all the difference between easy and hard liquidation at month's end (Landes, 1969: 205)

Watson also envisaged other uses for his telegraph: information for managing the railways (in particular he drew up a plan for a telegraph along the Liverpool–Manchester line in 1836), and stock market information between Paris and London.

Commercial use of the telegraph thus existed in the 1830s in England as in France. It gave rise to the installation of networks distinct from those of the state.[56] In France, the government blocked the development of private networks; in England, it left them to be created. Commercial liberalism was to constitute a framework favourable to the development of the telegraph. Innovation, in the form of electricity, was to find a new field for development.

Notes

1 The English poet Mark Akenside, in *Pleasures of Imagination* (1744), gave an interpretation of this magnetic action: 'Two faithful needles – from the informing touch of the same parent stone, together drew its mystic virtue; – And though disjointed by kingdoms . . . yet preserved their former friendship and remembered still the alliance of their birth.'

2 Because of the close ties between the construction of the first telegraphic network and the appearance of the new French revolutionary state, resulting from Enlightenment thought, reference will be made to political facts with which the reader may not be familiar. In such cases he or she might find the explanatory notes given here useful.

3 *Translator's note*: During this period in France legislative and executive power lay successively with the National Constituent Assembly (1789–91), the Legislative Assembly (1791–92) and the Convention (1792–5).

4 *Translator's note*: Commissaries, or peoples' representatives.

5 *Le Moniteur universel*, 1 and 2 September 1794.

6 *Translator's note*: This Committee was responsible for education but also for the arts and science in general.

7 *Le Moniteur universel*, 14 March 1793, p. 33.

8 Ibid., 4 April 1793, pp. 30–1.

9 *Procès-verbal de la Convention*, 26 July 1793.

10 *Le Moniteur universel*, 18 August 1794, p. 516.

11 Ibid., 22 July 1795, vol. XII, pp. 265–6.

12 Ibid., 22 July 1795, vol. XII, p. 266.

13 *Translator's note*: From 1795 to 1799 the régime in France was that of the *Directoire*.

From 1799 to 1804 Bonaparte was First Consul. In 1804 he became Emperor Napoleon I, until 1814.

14 The two reforms were soon to be led by different men, at a different pace. Prieur de la Côte-d'Or was to lead the commission on the reform of weights and measures, together with Arbogast who was also to form part of the commission responsible for evaluating Chappe's first experiment.

15 On this point, the reader is referred to the excellent book by Witold Kula, *Les mesures et les hommes* (1984), from which I have borrowed all my information.

16 The *écoles normales* (teachers' training colleges) were an essential link in the imparting of knowledge because teachers were trained there in contact with academics.

17 On Romme's educational ideas, and more generally on his activities within the Committee of Public Education, see Allessandro Galante-Garonne, *Gilbert Romme: histoire d'un révolutionnaire* (1971).

18 Lancelin, *Introduction à l'analyse des sciences*, 1801, quoted by Branca (1982: 59–66).

19 Augustin Gazier, *Lettres à Grégoire sur les patois de la France (1790–1794)*, 1880, p. 292, quoted by Braudel (1986).

20 Degeranda, *Des signes et de l'art de penser*, quoted by Branca (1982).

21 Sigard, *Débats de l'Ecole normale*, quoted by Branca (1982).

22 Claude Chappe built and managed the telegraphic network with the cooperation of his four brothers, Ignace, Pierre, René and Abraham. After Claude's death (1805), his brothers Ignace and Pierre succeeded him. When they retired, Abraham and René took over until 1830.

23 *Archives nationales*, F17–1137.

24 Ibid.

25 Ibid., F17–1281.

26 Report by the Committee of Public Education, 3 January 1795.

27 Gilbert Romme popularized the republican calendar by having an almanac published, the *Annuaire du cultivateur*, which gave day-by-day advice to farmers.

28 *Archives nationales*, F17–1009A.

29 In a letter to the Polish king's secretary, Fénelon described Amontons' experiment and judged his invention as 'more curious than useful', quoted by Belloc (1888).

30 *Translator's note*: '*Prenons nos désirs pour des réalités*', literally, 'Let our desires be our reality.'

31 *Le Moniteur universel*, 29 April 1798.

32 Ibid., 22 July 1795.

33 *Translator's note*: With the *Restauration* in 1815, royalty was reinstated until the July 1830 revolution. Thereafter a constitutional monarchy (the July Monarchy) ruled until 1848.

34 *Archives nationales*, F90–1427.

35 For an exhaustive presentation of semaphore telegraphs in the world see G. Wilson's book *The Old Telegraphs* (1976).

36 Transmission difficulties caused by fog were less frequent than is often thought. According to *The Times* of 4 April 1830, the semaphore telegraph was only interrupted for 29 days in 1839.

37 Germany: 1852; Russia: 1854; Spain 1855; Sweden: 1858 (Wilson, 1976).

38 During a visit to Paris, O'Etzel, director of the German semaphore telegraph, met Ferrier who presented his project for a European network to him (see Herbath, 1978: 21).

39 Quoted in *Consultation pour M. Alexandre Ferrier, gérant de l'entreprise des télégraphes publics*, by Me Ad. Crémieux et al., *Archives nationales*, F90–1456.

40 Ph. Dupin in *Consultation*, *Archives nationales*, F90–1456.

41 *Archives nationales*, F90–1456.

42 Manuscript note from the Minister of the Interior's office on the breaking off of negotiations, 4 August 1833, *Archives nationales*, F90–1456.

43 Circular from the Minister of the Interior to the prefects, 29 June 1833, *Archives nationales*, F90–1456.

44 de Vatimesnil in *Consultation*, *Archives nationales*, F90–1456.

45 For more details on the arguments of the defenders of telegraphic freedom, see Lefébure (1984).

46 Jollivet, consultant for A. Ferrier, quoted by Delespaul, debate in the Chamber of Deputies, 14 March 1837, in *Archives parlementaires*, vol. 108.

47 Adrien de Gasparin, speech to the Chamber of Deputies, 6 January 1837, in *Archives parlementaires*, vol. 106.

48 Tesnière, debate in the Chamber of Deputies, 14 March 1837, in *Archives parlementaires*, vol. 108.

49 On this point see Pierre Rosanvallon's book, *Le moment Guizot* (1985).

50 Gasparin's speech to the Chamber of Deputies, 6 January 1837, *Archives parlementaires*, vol. 106.

51 Weather conditions could delay a dispatch. A statistic obtained in 1842 and 1843 gave the transmission speed as 50 kilometres per minute. However, only 64 per cent of the dispatches arrived the same day and this figure dropped to 33 per cent in winter (Ministry of the Interior statistic). Lardner also describes how, during the Napoleonic wars, a message was sent from Plymouth to London. Only the first part arrived: 'Wellington defeated . . .'. The rest of the message was blocked by thick fog and was only sent the next day. It profoundly modified the meaning: '. . . the French at Salamanca' (Lardner, 1867: 40).

52 Gasparin's speech to the Chamber of Deputies, 6 January 1837, *Archives parlementaires*, vol. 106.

53 J-M. Portalis, Chamber of Deputies, 28 February 1837, *Archives parlementaires*, vol. 107.

54 A. de Gasparin, *Chambre des Pairs*, 21 March 1837.

55 A. de Gasparin, speech to the Chamber of Deputies, 6 January 1837, *Archives parlementaires*, vol. 106.

56 The same was true in Germany where private networks were built in Hamburg and Bremen.

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2

Networks and Electricity

Before looking at the history of electricity, which made another form of long-distance communication possible, the telegraph must be placed in a different technological perspective – that of the evolution of transport and the genesis of technological networks.

The invention of networks

The Chappe telegraph was part of a tradition which we have not yet mentioned, that of the reorganization of road networks. In *Lire et écrire*, François Furet and Jacques Ozouf note: 'The school is a marvellous example of the main paradox of the French Revolution – rupture and continuity' (Furet and Ozouf, 1977: 97). While the semaphore telegraph was a significant novelty and represented a definite break in representations of time and space, it was also part of the continuity of an evolution, that of the transport of messages.

During the 40 years preceding the Revolution, France experienced what some historians have called a transport revolution. New techniques were used to build a network of main roads on which it was possible to travel 'at a gallop'. Postal networks also multiplied and in 1775 the creation by Turgot of the state-controlled stagecoach and messenger service made regular traffic possible. These major improvements had the significant effect of increasing the speed of traffic which had remained unchanged since the Middle Ages. Fernand Braudel, who analysed the transport of mail to Venice between 1500 and the mid-eighteenth century, shows that there was no fundamental change during that period. A letter from Paris took two to three weeks to reach the city of the doges. In short, as Paul Valéry said, 'Napoleon moved no faster than Julius Caesar' (Braudel, 1979: 374–5).

