Chapter Title: Enlightenment and Information

Book Title: The Power of Knowledge

Book Subtitle: How Information and Technology Made the Modern World

Book Author(s): JEREMY BLACK

Published by: Yale University Press

Stable URL: http://www.jstor.com/stable/j.ctt5vm805.10

7

Enlightenment and Information

Western society was increasingly impressed by the idea that authority should take rational form, as seen in the attempts in Britain to reconcile revealed religion to the insights gained by Newtonian science. From 1714, with a new ruling dynasty in power, the monarch no longer touched to cure those suffering from scrofula. To use the term 'rational' to describe this situation smacks of a presentist critique of what came before, but there was even at the time a self-conscious use of a rationalist language only indirectly grounded in sacral origins. This usage was distinctive, although it would be mistaken to see it as having no religious context at all. This chapter ranges from the Enlightenment to the French Revolution, considering the wider political contours and consequences of the rationalism of the period.

Religious and Social Contexts

The limitations in eighteenth-century Western science and thought were considerable, but this science and thought also represented an infinitely extendable attempt to understand natural forces and to encode them in laws that did not rest for their authority on a culturally specific priesthood or foundation myth. That focus on a materialist basis for observation and philosophy, however, did not amount to a denial of a divine role or to a democratisation of knowledge. The idea of God as the ultimate source of existence and value was widely held in Western scientific opinion, as in the argument that God first bestowed language.[1] In Britain, itinerant lecturers on 'Natural and Experimental Philosophy' introduced the public to topics such as electricity, hydrostatics, optics and astronomy, but did not see these as incompatible with traditional Christian themes. James Ferguson (1710–76) determined the year of the Crucifixion by reference to the dates of Paschal full moons and reconciled the Mosaic account of the Creation with Newtonian mechanics.[2] *The Knowledge of* *the Heavens and the Earth Made Easy* (1726) by the noted hymn-writer Isaac Watts was designed to strengthen religious knowledge.[3]

Moreover, in opposition to any democratisation, knowledge and expertise were seen as a key element of social hierarchy and were understood accordingly. The bulk of the population was granted scant consideration. French *philosophes* were scathing about what they presented as the superstitious ignorance of the peasantry.[4] In addition, the dangers presented by information that was not understood were a frequent theme, and a theme that was used to oppose not only social mobility, but also what was characterised as uninformed scrutiny.

Although they were the usual butt for it, criticism was not only directed at those of humble rank. In 1745, when Britain was involved in the War of the Austrian Succession, the diplomat Thomas Villiers wrote to his brother, the 3rd Earl of Jersey:

> the independent country gentleman . . . must not take it amiss if those, labouring for the public good, don't always give the great attention he thinks his lamentations deserve. I look upon him as one of the happiest animals when he keeps himself clear of politics; but if once infected, he is more miserable than if he had the plague . . . The interests of states and princes, and the care of preserving and destroying of birds and beasts (which is properly his department) are occupations of no connection; and a man taking a 11 hours and ¾ out of the 12 that he don't sleep by the latter can be but a very incompetent judge of the former. The few confused notions he can collect only perplexes his mind, and make him more wretched than a valetudinarian with a smattering of physick or anatomy. His first step towards recovery is to have recourse to somebody more skilful than himself, and to let nature alone.[5]

Aside from such diatribes, however, a sense of mobility in society encouraged a discussion of social classification, notably in Britain, where economic development facilitated, and was encouraged by, social change. Class came into use as a 'powerful organising concept', and society was increasingly experienced as 'mutable and combative'.[6]

Information – its definition, acquisition, classification and use – is not generally seen as being at the forefront of politicisation, but this chapter considers the relationship between the two alongside the discussion of the linkage between self-conscious rationalism and modernity. There was an emphasis on explicitly utilitarian elements in the accumulation and display of information, and in part this emphasis entailed a transition from the use of information in terms of established, conservative models and modes of the image of authority, of the symbolisation of knowledge and of the employment of power. Instead, a linkage between information and freedom of discussion was readily advanced in Britain where it served to justify the position of the greatly expanded press and provided an opportunity to criticise government, a process encouraged both by the constitution and by the nature of political society. The lapsing of the Licensing Act in 1695 facilitated the growth of the press.

The expansion in the amount of material available in print in Britain was such that it no longer seemed necessary to provide, in letters, diary entries or other forms, some categories of information in manuscript. Thus, John, 1st Earl of Egmont, a former MP, who heard the debate in the House of Commons on the size of the army on 18 February 1737, wrote in his diary: 'I will not set down the debates at length because the *Political State of Great Britain*, the *Gentleman's Magazine* and the *London Magazine*, which come out monthly, has of late years done it.'[7]

Coffee-houses, the key sites where newspapers could be consulted, were part of a new structure of sociability. This structure focused on public spaces where issues could be discussed on the basis of equality and without social differentiation being to the fore. Coffee-houses were also significant for the organisation and ethos of the book trade.[8]

The Enlightenment

The increased use of new information was not only part of the general trend of eighteenth-century Western society, but also a significant aspect of the Enlightenment. This last term, most often employed to describe eighteenth-century progressive Western thought, is not easy to define, and it is also difficult to avoid the temptation to reify it and then give it causal power. Frequent reiteration does not make the term any easier to define, and this has anyway become more difficult as attention has turned away from a traditional concentration on the writings of a small number of self-consciously progressive French thinkers, the *philosophes*, to an assessment of the situation throughout the West. Such an assessment reveals that the political, social and religious setting of the Enlightenment varied in different states. As such, alongside its internal links, the West was highly diverse. The degree of religious toleration was particularly important in this diversity as toleration offered the possibility of personal choice, loosened restraints on the individual and contributed greatly to the questioning of accepted beliefs.[9] At the same time, it only emerged in large part as a result of bitter partisan conflict, as in England in 1688–1720.

As an overarching theme, the Enlightenment could be described as a tendency, rather than a movement, towards critical enquiry and the application of reason in the cause of improvement. Information served this instrumental view of human capability, as well as playing a crucial role in the understanding of the human and natural environment, both of which were believed to be significant causal factors. Indeed, there was an attempt to emulate the Scientific Revolution with a science of man.

Information, moreover, was a key form of operation in the extensive and frequent correspondence that gave meaning and shape to the cosmopolitan links described by contemporaries as the 'republic of letters'. This exchange was regarded as important to the acquisition, definition and dissemination of information, and was also significant for establishing hierarchies of intellectual predominance.[10] Its cosmopolitan character was important to the self-image of the Enlightenment.

The republic of letters operated both as a general system and in particular fields. Thus, the *Institutiones Medicae* (1708) by the famous Dutch physician Herman Boerhaave (1668–1738) was translated into the major Western languages, while many medical students came to Leiden to attend his lectures. Rather than emphasising a devotion to received wisdom, Boerhaave encouraged his students to conduct their own experiments, as well as to think about the causes of disease. He saw chemistry as throwing light on the inherent character of natural bodies, although in practice his engagement with the subject also involved alchemical approaches.[11]

Reason was a goal as well as a method of Enlightenment thinkers. They believed it necessary to use reason, uninhibited by authority and tradition, in order to appreciate man, society and the universe, and thus to improve human circumstances, an objective in which utilitarianism and the search for individual happiness could combine. It was argued that the application of reason had freed men from unnecessary fears and could continue to do so, ensuring that men did and would not act like beasts. Reason was seen as a characteristic not only of the human species, differentiating humans from animals and from animal tendencies, but also as a characteristic of human development and social organisation. This was also an approach taken to justify the treatment of people brought under imperial control,[12] a claim that very much reflected Western suppositions about these people.

