Science

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"Science" is a key concept of modern culture. It is characterized in a unique way both by the adherence to strict principles and by a large degree of openness. Science produces knowledge that is supposed to meet the highest epistemological standards, while at the same time science is undergoing constant change and transformation. The history of science, the history of the concept of science, and the influence of science in history, therefore, can only be understood by investigating the interconnectedness of the field of science with concepts and practices that serve to delimit this field. The sciences and their genesis have to be studied together with the institutional contexts of universities, academies, societies, journals and conferences, in which science has been conducted and institutionalised. These concepts and practices are themselves subject to historical processes. The nature and function of science has to be investigated as a complex history of differentiation and interconnection, which is described in broad outlines in this article.

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Histories of the Concept of "Science"

"Science" is one of the defining concepts of modern history and culture. The scientific revolution of the 17th century was a central element of the revolutionary changes in European thought which occurred in the early modern period and the Enlightenment.[1] Due to the enduring success of the natural sciences and the technological application of the natural sciences during the 19th century, that century has been called the "Jahrhundert der Naturwissenschaften"[2] ("century of the natural sciences"), and the importance of the natural sciences and their applications has continued to grow ever since. As regards the history of the concept "science" itself, this concept is characterized by an unusual dialectic, which ultimately can only be understood in its historical context. On the one hand, the concept of "science" has normative connotations and implies strong assumptions and claims with regard to the validity of scientific methods and the veracity of scientific results; science creates and processes knowledge that meets particularly high standards. On the other hand, the concept contains a remarkable degree of openness and plurality; the adjective "scientific" encompasses numerous normative practices which differ fundamentally in the central questions which they seek to answer, the methods employed and the objects of enquiry, and which cannot be reduced to a single standard of validity.[3]

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This openness of the concept of science manifests itself in the notorious difficulties involved in translating the term "science". The broad concept of "Wissenschaft" in German – and, similarly, of "wetenschap" in Dutch – is not equivalent to the term "science" in English and French, which in present usage refers almost exclusively to the natural sciences. Furthermore, the distinction between science and other forms of knowledge emerged relatively recently. As late as the 18th century, "science" could simply mean that one knows about something.[4] A similar breadth and openness can be observed up to the present in the universities, one of the most important scientific institutions: there is no common, binding scientific ideal which is equally normative in all fields and faculties.

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This openness is reflected in the processes leading to a theoretical sharpening of the concept of "science". Throughout its history, the term "science" was usually not regulated by clear definitions. For a long time, alternative terms were preferred (less formal terms relating to the practice of education, such as "learning" – as in the title of Francis Bacon's (1561–1626) (➔ Media Link #ac) *Advancement of Learning* of 1605 – or a term from the traditional university faculties, "philosophy", which persisted for a long time in the English term "natural philosophy", referring to what one would now call theoretical physics). Alternatively, the term "science" was used in combination with other terms, as in the title of the *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers* published by Denis Diderot (1713–1784) (➔ Media Link #ad) and Jean-Baptiste le Rond d'Alembert (1717–1783) (➔ Media Link #ae), which provided a comprehensive picture of the state and organization of knowledge around 1750 (➔ Media Link #af).[5] There were English-language works with corresponding titles, as evidenced by the title page of Ephraim Chambers's (1680–1740) (➔ Media Link #ag) *Cyclopædia* of 1728 (➔ Media Link #ah).

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These baroque titles reflect very well the state and nature of reflection on science in the 18th century. They also demonstrate that it was considerably more problematic to form a notion of "science" in the singular than to operate with a plural concept of "sciences". The singular concept of "science" emerged from the practice of the various sciences and has always been defined with reference to the many activities described as scientific.

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This becomes apparent in the typical characterizations of the concept of science in the 17th and 18th centuries. In these, "science" is described in the form of open lists of activities and results which could be associated with the concept of science. A striking example of this is the *Introduction* to the first volume of the *Philosophical Transactions* of 1665/1666, the first journal to be devoted to the sciences in a recognizably modern sense of the word. The *Philosophical Transactions* – the title contains no reference to "science", and a very open description in the form of a list is chosen – are introduced as follows:

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> the most proper way to gratifie those, whose engagement in such Studies, and delight in the advancement of Learning and Profitable Discoveries, doth entitle them to the knowledge of what this Kingdom, or other parts of the World, do, from time to time, afford, as well of the progress of the Studies, Labours, and attempts of the Curious and learned in things of this kind, as of their compleat Discoveries and performances.[6]

The distinction between the "sciences" and the "arts" which is common to most contemporary European languages is to some extent overcome here. In the course of the 18th century, extensive areas of the "arts" – such as geometry, arithmetic and astronomy, which had belonged to the traditional seven "liberal arts", but also the technical skills of mechanics and optics – were incorporated into the field of science. Terminological remnants of this original link between the natural sciences and the "arts" survived for a long time, for example in the term *Scheidekünstler* ("artist of analysis"), which was a common German designation for a chemist in the 18th century.

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The dialectic in the concept of science which led to this openness and simultaneously to science's supremely elevated epistemological claims is connected with two fundamentally different interpretations of the history of science. One can argue that science was conducted as early as Greek antiquity and that it was connected from the beginning with clear ideals of knowledge, building upon even older models of scientific activity, for example, in Babylonian and Egyptian astronomy and mathematics. From this perspective, the cosmology of the Pre-Socratic philosophers, the search for general proofs in Greek mathematics and philosophy, the development of a general logic of scientific knowledge in the writings of Plato (ca. 427–ca. 347 BC) (➔ Media Link #ai) and, in particular, in Aristotle's (384–322 BC) (➔ Media Link #aj) *Analytics* were important milestones in the development of the concept of science. The works of Euclid (ca. 360–ca. 280 BC) (➔ Media Link #ak), Archimedes (287–212 BC) (➔ Media Link #al), Ptolemy (100–180) (➔ Media Link #am) and others of the same period can then be considered brilliant examples of scientific achievement which remained highly influential throughout the entire history of science. The practice of interpreting Aristotle, the natural history and the technology of the Roman era, the incorporation of themes from antiquity into university teaching during the Middle Ages, and the re-ordering of the system of knowledge based on models from antiquity during the Renaissance and in humanism can be interpreted as continuations and re-interpretations of this concept of knowledge.

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However, it is possible to write a fundamentally different history of the concept of science: one which stresses the openness of the concept and interprets the emergence of the concept of science as a remarkably late result of complex processes which were initially not understood in terms of "science". According to this version, "science" should not be considered the product of a linear, teleological development. The programmatic characterizations of "science" and the titles of important works from the 18th century quoted above provide clear evidence that the concept of science developed comparatively late. Even in the most advanced statements on the concept of science during the Enlightenment, systematic thinking regarding the concept continued to contain considerable ambiguities.[7] Furthermore, "science" still had not yet become clearly embedded within the universities.

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If one subscribes to the second interpretation of the history of science – and the difficulties involved in clearly locating the emergence of the concept of "science" favour this interpretation –, "science" is understood as the product of processes of stabilization which emerged from a very open collection of practices. These became specifically scientific, and were subsumed under the general notion of "science" only thanks to these processes of stabilization and structuralization which occurred primarily during the 17th and 18th centuries.

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An important consequence of this openness is the fact that the fixed dichotomies which nowadays exist within the knowledge system – in particular, the dichotomy between the natural sciences and the humanities – are surprisingly late products of the development of science.[8] The classifications of science provided by Bacon and d'Alembert contain both the natural sciences and the humanities; Giambattista Vico's (1668–1744) (➔ Media Link #ao) *Scienza Nuova* discusses the *comune natura delle nazioni* and formulates a programme for the development of the humanities under the concept of *scienza*.[9] This makes the very question what the object of the history of science actually *is* a fundamental problem: should the history of science focus on science in general, or on the individual sciences, or on the disciplines, or on the practices which preceded these and which were less clearly ordered?