From the end of the eighteenth century the speed of traffic was doubled, so that a journey from Paris to Marseilles, for example, took only a week instead of a fortnight (Braudel, 1986: 238–9). Chappe's telegraph continued this evolution but also introduced a break, since the average message took 15 minutes from Paris to Valenciennes in the North. With this quasi-instantaneous means of transmission, the aim was to conquer space, rather than time. It is therefore hardly surprising that the tachygraph (the first name imagined by Chappe) became the telegraph. From 1793 the network spread out from certain main axes and was to be extended to other European countries during the Empire. While their network never comprised more than five main lines, the Chappe brothers' goal was to link all important towns so as to

'cover the kingdom with a telegraphic network linking all areas to one another and to a common centre. The French . . . [would] thereby benefit from the considerable social advantages provided by frequent and rapid communications' (Chappe, 1840: 133).

It is interesting to compare this telegraphic network, imagined and partially realized by the Chappe brothers, with transport networks built during the same period. Bernard Lepetit shows that, until the eighteenth century, French roads were merely earth tracks, all more or less the same, and that traders used or abandoned a particular road depending on its state. While the 'memorandum on the reparation of roads' in 1738 introduced a first hierarchical classification of roads,[1] the attempt to plan an ordered and articulated network was not to materialize. Improvements were carried out on sections of roads only, and although towns were well aware of the advantages in being situated on an important road, their main concern was their connection with neighbouring cities. The situation was to differ with the first railways which were built on a line-by-line basis, even though multiple local and regional interests had to be taken into account.[2]

The engineers of telegraph lines were subjected to far fewer constraints. Telegraph installations were not of the same size and local authorities' intervention was insignificant since the central government was the sole user of the telegraph. When Chappe launched a line, he had a global view of it and carried it through to completion. The Chappe brothers' network (as we have seen, Ignace used the term in his book of 1840) nevertheless remained a group of lines from Paris to the provinces, with no connection between them.

In a memorandum in 1829 Abraham and René Chappe presented their 'general telegraphic communication system'. To the lines which spread out from Paris and between which there were no links, they suggested adding 'junction lines' so that a message leaving a given point could take several different routes (Chappe and Chappe, 1829: 7–8). A few years later, a text written by the Chappe brothers' successors referred to this same notion of junction lines (the principle of a multiconnection network):

> There is no relation between the five lines from Paris. They are isolated, so that each of them has to be self-sufficient and can expect no help from any of the others . . . The causes for a suspension or slowing down of transmissions (bad weather or heavy traffic) are reduced when the lines are linked . . . so that each telegraphic direction has at least two alternatives for corresponding with the centre.[3]

The Toulon and Bayonne lines were first linked in 1835 and in the following year 10 per cent of the traffic from Toulon used the Bayonne line (via Montpellier–Toulouse). A systematic connection between lines was then envisaged. The discovery was an important one, since a network was no longer conceived as a juxtaposition of lines, but as a coordinated set in which the optimization of transmission time did not necessarily imply use of the shortest route.

The concept of a multiconnection network appeared in the telegraph at the same time as in other urban networks. Networks built at the beginning of the

nineteenth century for the distribution of water had a branching structure, with several independent networks in each large town. In 1820 engineers started envisaging the interconnection of the branches or trunks of this structure and the construction of a 'circumvallation' canal to allow for a more balanced flow. This reticular design for the distribution of water may have been based on work on the human circulatory system.[4] Doctors and engineers had the opportunity of comparing their network designs at the *Ecole polytechnique*.[5]

To return to the semaphore telegraph, one of its main drawbacks was that it could not function perpetually and was interrupted during rainy or misty weather and particularly at night. Chappe made several attempts at adapting the telegraph to night use, and up till the 1840s a number of other inventors proposed a variety of systems with the same objective in mind. These telegraphs were often called universal, although none of them functioned perfectly. In a note on this question, Alphonse Foy, the general administrator of telegraphs, wrote in 1842: 'A nocturnal telegraph [achieved] by means of lighting the machine would certainly be a beneficial extension since it would increase available time for the work. However, it would not free telegraphic transmission from the precarious state in which it is placed by the weather.' He therefore wanted a detailed examination of whether the electric telegraph 'did not allow for the perfection of the telegraphic systems – the continuity of transmissions'.[6] Beyond technical choices, this telegraph operator had thus clearly defined his goal.

Chappe contributed another significant innovation when he discovered that for information to be transmitted efficiently, it had to be coded with a universal code used in every network. He examined several alternatives. First, he used a code based on the decimal system and then, in 1800, switched to a system with 92 elementary signals which made it possible to define a ciphering system similar to that used by diplomats. He thereby constituted a vocabulary of 8,464 words. Each word was identified by its page number and its order on the page. The system ensured an economy of signals and confidentiality of messages. Competing telegraph systems used other codes: an alphabetic code was used in England, while Bergstrasser in Germany used a binary code.

Whatever the technical system proposed, each inventor imagined a universal code. In the 1820s F. Sudre, for example, developed a 'universal musical language' consisting of four notes transmitted by means of a bugle. The army experimented with this rudimentary system in 1829 and called it 'telephone' (Libois, 1983: 13).

Thus, the semaphore telegraph was the starting point for telecommunications systems. Even though it was an almost outdated technical system, it included the four basic characteristics of telecommunications, which other systems were to reorganize:

1 Although not instantaneous, transmission was extremely fast. Chappe increased the speed by improving the coding system.

2 A permanent network was constituted which spread further and further afield.
3 A specialized technical body took over the operation of the network.
4 Information was coded in a 'universal language'. Chappe had integrated operational constraints in the communication system by defining operation signals (start, end, interruption, station number, etc.) which were distinct from correspondence signals.

In order to understand fully the highly innovative aspect of the telegraph as an integrated system, it is interesting to compare it again with the railway. In 1802 the Englishman Edgeworth suggested establishing railways for public transport. As W. Schivelbusch (1977) points out, the railway was in this case seen as a road equipped with rails, rather than as an autonomous transport system. Twenty years later, railways were conceived of as distinct from the road network, yet they were based on the same principle as toll roads which could be used by private vehicles. Schivelbusch, who studied the constitution of the system of railway machines, indicates that in 1848 there were still private vehicles using the Manchester–Liverpool line (Schivelbusch, 1977). Individualism in the use of railways naturally posed a number of traffic coordination problems and was consequently abandoned. The operator of each line was granted an absolute monopoly of traffic. This technical option was, however, opposed to the liberal economic spirit of the day and was not enforced immediately. The final stage in the construction of a railway system was the interconnection of lines designed independently of one another, on a purely local basis.

The beginnings of electricity

'Parlour' electricity

While a permanent communication network for the transmission of coded information was being set up at the turn of the eighteenth century, a new technology was being developed: electricity. Until the first third of the eighteenth century, electrical phenomena were a mere curiosity. It was found that light bodies could be attracted by rubbing together certain substances, and sparks were obtained from an electrostatic machine. Around 1730, the British physicist Stephen Gray showed that electricity was propagated along a wire. With certain bodies called conductors, it was possible to obtain the propagation of a charge over a few hundred feet (Taylor, 1879: 6; see also Shiers, 1977). A few years later, Petrus van Musschenbroek of Leyde in The Netherlands and Ewald Kleist in Pomerania found a device for accumulating electricity. The 'Leyde bottle'[7] (called the 'Kleist bottle' in Germany) was to serve as a basic tool in the 'amusing', commonplace scientific experiments carried out in small private physics laboratories.

In an age when the distinction between science and technology had not yet been defined, scientists were to envisage both the hypothesis of a link between

vital energy and electrical fluid, and the use of electricity as a medical instrument. Abbey Nollet wondered, in 1746, whether an electric shock could be used to 'revive more or less inhibited movement in a sick part' (Zelbstein, 1985: 297). Electrical therapy was used by the English theologian John Wesley (mainly known as the founder of Methodism) and by Marat, the future French revolutionary (1782), while Bichat studied muscular contractions by 'galvanizing' the bodies of executed prisoners.

Another research field – the study of the propagation of electric fluid – was also to gain importance. By using a Leyde bottle, Louis Le Monnier, in France, Watson, Folkes and Cavendish, in England, and Father Joseph Franz, in Austria, managed to attain distances of several miles. Johann-Heinrich Winkler already thought that 'electricity could be transmitted to the ends of the earth' (von Klinckowstroem, 1967: 220). Certain observers of these experiments imagined transporting information in this way. In 1753 an article signed C.M. in *Scot's Magazine* proposed sending messages by electricity, with a system of 26 wires each connected to a letter of the alphabet.[8] Georges-Louis Lesage, professor of mathematics in Geneva, designed a similar project in 1760. In 1774 he built an experimental device. At the transmitting end a wire linked to a letter was touched by a wax stick electrified by friction. At the receiving station the electric spark pushed an elderberry corresponding to the letter being transmitted. This experiment attracted the attention of the scientific community. The Swiss physicist Louis Odier considered that the procedure should make it possible to 'converse in less than a half an hour over four or five thousand leagues, with the Great Mogul or the Emperor of China' (von Klinckowstroem, 1967: 221). Similar experiments were carried out by other inventors: Lomond (1787) and Jean Alexandre (1802) in France, and Cavallo (1795) in England. The Spaniard Francisco Salva is said to have conducted a larger experiment, over 40 kilometres, from Madrid to Aranjuez.