Focusing on Westerners, it was argued that reason aided human development by helping man to explore, understand and shape his environment, and that this process was facilitated by a reliance on objective fact, scepticism and incredulity. For example, Newton had demonstrated that comets were integral to nature, and not portents that provided opportunities for troubling mystical interpretation. Geological research, such as that of Jean-Étienne Guettard in 1751 in the Puy de Dôme, a major igneous structure in central France, threw doubt on the biblical view of the age of the Earth. The response to earthquakes similarly altered during the eighteenth century, with scepticism about providential explanations becoming more prominent from the 1750s, although that did not prevent such explanations for the London and (more spectacularly) Lisbon earthquakes. At the same time, traditional religious attitudes continued to play a powerful role, as in the assumption that calamities, such as the Lisbon earthquake of 1755, were a consequence of divine judgement.[13]

Nevertheless, the emphasis placed on the application of reason helped ensure that the Enlightenment represented a new development in assumptions deeply rooted in Judaeo-Christian and Classical thought about the need for improvement.[14] There was also a stress on personal commitment and a domesticated religious practice, rather than on the authority of established churches. This stress was significant in discussions about education, including the self-education catered for by the large numbers of devotional works published by entrepreneurs.[15] Education was important to the Enlightenment's quest for improvement and progress, even at the cost of challenging tradition.

A Mechanistic Mood

Reason was applied in the discussion of mechanistic themes that were significant in assessing the state as well as the world of matter. These themes offered the prospect of a science of politics in which information could be applied fruitfully. This science was seen both in international relations and in domestic constitutional issues. As far as the former were concerned, states were presented as sovereign but linked as if within a machine in a well-ordered world. This machine model suggested that activities could be conducted only in accordance with its construction and working, which put a premium on knowledge. Moreover, information was required for states to operate rationally within this system. The gathering of intelligence about other states was indeed highly important to rulers, and was encouraged by their number and proximity in the West and by the frequency of wars within the West.[16]

The mechanistic concept of the system of states was well suited to the wider currents of thought of the period, specifically Cartesian rationalism and Newtonian physics. Mechanistic concepts provided a ready context for integrating information, and this information could be quantified in terms of a balance of power, an idea that enjoyed much attention during the eighteenth century.

However, such a balance was (and is) a problematic concept. First, it served as much for policy prescription as for analysis, and as such was affected by the political contention involved in debates over policy. Secondly, as an assessment of strength, it was unclear what was relevant information and how it could best be obtained. It was difficult, for example, to assess fiscal strength or military quality. Whereas the number of warships could be counted, it was difficult to know their state of repair, let alone how easy it would be to raise the crew they required. Even if the available statistics had been better than they were – for example, for population or government revenues – it would still have been difficult to assess the ability of particular political systems to mobilise strength. As well as hard power, governance depended on consent, and information on this element tended to lack ready quantification, a point that remains relevant today, as do the very flaws of analytical systems based on such measurement and on related mechanistic assumptions, not least the supposition that more always makes success more likely.

At the same time, however problematic in terms of the ready measurement of a clear balance of power, the material made available to the public and to governments encouraged a degree of interaction and assessment within the information culture of the period. For example, a large section of the 28 February 1711 issue of the *British Mercury*, a London newspaper, began:

> We inserted some time ago, the French King's [Louis XIV] Declaration for levying recruits for the infantry of his army in Flanders, and did afterwards subjoin a general account of the numbers to be furnished by the several places. We shall now in this long want of foreign news, insert the particular repartition of the said levies, and the regiments they are appointed to recruit; from whence the curious may make some useful observations, both as to the proportion of strength of the several cities and generalities of France, with regard to each other; and also as to the present state of their army, and what likelihood there may be of their acting offensively in Flanders this campaign, as they have so industriously given out.

Similar points to those about the balance of power, both in terms of the measurement of power and the inherent value of the theory, can be made about the Western economic thought of the period subsequently described as mercantilism. This reflected an inherent problem with the idea of information systems. In practice, mercantilism was not really a common body of economic thought in which information could be integrated and resulting in a coherent policy. Instead, it was a set of familiar biases and accustomed responses to frequently occurring problems, within a context in which much lobbying and writing involved special pleading, and information was deployed accordingly. At the same time, the quantity of information provided to governments and to some of the public was considerable. For example, British readers interested in Dutch politics were given much material in Onslow Burrish's *Batavia Illustrata: or, A View of the Power and Commerce of the United Provinces* (1728).

Economic theory itself was not the cause of developments in production. Nevertheless, information did have consequences for economic development. In particular, the application of engineering knowledge in Britain reflected an understanding and use of Newtonian mechanics that represented considerable social capital and intellectual application that were lacking elsewhere in the world. Information was transmitted by example, publication and purchase, the viewing of steam engines in operation being an important means, and one that became fashionable. The ideas and practices of mechanical knowledge were widely diffused.[17] When Thomas Jefferson visited Britain in 1785 to pursue diplomatic negotiations, he toured the New Albion Flour Mill in London, a major site of steam power, as well as James Watt and Matthew Boulton's works in Soho, outside Birmingham. Both were important destinations for travellers.

Although its potential was not realised in many spheres until the nineteenth century, steam power gave humans the ability to speed up existence and to overcome the constraints under which all other animal species operated. For much of history, although humans alone created symbolic meanings that could change behaviour, they had not been radically different in organisational terms from other animals that had language, the capacity for acting as a group and systems of hierarchy. That was no longer the case. Indeed, steam power was to prove a prime instance of the way in which humans surpassed other species by using part of the accumulated energy of the world (in the shape of coal). Steam power therefore represented the use of knowledge to help humans adapt to and utilise their environment, and at a speed that cannot be explained in terms of theories focused on genetic change.

However, compared with the impact of steam power on printing from the early nineteenth century, there was scant mechanisation of the processes of information accumulation and distribution in the eighteenth. A desire for change accompanied by the frustrating limitations of new technologies was captured by the attempts by Jefferson to keep systematic records of his own transactions and correspondence, and to do so without reliance on copyists, the method generally used, notably in Europe where labour was more plentiful and less expensive than in America. Elected to Congress in 1783, Jefferson used Watt's new copying presses to retain copies of his writings, employing pressure to transfer soluble ink from the original writing in reverse to a translucent tissue copy paper laid over it. Via copying books, carbon paper and wax-stencil duplicating, the copying-press was to be the basis of the Xerox machine. Jefferson subsequently moved to the polygraph, a device with two pens and a writing frame, in which the writer, utilising one of the pens, produced two similar specimens.[18]

Experimentation

More generally, experimentation played a major role in producing the information that was to be self-consciously deployed in the cause of reason. Even if designed to sustain established views, this experimentation reflected a determination to expand on received information. Exploration played an important part, especially in botany, astronomy and geology. The collection of new species of plants and animals was a strong interest of the period, and was related to the major role attributed to tactile stimulus in ideas of education and information that drew on John Locke's account of the soul as dependent on external sensations.

Prominent individuals were happy to be associated with this process. Anne-Robert-Jacques Turgot, French controller-general from 1774 to 1776, sent two naturalists abroad, while Charles III of Spain founded a Royal Botanical Garden in Madrid and dispatched royal botanical expeditions to Spanish America from 1777 to 1816 in order to discover plants with medicinal and economic properties. This activity was part of a sustained Spanish effort to understand and use the natural products of its empire.[19] Similar attempts were made by other rulers: for example, in the mid-century Danish empire, leading to a gathering of information about Iceland.