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The same applies to the typical categorizations of philosophical positions. For example, many authors cannot be definitively assigned to an empiricist or a rationalist camp: Aristotle, René Descartes (1596–1650) (➔ Media Link #ap) and Immanuel Kant (1724–1804) (➔ Media Link #aq) are notable examples. Equally, it is impossible to identify clear standards for scientific rigour or a definitive scientific method. Since classical antiquity, experimentation, observation and description, mathematization and the explanation via causes have co-existed without any of these methods gaining clear primacy up to the present – the various scientific disciplines in the universities have parity of importance.[10]

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Consequently, the retrospective application of modern standards becomes highly problematic; many historical phenomena defy an easy classification: The alchemists of the Middle Ages and the early modern period worked experimentally and in a technologically oriented fashion. The "magia naturalis" of the 16th and 17th centuries can be viewed as a form of technoscience.[11] Important early examples of the use of the German term "Naturwissenschaft" come from physico-theological contexts in which innovative natural science was employed to defend religious principles.[12]

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Definitions and Classifications: Tendencies in the Theoretical Clarification of "Science"

For reasons already outlined, there is little point in writing the history of science as a history of the clarification of the definition of "science". The difficulties become apparent when one considers some of the more clear-cut definitions which have been suggested. Aristotle closely connects the definition of "science" with the themes of his *Metaphysics*. In his *Analytica Posteriora*, he defines "episteme" – which can best be translated as "scientific knowledge" – as knowledge of the causes for the existence of something. Or put another way, scientific knowledge follows from premises that are "true, primary, immediate, better known than, anterior to, and the cause of the conclusion".[13] This definition points directly to two difficulties. The logical connection between the elements in this list remains to be explained; additionally, this definition is too narrow to justify Aristotle's own endeavours in the field of enquiry which we now recognize as "scientific". For example, his writings on zoology are more descriptive than causal in their approach, and therefore do not meet the criteria of his own definition. Take another example: In his *Regulae ad directionem ingenii*, Descartes raised the problem that there are many "scientiae", but that the "scientiae" must ultimately come together in a single "humana sapientia",[14] a unified form of human wisdom which must be defined solely in terms of its methodology, and not in terms of its content: "Omnis scientia est cognitio certa & evidens"; "all science is a certain and evident cognition".[15] However, in this case, too, there is a fundamental problem with regard to the application: If one applies the criterion of evidence, it remains possible that even the best human knowledge is just a man-made model, a "fable", as it is expressly called in the book which Descartes is holding in a contemporary portrait (➔ Media Link #ar).

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Towards the end of the 18th century, Kant promised a fundamental revolution in philosophy in which the forms of knowledge which already existed in mathematics and physics could be taken as a starting-point. However, Kant then lost sight of the goal of defining science unequivocally. His works contain (at least) two parallel definitions, one of which involves the systematic-organic ordering of knowledge components to form a whole, while the other refers to the degree of mathematization.[16] In the case of Kant also, the problem of how to differentiate between, and how to order, different forms of science remained. He was one of the first to clearly formulate the problem of the relationship between a general concept of science per se and the many specific sciences, employing a terminology which is still recognizable today. The parallel existence of forms of knowledge with various fields of transition between them is particularly evident in the spectrum of various approaches to nature that were adopted in the 18th century: In the 18th century, a threefold division was typical, which differentiated between a descriptive "natural history", a causal "natural philosophy", and an "applied mathematics" which encompassed the few fields which could be mathematicized in the strict sense, such as classical mechanics and ray optics. With his "pure" natural science and his "metaphysics of nature", Kant introduced a new level, which, however, is connected with the existing forms of approaching nature in a complex way (for example, the mathematical formulation of the Newtonian laws of motion form part of Kant's metaphysics of nature). Significantly, the first recorded instances of a comprehensive ordering function being ascribed to the term "natural science" occurred around 1800 and were directly connected with the reception of Kant's philosophy.[17]

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The 19th century witnessed several approaches which attempted to embed the sciences – in the broad sense – in wider contexts. Empiricists stressed the continuity between scientific and everyday knowledge.[18] Positivists called for a reform of the whole society – and consequently also of forms of knowledge – based on the model of the exact sciences. Ideological movements searched for scientific ideas which would enable them to define all aspects of life in a uniform manner, leading to a scientific world-view. This demonstrates a fundamental trust in science, which also resulted in the acceptance of very different fields as existing side by side in the system of the sciences. Typical visual representations of the system of sciences from the 19th century depict flat hierarchies. New disciplines and disciplinary fields – most notably the humanities, but also psychology and the other social sciences – were created and incorporated into the system of sciences, though not without controversy.[19]

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In the 20th century, a professionalized philosophy of science (see section 5) established itself, though even here a remarkable degree of openness remained. The "Vienna Circle", which started to dominate the genesis of analytical philosophy and philosophy of science in the 1920s, demanded that its members be competent in a scientific discipline, though that competence could be in any field of science. Additionally, two models of science were accepted in the Vienna Circle: a strictly formal logic, on the one hand, and the empirical sciences, on the other hand. Many of the systems proposed for the "unity of science" which were formulated in the context of the Vienna Circle – but also in subsequent decades – were remarkably tolerant with regard to the sciences that they deemed acceptable.[20] Karl Popper's (1902–1994) (➔ Media Link #as) attempt to formulate a clear standard for scientific validity by means of his falsifiability criterion (that is, the thesis that the scientific validity of a theory is determined by the degree to which the theory is open to being falsified) was quickly criticized by Thomas Kuhn's (1922–1996) (➔ Media Link #at) thesis of the unpredictably revolutionary character of changes in science.[21] In addition to these attempts to establish a standard based on the perspectives of philosophy and the history of science, the sociological analysis of science became increasingly important. In this context, Robert Merton (1910–2003) (➔ Media Link #au) returned to the approach of trying to define science by listing its central characteristics (according to Merton, science is characterized by four criteria: communalism, universalism, disinterestedness and organized scepticism).[22] However, sociological analysis also increasingly called into question the guiding concept of the superior status of scientific knowledge.[23] Peter Galison (*1955) (➔ Media Link #av) combined sociological insights with ideas from the philosophy and history of science to produce a very potent metaphor for the status of scientific knowledge when he proposed "trading zones" – that is, sites of interaction and negotiation – as the only appropriate designation for science, capturing the openness and flexibility of science, but also its claim to high-standard negotiations about results, methods and practices.[24]

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All these authors employ a strategy that is effective even in those cases where no clear definition of "science" can be given: Reflection on science essentially becomes a reflection on the *systematization* and *classification* of sciences. This area of debate is characterized by surprising continuities. Perhaps the most influential suggestion regarding the classification of sciences follows the structure that is assumed to exist among man's basic cognitive capacities. Drawing on suggestions of Aristotle, whom he otherwise criticized in the starkest terms, Francis Bacon divided these capacities into the three areas of memory, reason and imagination, which correspond to the three archetypal types of science (history, natural science and art). This classification is still present much later, forming the basis of the *Encyclopédie* of Diderot and d'Alembert, where the capacities are also referred to as *mémoire*, *raison* and *imagination*.[25]

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There are three important points to be made in this context. Firstly, the proposed classifications of science are all intended to be comprehensive and are consequently formulated in a tolerant and open way. Secondly, the "sciences" in the plural proved considerably less problematic than the development of an overarching concept of "science" in the singular; the greatest challenge lies in the conceptual or classificatory systematization of the sciences.[26] Thirdly, the typical terminology which is used in the discourse on science in the present day – natural sciences, humanities – also stems from the discourse on the systematization and classification of the sciences, which was conducted with great intensity in the 19th century in particular (➔ Media Link #aw).[27]

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Scientific Institutions: Sites of the Stabilization of Science

The fact that the sciences are essentially the result of a structuring of existing practices is demonstrated by the large role that institutions have played in defining the concept of science. These institutions formed relatively late in the history of science, and are also characterized to a considerable degree by science's characteristic openness. The relationship between universities and non-university institutions is a useful starting point for the reconstruction of the history of institutions that are devoted to science in a more specific sense. Historically, universities are rather conservative organizational structures due to the longevity of their institutional form, but also due to their independent legal status. In the beginning, their main role was seen as the dissemination of knowledge and professional preparation, and from the Middle Ages onwards they were essentially uniform in structure: a propaedeutic faculty, the philosophical faculty, prepared students for profession-oriented studies in one of the higher faculties of medicine, law and theology.[28] Science was not a primary organizational criterion in the traditional university.