These diverse instruments, based on the use of static electricity, were interesting objects for playing around with in private laboratories, but they remained too rudimentary to be used for a regular telegraphic service. Hence, the Spaniard Bethencourt,[9] who conducted an experiment on electric telegraphy in 1787, abandoned this technical solution in favour of a semaphore telegraph which he developed with Bréguet to compete with Chappe's system (see above). In fact, Chappe himself was already studying the electric solution. 'Electricity first held the attention of this hard-working physicist' Lakanal (1795: 4–5) tells us:

> he imagined corresponding by using two identical clockworks to electrically mark time corresponding to the same values. He placed and isolated conductors at certain distances, but the difficulty of insulation, the lateral expansion of the fluid in a long space and the intensity that would have been required – subjected to the state of the atmosphere – made him see his project of communication by means of electricity as chimerical.

The rudimentary nature of all these experiments does not, however, adequately explain why the electric telegraph was not developed. Within the

context of technical knowledge at the time, significant improvements could be made. In 1816 Francis Ronalds, for example, developed a system with a single electric wire. In each of the two stations a small wheel, driven by a clock, successively displayed the letters of the alphabet in an aperture. The two clocks were synchronized. If an electric charge was emitted when a letter appeared on the transmitting end, this charge could be detected on the receiving end. Yet, as we saw in Chapter 1, Ronalds received a dilatory response from the British Admiralty when he proposed his system to it.

Why were inventors discouraged? The main reason was that the model of commercial communication had not yet appeared, while the state's limited communication needs were fulfilled by the semaphore telegraph. This is what the chemist Chaptal, Minister of the Interior, explained with respect to Jean Alexandre's invention: 'Besides the fact that his machine would leave much to be desired even if it were created on a workable scale, what he announces as a discovery is no more than the varied and well-known art of transmitting by signs or figures. The [semaphore] telegraphs used until now are far better and simpler' (Stourdzé, 1987: 191). Yves Stourdzé who reports this event is shocked by the short-sightedness of the French government which tended to 'imagine that mechanics alone constitutes a reliable universe'. Was this behaviour so typically French? In Britain, the Admiralty refused Ronalds' propositions in 1816 and, two years earlier, it had replied to similar propositions by Ralph Wedgwood that 'the war being over and money scarce, the old semaphor system is altogether sufficient.' Thus, both major states at the beginning of the nineteenth century refused the innovation of electricity. And, as Stourdzé rightly points out, 'there was no recourse possible . . . what the inventors did not manage to get from the government they did not either manage to wring out of the banks and commercial institutions' (Stourdzé, 1987: 191).

Electric action and magnetic action

While inventors waited to find an alternative to state support, scientific knowledge on electricity progressed. In 1800, the Italian Volta managed to set up a regular source of electricity by means of the chemical action of copper and zinc discs separated by cloth. His famous voltaic battery opened new possibilities to telegraphy even though a way still had to be found to make the electricity effective over a distance. In 1809, the German physicist Soemmering imagined a device based on the electrochemical decomposition of water. An electrical circuit corresponding to each letter of the alphabet, with the extremity immersed in a basin of water, was set up. When a charge was sent through one of the circuits the water decomposed and vapour appeared. Soemmering circulated models of his telegraph in Paris and Vienna. In Philadelphia, John Coxe imagined a similar device in 1816 (Taylor, 1879: 13–14; Jarvis, 1956: 135).

From 1820, with the discovery of electromagnetism, another device for signalling information became possible. The Danish physicist OErsted

showed, in 1820, that electric current had an influence on magnetic needles. As soon as he became aware of its existence, Ampère took an interest in his colleague's work. In a memorandum to the *Académie des sciences*, he suggested that the action of an electric current on the magnetic needles could constitute a telegraphic device. But Ampère never implemented his idea; he preferred devoting himself to the theory of electrodynamics. In the same year, Arago's work on the temporary magnetization of iron by an electric current made the creation of electromagnets possible.[10]

The needle-telegraph device described by Ampère was realized by a Russian diplomat, Baron Schilling. He witnessed several experiments by Soemmering, with whom he corresponded regularly. In 1825 he created a device with five wires connected to five magnetic needles. The combination of the respective positions of the needles enabled him to represent all the letters of the alphabet. He presented his device several times to the Emperor, who nevertheless opted for a semaphore line between St Petersburg and Warsaw (see above). In parallel with Schilling's research, the physicist Gauss – who had also seen Soemmering's device – and his young colleague Weber also designed a needle telegraph. They used this at Göttingen from 1833 to 1838 to communicate between the observatory which Gauss directed and the university situated 1,500 metres away. However, Gauss and Weber preferred devoting themselves to their scientific work and therefore suggested that one of their colleagues, Steinheil, develop their invention. Steinheil improved the device in several ways. He used two stylets to transcribe the codes corresponding to each letter on a strip of paper. He, moreover, discovered that the current could return through the earth and he built a permanent line of about 5 kilometres between the Royal Academy, the observatory and his home in Munich.

From the middle of the 1820s the electric telegraph became an object of scientifico-technical debate. In 1825 Peter Barlow challenged Ampère, proving that beyond 200 feet a telegraph based on the deviation of a magnetic needle was not only unfeasible but also impossible for theoretical reasons (King, 1962: 281; see also Shiers, 1977). William Richtie, however, responded to Barlow's objections in 1830 by presenting the Royal Society with a prototype corresponding to Ampère's description.

In central Europe, debate first crystallized around Soemmering's device in the 1810s. In 1833 Schilling visited Gauss. Two years later he returned to Germany to a congress where one of the participants, Muncke from Heidelberg University, asked him for a copy of his device to present to his students. A young Englishman, William Cooke, witnessed such a demonstration in 1836 and his ensuing enthusiasm led him to build a first prototype even before returning home.[11]

In the United Kingdom various research projects were developed concurrently during the second half of the 1830s. The physicist Wheatstone measured the speed of electricity in 1834, concluding that electricity was the best solution for transmitting information over a distance. He then developed a first model of such a device. Cooke, who had difficulties in making

his device reliable, met Wheatstone in 1837 and they decided to cooperate. It seems that the difficulties in transmitting over a long distance, which neither of them had until then managed to overcome, were solved after a meeting with the American physicist Joseph Henry when he was in Europe. In 1831 Henry had already published his works on electromagnetism and long electric circuits (King, 1962: 289; Taylor, 1879: 81). Independently of Cooke and Wheatstone, Davy started working on the telegraph in 1835 and presented a prototype two years later. In the same year, the Scot William Alexander demonstrated a device based on Ampère's principles (Kieve, 1973: 23–4).

The year 1837 was not only one in which electric telegraph projects flourished, it also saw a shift from purely scholarly research to the desire to exploit the invention commercially. Cooke and Wheatstone patented their five-needle six-wire apparatus; a year later, Davy patented one with two wires, while Alexander limited his patent to Scotland. When the US federal government put out a call for tenders for the construction of semaphore telegraph lines, Samuel Morse, Professor of Art at New York University, who had been working on an electric telegraph prototype in his free time, immediately saw the opportunity for having his invention recognized. He intensified his research and started working with a mechanic, Vail, and one of his colleagues, Gale, who used Henry's research results on electromagnetism. In February 1838 Morse was able to demonstrate his device to federal government representatives in Washington. A few months later he travelled to Europe in search of support and with the hope of filing a patent. Although the precedence of Cooke and Wheatstone's patent prevented him from doing so in London, he was able to patent his device in Paris in 1838 and again in the United States on his return in 1840.

Unlike the first inventors of the telegraph, Morse, like Cooke, was not a scientist. He was interested in a simple and practical device. Rather than moving needles on a dial to indicate letters, as in the European instruments, his telegraph executed coded signals by means of a manually activated lever. By opening or closing a circuit, it stimulated identical signals in the receiving device. The code was composed of only two elements – a short and a long signal – and a combination of only four of these sufficed to represent the letters of the alphabet.

France was largely absent from this period of invention in electric telegraphy. After Ampère's article, French inventors had kept in the background. Yet, in 1838 the French government organized an official comparison between Cooke's, Morse's and Steinheil's telegraphs on the one hand, and a local system developed by Bréguet on the other. No decision was forthcoming from these tests, but the operation amply illustrated the changing trend. Until then comparisons had been limited to the scientific community itself and scientists visited and wrote to one another. As soon as the commercial exploitation of a system was envisaged, the various prototypes were compared in order to determine the most effective one.