Accompanied by the specialised staff and equipment that his landed wealth permitted him to finance, the British gentleman-botanist Joseph Banks (1743–1820) sailed round the world with James Cook on HMS *Endeavour* in 1768–71. Alongside claiming possession of territory for George III, Cook's three voyages to the Pacific, a microcosm of the Enlightenment, were important to a whole range of scientific activity adjudged useful to government. Banks also collected plants on expeditions to Newfoundland and Iceland, as well as succeeding George III's favourite, John, 3rd Earl of Bute, as director of the new gardens at Kew. Drawing on the global presence of British power and trade, and seeing plant classification as a means to imperial benefit, Banks helped to make Kew a centre for botanical research based on holdings from around the world and on information derived from a far-flung system of correspondence.[20]

Although the attempt by the Spanish crown in the sixteenth century to make scientific use of its American conquests anticipated some aspects of this activity, the scale and ambition were now very different. President of the Royal Society from 1778 to 1820, Banks helped establish both the idea of the scientist as, successively, heroic explorer and statesman, and the Royal Society as a key source and means of state policy. British imperial activity was presented and understood as a means to further scientific progress. In order to reduce tea imports from China, Banks suggested its cultivation in India – as, indeed, happened, in a major instance of imperial activity linked to environmental change. Earlier, the cultivation of rice in the coastal regions of the British colonies of South Carolina and Georgia had stemmed from the movement of rice plants, and of slaves used to cultivating them, from the British slaving bases in West Africa.[21]

Collecting took a number of forms. Banks also played a role in the British acquisition of the botanical and zoological collections of the Swedish naturalist

Carl Linnaeus (1707–78), who had been very influential in developing an information system capable of dealing with the vast amount of material being acquired, a process designed to help national growth through the governmental management of natural resources.[22] Linnaeus created a comprehensive Latin binominal system for plants and animals, grouping both into genera and species. A systematiser, in the fashion of the period, he emphasised taxonomic clarity, and therefore ease of use, as the way to understand and reproduce information, and thus to put plants to work on a world scale. In doing so, Linnaeus downplayed the previous emphasis for flora on local knowledge and names.[23] Similarly, botanical illustrations linked to Western expeditions produced 'highly selective visions of decontextualized specimens, allowing for their inclusion in global natural history'.[24]

Linnaeus's career illustrates several aspects of the eighteenth-century quest for information. He was ready to gather such material in person, travelling, for example, to Lapland in order to collect plants, a process eased by it being under Swedish rule. At the same time, his data-collection enterprise drew on by now characteristic features of the Western information system, including printing, the book market, the paper trade, a global postal system and trans-oceanic trade.[25]

The various milieux of the gathering and discussion of information were also illustrated by Linnaeus's activities. A professor who published in Latin in order to reach the scholarly community, he also inspired a group of amateurs, the Linnean Society of London, established in 1788, the founder of which, in 1784, purchased Linnaeus's massive collections, a step encouraged by Banks and one that helped advance Britain's position as a centre of classification, notably in competition with France. In 1783, Linnaeus was translated into English by Charles Darwin's grandfather Erasmus Darwin, in *A System of Vegetables according to their Classes, etc.* Aside from translations, the extent to which correspondence, illustrations, specimens, instruments and texts crossed international boundaries contributed to the cosmopolitan character of Western science.

Linnaeus's system was challenged by other scientists, an indicator of the way in which the classification of information drove contention and thus challenged the status of such systems. Buffon, the influential director of the Paris Jardin du Roi, began in 1749 to publish an *Histoire naturelle*, which, when completed in 1789, reached to thirty-six volumes. Achieving great popularity and fame, and testifying to the fashion for encyclopaedic knowledge, this work was partly designed to replace what he saw as the arbitrary taxonomic classifications of Linnaeus. Like Linnaeus and Banks, Buffon regarded information as a means to enable humanity to fulfil its potential, with reform presented as dependent on the rational governance of nature in order to improve the economy and enhance the human environment.[26]

The pace of exploration affected Buffon's work: the publication, in 1753, of the fourth volume, which introduced the account of quadrupeds – which would later be termed (terrestrial) mammals – was delayed for nearly three years as a result of the emergence of greater understanding of the diversity of these creatures. Travellers' correspondence proved a major source of information. Moreover, Buffon was not a passive reader and recipient of correspondence. He also experimented, notably with crossbreeding, in order to use hybridity as an element in advancing a new definition of species, one that addressed both their constancy and their variation.[27]

This combination posed issues not only of classification but also of the development of species, the latter inviting troubling questions of process, chronology and intention, as in the response to Erasmus Darwin's classification of animal life in his medical text *Zoonomia* (1794–6). Discovery and classification were linked to the presentation of information in publications, and in public spaces, notably museums and botanical gardens, such as the Jardin du Roi, as well as the personal collections favoured in the previous century.[28]

The value of travel for the acquisition of botanical information was also seen in other branches of knowledge such as astronomy. Travel was also important in making contact with entrepreneurs and in visiting industrial sites.[29]

Data could be collected across time as well as space. Venetian forestry officials studied changes in the forests that were recorded in their archives and used this data in order to assess the dynamics of forest development. This method offered an alternative to seeing resources as static.[30] So did the interest in agricultural improvement. The dissemination of information to this end through printing was significant, and included movement to the colonies. In his library, George Washington had a copy of the second edition of Edward Weston's *New System of Agriculture; or, A Plain, Easy, and Demonstrative Method of Speedily Growing Rich* (London, 1755), a work that on its title-page proclaimed that agriculture offered the 'only gentleman-like way of growing rich',[31] an approach not taken in many other cultures.

Most of the acquisition of information did not entail travel, but rather experimentation *in situ*. This was true, for example, of medicine and chemistry. Medical research became more important than hitherto in the West in the eighteenth century and was linked to a rejection of earlier ideas, and of the processes of authority and hierarchy on which they were based, notably longevity and traditional educational methods. The appointment of physicians to the London charity hospitals turned them into centres of research, and in Edinburgh the modernisation of the curriculum strengthened the role of hospital-based research. New information was increasingly important in England because the training of surgeons came to be largely conducted in hospital schools rather than through apprenticeships, the latter a process that lent itself to conservative inflexibility. Guild structures were capable of change, but it was easier to impose it through institutional provision via new facilities and working systems, although that method also posed problems, notably of flexibility.

This process was not only seen in Britain. The major purpose of the Academy of Medicine founded at Madrid in 1734 was to study medicine and surgery from observation and experience. Gaspar Casal (1679–1759) was the first doctor to introduce the modern, empirical, symptomatic concept of illness in Spain. He used this method to describe the symptoms of pellagra and to differentiate the disease from scabies and leprosy. More generally, the understanding of anatomy and disease was designed to serve a variety of purposes. Models of the human body displayed from 1775 in Florence in the Museum of Physics and Natural History were intended to help create the model citizen.[32]

The spread of information owed much to publications. In his *Medical Sketches* (1786), John Moore, a British doctor, discussed the transmission of impressions from one nerve to another, illustrated by the fact that eating ice cream causes pain in the root of the nose. He also described the effects of temporary pressure on the surface of a brain exposed by trepanning. Publications, moreover, were deployed across linguistic borders. Thus, in 1736, Venice's envoy in London sent home a printed French account of a British machine designed to extinguish fires and to water gardens.[33] At the same time, publications served as a way to debate devices and practices, as with contention over the therapeutic values of mesmerism and, in the USA, tractoration, the process of relieving pain by using a device invented by Elisha Perkins containing pointed rods of different metals.[34]

The spread of information was also seen in the diffusion of best practice concerning the use of spectacles. Publication played a major role in this process. In 1750, the optician James Ayscough published an account of the nature of spectacles, in which he recommended a tinted glass to reduce glare, and in 1755 an *Account of the Eye and the Nature of Vision*. A type of spectacles known as Martin's Margins employed refraction to diminish the glare of the sun, which proved useful for those sent to the Tropics, such as Admiral Rainier, British commander in the Indian Ocean in the Napoleonic Wars.