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The present-day natural sciences illustrate best the difficulties resulting from this structure of the university. The subjects which today make up the natural sciences were spread across the university faculties, and differed in status. Some had the function of auxiliary disciplines of medicine (botany, zoology, mineralogy and chemistry), while others were subjects within the philosophical faculty (mathematics, applied mathematics and physics). Camerialist faculties and specialist academies – for example, the Mining Academy which has existed in Freiberg since 1765 – further complicated the picture, as did theological positions that took the explanation of nature in scientific terms as part of a theological argument, as referred to above. In spite of these structural problems of the traditional universities, individual universities emerged as centres which attracted acclaim and students from throughout Europe, often due to the achievements of individual scholars or schools based there (examples are Herman Boerhaave (1668–1738) (➔ Media Link #ax) in Leiden (➔ Media Link #ay) and Albrecht von Haller (1708–1777) (➔ Media Link #az) in Göttingen (➔ Media Link #b0) in the field of medicine and its auxiliary sciences; philology and orientalism in Göttingen in the 18th century). The large role played by medicine is conspicuous in this context. In addition to Boerhaave and Haller, Marcello Malpighi (1628–1694) (➔ Media Link #b1) and Giovanni Borelli (1608–1679) (➔ Media Link #b2) in Pisa, Frederik Ruysch (1638–1731) (➔ Media Link #b3) in Amsterdam and William Harvey (1578–1657) (➔ Media Link #b4) in Padua und Cambridge were prominent figures. The central importance of medicine is understandable in view of its practical importance and the internal diversification of medicine, which remained the primary site within the university for the teaching of many areas of the natural sciences into the 19th century.[29]

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The sciences were addressed far more directly and explicitly in non-university institutions such as academies and learned societies. Proto-institutions had existed since the Renaissance, but the typical scientific societies and academies which were to play an important role over a long period were founded in the 17th and 18th centuries. In particular, the 18th century witnessed an explosion in the number of societies, especially smaller ones, many of which existed only for a short period of time.[30]

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In many cases, these societies emerged from pre-existing structures (court structures; professional structures such as doctors' networks, which played a central role in the establishment of learned societies in Germany; social classes such as the "invisible college" of university professionals and wealthy amateurs in England, out of which developed the Royal Society). The "Academia naturae curiosorum", which subsequently became the German national academy for the sciences, "Leopoldina", is a prominent example of the emergence of new institutions and societies from existing structures, as is indicated by the fact that initially, this society had no set location, but was located at the place of residence of the respective president. In many cases, the early societies and institutions remained quite vague in their structure and goals. Broad titles such as "Académie des sciences" and "Royal Society for Improving Natural Knowledge"[31] are once again indicative of the openness of the concept of science. The concept of the academy and the learned society was not restricted to particular fields. In many cases, such institutions and societies were founded almost simultaneously for different subjects. This point is well illustrated by the following examples from mid-17th-century Paris: Académie Française (founded in 1635), Académie Royale de Peinture et de Sculpture (founded in 1648), Académie des Inscriptions et Belles-Lettres (founded in 1663), Académie des Sciences (founded in 1666), Académie Royale d'Architecture (founded in 1671).

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Typically, there were three forms of membership in these societies: full members, external or corresponding members, and honorary members. The interaction between these three groups further contributed to the refinement of the concept of science, as this membership structure established a local context for scientific endeavour, built up an (often international) network of correspondents, and also contributed to the archetypal concept of the scientist (though this term was not yet in use), primarily through the "honorary members" category and the phenomenon of membership of multiple institutions. Almost all of the important scientists of the 17th and 18th century held central positions in academies and learned societies, for example Galileo Galilei (1564–1642) (➔ Media Link #b5) in the Accademia dei Lincei, Isaac Newton (1643–1727) (➔ Media Link #b6) in the Royal Society, and Gottfried Wilhelm Leibniz (1646–1716) (➔ Media Link #b7) in the Berlin Academy.

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Many of these societies provided an infrastructure which could be used for research. The collections, libraries and laboratories (➔ Media Link #b9) of the societies were generally much more accessible than the corresponding resources in universities (➔ Media Link #ba). Most importantly, however, the societies established networks of people – which were in many cases international in scope, and which through correspondence and publications provided the context in which these institutions took a more fixed form – and the framework for the exchange and coordination of different activities happening at the local level. The genre of the scientific journal emerged from the activities of the academies and societies (see section 4).[32] The correspondence of the societies related to all aspects of science. Correspondence not only included the exchange of data and information regarding research results; concrete materials such as collection objects were also exchanged. The organization and evaluation of research voyages and voyages of discovery were another core activity of the learned societies.

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In many cases, universities and other forms of institutions cooperated with one another in a complementary way, whereby the connection between research and teaching which is typical of the modern understanding of science emerged. This cooperation was explicitly stated and developed during the joint founding of the University and the Academy in Göttingen in 1751. Albrecht von Haller, who was the main originator of this double foundation, spoke of "zweyerley Academien" ("two types of academy"), one of which – the University – was aimed at the "Belehrung der Jugend" ("instruction of the youth"), while the other was devoted to "Erfinden" ("invention").[33] Jena provides a similar example of cooperation – albeit less formally established – between a traditional university and more flexible private institutions such as learned societies. The Jena model was influential, because the texts which appeared around 1800 defining the role and function of a university, in which the connection between research and teaching was identified as indispensable, and in which science was expressly named as the guiding concept of universities for the first time, emerged from debates in Jena.[34]

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In a text on the *Streit der Facultäten* (*Conflict of the Faculties*) of 1798, Kant noted merely in an aside that one could invert the traditional university hierarchy and place the philosophical faculty at the top, because philosophy involves general reflection on science which is not subject to pragmatic aims or a direct benefit. The generation of thinkers who directly continued and superseded the work of Kant – most prominent among them as theorists of the university were Johann Gottlieb Fichte (1762–1814) (➔ Media Link #bb), Friedrich Wilhelm Joseph von Schelling (1775–1854) (➔ Media Link #bc) and Friedrich Schleiermacher (1768–1834) (➔ Media Link #bd) – proposed just such a reconstitution of universities into scientific institutions, as was then indeed to occur in Berlin in 1810 and as was ultimately described in the writings of Wilhelm von Humboldt (1767–1835) (➔ Media Link #be).[35] This reform emerged from the philosophical faculty, which thereby claimed for itself the concept of "science", as well as the ultimate responsibility for interpreting the concept, and which, in so doing, became an institution for scientific reflection. Science thus became a concept *sui generis* and was no longer dependent on external justification. In particular, these philosophical definitions of the concept of science deliberately dispensed with all reference to the utility of science.

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This innovation in the history of the concept "science" coincided with fundamental changes in university structure – the ways in which these two developments influenced each other requires further investigation – which occurred throughout Europe. The traditional spectrum of faculties was subdivided further. In particular, independent faculties of mathematics and natural sciences were established. The important role played by centralist political structures, such as in France and the French-dominated territories under the influence of Napoleon Bonaparte (1769–1821) (➔ Media Link #bf), and in the Russian Empire under Alexander I (1777–1825) (➔ Media Link #bg), is conspicuous. The profound changes that reformed the traditional self-governing university structure were only possible in the context of the general restructuring of society. Even in cases where entirely new faculties were not established, "seminars"[36] and "institutes" created within existing university structures provided institutional entities devoted to research.[37]

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Overview: Specialization in the Spectrum of Faculties of Universities (up to 1890)

Year	Place/Institution	Description
1713	Charité, Berlin	Medical teaching and research institution
1765	Mining Academy, Freiberg	Higher institute for mining
1794	École polytechnique, Paris	Specialized in mathematics and physics
1802	Moscow, St. Petersburg, Kazan, Dorpat (Tartu), Vilnius (Imperatoria Universitas Vilnensis)	Foundation or re-opening of universities as part of the programme of educational reform of Tsar Alexander I, with an independent faculty for mathematics and exact sciences
1808	Université Impériale, Paris; Toulouse	Faculté des Sciences (Chairs: differential and integral calculus; mechanics and astronomy; physics; chemistry; natural history)
1808	Padova	Separate faculty for physics and mathematics
1811	Leiden, Groningen, Utrecht	Independent faculty for mathematics and the natural sciences established in the context of incorporation into the French Université Impériale

1815	Amsterdam (École secondaire de l'Université Impériale)	Ditto
1817	Liège, Gent, Louvain	Facultas matheseos et philosophiae naturalis
1832	New York University	New York University founded; a College of Arts and Science existed from the beginning
1834	Königsberg	Seminar for mathematics and physics (Karl Gustav Jacob Jacobi (1804–1851) (➔ Media Link #bh), Franz Ernst Neumann (1798–1895) (➔ Media Link #bi)), which was dedicated, in particular, to mathematical physics
1837	Lausanne	Separate faculty for mathematics and physics
1839–1840	Pisa	Faculty of "scienze" divided into the faculties of mathematics and natural sciences
1848	Cambridge	The "Natural Sciences Tripos" is introduced as a study programme and system of examination
1850	Copenhagen	Faculty of mathematics and natural sciences founded
1850	Oxford	Honours School of Natural Sciences founded (originally consisting of mechanical philosophy, chemical philosophy and physiology); extended in scope in 1871
1852	Helsinki	Philosophical faculty divided into faculties for the humanities and mathematics
1854	Lille	Faculté des Sciences
1855	Zurich	Eidgenössisches Polytechnikum (subsequently became the Eidgenössische Technische Hochschule)
1855	Heidelberg	Separate institute for chemistry
1857	Madrid	Natural sciences faculty founded
1859	Zurich	Subdivision of the philosophical faculty
1860	Oslo	A separate faculty for mathematics and natural sciences founded
1862	Urbino, Modena	In the context of the re-ordering of Italy as a unified nation, a separate faculty for physics and mathematics was founded
1863	Tübingen	Faculty for mathematics and natural sciences founded
1863	Perugia	Same as Urbino and Modena above
1864	Odessa	Faculty for mathematics and natural sciences founded
1865	Munich	Philosophical faculty subdivided into following three faculties: philosophy, philology and history; mathematics; natural sciences
1866	Würzburg	Research institute for chemistry founded
1868	Bonn	Research institute for chemistry founded
1868	Bologna	Natural sciences faculty founded (*scienze fisiche, mathematiche et naturali*)