Circulation of the invention

To conclude this brief technical history, we can but support the view of Robert Sabine the English historian who in 1867 wrote that 'The electric telegraph did not, strictly speaking, have an inventor. It grew little by little towards perfection, with each inventor adding his bit' (Sabine, 1867: 40). This cumulative technical progress (which did not exclude work carried out simultaneously – for competitive reasons or through ignorance) was only possible because ideas and prototypes could circulate thanks to the personal contacts of scientists and to the institutions which facilitated this exchange of knowledge: the press, the academies and exhibitions.

It was chiefly in the academic press that the first publications appeared. Ampère's report was published in the *Annales de chimie et de physique* (1820) and Barlow wrote in the *Edinburgh Philosophical Journal* (1825). The *American Journal of Science* (January, April and July 1831) described Henry's experiments, while the *Philosophical Transactions of the Royal Society* reported Wheatstone's experiments on the speed of electricity. Demonstrations were also performed before recognized scientific bodies: Schilling presented his prototype to the congress of German physicists in 1835; Richtie, Wheatstone and Alexander demonstrated their invention to the London Royal Society in 1830 and 1838, and Morse was invited to the *Académie des sciences* in Paris in 1838.

From 1837 the debate started to move beyond the scientific community and articles appeared in the general press. *The Times* of 8 July 1837 presented Alexander's system, while the American *Journal of Commerce* spoke of Morse's telegraph in September of the same year. The popular press, which a scientist like Wheatstone did not scorn (*Magazine of Popular Science of March 1837*), also took an interest in the subject, and the first field experiments received general press coverage. *The Times* of 2 September 1839 and the *Railway Times* of December 1839 both reported on the opening of Cooke and Wheatstone's experimental line along a railway track. A detailed description of the telegraphic machine was, however, presented in several issues of the technical journal *Mechanics Magazine* in 1838 and 1839. Furthermore, these inventors also held public presentations: Alexander at the Royal Gallery of Practical Science in 1839 and Davy at Regent's Park in 1837.

This diffusion of technical ideas also promoted the capitalization of technological progress, with each inventor re-using certain ideas or systems developed by his peers. Thus, around 1843, Morse decided to change his system of telegraphic wires. Until then he had buried them but, because of imperfect insulation, transmission of the signal never exceeded 10 miles. When he read in the English press that Cooke and Wheatstone attached their wires to poles, he adopted the same method (Bidder, 1944; Shiers, 1977).

A universal system

In 1843, four years after the installation of the first line, Cooke organized public demonstrations of his telegraph. The main point emphasized in public

posters (see Jarvis, 1956: 588) was the transmission speed which was that of electricity: 280,000 miles per second (according to Wheatstone's measurements). With that kind of performance, the telegraph promised to reach the whole world, crossing oceans and continents. The first inventors thus strove to realize Winckler's forecasts a century earlier. In 1840 Wheatstone suggested a Dover–Calais line to the special railway committee in the House of Commons. He had already mentioned the idea in 1837 in a letter to friends. The cross-Channel link was finally established in 1850. Eight years later the first transatlantic cable was laid.[12] In 1860 another line linked London to India.

In the United States, Samuel Morse set up a first inter-urban line between Washington and Baltimore in 1844. New York was linked to San Francisco 15 years later. In 1866 Western Union had unified the American network which was 37,000 miles long and included 22,000 telegraphic offices. Morse was able to write that the telegraphic network was 'very much as . . . I wished them to be at the outset . . . making one great whole like the Post Office system' (Winston, 1986: 303).

This desire for universality, found at the birth of both the semaphore and the electric telegraphs, steered the different systems towards standardization – one of the conditions of a truly universal communication system. Communication was, moreover, the industrial sector in which standardization was achieved the fastest. According to David Landes (1969), it was only in the 1830s in Great Britain that the systematic standardization of parts within the same company was introduced,[13] and this was moreover only generalized in the latter half of the nineteenth century. 'If standardization within a firm was difficult, how much harder was it to persuade manufacturers throughout an industry to accept a national norm!' (Landes, 1969: 315).

In the United States national standards only started to appear in the 1880s, while England set out on this path much later with the creation of the Engineering Standards Committee in 1901. In newer industries, such as electricity, standardization was more rapid, although the current provided in each country was often different. Despite the difficulties involved, standardization in industry was always necessary because it was a significant source of economy of scale. In the communications sector, in particular, the universal nature of the activity made standardization all the more essential. It was therefore in this field that national and international standardization first became indispensable and was introduced almost immediately.

The Morse alphabet was to be used 15 years after the invention of the electric telegraph by all the countries that installed the technology. The interconnection of national networks was begun in 1849 (or 10 years after the installation of the first network in England) between Prussia and Austria. In the following year the agreement was extended to Saxony and Bavaria. We thus witness the telegraphic unification of German-speaking countries at a time when political unification had not yet been realized. In 1855 Belgium, Switzerland, Sardinia, Spain and France created the Telegraphic Union of Western Europe. These different international agreements led to the creation

of the International Telegraphic Union in Paris in 1865 (Codding, 1972). It was the first international body of a technico-administrative nature.[14]

Standardization of the railways, another network where a universal system offered numerous advantages, took more time than that of the telegraph. The standardization of gauges in Great Britain was instituted by parliament through the Gauge Act in 1846. This legislative decision, taken 25 years after the opening of the first railway line to the public, solved a conflict over two different gauges. The English standard was adopted on the Continent, with the notable exceptions of Spain and Russia (Daumas and Gille, 1968). The international interconnection of railways was simultaneous with that of the telegraph; in 1850 a first line crossed the Franco-Belgian border.

Notes

1 See Bernard Lepetit, 'L'impensable réseau: les routes françaises avant les chemins de fer', in Dupuy (1988: 21–2).

2 See Georges Ribeil, 'Au temps de la révolution ferroviaire, l'utopique réseau', in Dupuy (1988: 57–8).

3 Ministère de l'Intérieur, *Exposé des motifs à l'appui du projet de loi relatif au complètement des communications télégraphiques*, handwritten text 1830 (?), *Archives nationales*, F90–1456.

4 See André Guillerme, 'L'émergence du concept de réseau (1820-1830)' in Dupuy (1988: 41–7).

5 The Saint-Simonians played an important role in developing the concept of a network. On this question, see Musso (1988: 11–30).

6 Alphonse Foy, handwritten note on a night telegraph, 12 January 1842, *Archives nationales*, F90–1456.

7 The Leyde bottle is a capacitor, an instrument which makes it possible to accumulate significant quantities of electricity on limited surfaces. A set of capacitors forms a battery.

8 Historians of electricity attribute this to either Charles Morrison or Charles Marshall (see Taylor, 1879: 6; Jarvis, 1956: 130).

9 His name is also spelled Bettancourt.

10 Louis Figuier gave an accurate description of the role of electromagnets in telegraphy: 'In Paris there is an active cell. The conducting wire of this cell stretches right to Calais, for example. There it is wound around an iron vane and led back to the cell in Paris. The electric current leaving Paris magnetizes the iron vane in Calais and, if we place a moving iron disc in front of the vane, this disc, when it is attracted, will touch our artificial and temporary magnet. Now, if in Paris we cut the contact between the conducting wire and the cell, the iron vane in Calais is demagnetized; it no longer holds the mobile iron disc, which returns to its original position. Thus, by successively connecting and interrupting the current in Paris, we obtain a back and forth movement of the iron disc in Calais. This movement, made possible over long distances by temporary magnetization, is the fundamental fact on which the construction of the electric telegraph is based' (Figuier, 1873: 358).

11 William Cooke's father was a friend of Ronalds, whose telegraph he often handled in his garden. The young Cooke probably observed these experiments (Kieve, 1973: 18).

12 This cable only functioned for a month. A permanent link was established in 1866 (Kieve, 1973: 109–15).

13 Landes was referring here to the systemization of standardization. The first examples of standard parts appeared in the United States at the end of the eighteenth century in the armaments industry.