In turn, spectacles, which had been in use for centuries, were themselves significant in the accumulation and transmission of information. They helped people to read and also enabled old people to see in order to be able to write, and thus permitted them to pass on accumulated wisdom. There were related cultural changes. The difference between the blind and those with sight was demystified in the eighteenth century, both by the introduction of surgical cures for cataracts and by philosophical and medical discussion.

Chemistry, a subject that developed greatly in the West in the last third of the eighteenth century, indicated the dynamic interaction between acquiring more information through experimentation and advancing new ideas of classification. Both processes were combined in the career of Antoine Lavoisier (1743–94) who, through his experiments, came to the conclusion that the weight of all compounds obtained by chemical reaction is equal to that of the reacting substances, a conclusion that he generalised as the law of conservation of mass in 1789. Moreover, his *Méthode de nomenclature chimique* (1787) defined a system of quantification that could be used to facilitate comparative experimentation. Lavoisier's systematisation of the chemistry of gases in his *Traité élémentaire de chimie* (Elements of Chemistry) (1789) set the seal on one of the more successful areas of eighteenth-century chemical advancement, the recognition that gases can be separated and identified, rather than being simply variants of 'air'. Lavoisier's systematic rewriting of the very language of chemistry[35] was an aspect of its creation as a separate science, with a methodology that distinguished it from alchemy. Such a transformation was part of the reorganisation of knowledge that was important to eighteenth-century Western intellectual activity.

The language of mathematics was also expanded. William Oughtred (c. 1575–1660) introduced a number of mathematical symbols, including :: for proportion and × for multiplication, while William Jones (1675–1749), a mathematics teacher, in his book *Synopsis Palmariorum Matheseos, or A New Introduction to the Mathematics* (1706), first used π (pi) as the irrational number (infinite, non-repeating, sequence of digits) that expressed the constant ratio of the circumference to the diameter. Jones's activities link a number of individuals and themes: he was a supporter of Newton's reputation in the dispute over whether he or Leibniz invented calculus first, as well as a writer on navigation, the subject in 1702 of his first book – he had taught mathematics on an English warship. Jones was interested in longitude (like many mathematicians), became vice-president of the Royal Society in 1749, and his one-time pupil George Parker, 3rd Earl of Macclesfield, a keen astronomer, became president in 1752 and helped push through the adoption of the Gregorian calendar that year, thus bringing Britain into line with most of the Continent. Although Russia continued to follow a different calendar, Britain's move, which ended an eleven-day difference, was an important step in bringing cohesion to the treatment of time in the West. Jones's son William was to find fame as 'Oriental' Jones (see p. 157).[36]

The process of research became more established across the West as the relevant infrastructure developed, while both process and infrastructure were linked to a degree of specialisation: for example, in the establishment of disciplinary journals.[37] In Germany, the number of academic posts and laboratories for chemistry and the number of chemists increased dramatically in 1720–80, thanks largely to government interest in promoting public health and industry.

Whereas, in 1720, most German chemists were practising medical doctors or teachers of medicine, by 1780 most worked in pharmacy, technology and the teaching of chemistry. Specialisation increased and chemists were more able and willing to conduct experimental research. The first German periodical devoted exclusively to chemistry, the *Chemische Annalen*, was founded by Lorenz Crell in 1778. The *Journal der Physik*, established by F.A.C. Gren, followed in 1790.

Infrastructure was not simply a matter of facilities and posts provided by government. There was also a public interest in science and a commitment to the idea that it could lead to beneficial change. This interest was seen in learned societies and lectures that attracted informed amateurs. Northampton in the mid-eighteenth century had a population of only five thousand, but it supported from 1743 to about 1751 the Northampton Philosophical Society, the lectures of which covered the full syllabus of contemporary physics. Members also had access to the latest published works.

Aside from advertising lectures and demonstrations, providing a market for the popular touring lecturers on Newton,[38] British newspapers covered science as a topic. A rapidly and widely diffused scientific culture was particularly apparent in Britain. Whereas French newspapers had few advertisements,[39] those in British newspapers helped ensure the multiple sales of books and of tickets for lectures upon which scientific knowledge relied as an alternative to that of individual patrons: 'the general popularity of natural knowledge as a form of urban cultural activity was the result of the universalist aspiration of natural philosophy to be the summit of objective rationality, a status due in part to the importance of natural science in natural theology, to the growth of urban consumer society, and to the nature and status of the new "public" experimental science.'[40]

This point is relatively uncontroversial, but the lack of an equivalent across most of the rest of the world is also instructive, not least because of the relationship between religion and science in Britain and elsewhere. The English Dissenting Academies introduced the teaching of experimental science as a means of understanding the wisdom of God.[41] It would be mistaken to see the relationship between science and religion in Britain as free from tension, however. For example, towards the end of the eighteenth century, in part related to the reaction against religions and political radicalism, there was renewed interest in revealed theology and a greater suspicion of arguments based solely on reason.[42]

Nevertheless, there was an essentially welcoming context for experimentation. Popularising the study of chemistry in Britain, Joseph Priestley (1733–1804) presented scientific knowledge as demonstrating God's laws, leading both to social progress and to moral reform.[43] Moreover, in Scotland in the

1790s, taking forward considerably a 1720–1 Church survey on the geography of the parish,[44] Sir John Sinclair used the efforts of parish ministers to produce the answers in his Statistical Survey, an attempt to accumulate information in order to further economic improvement.

The situation was less favourable in some Western states, but the freedom of discussion was generally greater than it had been in the seventeenth century. In particular, censorship, of both information and opinion, became less insistent. Instead, there were attempts – for example, in Italy – to encourage a measure of authorial self-censorship.[45] Persuasion became more significant than control across the West, a situation that encouraged debate.[46]

Commentators made less reference to the role of divine intervention than had been the case in the seventeenth century. In France, historians changed the customary presentation of Clovis (r. 481–511), the conquering Frank who converted to Christianity in 493, from miracle-working royal saint to that of royal legislator. As such, there was a parallel to the rise of Newtonian science, which did not seek to dethrone God but nevertheless limited the divine role, certainly in terms of causing specific events. This intellectual thrust represented a new form of realism, one separate from direct manifestations of divine action and therefore minimising the role of providence.

The final ending of the royal touch in England with the accession of George I in 1714 was instructive. Earlier, William III (r. 1689–1702) had ended the practice, only for his sister-in-law Anne (r. 1702–14) to revive it. She claimed direct descent from Stuart predecessors (as daughter of James II; William was a grandson of Charles I via the female line), as well as a more traditional piety and a clear sense of the monarch as head of the Church. William III, George I and George II held the latter position too, but the first was a Calvinist and the others were Lutherans. Far from tailing off, demand for the royal touch had grown dramatically under Charles II (r. 1660–85) and James II (r. 1685–8).

Similarly, theological issues were in part discussed by means of consideration of secular historical evidence, notably in the case of miracles. Attempts to bring Christianity in line with an understanding of human history and circumstances applicable to all cultures led to a rejection of the idea of miracles, although there was continued support for the idea of divine intervention: for example, from John Wesley in his *Letters to Conyers Middleton* (1749).[47] So also with comets: alongside criticism of the idea that they reflected divine intervention came condemnation of such a 'specious part of reason' and a conviction of the role of God in causing them.[48] In addition, second sight was dismissed as a fraud by John Toland (1670–1722) and Robert Molesworth (1656–1725), British radical controversialists. More generally, there was a stronger emphasis on the reality and importance of 'facts' (see p. 308), and an assertion of their primacy over attempts at expository manipulation.