1868	Oxford	Clarendon Laboratory founded
1869	Berlin	Research institute for chemistry founded
1874	Cambridge	Cavendish Laboratory founded
1876	Lund	Philosophical faculty divided into faculties for the humanities and the natural sciences
1878	Berlin	Research institute for physics founded (for Hermann von Helmholtz)
1879	Würzburg	Research institute for physics founded
1888	Tübingen	Research institute for physics founded
1890	Heidelberg	Faculty for mathematics and natural sciences founded
1890	Harvard	Faculty of Arts and Sciences founded; remains in existence to the present – Harvard has no separate faculty for the natural sciences[38]

A comparison of the above dates highlights a number of structural trends. In many cases, chemistry received separate institutional status earlier than physics, which may be connected with the fact that chemistry had to separate out from the medical faculty and was not involved in the subdivision of the philosophical faculty. It may also be significant that chemistry was a more recent discipline than physics and as such was forced to differentiate itself more clearly. It is also noteworthy that mathematics and the natural sciences remained part of the philosophical faculty or the faculty of arts for a long time in many places (for example, up to 1910 in Freiburg, up to 1921 in Bern, up to 1971 at McGill).

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Forms of the institutionalization of science can also be found within other institutions, though it is difficult to clearly identify the profile and function of these institutions. The *Kunstkammern (➔ Media Link #bj)*(cabinets of curiosity) of the 17th and 18th centuries always contained elements of later research collections, such as scientific instruments and natural specimens, but also book collections.[39] Botanical gardens reflected the changing status of botany as this former auxiliary discipline increasingly became a scientific discipline in its own right. Anatomical theatres (➔ Media Link #bk)and medical demonstration collections mediated between didactic goals and research.[40] At an early stage, scientific experiments became spectacular public demonstrations, and it was difficult to distinguish between the two (➔ Media Link #bl) (➔ Media Link #bm).[41]

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Institutions of Scientific Communication

The history of the sciences as a history of the structuring and stabilization of an open field of activities presupposes forms of exchange and communication. The relationship between the formation of a scientific worldview and the invention of printing has been well researched, as has the close connection between the dissemination of Enlightenment knowledge and commercial booksellers.[42]

▲30

As already mentioned, communication was one of the primary functions of the academies and learned societies. The different forms of communication permeated one another. Correspondence networks and publications were inextricably linked. Journals were often based on letter correspondence. Indeed, right up to the present, the most important natural science journals feature "letters to the editor". Gigantic correspondence networks encompassed the European scientific landscape. In many instances, the persons involved also served as nodal points in the institutional networks (see the EGO article (➔ Media Link #bn) on Christoph Jacob Trew (1695–1769) (➔ Media Link #bo); other central figures of scientific exchange were Haller and the Bernoullis. Large projects such as the *Encyclopédie* would have been impossible without a network of correspondents).

▲31

Scientific journals made use of the structures of the learned societies and existing correspondence networks, complemented existing forms of publications such as newspapers and bookshop catalogues, and, in the form of review journals and excerpt journals, disseminated existing literature. There was a wide variety of types of journals and the spectrum of their functions was broad: collecting and disseminating results and data; discussion of theories; information on literature.[43] The target readership was diverse and included a broad public as well as professional colleagues. In the 18th century, even fashion journals contained reports on scientific innovations.

▲32

The relevant journals emerged soon after the founding of the academies and learned societies of the 17th century and as a result of the organizational structures of the latter. From 1665, the *Philosophical Transactions* reported on the activities of the Royal Society. The Paris Academy presented its results in the form of *Memoires.*[44] However, independent journals also came into being and developed into influential institutions in their own right (such as the *Journal des Sçavans*, which also started in 1665;[45] the *Acta Eruditorum*, published from 1682, which was influenced by Leibniz and which followed the example of French journals; and the *Allgemeine Literaturzeitung* in 18th-century Jena). It is noteworthy that most of the early journals were general in the sense that they did not limit themselves to particular subfields of the sciences. Differences in the approaches of the various journals were on a far more general level: the French publications were associated with a more "abstract" approach, while the journals of the Royal Society were seen as featuring a "concrete" approach.[46]

▲33

In addition to the universities, the academies and societies, and the journals, a further organizational form developed – significantly, also from the late-18th century onwards: supra-regional and international *conferences*. These conferences were of two types. On the one hand, there was the model of the trade fair which presented new products. In the case of the sciences, new technical and industrial products were particularly relevant. Conversely, one could also view book fairs, which had existed for far longer, as scientific events. The unmistakable and important influence of this model continues to be observable in the world exhibitions.

▲34

A second model was established with the foundation of the "Gesellschaft Deutscher Naturforscher und Ärzte" (Society of German Natural Scientists and Doctors) in 1822 by Lorenz Oken (1779–1851) (➔ Media Link #bp). This society was influenced by the concept of science developed in Jena and had its own journal called *Isis*.[47] Each year, this society brought together all those who were active in the field of medicine and natural science, keeping the membership criteria very liberal. Both of these models of scientific conferences carry a clear societal and political agenda.[48] The paradigm of the "Gesellschaft deutscher Naturforscher und Ärzte" gave rise to a series of new associations, such as the British Association for the Advancement of Science (1831), the Riunione degli Scienziati Italiani (1839) and the Nordiske Naturforskermøde, Naturforskerselskabet (1839). At the conferences of these associations, "general" lectures discussed general questions regarding the organization of science. The increasing degree of specialization of the natural sciences was clearly reflected in the development of the special sections of these conferences. It is also noticeable that many of the early conferences were devoted to questions regarding standardization (➔ Media Link #bq) in science (such as in units of measurement or terminology). The large conferences were indispensible for the formation of a collective identity and shared norms of practice in the sciences.

▲35

Overview: Important Scientific Conferences

Year	Name	Description
1791		First industrial exhibition in the Klementinum in Prague
1798		Industrial exhibition in Paris; subsequent exhibitions occurred in 1801, 1802, 1806, 1819, 1823, 1827, 1844, 1849
1822	Gesellschaft Deutscher Naturforscher und Ärtze	Founded by Lorenz Oken in Leipzig; strongly influenced by idealistic/romantic natural philosophy[49]

1829	Prima Triennale Pubblica Esposizione dell'anno 1829	Exhibition of inventions in the areas of agriculture, industry, commerce and applied sciences; further exhibitions occurred in 1832, 1839, 1844, 1850, 1858
1829	American Institute Fair	Occurred annually up to 1897; its goal was to promote agriculture, commerce, manufacturing and the "arts"
1831	British Association for the Advancement of Science	Followed the example of the Gesellschaft Deutscher Naturforscher und Ärzte; annual conferences
1833	Congrès Scientifiques	Subdivided into six sections: *Histoire naturelle générale; Science physiques, mathématiques et agricoles; sciences médicales, archéologie et histoire; littérature et beaux-arts; économie sociale*[50]
1839	Riunione degli Scienziati Italiani	Followed the example of the Gesellschaft Deutscher Naturforscher und Ärzte; first conference in Pisa, then annually up to 1847; resumed in 1862 in Siena after the foundation of the Italian society for the progress of the sciences. Subdivided into the following disciplines: zoology, comparative anatomy, chemistry, physics, mathematics, "agronomy", technology, botany, plant physiology, geology, mineralogy, geography, medicine
1839–1936	Nordiske Naturforskermøde, Naturforskerselskabet	19 conferences for scientists from Scandinavia; followed the example of the Gesellschaft Deutscher Naturforscher und Ärzte
1851	The Great Exhibition of the Works of Industry of all Nations (Crystal Palace Exhibition)	
1855	Exposition Universelle, Paris	
1860	International congress of chemists in Karlsruhe	First international conference specifically for chemistry; topics included the standardization of nomenclature, notation, weight conventions
1878	First international congress for geology in Paris	Organized in the context of the world fair, and was also essentially concerned with standardization[51]
1886	International Exhibition of Industry, Science and Art, Edinburgh	
1888	Grand Concours International des Sciences et de l'Industrie, Brussels	
1893	First Historikertag, Munich	Emerged from debates regarding the role of the teaching and study of history in the national context; as a result of the Historikertage, a new association, the Verband deutscher Historiker, was founded in 1895 in Frankfurt[52]
1897	First international congress of mathematicians, Zurich	Organized every 4 years; devised by Felix Klein (1849–1925) (➔ Media Link #br) and Georg Cantor (1845–1918) (➔ Media Link #bs)
1897	First Conference of Astronomers and Astrophysicists, Yerkes Observatory in Williams Bay[53]	