14 The Universal Postal Union was created in 1874, and the International Railway Conference in 1882.

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3

Market-controlled Communication: the Electric Telegraph

Among the numerous inventors of the electric telegraph, those who wanted their device to be more than just a scientific plaything adopted the same approach as Chappe; they turned to the state. We have already mentioned Alexandre who wrote to Chaptal to obtain an audience with Bonaparte, and Wedgwood and Ronalds who appealed to the British Admiralty, but there are other examples. Schilling never got effective support from the Russian government, and although Parodi – who continued Schilling's research after his death in 1837 – received an order from the Czar, this was merely for an experimental line linking two imperial residences. Steinheil in Bavaria managed to convince the government to finance a Munich–Augsbourg line but the funds were never made available (King, 1962: 284–6). Finally, in England in 1837, Alexander addressed a proposition to the Home Secretary, Lord Russel, for the construction with state aid of a telegraphic line between Edinburgh and London (Kieve, 1973: 24). In spite of support from a member of the Royal family, the Duke of Sussex, who let him set up a model of the telegraph at his residence Kensington Palace, Alexander received no order from the state.[1]

Cooke, on the other hand, was truly innovative in that he tried to find a commercial use for his telegraph and contacted potential investors. Unlike his predecessors and Wheatstone, it was not academic renown that interested him; he wanted to become an entrepreneur in telegraphs. Cooke's system was probably not of the most advanced, but he was the first to take out a patent. While his machine is sometimes presented as the technical conclusion of research in the late eighteenth and early nineteenth centuries, this is an erroneous interpretation of his role. Cooke was in fact a 'pirate' who had found in Germany a device which had until then remained confined to a laboratory, and modified its use. The Cooke–Wheatstone alliance was particularly representative of the change that took place at the end of the 1830s when telegraphic technology left the private laboratories of individual scientists to form the basis of new enterprises. Whereas Chappe was part of the nascent tradition of state engineers, Cooke was one of the first Schumpeterian entrepreneurs.

While Alexander was wearing himself out in his negotiations with the state, Cooke was approaching the railway companies and presenting his system as suitable for facilitating security – particularly in tunnels – and generally improving the running of their lines.[2] He demonstrated his system to the

directors of several railway companies and signed an agreement in 1838 with the Great Western Railway for the installation of a first line of 13 miles. Thus, Cooke was taking advantage of the latent demand from railway companies, to which Watson had also tried to respond and which Ferrier had similarly perceived when he wrote in 1832: 'The discovery of new accelerated means of transport demands greater rapidity in written communication . . . The railway lines need to be complemented by telegraphic lines.' The telegraph was first used as a security device to avoid collisions on single tracks; it provided the possibility of controlling traffic since it could be used to anticipate the arrival of trains.

But, whereas the electric telegraph network was originally built for the individual needs of the railway companies, it was to be opened to private use at the end of 1842. Other uses appeared during the following years. In 1845 a line replaced Watson's semaphore telegraph between Liverpool and the Welsh coast. In the same year the Admiralty signed an agreement with Cooke (Wilson, 1976: 60) for its exclusive use of two specialized wires on the London–Portsmouth telegraphic line.[3] Two years later, the Admiralty closed all its semaphore lines. In 1850 a telegraph was installed at the Central Post Office in London. Thus, the English telegraphic network was developed by private enterprise, without the intervention of the state which abandoned its own network and used a private one.

In the United States, Morse made the same choice as most of his European emulators: he tried to obtain federal government backing. After lengthy discussions, Congress financed a first line between Washington and Baltimore in 1844. In the following year, the telegraph was handed over to the Post Office which employed Morse to manage it. But Congress's inability to provide the investments needed to develop the network led it to sell the first telegraphic line to a private company. Growth was extremely rapid. In 1850 there were already 12,000 miles of telegraphic lines, compared to 2,200 in Britain (Kieve, 1973: 51). Two years later, the American lines measured 22,000 miles. The network was developed by a few large companies which merged in 1866 to become Western Union, the first American firm with activities spanning the entire continent (Chandler, 1977: 197). In the 1870s it had the telegraph monopoly. The telegraph played an essential role as a social and economic link in a nation-in-the-making, and in its territorial expansion. The state, although outside this development, provided financial and military support for the lines used in conquering the West. In 1860 Congress passed a bill for 'facilitating communication between the States of the Pacific and the Atlantic by means of the electric telegraph'. Western Union obtained a 10-year deficiency grant for the operation of this line. When the line was opened on 24 October 1861, on the eve of the War of Secession, Abraham Lincoln received the following message at the White House: 'The Californian people desire ... to express their loyalty to the Union and their determination to stand by its government on this, its day of trial' (Barett, 1941: 60).

A state electric telegraph

In France the 1840s were a decade of twofold evolution: that of the change from the semaphore to the electric telegraph, and that of the abolition of state monopoly over its use. In 1838 the telegraph administration examined the possibilities offered by the application of electricity in its communication system. On the occasion of the vote in 1842 for funds to experiment with a night semaphore telegraph proposed by Dr Guyot, the Chamber of Deputies debated the question of telegraph technologies. In spite of Arago explaining that the semaphore solution was obsolete and that the state should invest in the electric telegraph, funds were voted for the former. This debate on the choice between two technologies provides some insight into the political classes' representation of the telegraph. They saw it solely as an administrative instrument for controlling territory and communicating rapidly with government officials. An instrument of control, the telegraph had to be closely guarded. Since it was easier to protect a few hundred Chappe towers than several thousand kilometres of wire, the Assembly naturally preferred the semaphore technology. Behind this technical choice lay another choice, that of the function of the telegraph which was consistent with the one made in 1837. If the Assembly financed Guyot's innovation, it was not because it was more reliable than the numerous other night telegraphs which had been envisaged over the preceding half-century, but because the inventor had the same representation of communication as its own. Guyot wrote: 'No, the electric telegraph is not a feasible invention . . . A single man could, without being seen, cut all the telegraphic wires leading to Paris . . . in contrast, the semaphore telegraph has its towers, its walls, its gates guarded by strong men with guns' (IRIS, 1978: 38–9).

The debate was not, however, closed. In November 1844, the government appointed a commission of enquiry into the electric telegraph, comprising the physicists Arago, Becquerel and Pouillet, the administrator of telegraphs, Foy, and a Saint-Simonian economist,[4] Michel Chevalier, author of a report on the means of communication used in the USA. In less than a fortnight the commission had come to the conclusion that, in view of the extent to which the electric telegraph was being developed in England, the USA and Germany, it was essential that an experimental line be built in France. The government took an immediate decision and the Paris–Rouen line was tested in the spring. In the following year construction of the Paris–Lille line was begun.

The electrico-semaphore telegraph

The French telegraph authorities soon had to control a mixed network of semaphore and electric lines, in which the electric telegraph was to execute the ordinary signals of the semaphore telegraph. The Chief Administrator, Alphonse Foy, asked Bréguet to have this type of device built. The Foy-Bréguet electric terminal used two needles to reproduce the movements of the

Chappe telegraph. 'Its performance was perfect', wrote Ludovic Ternant in 1884, 'but the idea was so strange that the transmission of messages by electricity remained altogether unsatisfactory and the use of this "electrico-semaphore" telegraph had to be abandoned' (Ternant, 1884: 15).

In fact, the device was more than just a passing whim of the authorities, and a large-scale controversy broke out around it. *L'Illustration* of 26 June 1847 spoke of 'the defective system of electric telegraphs that the French authorities have maintained'. Abbey Moigno also attacked the electric telegraph in his treatise in 1852, but admitted that 'it is impossible to formulate a definite judgement'. Some experts strongly opposed the device, while others recognized its merits. Bréguet and the telegraph engineer Gounelle were persuaded of its qualities: 'speed, easy crossing of questions and answers, simplicity and convenient manipulation'.[5]

A hundred and thirty years later, Yves Stourdzé (1979) was to consider the Foy-Bréguet telegraph as an archetype of the half-measures and makeshift solutions that the French telecommunications authority adopted for a century. Consistently reticent with regard to new technologies, it opted for hybrid systems when it could no longer refuse innovation. Parliament was certainly not inclined to vote funds for the construction of electric lines, and Stourdzé was therefore right in noting the political classes' resistance to electricity. Nevertheless, Alphonse Foy's position was less clear cut than it seemed (see Chapter 2), and Gounelle's interest in electricity could not be denied. He performed experiments on the speed of electricity and was responsible for the construction of the first Paris–Rouen electric line. His defence of the Foy-Bréguet system was certainly not due to his technical incompetence. Should one not rather consider, as Michel Atten does, the system to be 'one of the first examples of the compatible development of two technological systems' (Atten, 1988: 71).

With hindsight, the 'electrico-semaphore' telegraph appears as an aberration without any technological merit. It was, nevertheless, a socio-technical compromise which allowed it to be appropriated more easily by its users (telegraph operators). It was what development specialists today call an 'appropriated technology'. With the Foy-Bréguet device, we have an example of a situation where controversy around two technological systems did not consist only of opposition between engineers, but also of a general debate. Like any compromise, it was debatable, but respectable.