Experimentation provided far more information about the natural environment, including about what was not readily graspable without the benefit of pieces of equipment such as microscopes and telescopes.[49] Experimentation was certainly important in chemistry where it helped expand the known number of gaseous elements and compounds. In Britain, Joseph Black (1728–99), professor of chemistry at Glasgow, and later Edinburgh, discovered latent heat and first fixed the compound carbon dioxide. In 1766, Henry Cavendish (1731–1810), a master of quantitative analysis, became the first person to define hydrogen as a distinct substance and, in 1781, the first to determine the composition of water by exploding a mixture of hydrogen and oxygen in a sealed vessel. The Swedish pharmacist Karl Scheele (1742–86) discovered chlorine in 1774, and isolated a large number of new compounds in organic chemistry.

Experimentation – for example, on successive models of steam engines – was linked to the new thinking and to an emphasis on useful knowledge that facilitated wealth creation. These attitudes and practices contributed to industrialisation in Britain, as well as to improvements in agriculture, transport and other fields. In 1733, Sir James Lowther, a major Cumbrian landowner and colliery entrepreneur, had an experiment carried out before the Royal Society in order to seek help from the Fellows about the problems of inflammable gases in mines.[50] At the same time, alongside scientific knowledge, industrial development benefited from craft skills, not least in relation to mechanisation.

Although measurement played a major role in the experimentation of the period, it faced important problems. It was not easy to make standard instruments or to replicate laboratory results, and research in chemistry was hindered by the difficulty of quantifying chemical reactions. Good vulcanised tubing did not appear until the mid–1840s. Not only chemistry was affected by the problems of experimentation. The British-based German astronomer William Herschel (1738–1822) encountered numerous difficulties in 1773–4 in the construction of his first telescope. His quest for knowledge benefited from royal patronage and was also carried out in a blaze of publicity that reflected public interest. Determined 'to take nothing upon trust', 'to carry improvements in telescopes to their utmost extent' and 'to leave no spot of the heavens unexamined', Herschel found Uranus in 1781, the first planet discovered since Antiquity. This advance, which followed on others achieved with telescopes in the seventeenth century, notably with Jupiter's moons, underlined the limitations and failings of Classical knowledge. Herschel's achievement was regarded as considerable, and not only in Britain. The precision offered by telescopes was also seen in the arts as with John Russell's *The Face of the Moon* (c. 1795), a pastel based on precise observations made through telescopes, which hung in the house of James Watt's business partner, Matthew Boulton.

Designed to aid research, classification also faced problems. Various systems of measurement were introduced, but they did not always correspond to one another. For example, thermometers were produced in the eighteenth century by Celsius, Fahrenheit and Réaumur, each, however, using different scales. This was an example of the uncoordinated nature of most Western scientific work in the period, which was only partially counterbalanced by the extensive correspondence between experts. There was neither comparable work nor links in other cultures.

At the same time, the measurement of both climate and weather in the West reflected a major intellectual departure from an emphasis on moral failings, divine action and biblical literalism, towards a discussion framed in terms of scientific rationalism. This change, which reflected the extent to which climate as a form of classification was (and is) a cultural and moral phenomenon,[51] encouraged an emphasis on measurement in the eighteenth century. Those who could afford to do so furnished their houses with clock-like cased barometers which both provided information and offered a way to display and enjoy taste.[52]

Measurement was linked to classification and codification. Mathematical symbols, standardised measures and universal scales also aided the recording and communication of discoveries and innovations. Moreover, the development of descriptive geometry by the French mathematician Gaspard Monge (1746–1818) between 1768 and 1780 made the graphical presentation of buildings and machine design mathematically rigorous.[53] Such rigour was linked to a Neoclassical style of precision in which the abstract value of mathematics played an aesthetic as well as an intellectual role.[54]

Race

Racial classification reflected very different issues, not least the desire to explain all, to fit information into a clear system. Thus, increasing racial classification was linked to the growing emphasis on the organisation of knowledge. Related to this emphasis, there was a need to respond to the new information from voyages of exploration. Indeed, the understanding of the outside world is an aspect of the geographies of science that were so important in constructing and reflecting networks of thought and activity.[55]

At the same time, the interaction of racism and poor science was significant, as was the classification of evidence in terms of heavily biased social and cultural assumptions. Racism was reflected in Western notions of an inherent hierarchy based on ideas of sharply distinguished races and on supposed differences between them that could be classified in a hierarchical fashion and whose genesis could be traced back to the biblical sons of Adam.

Evidence of racial difference was seen in physical attributes, especially, but not only, in skin colour. The argument that bile was responsible for the colour of human skin, advanced as a scientific fact by writers in Antiquity, was repeated without experimental support by eminent eighteenth-century scientists, including Buffon, Feijoo, Holbach and La Mettrie. This error was linked to false explanations, such as that of Marcello Malpighi (1628–94), professor of medicine in Bologna and the founder of microscopic anatomy, who believed that all men were originally white, but that the sinners had become black. Another Italian scientist, Bernardo Albinus, proved to his own satisfaction, in 1737, that Negro bile was black; in 1741, a French doctor, Pierre Barrère, published experiments allegedly demonstrating both this and that the bile alone caused the black pigment in Negro skin. This inaccurate theory won widespread acclaim, in part thanks to an extensive review in the *Journal des savants* in 1742, which reflected the importance and prestige of print. The potentially erroneous character of new experimentation was also reflected in the flawed nature of the proof for the theory of phlogiston, the supposed universal element.

Barrère's theory played a major role in the prevalent mid-century belief that black people were another species of man without the ordinary human organs, tissues, heart and soul. In 1765, the chief doctor in the leading hospital in Rouen, Claude-Nicolas le Cat, demonstrated that Barrère's theory was wrong, but he was generally ignored and Barrère's arguments continued to be cited favourably.[56]

Race was also linked in the West to alleged moral and intellectual characteristics, and to stages in sociological development. This linkage encouraged a sense of fixed identity as part of a compartmentalised view of mankind, rather than an acceptance of an inherent human unity and of shared characteristics, a view also held in China and Japan. This compartmentalism furthered classification, although the factors that were supposed central to the diversity of human groups, and thus to their classification, varied. In the West, religious and biological explanations of apparent differences between races were important, with black people presented as the children of the cursed Ham, a son of Noah. These explanations were linked to the idea that species of animals had been separately created by God.[57]

Influential writers, such as Georg Forster and Henry, Lord Kames, argued in favour of polygenism, the theory of the creation of different types of humans, which led to suggestions that black people were not only a different species, but were also related to great apes such as orang-utans. However, this idea ran counter to Christian tradition. Moreover, an environmental/climatic model which provided an (inadequate) explanation for racial variation was influential. This reflected the interest of eighteenth-century Western thought in environmental influences, especially climate, which were regarded as explaining apparently fundamental contrasts in behaviour. Information from exploration threw light on these influences and encouraged engagement in related analysis. Montesquieu and Buffon explained colour as due to exposure to the tropical sun.