1898	First International Congress of Historical Sciences, The Hague (dedicated to diplomatic history); after the 1900 congress in Paris, the thematic scope broadened	This also subsequently led to the establishment of a separate organization, the "International Committee of Historical Sciences" (1926)[54]
1900	World Congress of Philosophy, Paris	
1904	Louisiana Purchase Exposition	"World Fair" in St. Louis, simultaneously a "Congress of Arts and Science"
1910	First conference of the Deutsche Gesellschaft für Soziologie, Frankfurt	Initiated by Max Weber (1864–1920) (➔ Media Link #bu), Georg Simmel (1858–1918) (➔ Media Link #bv), Ferdinand Tönnies (1855–1936) (➔ Media Link #bw) and Ernst Troeltsch (1865–1923) (➔ Media Link #bx)
1911	Conseil Solvay	First world congress for physics; usually held every 3 years; first congress in Brussels; fundamental debates on atomic physics
1912	First International Eugenics Congress, London	
1918	Bronx International Exposition of Science, Arts and Industries	
1922	First Solvay Conference on Chemistry	
1927	Fifth Solvay Conference	Climax of the debates over the interpretation of quantum mechanics (Albert Einstein (1879–1955) (➔ Media Link #by), Niels Bohr (1885–1962) (➔ Media Link #bz), Louis-Victor de Broglie (1892–1987) (➔ Media Link #c0), Hendrik Antoon Lorentz (1853–1928) (➔ Media Link #c1), Max Planck (1858–1947) (➔ Media Link #c2), Paul Dirac (1902–1984) (➔ Media Link #c3), Arthur Holly Compton (1892–1962) (➔ Media Link #c4), Max Born (1882–1970) (➔ Media Link #c5), Marie Curie (1867–1934) (➔ Media Link #c6))
1949	First international congress for the "philosophie des sciences", Paris	Organized by the Union Internationale de Philosophie des Sciences
1950	First International Conference on High Energy Physics, Rochester	
1951	Shelter Island Conference on Quantum Mechanics in Valence Theory	First of a series of conferences on theoretical chemistry; "singularly important" for the development of quantum chemistry[55]
1955	International Conference on the Peaceful Uses of Atomic Energy	Geneva, August 1955, organized by the UNO
1970	Apollo 11 Lunar Science Conference, Houston	Interdisciplinary conference

1972	International Congress on Mathematical Physics	Largest congress for mathematical physics

Many of these conferences continue to be held regularly, particularly the conference series initiated more recently.

▲36

Science, Popularization, *Weltanschauung*: Blurring of Boundaries and Radicalized Demarcation

The history of science is the history of positioning science in relation to other forms of knowledge, and this can occur through the development of an internal frame of reference within the sciences or by locating science in the context of general cultural developments. Indeed, there is a strong tradition of science's being discussed in such broader cultural contexts, both positively and critically. Bacon presented his idealized projects for the development of science in the form of an utopian novel, *Nova Atlantis* of 1627. Jonathan Swift (1667–1745) (➔ Media Link #c7) caricatured the contemporary academies already in the 18th century as sites where otherworldly and abstruse practices occurred (➔ Media Link #c8). The presentation of new scientific results in the convivial context of the salons of the 18th century had a fundamental effect on scientific experiments.[56]

▲37

At least from the 18th-century glorification of Newton onwards, the natural scientist became an archetypal creative genius, though this was not reflected conceptually until around the end of the 18th century when idealistic and romantic philosophy expressly claimed the genius status not only for the artist, but also for the natural scientist. This development continued in the 19th and 20th centuries, which saw Charles Darwin (1809–1882) (➔ Media Link #c9) and Albert Einstein (➔ Media Link #ca)become icons – with the most diverse and sometimes extremely critical and polemical connotations – and whole genres in literature and film referring to a particular, often rather negative, image of the scientist.[57]

▲38

All trends referred to so far converge on the 19th century. The "century of the natural sciences" institutionalized a general reflection on the sciences and their development. Two trends converge in this context: on the one hand, the movement towards the professionalization of reflection on science in the philosophical faculty, which began around 1800 and which made reflection on science a topic equal in importance to the traditional themes of philosophy, which was rendered even more important by its being intertwined with large-scale cultural development; on the other hand, the increasingly important role played by science and technology in everyday life.

▲39

The growing importance of science had several causes. Scientific theories such as Darwinism and materialism became directly relevant to the position of humans in history and in the universe.[58] The movement beginning around 1800 which was occupied with new forms of reflection on science and with the differentiation between forms of science ultimately led to a dynamic process of specialization which, in the context of the industrial revolution (➔ Media Link #cc) and the concomitant explosion in knowledge and new forms of legitimization through the application of scientific results, resulted in a complex situation: specialization makes unprecedented progress in science and technology possible, but leads, on the other hand, to negative consequences that were highlighted by contemporaneous cultural criticists, who used terms such as "alienation" and "demystification". Almost all concepts that were used to criticize culture around 1900 could be related to science, which was depicted simultaneously as a promise of salvation and a constant source of problems.[59] Additionally, changes to the educational system had increasingly important consequences for the role played by science in society. In the 19th century, alternatives were sought to the classical model of humanist grammar school education, which had previously been the sole route to university education. *Realgymnasia* and technical academies were founded. Additionally, science became a central element in the adult education movement and in workers' education (➔ Media Link #cd).

▲40

The promise of salvation that could be associated with science expressed itself most clearly in the elevation of the scientific worldview to a scientific religion, as emerged from Auguste Comte's (1798–1857) (➔ Media Link #ce) positivism, and in large *Weltanschauung* organizations, such as the "Deutscher Monistenbund" founded in 1906, which – resulting primarily from the ideas of the zoologist and Darwinist Ernst Haeckel (1834–1919) (➔ Media Link #cf), the chemist Wilhelm Ostwald (1853–1932) (➔ Media Link #cg) and the neurologist and entomologist Auguste-Henri Forel (1848–1931) (➔ Media Link #ch) – devoted itself to the propagation of a uniform scientific worldview encompassing all aspects of life. All the types of organizations referred to served the new forms of education and deliberately contributed to a comprehensive popularization of science. New types of publications brought science to a new readership. The societal responsibilities of science led to a growing consciousness of the political role of science. Ideals such as cosmopolitanism were expressly supported in the types of organizations referred to above (➔ Media Link #ci).

▲41

Science, Standardization and the Institutionalization of Reflection on Science

Science moves continuously between standardization and openness. From the *Weltanschauung* movements around the turn of the century emerged very detailed suggestions ranging from the standardization of languages to library systems and efficient paper formats, though the calls for standardization were directly undermined by the fact that the suggestions were so varied: suggestions on the standardization of languages included a formal logic based on mathematics and a world language intended for everyday use, such as Esperanto.[60] On the other hand, recent research has demonstrated that the adoption of standardized scientific practices was neither conducive to progress (as the romantics and *Weltanschauung* thinkers had already pointed out) nor unequivocally suggested by the sources. Science finds its place between ideals and concrete practices. It does not adhere to any linear path of development. The formation of disciplines and the establishment of concrete structures proceeded from a starting point of openness in a second, derivative step.

▲42

History does not suggest a unique model for science. No form of science consistently held the position of the main and leading paradigm of science throughout history. Thus, the assumption that such models exist is questionable. A central element of the history of science, therefore, has to be the history of reflection on science and the emergence of a philosophy of the sciences. The latter is closely connected with developments in the history of ideas and institutions which are described above. The central role played by philosophical concepts of the system of science from the time around 1800 onwards has already been discussed above. In the 19th century, a separate tradition of reflection on science took institutional form. The *Weltanschauung* organizations of the 19th century performed an important function in this context. Wilhelm Ostwald, who was president of the Deutscher Monistenbund from 1911, published a periodical called *Annalen der Naturphilosophie (➔ Media Link #cj)(Annals of Natural Philosophy)* , in which Ludwig Wittgenstein's (1889–1951) (➔ Media Link #ck) *Tractatus Logico-Philosophicus* was published in 1921, and his series entitled *Ostwalds Klassiker der Naturwissenschaft (Ostwald's Classical Texts on the Natural Sciences)* made primary texts of the history of science available.