Opening up to private communication

The advent of the electric telegraph in France did not prevent the state from steadfastly clinging to its monopolistic use of the lines. In July 1847 the Minister of the Interior declared (Kieve, 1973: 46): 'telegraphy must be a political and not a commercial instrument.'[6] The state did nevertheless extend its use of the electric telegraph. News reports sent every day by Havas to the prefects by carrier pigeons were henceforth sent by electric telegraph when lines existed.[7] In the following year, the 1848 Revolution[8] was to intensify the

state's telegraphic activities; traffic doubled in a year and remained constant in 1849.[9]

However, contradictions between the potential of the electric telegraph and the idea of a state-monopolized telecommunication system became more and more marked. The government decided to create new electric links in the framework of an agreement with the railway companies for the construction of lines on railway territory. In exchange, the latter would be able to use the telegraph for their own purposes. The deputy Marchal noted, in a question put to the Minister of the Interior in April 1849, that 'electric telegraphs are occupied at the most one-tenth of their potential working time.' The other nine-tenths could be used for industrial and commercial business and 'ordinary relations'. This would provide the state treasury with a means for obtaining returns on its investments. Finally, he noted that the privilege enjoyed by the railways seemed totally unwarranted. Change became inevitable. On 1 March 1850 the government presented the Assembly with a bill on 'private telegraphic correspondence'. Thirteen years after the 1837 law, the state finally acknowledged that the telegraph could be used for private communication. Yet a striking feature of National Assembly debates at the time is the continuity in attitudes regarding the telegraph.

The rapporteur Le Verrier considered, as he had in 1837, that 'it would have been impossible to place the semaphore telegraph at the disposal of private interests' not for political reasons, but because of material obstacles. 'Semaphore telegraphs could at the most meet official needs; no part of available time could have been ceded to the public without compromising the state's service.' As for private telegraph lines, 'they have always been at the sole disposition of speculators.' Change was finally prompted by technology; owing to the use of electricity, 'the number of dispatches that could be transmitted in a given timeframe was suddenly multiplied a hundred-fold.'[10] Furthermore, this technological innovation became 'the inevitable complement to the existence of the railways', and most foreign countries opened their telegraph lines to private individuals. 'Faced with such a general movement, it seems impossible', concluded the Minister of the Interior, 'that the French government refuses to let commerce and industry in our country share the wonderful facilities of correspondence which saves time – the most precious element in business.'[11]

Like the Saint-Simonians, Louis Napoléon Bonaparte's government saw in the telegraph an instrument likely to benefit commerce and industry. He wanted to see its use spread, but the Assembly remained reticent. Some deputies 'viewed this measure with regret and would have preferred to postpone its application'. By losing its monopoly over the use of the telegraph, they said 'the government will no longer have any privilege, and private persons will be informed at the same time as it of events throughout the territory. For the government, the result will be roughly the same as if the telegraphic invention was reduced to nothing.'[12] However, to allay the Assembly's fears of commercial communication overwhelming state communication, the priority of government dispatches was protected by law.

Similarly, to prevent criminal elements from 'using the telegraph to hatch their detestable plots with more ease and rapidity',[13] the law demanded that private dispatches be sent uncoded and signed, and that the user declare his or her identity. This constraint was added by the Assembly which changed the government's wording ('any person is allowed to correspond') to 'any person whose identity has been established'. The Director of Telegraphs could refuse to send or to distribute messages. This form of censorship was not specifically French; similar regulations existed in Prussia, Austria and The Netherlands. In England, even though the telegraph was private, the state could, in exceptional circumstances, interrupt use of the network.

Thus, the model of state communication remained largely present in the 1850 law. Moreover, the state rapporteur suggested taking advantage of the new possibilities offered by the electric technology to create a government news bulletin. 'By thus guaranteeing the authenticity of documents which often arrive altered or mutilated, one could produce in the press a widespread moral revolution in favour of the truth.'[14] In the mind of French legislators, commercial communication remained secondary.

The stock market operator

The quasi-police surveillance of private use of the electric telegraph at the start of the Second Empire has provided historians with detailed statistics on the subject. From the outset the network was used extensively and, during the first year, with fewer lines than the semaphore telegraph, the traffic showed a 50 per cent increase over official messages sent the preceding year. It quadrupled in the second year (1852) and by 1858 it had multiplied fifty-fold.[15]

Distance, or more precisely the difficulty in communicating, was one of the main reasons for using the telegraph. In France, international traffic accounted for 47 per cent of all traffic in 1851.[16] In North America, where transport difficulties were far greater than in Europe, the telegraph's success was striking. During its first year of use (1847) the Toronto–Quebec line carried no less than 33,000 messages (Foreman-Peck, 1989), twice as much traffic per mile as in Britain in 1851 (Kieve, 1973: 68).

The main use of the electric telegraph was the transmission of stock exchange information (see Tables 3.1–3.3).[17] In the first months after the French network had been opened to the public, it accounted for half of the traffic, before stabilizing at around 40 per cent. In Britain, the stock market similarly accounted for half of the traffic on the network and in Belgium this number was even higher (Table 3.1). If one separates national and international traffic, it becomes clear that stock exchange use predominated in the international sector. Its share in the national network increased significantly from 1851 to 1858 (see Tables 3.2 and 3.3).

Use of the telegraph in stock exchange activities introduced a greater degree of rationality into investors' transactions. Until the mid-nineteenth century, stock exchange information circulated essentially in the form of

Table 3.1 *Nature of dispatches on the telegraphic network by country*

	Stock market (%)	Trade (%)	Family (%)	Other (%)
France (1851)	38	28	25	9
France (1858)	39	33	20	8
Britain (1854)	50	31	13	6
Belgium (1851)	60	19	10	11

Sources: *France*: 1851, Ministry of the Interior statistics, *Archives nationales*, F90–1468; 1858, Pélicier (1859) (I have taken a weighted average of national and international statistics); *Britain*: Kieve (1973: 119); *Belgium*: Vercruysse and Verhoest (1991)

Table 3.2 *Nature of dispatches on the international telegraphic network in France*

	Stock market (%)	Trade (%)	Family (%)	Other (%)
1851	62	17	11	10
1858	48	20	20	12

Sources: Ministry of the Interior statistics, *Archives nationales*, F90–1468; Pélicier (1859)

Table 3.3 *Nature of dispatches on the domestic telegraphic network in France*

	Stock market (%)	Trade (%)	Family (%)	Other (%)
1851	17	38	37	8
1858	34	40	20	6

Sources: Ministry of the Interior statistics, *Archives nationales*, F90–1468; Pélicier (1859)

rumours. Peter Mathias (1969: 235) describes this speculative activity as follows: 'On the Stock Exchange the sharks moved in with bogus companies, patents for perpetual motion and other fraudulent schemes. Persons came into the market to play for capital gains, ready to jump out again as soon as prices showed any hesitation.' Charles-Albert Michalet (1968: 31) comments on the 'poor financial information [available] to the public'.

The telegraph made it possible to supply up-to-date and reliable information on prices of other markets. The English Telegraph Company, moreover, set up news rooms in the main stock exchanges in the provinces, thus making political and economic information more readily available. Interestingly, a first attempt at creating news rooms in public places had been unsuccessful (Lardner, 1867: 237); only stock exchange activities gave fast information its true value. In the United States, the Gold and Stock Telegraph Company, established in 1867, provided its subscribers (of whom there were 729 in

1871) with instantaneous information on gold and stock market prices (Tarr, 1987: 44).

The predominance of stock exchange news in telegraphic activities explains why traffic decreased or stagnated, depending on the market, after economic crises. An analysis of the evolution of the main English telegraph company's traffic (Electric and International Telegraph Company) from 1851 to 1868 shows that the number of messages sent per mile of network rose sharply, by 15 per cent on average every year. The two lowest growth rates appeared after the depressions in 1857 (minus 9 per cent) and 1866 (1 per cent) (Kieve, 1973: 66).

Hence, the stock exchange and the electric telegraph were closely linked. In the 1840s, in England, the railway boom led to a surge of activity on the London stock exchange and a dozen new stock exchanges were created in the provinces (Crouzet, 1978: 267). The circulation of information between these different places was, of course, provided by the fledgling telegraph. In France, the railway boom took place during the 1850s, when the electric telegraph was opened to commercial use. Stock market activity (which can be measured by market capitalization) was rising steeply: from 1851 to 1860 market capitalization increased seven-fold. If we take 1853 as a reference point (the year in which capitalization was identical to that before the 1848 Revolution), growth over a period of seven years remained at around 150 per cent. From 1860 to 1870 the growth rate was 100 per cent (Saint-Marc, 1974).

In order to compare prices on the different stock exchanges, and to transmit purchasing or selling orders rapidly, the telegraph became indispensable to investors. Kieve considers that the telegraph enabled the industrial and commercial world to provide 'enormous subscription of English capital to foreign loans' (Kieve, 1973: 238). The telegraph was also a key player in crises on the stock market. In 1879 Jules Verne described an imaginary crash as follows: 'Telegraphic dispatches started flowing in from all corners of the globe. Hardly a minute passed without a strip of blue paper, shouted out over the din of voices, being added to the collection of telegrams posted on the north wall by the stock exchange guards.'