This explanation was linked to the thesis that, while black people were believed to be inherently inferior, they were also particularly adapted to living in the Tropics. Adaptation to the environment could be linked to an argument that black people were essentially different from white people and closer to the animals that lived in the Tropics, a view that was held to justify slavery.[58] Such justification was also still advanced by some who sought to reconcile slavery with the supposed Christian commitment to a message for all people, a long-standing issue for clerics and apologists. Far from there being a monolithic racism in the West, however, the experience of Africans in Christian Europe in the eighteenth century suggests a variety of treatment, in which individual status and personal links played a major role.[59]

Differences in classification in terms of race indicated the nature of Enlightenment thought, at once bold and yet lacking in stability, as well as reflecting major tensions in theological readings of racial difference and development.[60] By the end of the eighteenth century, most advanced opinion no longer regarded black people as a different species, but rather as a distinct variety. This interpretation, monogenesis – the descent of all races from a single original group – was advanced by Johann Friedrich Blumenbach (1752–1840) a teacher of medicine at the University of Göttingen who, in 1776, published *De Generis Humani Varietate*, an influential work on racial classification. Blumenbach was a key figure in the development of anthropology and his book went through several editions.[61]

However, aside from the misleading assessment of the supposedly inherent characteristics of non-Westerners, a belief in progress, and in the association of reason with Western culture, necessarily encouraged a hierarchy dominated by Westerners, and thus a treatment of others as inferior. Thus, although monogenesis can be presented as a benign theory that could contribute to a concept of the inherent brotherhood of man that was voiced during the Enlightenment, and especially in the French Revolutionary period, it was also inherently discriminatory. Blumenbach assumed the original ancestral group to be white, and that climate, diet, disease and mode of life were responsible for the developments that led to the creation of different races. Considering the relative beauty of human skulls, so as to determine the history of the human species, Blumenbach claimed that that of the Caucasian girl was most beautiful and the original production of nature. Aesthetics, therefore, was deployed alongside racial science in support of notions of Western superiority.[62] Moreover, race came to be understood as a biological subdivision of the human species rather than, as originally, a people or single nation linked by a common origin.[63]

Understanding the Human Environment

More generally, cultural characteristics and developments in the world were presented in terms of the suppositions of Western culture, with a parallel process occurring in China. This led to, and supported, a hierarchisation dominated by the West, as again with China. In China, the prevailing orthodoxy offered the benefits of Manchu rule to all subjects, but distinct ethnic definitions remained important and ethnographic atlases were used by the state as part of a strategy of ethnic classification.[64] China, however, does not appear to have matched the developing Western idea of cultural relativism seen, for example, in Johann Gottfried von Herder's *Auch eine Philosophie der Geschichte* (*Another Philosophy of History*) (1774) and in the interest in comparative religion. Explorers and other travellers, such as James Cook, both tried to understand the peoples they met in their own terms and also imposed Western categories and values on them.[65] Moreover, there was Western interest in comparative linguistics, as in 'Oriental' Jones's work (see p. 157) and in Jonathan Edwards's *Observations on the Language of the Muhhekaneew Indians; In Which . . . Some Instances of Analogy between That and the Hebrew Are Pointed Out* (New Haven, 1788). George Washington saw such information as contributing to an understanding of 'the descent or the kindred of nations'.[66]

The changing ideology of science was significant in encouraging an emphasis on experimentation and thereby on new theories that arose as a consequence. The growing prestige of science reflected the sense not only that it could have practical value, but also that, in extending man's knowledge, it was worthy of praise. The *philosophes* applauded science as an example of human creativity and extolled the achievements of contemporary and recent scientists. The public tributes of the French Académie des Sciences helped to establish an image of scientists as disinterested, passionless seekers after truth. History offered another form of study designed to deploy information in the cause of improvement. The classifying of human experience, past and present, in terms of a stadial theory of development offered a 'science of man' linking past, present and future.[67] Across the West, historical developments were shaped by analyses designed to help explain how the present could be improved.

Experimentation was widely extolled. In works such as Étienne Bonnot de Condillac's *Traité des systèmes* (1749), the *philosophes* condemned Descartes's ideal of *a priori* rationalist science. At the same time, thinkers responded to the perspectives offered by Newtonian natural philosophy. Thus, Kant tried to grasp the philosophical significance of Newton's ideas.

Intellectual advances gave some people a sense that certain aspects of the environment could be controlled or better understood. The development of statistics and probability theory was particularly pertinent, not least as they offered alternatives to astrology and fatalism as ways to understand the present and predict the future. As such, the information deployed, and the analysis offered, were of great importance for capitalism, by fostering informed, and thus efficient, investment. Through probability, prediction could be mathematical and the uncertainties of distance and time overcome, or at least countered.[68] Moreover, statistics qualified the use of reason to ascertain economic realities and improvability in terms of scientific laws, the approach taken by French commentators in particular, notably Condillac's *Le Commerce et le gouvernement* (1776).

The *Ars Conjectandi* (*The Art of Conjecturing*) (1713) of Jacob Bernoulli (1654–1705), professor of mathematics at Basle, was the first major work on the theory of probability. His nephew, Daniel Bernoulli (1700–82), professor of mathematics at St Petersburg and, successively, professor of anatomy, botany, physics and philosophy at Basle, and the formulator of the law of conservation of mechanical energy, applied statistics and probability calculus to determine the usefulness of inoculation against smallpox. He examined the differentiated risk of dying from artificial (as a result of inoculation) or natural smallpox and, in 1760, produced tables to demonstrate the advantage of inoculation in bringing to productive and reproductive maturity the maximum number of infants born, and thus in preserving the investment made in bringing them up.

The statistical evaluation of medical treatments also developed in Britain, as therapies and techniques were assessed quantitatively. Moreover, there were comparative therapeutic trials, such as James Lind's trial of antiscorbutics in 1747. By showing the curative and preventative power against scurvy of citrus fruit, this trial lessened mortality on long-distance Western voyages. As more generally with British medical practitioners active in empire, those who ran the trials were often Dissenters (Protestant Nonconformists) who had frequently been trained in Edinburgh. Committed to improvement, they were willing to undertake the hard work of statistical investigation. Such research encouraged the use of standard treatments as part of an evolving body of medical knowledge guided by empirical research and statistical probability.[69] The influence was not all one-way: medical conceptual advances owed something to the experience of trans-oceanic imperialism.[70]

Meanwhile, probability theory was taken forward as a theme for public policy by the Marquis de Condorcet (1743–94). In his *General Picture of Science, Which Has for its Object the Application of Arithmetic to the Moral and Political Sciences* (1783), Condorcet argued that a knowledge of probability, 'social arithmetic', allowed people to make rational decisions, instead of relying on instinct and passion. Condorcet was a great believer in the possibility of indefinite progress through human action, seeing the key in universal state education focused on practical subjects. Like Lavoisier, he was to be a victim of the French Revolution. Both men were products of the close relationship between a new generation of scientists and reformers among senior French administrators.[71]

Greater use of statistics encouraged greater investigation of social consequences and of probabilities. In Britain, Jeremy Bentham's *Table of Cases Calling for Relief*, which appeared in the *Annals of Agriculture* for November 1797, provided a basis for distinguishing between the inherently dependent poor and those only in poverty. The statistics also encouraged support for a fact-based approach to reforming the Poor Law. Probability theory was also of great value for those working on cryptology.[72]

Fact- and theory-based approaches to issues of finance and credit[73] were also stimulated by the information offered in a large number of publications, notably in Britain and France. The very process of valuing forms of paper credit, such as banknotes, reflected the extent to which money itself was a form of information, as its worth rested on a knowledge of fiscal circumstances including credit obligations.[74] Moreover, the circulation of information was designed to counter irrationality on the part of investors as well as to facilitate the operation of the fiscal system, notably with the mutual quotation of exchange rates which helped facilitate a cashless Western payment system.

Each of these points remains relevant today. The financial crisis of the late 2000s and early 2010s in part reflected an understanding of the information available that pointed to the lack of creditworthiness of overly extended governments and banks. However, during this crisis, the availability of information designed to limit investor risk, notably credit ratings, was itself condemned by governments as a cause of instability.