▲43

Universities began to provide courses of study corresponding to this increasing interest in a reflection on science, beginning with the founding of a chair of "inductive philosophy" in Zurich in 1870,[61] and with the establishment of a professorship for *Philosophie, insbesondere Geschichte und Theorie der induktiven Wissenschaften* (philosophy, in particular the history and theory of the inductive sciences) in 1895 in Vienna, which was initially held by Ernst Mach (1838–1916) (➔ Media Link #cl). These were once again connected with broader societal organizations such as the "Verein Ernst Mach" in Vienna, of which the Vienna Circle which emerged in the 1920s was a direct follow-on. Conferences on the "unity of science" were held from 1935 onwards, though natural science conferences such as the Solvay conferences also helped establish a defined image of science.[62]

▲44

All the processes and structures discussed here in the context of the emergence of science and of reflection on the concept of science are characterized by the same dialectic between precise standardization, on the one hand, and liberal openness, on the other. In this context, even the development of a professional form of self-reflection of the sciences can be understood as a reflex of the openness of the scientific concept, which does not meet any clearly defined standard.

▲45

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Appendix

Sources

[Anonymous]: Introduction, in: Philosophical Transactions Giving Some Accompt of the Present Undertakings, Studies, and Labours, of the Ingenious in Many Considerable Parts of the World, published by the Royal Society, London 1665/1666, vol. 1, 1f., online: http://gallica.bnf.fr/ark:/12148/bpt6k55806g/f4 [07/03/2012].

Aristotle: Analytica Posteriora, translated by Jonathan Barnes, Oxford 1976.

Descartes, René: Regulae ad directionem ingenii, in: Charles Adam et al. (eds.): Œuvres de Descartes, Paris 1897–1910/1972, vol. 10, pp. 359–469.

Flint, Robert: Philosophy as Scientia Scientiarum and a History of Classifications of the Sciences [1904], New York, NY 1975, online: http://www.archive.org/details/philosophyassci00flingoog [07/03/2012].

Frisius, Friedericus: Anweisung zur Physica, oder Natur-Wissenschaft, welche in deutlichen Fragen und Antwort der Tugend ergebenen Jugend zur nützlichen Ergötzung und Erkänntniß des Allweisen Schöpfers kürtzlich verfasset, Leipzig 1715.

Gascoigne, Robert Mortimer: A Historical Catalogue of Scientific Periodicals, 1665–1900: With a Survey of Their Development, New York, NY 1985.

Kant, Immanuel: Metaphysische Anfangsgründe der Naturwissenschaft [1786], Gesammelte Schriften (Akademie-Ausgabe), Berlin 1903, vol. 4.

idem: Prolegomena, and Metaphysical foundations of natural science, translated from the original, with a biography and introduction, by Ernest Belfort Bax, London 1883, online: http://www.archive.org/stream/kantsprolegomen00kantuoft#page/n9/mode/2up [07/03/2012]

idem: Kritik der reinen Vernunft [1781/1787], Gesammelte Schriften (Akademie-Ausgabe), Berlin 1904, vol. 3.

idem: Der Streit der Facultäten [1798], Gesammelte Schriften (Akademie-Ausgabe), Berlin 1917, vol. 7.

Leibniz, Gottfried Wilhelm: Sämtliche Schriften und Briefe, Berlin 1966, series 6, vol. 2.

Müller, Ernst (ed.): Gelegentliche Gedanken über Universitäten von J.J. Engel, J.B. Erhard, F.A. Wolf, J.G. Fichte, F.D.E. Schleiermacher, K.F. Savigny, W. v. Humboldt, G.W.F. Hegel, Leipzig 1990.

Münsterberg, Hugo: The Position of Psychology in the System of Knowledge, in: Harvard Psychological Studies 1 (1903) (The Psychological Review, Series of Monograph Supplements, vol. IV, No. 1), pp. 641–654 [with table], online: http://gallica.bnf.fr/ark:/12148/bpt6k94342j/f658 [07/03/2012].

Nollet, Jean-Antoine: Essai sur l'électricité des corps, 5th ed., Paris 1771.

Ostwald, Wilhelm: Der Bau der Wissenschaften, in: idem: Monistische Sonntagspredigten, second series [42nd sermon], Leipzig 1912, pp. 329–336.

Pfannenstiel, Max: Kleines Quellenbuch zur Geschichte der Gesellschaft Deutscher Naturforscher und Ärzte, Berlin 1958.

Scheuchzer, Johann Jakob: Jobi Physica sacra, oder Hiobs Natur-Wissenschaft vergliechen Mit der Heutigen, Zurich 1740.

Siemens, Werner von: Das naturwissenschaftliche Zeitalter, in: Tageblatt der 59. Versammlung Deutscher Naturforscher und Aerzte in Berlin (1886), pp. 92–96.

Sulzer, Johann Georg: Kurzer Begriff aller Wissenschaften und andern Theile der Gelehrsamkeit, worin jeder nach seinem Inhalt, Nuzen und Vollkommenheit kürzlich beschrieben wird, Leipzig 1759.

Vico, Giambattista: Principii di una scienza nuova d'intorno alla commune natura delle nazioni, Naples 1725.

Weischedel, Wilhelm (ed.): Idee und Wirklichkeit einer Universität: Dokumente zur Geschichte der Friedrich-Wilhelms-Universität zu Berlin, Berlin 1960.

Windelband, Wilhelm: Geschichte und Naturwissenschaft: Straßburger Rektoratsrede, in: idem: Präludien: Aufsätze und Reden zur Philosophie und ihrer Geschichte, 9th ed., Tübingen 1924, vol. 2, pp. 136–160.

Bibliography

Applebaum, Wilbur (ed.): Encyclopedia of the Scientific Revolution From Copernicus to Newton, New York, NY et al. 2008.

Balbiani, Laura: La Magia naturalis di Giovan Battista Della Porta: Lingua, cultura e scienza in Europa all'inizio dell'età moderna, Bern et al. 2001.

Barnes, Barry / Bloor, David / Henry, John: Scientific Knowledge: A Sociological Analysis, London 1996.

Bayertz, Kurt et al. (eds.): Weltanschauung, Philosophie und Naturwissenschaft im 19. Jahrhundert, Hamburg 2007.

Bazerman, Charles: Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science, Madison, WI et al. 1988.

Boas Hall, Marie: All Scientists Now: The Royal Society in the Nineteenth Century, Cambridge 1984.

Bod, Rens: De vergeten wetenschappen: Een geschiedenis van de humaniora, Amsterdam 2011.

Bredekamp, Horst: Darwins Korallen: Die frühen Evolutionsdiagramme und die Tradition der Naturgeschichte, Berlin 2006.

Broman, Thomas: Periodical Literature, in: Marina Frasca-Spada et al. (eds.): Books and the Sciences in History, Cambridge 2000, pp. 225–238.

Clark, William: On the Bureaucratic Plots of the Research Library, in: Marina Frasca-Spada et al. (eds.): Books and the Sciences in History, Cambridge 2000, pp. 190–206.

Clucas, Stephen: Magic, Memory and Natural Philosophy in the Sixteenth and Seventeenth Centuries, Farnham 2011.

Cohen, Floris H.: De herschepping van de wereld: De moderne natuurwetenschap verklaard, Amsterdam 2007.

idem: The Scientific Revolution: A Historiographical Inquiry, Chicago, IL 1994.

idem: How Modern Science Came Into the World: Four Civilizations, One 17th-Century Breakthrough, Amsterdam 2011.

Collins, Harry / Pinch, Trevor: The Golem: What Everyone Should Know about Science, Cambridge 1993.

Darnton, Robert: The Literary Underground of the Old Regime, Cambridge, Mass. 1982.

Daston, Lorraine / Galison, Peter: Objectivity, New York, NY 2007.

Diemer, Alwin (ed.): Der Wissenschaftsbegriff: Historische und systematische Untersuchungen, Meisenheim am Glan 1970.

Döring, Detlef et al. (eds.): Gelehrte Gesellschaften im mitteldeutschen Raum (1650–1820), Leipzig et al. 2000–2002.

Dülmen, Richard van: Die Gesellschaft der Aufklärer: Zur bürgerlichen Emanzipation und aufklärerischen Kultur in Deutschland, Frankfurt am Main 1986.

Fehér, István M. et al. (eds.): Philosophie und Gestalt der Europäischen Universität, Stuttgart et al. 2008.