Commercial use of the telegraph accounted for 30 per cent of all traffic. Le Verrier's report provides details of such activity in the United States. Shipowners and traders had information sent to them on the departure and arrival times of ships or the prices of wheat and cotton in the different towns. Shippers followed the progress of their products along the Mississippi, the Great Lakes and other waterways. Thus, the electric telegraph appeared as being linked to other means of transport in the creation of modern distribution during the second half of the nineteenth century. It made it possible to fit local trade into a broader regional or national context. Traders on the East Coast could order cereals from the West, resulting in a rapid increase in trading activities. Wheat could be sold while it was still in transit and even before it was harvested (Chandler, 1977: 210). According to Kieve (1973: 237), 'It made the world market a possibility. Its most efficient use was between the cotton and corn markets of Liverpool and the New York cotton and Chicago corn markets.'

Use of the telegraph by the general public, qualified as 'family use' at the time, remained minimal. In France, it only accounted for 20 per cent of both domestic and international traffic. In England and Belgium, where distances were shorter, this figure was even lower.

Other users of the telegraph were mainly the press and the railway companies. Kieve has evaluated the traffic of each of these users at 5 per cent in England in 1868. As for official dispatches, they were not included in French statistics, but a British report estimates them at 10 per cent of all French traffic in 1869 (Brown, 1870: 6; Foreman-Peck, 1989). Thus, at the end of the 1860s, the telegraph was no longer the instrument of state communication; it had become that of market communication. The use originally imagined by Cooke (service information for the railways), and which enabled him to develop his invention, had become marginal. We note in this respect that, as in the case of the Chappe telegraph, a discrepancy existed between the initial use – which allowed the inventor to be recognized – and the final use of the telegraph. The former was a response to an imperative demand related to current events of the day – the war for Chappe and management of the railways for Cooke – but was not sufficient to enable the new medium to develop significantly. In England, the Admiralty's semaphore network was abandoned after the Napoleonic wars and then reconstructed on a more modest scale.

In France, the Chappe system had been developed because it was a party to the project to centralize the state and thereby strengthen national unity. The same was true of the electric telegraph which was part and parcel of the development of the capitalist market in the mid-nineteenth century. This dominant use was no mere coincidence; a latent demand had already manifested itself in several semaphore telegraph projects, whether successful (Watson) or not (Ferrier). In particular, it matched prevailing economic theories at the time: liberalism in England and the Saint-Simonian movement in France. On both sides of the Channel, it was part of the current of ideas in favour of free trade.

Economists and the flow of information

The question of markets played an essential role in the construction of the classical economy; they provided both a system for adjusting supply and demand and a condition for the division of labour. Classical theoreticians have examined the conditions of the development of such markets. Adam Smith (1723–1790) showed the determining role played by transport. For example, with transport on waterways, the product of each kind of work had the whole world as its market (Smith, 1776). The importance of maritime transport was thus one of the main contributors to the wealth of nations and in particular that of England. Three-quarters of a century later, Jean-Baptiste

Say (1767–1832) spoke of the same question and remarked that 'the industries and population of the town of Manchester have tripled since the Duke of Bridgewater's canals linked it to the port of Liverpool' (Say, 1840: 177). He defined the notion of market in its original sense, that is, a place where transactions take place. The advantage of a permanent market as opposed to fairs, he said, is that it 'provides meeting points for all those who have goods to sell and those who want to acquire them, and serves to *fix the rates*' (Say, 1840: 175). Auguste Cournot (1801–1877) gave a different definition of the market in 1838: 'For economists the market is not a determined place where sales and purchases are accomplished, but an entire area where all parties are linked by free trade relations, so that prices are levelled out quickly and easily' (Cournot, 1838: 93).

To fix a price, to level it quickly, information has to circulate fast. That is precisely what Alexandre Ferrier proposed in 1832 with his semaphore telegraph which 'made it possible to know the state of every market at a glance'. Cooke made a similar proposition in 1836, suggesting that one of the potential uses of the electric telegraph might be to supply daily information on the state of different markets (Kieve, 1973: 18). The neo-classical economist William S. Jevons (1835–1882) was one of the first to show the role of information in the constitution of markets. Chapter 4 of his *Theory of Political Economy* (1871) dealt with the theory of trade. For Jevons, a market can exist without any fixed locality, if there is close communication between the partners of the transaction. For example, the expression 'Money Market . . . is applied to the aggregate of those bankers, capitalists and other traders who lend or borrow money, and who constantly exchange information concerning the course of business.' More generally, he considered that 'it is of the very essence of trade to have wide and constant information' and defined the theoretically perfect market as that in which 'all traders have perfect knowledge of the conditions of supply and demand, and the consequent ratio of exchange' (Jevons, 1871: 84–7). Thus, for Jevons, full information was one of the conditions for pure and perfect competition, the core of neo-classical theories.

Alfred Marshall (1842–1924) similarly considered the market 20 years later in his *Principles of Economics* (1890). When he wanted to quote a market that functioned on an international basis with rapid adjustments between supply and demand, he quoted the main international shares listed on a number of stock exchanges.

> For stock of this type, the telegraph maintains prices at roughly the same level on all the stock exchanges of the world. If the price of one of them climbs in New York or Paris, London or Berlin, the news of this is enough to provoke the same trend on other markets. If for some reason the rise is not immediate, that particular category of stocks will most probably be sold shortly on the market where the increase took place, following telegraphic orders from other markets. On the other hand, speculators on the first market will buy stocks on other markets by telegraph. (Marshall, 1890)

Thus, the telegraph was the technical agent of the international stock market.

The liberal state, telegraph operator

For liberal economists, state intervention in the economy had to be limited. In particular, it was not to intervene in production. Besides the exercise of monarchical functions (the army, justice, police), the state, according to Adam Smith in 1776, could develop public utilities (roads, bridges, canals): 'The expense of maintaining safe and practical roads and of facilitating communications is without a doubt beneficial to society as a whole and, consequently, one can in all fairness finance it by a general tax.' Nevertheless, in so far as these expenses only benefited a small minority, Adam Smith considered it preferable to finance them by the users in the form of toll charges.

John Stuart Mill (1806-1873) also discussed this question in 1848 in his *Principles of Political Economy*. He reasserted that 'laissez-faire should be the general rule: every deviation from it, unless it is absolutely necessary to achieve something great and good, is certainly harmful.' Neverthless, he did consider that for community services which became monopolies to a greater or lesser degree, it was the state's responsibility to control the quality of the service and to ensure that 'in the long run profits from the monopoly benefit the public.' John Stuart Mill nevertheless envisaged a few exceptions, notably the Post Office: 'This service is one of the few that a government can provide without any drawbacks' (Mill, 1848).

The position of French economists, and notably Jean-Baptiste Say, hardly differs from that of the English classical economists. Yet, the Saint-Simonians attributed a very important role to the state, due to the influence it could have on economic activity as a whole. In this movement it was Michel Chevalier (1806-1879) who considered the question most fully. After being the spokesman for the Saint-Simonian school, he became a Professor at the Collège de France in 1840, occupying the chair that had formerly been created for Jean-Baptiste Say. He developed a synthesis between liberal doctrine and Saint-Simonian thought. Jean Walch, a specialist on Chevalier, considers that 'he provided the "practical" Saint-Simonianism of the Pereires, the Talabots . . . and later of Napoleon III, a theoretical instrument on which they could lean' (Walch, 1975: 260).

For Chevalier, 'the government is the manager of the national association . . . Wherever the public interest is at stake, the government must intervene' (Chevalier, 1842: 69; Walch, 1975). This state intervention must take place in three domains: the development of means of communication, of money-lending institutions, and of professional training (Chevalier, 1844). Nevertheless, direct state responsibility for an economic activity must remain exceptional. In the field of communication, it is justified by the fact that this is a sector which:

1 'permanently affects all transactions';
2 requires an administrative unit;
3 requires an 'elite staff'.

Chevalier considered, for example, 'that canals could provide . . . trade with

the advantages one could reasonably expect it to' only if the state formed a regular body of lock-keepers, personnel for towage and probably even boatmen. We note that for the telegraph, this technical team was created by Chappe and his successors and that it later took over operation of the electric telegraph. Like all Saint-Simonians, Chevalier attributed a significant role to the railways in the advent of the industrial era. In 'the Mediterranean system', he qualified the railway as 'the most perfect symbol of a universal association'. More generally, means of communication were, according to him, an essential factor not only in economic growth, but also in the happiness of the people. Upon his return from a trip to the United States, he wrote:

> Improving communications is . . . working for true, positive and practical freedom . . . it is extending this liberty to the greatest numbers as far and as well as is possible by the laws of election. I would even go so far as to say it is a way of practising equality for all and democracy. Efficient means of transport reduce distances not only between different places, but also between different classes. (Chevalier, 1836: 3; quoted by Walch, 1975: 152)

Saint-Simonian thinking had a profound influence on political leaders of the time. In France, the state played a significant role in favouring the development of the railways. We have seen that it also provided considerable funds for the construction of the telegraphic network (in 1853, for example, when there were only 5,000 kilometres of telegraph lines, the government planned the construction of a further 9,000 kilometres during the same year).[18] It is, moreover, interesting that in parliament in 1851, unlike in 1837, no deputy proposed leaving it up to the private sector to build a telegraphic network for commercial use.