Probability was significant in the eighteenth century in helping explain the role of the environment as well as human responses. Moreover, emphasising the dynamic character of the situation, psychological theories suggested that man, both as an individual and as a social being, could be improved by education and a better environment. Activity was stressed, rather than the passive acceptance of divine will and an unchanging universe; and such activity required information.

The belief that the human environment could be better understood led to a scheme for a published compendium of knowledge. The *Encyclopédie*, launched in Paris by Denis Diderot and Jean le Rond d'Alembert in 1751, was originally a project to translate Ephraim Chambers's attempt to organise and cross-reference knowledge in his *Cyclopaedia, or An Universal Dictionary of Arts and Sciences* (1728). The *Encyclopédie* was then transformed into a work of reference by description that was also a vehicle for propaganda for the ideas of the *philosophes*. In his article 'Encyclopédie', Diderot wrote that, by helping people to become better informed, such a work would help them become more virtuous and happier. A guide to the known, the *Encyclopédie* was not interested in speculating about the unknown, and this focus encouraged a sense of human achievement as well as distancing the work from the occult and the mystical.

The *Encyclopédie*, like the *Cyclopaedia*, was published in the vernacular. It was also a synthesis that, unlike those of the humanists, was not dependent on elaborate indices in order to master the compilation of information.[75] At a very different scale, the acquisition, organisation and scrutiny of information were aided by the development of shorthand systems: for example, that of Thomas Gurney of about 1750.

Produced, like Samuel Johnson's *Dictionary* (an attempt to fix the language) in Britain, by subscription and individual support, not government commission, and followed by less expensive later editions, the *Encyclopédie* testified to the public, commercial character of Western culture in this period. This character, indeed, helped establish a context for information that was different from, even as it overlapped with, that of the governmental sphere. The commercial dynamic arose from, and ensured, an emphasis on intellectual products as property deserving investment, rather than as the permitted outcomes of regulation, licensing and governmental favour.

In Britain, the 1710 Copyright Act was significant as copyright was separated from censorship and established as a property in which the author, as well as the bookseller, had legal rights. This development reflected the need for a new form of organisation after the demise of the Stuart licensing culture and system, but also an evolving concept of intellectual and artistic production, away from an emphasis on honour and reputation and towards property rights. In part, this development was related to ideas of personality linked with John Locke (1632–1704). The key element was the notion of the author as an active moulder rather than more passive mouthpiece of deeper truths.[76] In France, where the pre-revolutionary regulation of the book trade by the *ancien régime* government and corporate bodies was weak, the interests of authors eventually led in 1793 to the Declaration of the Rights of Genius, which conferred literary property rights on playwrights.[77]

Both the governmental and commercial contexts of cultural activity were characterised by a developing interest in change that rested on an increasing view in the West that the processes and consequences of change were themselves valuable and could be planned, moulded and advanced by mankind. Human progress was to be understood, recorded and encouraged. This understanding relied on, and was expressed in, an empirically based description.[78] It also led to an interest in innovation, indeed in an industrial (and agricultural) enlightenment in which machines, notably steam-driven machines, were seen as being inherently beneficial. Developing intellectual and social values and practices were important in embracing new techniques and fostering economic progress,[79] while a shared commitment to improvement helped lessen tensions between central governments and local élites, as with a commitment to new road links and to raising agricultural production. Moreover, as an aspect of the (practical and ideological) support for the idea of change by Western governments and among influential Western groups, non-Western societies were increasingly to be presented, and thus criticised, as unchanging and reactionary, indeed as sclerotic. This view contributed to pejorative Western assumptions about race and religion.

Pressure for Change

In the West, both the process and the outcome of change could involve clashes with long-established assumptions and practices, and could be praised on that ground. In part, the rhetoric of assertion played a role in the affirmation of change, but the appeal to evidence was also significant. In England, for example, doctors and others criticised traditional Christian burial practices, including burials within church buildings, by using machines to collect and analyse the gases produced.[80] More generally, cleanliness was understood as being beneficial in terms of public health as well as being a virtue and a form of etiquette. Conventionally, water had been seen as a danger, and certainly not as a source of hygiene, but by the late eighteenth century – for example, in France – washing regularly was advocated as providing a protection against disease, and water was made central to a hygienic regime.[81] More generally, the possibility for profit from new developments was enhanced by the establishment of patent systems.[82]

Pressure for change was seen in calls to reform schools and universities, both by altering the curriculum and by reducing ecclesiastical influence. In Sweden, the Education Commission launched in 1745 had limited success but indicated the direction of change, notably as it pressed for a more utilitarian and scientific education, offered the possibility of going on to university without studying Latin and provided a context for the later Education Committees of the 1810s and 1820s.[83]

Contesting the Future

New information was designed to serve the cause of an open-ended future, one increasingly discussed (though not defined) in secular terms rather than with reference to traditional religious and humanist views. This definition played a role in both the Enlightenment[84] and the (in part overlapping) revolutionary process that affected Western thought in the last quarter of the century. Information gathering, use and representation were all significant to both the Enlightenment and the series of revolutions that began in British North America in 1775.

In each case, the emphasis on change altered the relationships between information and both state and society as part of a new politics of information. States and societies were reconceptualised as malleable entities that could, and should, be directed by information. A sense of the new as both present and inevitable led to a requirement that the promise offered by the new be fulfilled. There were also calls for freedom of expression, notably for the press, which was seen as a potent, but also dangerous, vehicle for proto-democracy. Indeed, eighteenth-century culture helped shape modern mass communications, with the reading experience proving only part of a propagation of emotionally manipulative arguments.[85] In British North America, prior to the Revolution, printers and their Patriot allies criticised the Post Office as an oppressive imperial abuse limiting the free circulation of news and correspondence.[86] Calls for freedom of expression were in part vindicated by high literacy rates, which implied a democratic quality to such freedom. In 1790, the freedom of the press was presented as a founding principle of the newly independent British North American colonies. In France, there was pressure, with the revolution, for open diplomacy and for the publication of information on state finances. The revolutionaries opened state archives to the public since sovereignty was now seen as being derived from the people.[87]

More generally, heredity as a justification for rank, hierarchy and subordination was attacked, both in the critique of aristocracy[88] and in pressure for the end of slavery. This pressure led to public activism involving the formation of committees outside the established governmental and political structures, notably the Society for Effecting the Abolition of the Slave Trade, founded in Britain in 1787, and the Société des Amis des Noirs (Society of Friends of Black People) which followed in France in 1788. These committees provided an institutional structure for the deployment of relevant information.

As another attack on established conventions, the value of the unique self – understood as an individual on Earth, and not a soul merely passing through – was emphasised.[89] Artists, writers and scientists were presented accordingly as Romantic heroes.[90] Moreover, with Romanticism, self-awareness became a cultural cause and a new idea of the spiritual was shaped. Demands from commentators outside academic establishments played the leading role in the pressure for change, with new information and ideas, such as mesmerism, linked to calls for new classifications and remedies.

In response, there was a conservative hostility to the idea of an inherent requirement for change. In 1791, George III of Britain was told by the French envoy that it was appropriate for the French Revolutionary government, pursuing a radical new course, to abolish feudal rights in Alsace, part of France acquired in part in 1648 by guaranteeing such rights, as, according to the envoy, 'for the sake of public utility, governments should seek administrative uniformity'. This claim led the temperamentally and intellectually conservative George to reply 'that such uniformity could exist only in small states, and that in kingdoms as big as France any attempt to introduce it would create problems'.[91] The king also took his position as Defender of the Faith very seriously, and sought accordingly to maintain the position of the Established Church, a stance that led to his resistance to Catholic Emancipation, which helped cause the resignation of William Pitt the Younger in 1801 and the fall of the so-called Ministry of All the Talents in 1806.