Felt, Ulrike / Nowotny, Helga / Taschwer, Klaus: Wissenschaftsforschung: Eine Einführung, Frankfurt am Main et al. 1995.

Frasca-Spada, Marina et al. (eds.): Books and the Sciences in History, Cambridge 2000.

Frigo, Gian Franco et al. (eds.): "Die bessere Richtung der Wissenschaften": Schellings Vorlesungen über die Methode des akademischen Studiums als Wissenschafts- und Universitätsprogramm, Stuttgart et al. 2011.

Galison, Peter: Image and Logic: A Material Culture of Microphysics, Chicago, IL et al. 1997.

Görs, Britta et al. (eds.): Wilhelm Ostwald at the Crossroads of Chemistry, Philosophy and Media Culture, Leipzig 2005.

Grafton, Anthony: Defenders of the Text: The Traditions of Scholarship in an Age of Science, 1450–1800, Cambridge, MA et al. 1991.

idem / Jardine, Lisa: From Humanism to the Humanities: Education and the Liberal Arts in Fifteenth and Sixteenth-Century Europe, Cambridge, MA 1986.

Grau, Conrad: Berühmte Wissenschaftsakademien: Von ihrem Entstehen und ihrem weltweiten Erfolg, Leipzig 1988.

Gross, Alan G. / Harmon, Joseph E. / Reidy, Michael: Communicating Science: The Scientific Article from the 17th Century to the Present, Oxford 2002.

Hahn, Roger: The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666–1803, Berkeley et al 1971.

Halleux, Robert et al.: Les publications de l'Académie Royale des Sciences de Paris (1666–1793), Turnhout 2001.

Hellyer, Marcus: Catholic Physics: Jesuit Natural Philosophy in Early Modern Germany, Notre Dame, IN 2005.

Henry, John: The Scientific Revolution and the Origins of Modern Science, Basingstoke et al. 2002.

Huxley, Thomas H.: On the Educational Value of the Natural History Sciences, in: idem: Collected Essays, New York, NY 1897, vol. 3, pp. 38–65.

Jacob, Margaret C.: The Scientific Revolution: A Brief History with Documents, Boston 2010.

Johnson, Samuel: A Dictionary of the English Language, vol. 2, London 1755, online: http://johnsonsdictionaryonline.com/?page_id=7070 [07/03/2012].

Jorink, Eric: Het 'Boeck der Natuere': Nederlandse geleerden en de wonderen van Gods schepping 1575–1715, Leiden 2006.

Kanz, Kai Torsten: Nationalismus und internationale Zusammenarbeit in den Naturwissenschaften: Die deutsch-französischen Wissenschaftsbeziehungen zwischen Revolution und Restauration, 1789–1832: Mit einer Bibliographie der Übersetzungen naturwissenschaftlicher Werke, Stuttgart 1997.

Kedrow, Boris M.: Klassifizierung der Wissenschaften, Berlin et al. 1975.

Kronick, David A.: "Devant le Deluge" and Other Essays on Early Modern Scientific Communication, Lanham, MD 2004.

idem: A History of Scientific and Technical Periodicals: The Origins and Development of the Scientific and Technical Press 1665–1790, New York, NY 1962.

idem: Scientific and Technical Periodicals of the Seventeenth and Eighteenth Centuries: A Guide, Metuchen, NJ 1991.

idem: Toward a Typology of the Seventeenth and Eighteenth-Century Scientific and Technical Periodical, in: idem: "Devant le Deluge" and Other Essays on Early Modern Scientific Communication, Lanham, MD 2004, pp. 40–80.

Kuhn, Thomas S.: The Structure of Scientific Revolutions, Chicago, IL 1962.

Latour, Bruno: Science in Action: How to Follow Scientists and Engineers Through Society, Cambridge 1987.

Lepenies, Wolf: Die drei Kulturen: Soziologie zwischen Literatur und Wissenschaft, Munich et al. 1985.

McClellan III, James E.: Science Reorganized: Scientific Societies in the Eighteenth Century, New York, NY 1985.

Meadows, Arthur Jack (ed.): Development of Science Publishing in Europe, Amsterdam 1980.

Merton, Robert K. et al. (eds.): The Sociology of Science: Theoretical and Empirical Investigations, Chicago, IL et al. 1973.

Middleton, Knowles / Edgar, William: The Experimenters: A Study of the Accademia del Cimento, Baltimore, MD et al.

1971.

Morgan, Betty Trabelle: Histoire du Journal des Sçavans depuis 1665 jusqu'en 1701, Paris 1928.

Moulines, C. Ulises: Die Entwicklung der modernen Wissenschaftstheorie (1890–2000): Eine historische Einführung, Hamburg et al. 2008.

Müller, Gerhard et al. (eds.): Die Universität Jena: Tradition und Innovation um 1800, Stuttgart 2001.

Müller-Bahlke, Thomas J. / Göltz, Klaus E. (photographs): Die Wunderkammer: Die Kunst- und Naturalienkammer der Franckeschen Stiftungen zu Halle (Saale), Halle an der Saale 1998.

Newton-Smith, William: The Rationality of Science, Boston 1981.

Olesko, Kathryn M.: Physics as a Calling: Discipline and Practice in the Königsberg Seminar for Physics, Ithaca, NY et al. 1991.

Oppenheim, Paul / Putnam, Hilary: Unity of Science as a Working Hypothesis, in: Herbert Feigl et al. (eds.): Concepts, Theories, and the Mind-Body Problem, Minneapolis, MN 1957 (Minnesota Studies in the Philosophy of Science), vol. 2, pp. 3–36.

Ornstein, Martha: The Role of the Scientific Societies in the Seventeenth Century, Chicago, IL 1975.

Parr, Robert G.: The Genesis of a Theory, in: International Journal of Quantum Chemistry 37 (1996), pp. 327–347.

Peuckert, Will-Erich: Gabalia: Ein Versuch zur Geschichte der magia naturalis im 16. bis 18. Jahrhundert, Berlin 1967.

Popper, Karl: Logik der Forschung, Vienna 1934.

Pyenson, Lewis et al. (eds.): The Art of Teaching Physics: The Eighteenth-Century Demonstration Apparatus of Jean Antoine Nollet, Sillery 2002.

Radkau, Joachim: Das Zeitalter der Nervosität: Deutschland zwischen Bismarck und Hitler, Munich et al. 1998.

Radtke, Julia: Der Historikertag: Ein akademisches Ritual, in: Zeitgeschichte-online, September 2010, online: http://www.zeitgeschichte-online.de/zol-historikertag2010 [07/03/2012].

Rickert, Heinrich: Die Grenzen der naturwissenschaftlichen Begriffsbildung: Eine logische Einleitung in die historischen Wissenschaften, 3rd and 4th eds., Tübingen 1921.

idem: Kulturwissenschaft und Naturwissenschaft, 6th and 7th eds., Stuttgart 1986.

Ridder-Symoens, Hilde de: A History of the University in Europe: Universities in Early Modern Europe (1500–1800), Cambridge 1996, vol. 2.

Ries, Klaus: Wort und Tat: Das politische Professorentum an der Universität Jena im frühen 19. Jahrhundert, Stuttgart 2007.

Rüegg, Walter: A History of the University in Europe: Universities in the Nineteenth and Early Twentieth Centuries (1800–1945), Cambridge 2004, vol. 3.

Schindling, Anton: Bildung und Wissenschaft in der frühen Neuzeit 1650–1800, Munich 1994.

Schmidt-Biggemann, Wilhelm: New Structures of Knowledge, in: Hilde de Ridder-Symoens (ed.): A History of the University in Europe: Universities in Early Modern Europe, Cambridge 1996, vol. 2, pp. 489–530.

Schwinges, Rainer Christoph (ed.): Artisten und Philosophen: Wissenschafts- und Wirkungsgeschichte einer Fakultät vom 13. bis zum 19. Jahrhundert, Basel 1999.

Secord, James A.: Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of Vestiges of the Natural History of Creation, Chicago, IL et al. 2000.

Shapin, Steven: The Scientific Revolution, Chicago, IL 1996.

idem: Never Pure: Historical Studies of Science as if it Was Produced by People with Bodies, Situated in Time, Space, Culture, and Society, and Struggling for Credibility and Authority, Baltimore, MD 2010.

idem / Schaffer, Simon: Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life, Princeton 1985.

Shinn, Terry et al. (eds.): Expository Science: Forms and Functions of Popularisation, Dordrecht et al. 1985.

Smend, Rudolf et al. (eds.): Die Wissenschaften in der Akademie: Vorträge beim Jubiläumskolloquium der Akademie der Wissenschaften zu Göttingen, Göttingen 2002.