Nationalization of the telegraph in Britain

In England state intervention in communication systems was far weaker. The railways were developed solely by private initiative and the state limited itself to supplying authorizations and imposing a few rules, primarily in security matters. We have already seen that the same was true of the telegraphic network. These choices corresponded to the thinking of liberal economists, although they did not rule out state intervention in the communications field. Indeed, it was traders and industrialists that were to demand the nationalization of the telegraph. In 1861, John Lewis Ricardo, nephew of the renowned economist David Ricardo (1772-1823), ex-president of the main English telegraph company and a member of parliament, sent a report to the Chancellor of the Exchequer Gladstone, suggesting that the Post Office buy the telegraph from the private companies that owned it. He compared the position in Great Britain with that on the Continent where, he concluded, the telegraph was 'a powerful engine of diplomacy, an important aid to civil and military administration, and an efficient service to trade and commerce' (Kieve, 1973: 121). This standpoint seems very surprising in a man who was known to be an advocate of free trade, who had fought in parliament for the abolition of the Corn Laws and, in particular, who had created, with Cooke

and Wheatstone, the Electric Telegraph Company and had presided over it until 1858.[19]

Yet his proposition was not totally incongruous. Despite the dominance of 'laissez-faire' theories, the British civil service had become stronger and had extended its ambit. In 1855 the creation of the Civil Service Commission put an end to the system of recommendations which provided access to employment in the civil service. The United Kingdom gradually enhanced the quality of its civil service (Checkland, 1964: 313). In the 1840s, the Post Office was reorganized and became an efficient service. The 1844 Railway Act provided for the possibility of buying out certain companies at the end of their concession, although this facility was in fact never used (Mathias, 1969: 288). In 1859 the government granted subsidies to maritime traffic in the north Atlantic for the transport of mail (Checkland, 1964: 361).

This context was, however, insufficient for J.L. Ricardo's ideas to be accepted and the government rejected his propositions. In 1863 a law on the telegraph, defining the regulatory role of the state, was voted. The debate was resumed in 1865 by the Edinburgh Chamber of Commerce, which severely criticized the telegraph companies. It accused them of high tariffs for a very poor service, including insufficient lines, excessive delivery time of telegrams, long distances between telegraphic offices and business centres, and limited office opening hours. To remedy these shortcomings, it proposed the nationalization of private companies and management of the network by the Post Office. The latter had, over the preceding 20 years, developed an efficient and inexpensive mail service.

The same stance was taken by other chambers of commerce. The press, which was similarly dissatisfied with telegraphic tariffs, also supported this campaign. Petitions were subsequently sent to parliament, presenting nationalization as 'essential to the progress of the mercantile and manufacturing interests of the country' (Kieve, 1973: 128). This wave of opinion was furthermore taken up by the directors of the Post Office who wanted to increase the scope of their activities. The economist J.S. Jevons also supported the proposition in favour of nationalization (Kieve, 1973: 136).

In 1868 a law nationalizing the telegraph was voted in parliament by both Conservatives and Liberals. The preamble clearly states the grounds for nationalization:

> Whereas the Means of Communication by Electric Telegraphs within the United Kingdom of *Great Britain* and *Ireland* are insufficient, and many important Districts are without any such Means of Communication: And whereas it would be attended with great Advantage to the State, as well as to Merchants and Traders, and to the Public generally, if a cheaper, more widely extended, and more expeditious System of Telegraphy were established in the United Kingdom . . . (Kieve, 1973: 231)

While the bill was being voted, the question of monopoly was debated. Was the Post Office to be given a monopoly on the telegraph? The majority felt that it would block technical progress and thereby the improvement of the service. The government, however, defended the principle of a monopoly for

two reasons. It believed that private competitors would operate on the more profitable lines, so reducing profits which the Post Office could otherwise reinvest in less profitable links. Furthermore, if the Post Office did not have a monopoly, it might not buy out all the private companies, thereby creating a situation of inequality with respect to nationalization. The monopoly bill was finally passed, but only for national lines. International lines, and particularly the main submarine lines to America and India, were to be built by private companies.[20] At the end of the nineteenth century these companies controlled two-thirds of all international cables. The network was used by the British state which finally subsidized certain strategic links – and by other major powers. When conflicts of colonial expansion became too intense, the British government censured telegrams between Europe and Africa or Asia, although this rarely occurred. As Daniel Headrick (1989) says: 'during a period of forty years, this technology which was the monopoly of a single power, contributed to the development of international trade and to the colonial expansion of all Western countries.'

By the end of the nineteenth century a European model of public management of the telegraph had been established. In France, it consisted of the opening of a state network to commercial use. This opening was concomitant with the abandoning of the semaphore technique in favour of the electric technique and rapid growth of the network. In England, limited development of the commercial telegraph led to nationalization (the first in the history of the nineteenth century) and management of the network by the Post Office (in France this was to take place in 1873). While the state developed and operated a communication network intended for the stock exchange and the market, private British capital created an international network for commercial and state use. A century after Chappe's invention, a balance was established between state-controlled communication and market-controlled communication. Although the latter played a preponderant role, it was the state that was chiefly responsible for its development.

Notes

1 It should, however, be pointed out that the British government did on occasion finance inventions to do with information machines. In 1823, Charles Babbage obtained public funds to develop a machine capable of automatically compiling various kinds of mathematical tables. State intervention was justified by the unprofitable nature of such an invention and its general interest (Hyman, 1982).

2 Cooke had also thought of state use of his telegraph. In a memorandum in 1836, he wrote that by means of the telegraph the government would be enabled 'in case of disturbance to transmit orders to the local authorities and if necessary to send troops to their support; whilst all dangerous excitement of the public might be avoided' (Kieve, 1973: 18).

3 In 1839, negotiations had been initiated for the opening of the Navy's London–Portsmouth semaphore line to private use.

4 *Translator's note*: The Saint-Simonians were disciples of the philosopher Claude-Henri de Rouvoy (known as Saint Simon), who believed that science and technology would solve most social problems and that the state should play a major role in industrial development. The ideas of the Saint-Simonians had a pervasive influence on the intellectual life of nineteenth-century Europe.

5 Quoted by Michel Siméon, 'Adoption du télégraphe Morse par la France (1850-1860)', in report of the *6e colloque international de FNARH*, Montpellier, May 1989.

6 This was not only a French point of view, since the first semaphore telegraph line built in Germany was at the initiative of the state. It linked Berlin, the seat of the Prussian government, and Frankfurt where the first German government was located. Siements built this line (Michel and Longin, 1990: 28).

7 Havas Agency archives, *Imprimerie nationale*, Paris, 1969 (quoted by Mattelart and Mattelart, 1979: 25).

8 *Translator's note*: In 1848 a new revolution put an end to the July Monarchy. The Second Republic lasted from 1848 to 1852, after which Napoleon III ruled the Second French Empire until 1871.

9 Number of dispatches sent in a year (a circular sent to several places counts as one unit): 1847: 4,787; 1848: 9,504; 1849: 8,902 (Ministry of the Interior statistics, *Archives nationales*, C1002).

10 Report by M. Le Verrier to the Chamber of Deputies on 18 June 1850 in *Le Moniteur universel*.

11 Ferdinand Barrot, speech to the Chamber of Deputies on 1 March 1850 in *Le Moniteur universel*.

12 M. Le Verrier's report, *Le Moniteur universel*.

13 Ibid.

14 Ibid.

15 Ministry of the Interior statistics. Since the network was opened in March, I have taken data from March 1851 to February 1852, for the first year. *Archives nationales*, F90–1468.

16 Statistics for eight months (March to October 1851) (Ministry of the Interior statistics, *Archives nationales*, F90–1468).

17 On 1 May 1849, even before the law liberalizing use of the telegraph was voted, the Second Republic had authorized the transmission of stock exchange rates on the Paris–Lille line (letter from the Minister of the Interior of 1 April 1849, *Archives nationales*, F90–1456).

18 *Archives nationales*, C1036.

19 According to certain sources, the memorandum was drawn up in 1858.

20 Nevertheless, the English state did intervene economically abroad since in 1875 it bought a 46 per cent stake in the Suez canal.

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