Systematisation on the French pattern certainly posed the danger of encouraging a politically misplaced utilitarianism. The abolition of feudal rights in Alsace, mostly enjoyed by German rulers, was appropriate from the perspective of the French Revolutionaries, with their commitment to uniform modern systems and their opposition to feudalism.[92] However, the measure would help alienate German support and cause a breakdown of relations that resulted in a lengthy war from 1792.

The French Revolutionaries also broke with the Church. Their policy of secularisation entailed a rupture with the role of religion in education. In its place, science and mathematics played a greater role, and the new educational institutions, notably the Institut National des Sciences et des Arts, established in 1795, adopted an ideology of nationalism and the spirit of progress. Despite subsequent changes in regime, the Revolution set a pattern of governmental encouragement of a meritocratic society employing useful knowledge.[93]

However, as an example of the problems presented by the commitment to new forms of systematisation, the change in the French calendar introduced in 1793 was unpopular. The National Convention had entrusted the task of developing a republican calendar to a commission headed by Charles-Gilbert Romme, a mathematician, who also drew on the expertise of other mathematicians. Dating the year retrospectively from the start of the French republic in September 1792, with each year commencing at the autumn equinox, the new calendar also changed the weeks and months of the year and decimalised the hours and minutes of the day, linking the reform to the adoption of new decimal weights and measures. Its unpopularity ensured that decimal time was speedily sidelined.[94] The calendar as a whole was discarded by Napoleon in 1805–6 for commercial and scientific reasons, but also as part of his wider reaction against the French Revolution and his reconciliation with

Catholicism, a reaction that included the resumption of slavery in the French West Indies.

Linked to the French Revolution, but also looking back to the 1735 expeditions to measure the length of a degree of latitude in order to test the sphericity of the Earth, another instance of far-flung activity in pursuit of universal standards occurred in the early 1790s. In 1790, the French National Assembly adopted a report proposing uniform weights and measures based on an invariable model taken from nature. The idea had been proposed initially in 1673 by Christiaan Huygens, inventor of the pendulum clock, who had suggested using the length of a pendulum beating at seconds as the basic unit for a universal measure. In 1790, the French proposed as this unit the length of a pendulum beating at seconds at latitude 45°, midway between the equator and the Pole. As a result, taking measurements using a pendulum to determine the strength of gravity at different locations was one of the tasks given to the Malaspina expedition, which was sent round the world by Charles IV of Spain in 1789–94.

Seeing the adoption of the metre, the universal measure, as making trade easier and as a symbol of international cooperation, the French suggested collaboration in its introduction with Britain, only to be rejected in December 1790; unsurprisingly so, as the two states had recently come close to war in the Nootka Sound Crisis over trading and settlement rights in the Pacific. Instead, in March 1791, the National Assembly adopted as its criterion for the universal measure the metre, one ten-millionth of the distance from the North Pole to the equator, as determined from the measurement of an arc of the Meridian of Paris between Dunkirk and Barcelona. A survey was accordingly conducted in 1792–8 by Jean-Baptiste Delambre and Pierre Méchain, two eminent astronomers.

This move from global to French data irritated Thomas Jefferson, who had also been interested in statistics gathered at latitude 45°. Moreover, as a further cause of concern over data, the Malaspina expedition took observations of gravity at fourteen locations, and these confirmed that the Earth was not symmetrical, as a pendulum revealed a stronger gravitational pull in the southern hemisphere, which corroborated the observations of Nicolas-Louis de la Caille at the Cape of Good Hope in 1750–2. The expedition revealed a different strength of gravity, length of pendulum and curvature of the Earth for every location at which observations were taken.

Thus, the French premise that the Meridian of Paris was the same as every other was misguided, and indeed the 1792–8 survey confirmed the irregularity. The astronomers set off in opposite directions from Paris in order, by means of triangulation, to measure the distance of the arc. It was intended to divide this distance by ten million to produce a definitive length for the new metre. It was planned that the measurements would take a year. In fact, they took seven and in the process revealed the chaos of the revolutionary years. Changes in government led to Delambre being dismissed by the Committee of Public Safety. Outside Paris, difficulties of travel added to the problems of suspicion and arrest the two encountered as apparently mysterious agents of the outside world. It did not help that France and Spain went to war in 1793. Delambre achieved his task in the end, but Méchain could not cope with the realisation of his fundamental error: because the world is not a perfect sphere, meridians vary in detail.

The search for perfection, so typical of revolutionary goals, was therefore bound to fail. The standard metre, adopted in 1799 by the International Commission for Weights and Measures convened in Paris, was based on the French survey, but fell short of being one-ten-millionth the distance between the equator and the North Pole. The metre was made compulsory by Napoleon in 1801, although in 1812 he rescinded his order. The 1799 metre was to be replaced in 1875 by another, which left out any reference to the shape of the Earth. Scientific surveying had thus proved that the irregularity of the Earth was such that simple extrapolation would not suffice.[95]

Conclusions

The drama of the French Revolution in one of the West's most prominent countries was matched by efforts to create radical new systems for presenting information. The reaction underlined a clash between rival ideas about the relationship between information and ideology. A sense of challenge was offered by Edward Nares, a Church of England cleric, in a sermon preached in 1797 on a day of public thanksgiving for a series of British naval victories over France and its allies in the French Revolutionary War, which Britain had entered in 1793. Nares contrasted the correct use of information with what he presented as the destructive secular philosophy of present-mindedness:

> From the first invention of letters, by means of which the history of past ages has been transmitted to us, and the actions of our forefathers preserved, it has ever been the wisdom of man, under all circumstances of public and general concern, to refer to these valuable records, as the faithful depositaries of past experience, and to deduce from thence by comparison of situations, whatever might conduce to his instruction, consolidation, or hope. Thither the statesman of the present day frequently recurs for the conduct and support of the commonwealth . . . Thither . . . the religious man . . . bent upon tracing the finger of God in all concerns of importance to the good and welfare of man, is pleased to discover, in the course of human events, a direction marvellously conducive to the final purposes of Heaven, the constant and eternal will of God,

> and continually illustrative of his irresistible supremacy, his over-ruling providence . . . the enemy begin their operations on the pretended principle of giving perfect freedom to the mind of man . . . the first step to be taken in vindication of such a principle, is to discard all ancient opinions as prejudices.[96]

Radical ideas about society and culture were advanced in the 1790s, ideas that were intended to have a worldwide validity, but a level of discrimination towards the non-West nevertheless remained. This contrast had already been seen with the Enlightenment. Thus, notions of global brotherhood were subordinated to a sense that Enlightenment and revolutionary ideas and movements originated within the West. Irrespective of the nobility and exotic interest of outsiders, their societies appeared deficient and defective, and thus inferior. In William Robertson's influential *History of America* (1777), the conquering Europeans were seen as more advanced economically and socially, while natives were presented as debilitated and concerned with self-gratification.[97] As such, there could be only limited interest in Native Americans as people and peoples, whereas there was considerable interest in how best to dominate them and to what end. The ambivalence felt by the French Revolutionaries towards the slaves who rebelled in Saint Domingue in 1791[98] was indicative of a more general situation.

The next chapter turns to the perspective of the state, but this one closes with a linkage of the three chapters on the eighteenth century. Greater interaction with the rest of the world led Western thinkers to validate their ideas in such a context, and with an awareness that their culture of innovation was not matched elsewhere. In validating their ideas, Western thinkers reflected political developments, but also responded to an increase in information partly, and sometimes largely, understood and classified in terms of established assumptions. At the same time, new theses were related to categories that developed in this period and were to be important over the following centuries, notably those relating to race, economics and social class. The need to propose theories that worked at the global level thus led to a hardening in attitudes towards the non-West, but as part of a more complex situation.