Stafford, Barbara Maria: Kunstvolle Wissenschaft: Aufklärung, Unterhaltung und der Niedergang der visuellen Bildung, Amsterdam et al. 1998.

Strano, Giorgio (ed.): European Collections of Scientific Instruments, 1550–1750, Leiden et al. 2009.

Stichweh, Rudolf: Zur Entstehung des modernen Systems wissenschaftlicher Disziplinen: Physik in Deutschland 1740–1890, Frankfurt am Main 1984.

idem: Wissenschaft, Universität, Professionen: Soziologische Analysen, Frankfurt am Main 1994.

Unverzagt, Dietrich: Philosophia, historia, technica: Caspar Schotts Magia universalis, Berlin 2000.

Voss, Julia: Darwin's Pictures: Views of Evolutionary Theory, 1837–1874, New Haven et al. 2010.

Voss, Jürgen: Akademien, gelehrte Gesellschaften und wissenschaftliche Vereine in Deutschland, 1750–1850, in: Etienne François (ed.): Sociabilité et société bourgeoise en France, en Allemagne et en Suisse, 1750–1850, Paris 1986, pp. 149–167.

Weber, Heiko: Monistische und antimonistische Weltanschauung: Eine Auswahlbibliographie, Berlin 2000.

Weingart, Peter (ed.): Wissenschaftssoziologie, Frankfurt am Main 1972.

Yeo, Richard: Encyclopaedic Knowledge, in: Marina Frasca-Spada et al. (eds.): Books and the Sciences in History, Cambridge 2000, pp. 207–224.

idem: Encyclopaedic Visions: Scientific Dictionaries and Enlightenment Culture, Cambridge 2010.

Zambelli, Paola: White Magic, Black Magic in the European Renaissance From Ficino, Pico, Della Porta to Trithemius, Agrippa, Bruno, Leiden et al. 2007.

Zaunstöck, Holger: Sozietätslandschaft und Mitgliederstrukturen: Die mitteldeutschen Aufklärungsgesellschaften im 18. Jahrhundert, Tübingen 1999.

Ziche, Paul (ed.): Monismus um 1900: Wissenschaftskultur und Weltanschauung, Berlin 2000.

idem: Von der Naturgeschichte zur Naturwissenschaft: Die Naturwissenschaften als eigenes Fachgebiet an der Universität Jena, in: Berichte zur Wissenschaftsgeschichte 21 (1998), pp. 251–263.

idem: Wilhelm Ostwald als Begründer der modernen Logik: Logik und künstliche Sprachen bei Ostwald und Louis Couturat, in: Pirmin Stekeler-Weithofer et al. (eds.): Ein Netz der Wissenschaften? Wilhelm Ostwalds "Annalen der Naturphilosophie" und die Durchsetzung wissenschaftlicher Paradigmen, Leipzig 2009, pp. 46–66.

idem: 'Wissen' und 'hohe Gedanken': Allgemeinheit und die Metareflexion des Wissenschaftssystems im 19. Jahrhundert, in: Michael Hagner et al. (eds.): Der Hochsitz des Wissens: Das Allgemeine als wissenschaftlicher Wert, Zurich et al. 2006, pp. 129–150.

idem: Wissenschaftslandschaften um 1900: Philosophie, die Wissenschaften und der nicht-reduktive Szientismus, Zurich 2008.

Notes

1. ^ For general accounts of the "scientific revolution" see: Shapin, The Scientific Revolution 1996; Cohen, The Scientific Revolution 1994; idem, Modern Science 2011; Jacob, The Scientific Revolution 2010; Henry, The Scientific Revolution 2002; Applebaum, Encyclopedia 2008.

2. ^ Siemens, Das naturwissenschaftliche Zeitalter 1886.
3. ^ For an important analysis of the historicity of a central epistemic ideal of science see: Daston / Galison, Objectivity 2007.
4. ^ Samuel Johnson's *Dictionary of the English Language* still lists "Knowledge" as the first synonym for "science" (Johnson, Dictionary 1755, vol. 2, p. 1760). For the history of the corresponding term in German, see the entry in the *Grimmsches Wörterbuch* (online: http://woerterbuchnetz.de/DWB/?sigle=DWB&mode=Vernetzung&lemid=GW23991, [07/03/2012]); the *Grimmsches Wörterbuch* also stresses that the word "Wissenschaft" is modern in origin and only entered the German language in the early-17th century.
5. ^ The *Encyclopédie* is accessible online under http://alembert.fr/index.php [07/03/2012]. For a general work on the concept of science see: Diemer (ed.), Der Wissenschaftsbegriff 1970. On the history of the term and the role of institutions in fixing the term "science", see also: Schmidt-Biggemann, New Structures of Knowledge 1996, p. 491: "The history of science – its institutions, objects, achievements and shortcomings – can be clearly observed in the history of the term 'science' and its cognates, which only since the nineteenth century has come to be divided into the natural sciences and the humanities. To define what 'science' meant for the early modern period, we must try to understand it in conjunction with its dominant formal and substantive concepts: *scientia*, *ars*, *prudentia*, *encyclopaedia*, *historia* and *philosophia*."
6. ^ Anonymous, Introduction 1665/1666, pp. 1f.
7. ^ Two examples: In the *Encyclopédie* of Diderot and d'Alembert, "science" received two general articles, one of which deals with science in the singular and the other with the sciences in the plural. However, these articles are not systematically coordinated with one another. For every entry in the *Encyclopédie*, the general terms to which the respective entry belongs are specified, and in this case "science" and "sciences" are not grouped together, since "science" is assigned to the general terms of "logic" and "metaphysics" while the "sciences" are assigned to the "connoissances humaines". The different definitions of "Wissenschaft" in the works of Immanuel Kant listed below are another example.
8. ^ The literature on the history of science, as well as the institutional context of the history of science as a subject, predominantly places the emphasis on the history of the natural sciences. In the context of the reconstruction of the history of science presented here, this one-sided focus is highly problematic. For a recent account of the history of the humanities see: Bod, De vergeten wetenschappen 2011. On the important role of humanist concepts in the development of the sciences in general, see the works of Anthony Grafton: Grafton, Defenders 1991; idem / Jardine, Humanism 1986.
9. ^ Vico, Principii di una scienza nuova d'intorno alla commune natura delle nazioni 1725 (extended versions appeared in 1730 and 1744).
10. ^ See also: Cohen, De herschepping van de wereld 2007. Cohen differentiates here between an "Athenian" type of science, which seeks to explain causes, and a mathematizing "Alexandrian" type of science.
11. ^ On "Magia naturalis", see for example: Balbiani, La Magia naturalis 2001; Unverzagt, Philosophia 2000; Peuckert, Gabalia 1967; Zambelli, White Magic 2007; Clucas, Magic 2011.
12. ^ See the examples given in: Scheuchzer, Jobi Physica sacra 1740 (numerous editions and versions); Frisius, Anweisung zur Physica 1715. See also more recent works on Jesuit scientists, e.g.: Hellyer, Catholic Physics 2005.
13. ^ Aristotle, Analytica Posteriora 1976, 71b9–12 and 71b21f.
14. ^ Descartes, Regulae 1897–1910/1972, Regula 1, p. 360.
15. ^ ibidem, Regula 2, p. 362.
16. ^ On the criterion of mathematization, see in particular: Kant, Prolegomena and Metaphysical Foundations 1883, p. 140 : "But I maintain that in every special natural doctrine only so much science *proper* is to be met with as mathematics; for, in accordance with the foregoing, science proper, especially [science] of nature, requires a pure portion, lying at the foundation of the empirical, and based upon an *à priori* knowledge of natural things." On systematicity, cf. for example: idem, Kritik der reinen Vernunft [1787] 1904, pp. 538, 543. To Kant, "Wissenschaft" is also defined epistemically by the attainment of stable knowledge and must be "pure", and therefore cannot be applied. Of course, these two approaches to definition can be viewed as complementing each other; however, it is striking that Kant himself did not produce any uniform standardization of the concept of science.
17. ^ Ziche, Von der Naturgeschichte 1998.
18. ^ This view was succinctly put in a famous quote by Thomas Henry Huxley (1825–1895): "Science is, I believe, nothing but *trained and organized common sense*, differing from the latter only as a veteran may differ from a raw recruit: and its methods differ from those of common sense only as far as the guardman's cut and thrust differs from the manner in which a savage wields his club." (Huxley, On the Educational Value 1897, p. 45.)
19. ^ On the question of how this affected the opposition of the two cultures of the natural sciences and the humanities, see: Lepenies, Die drei Kulturen 1985.

20. ^ See, for example, the broad spectrum of topics of the conferences on the unity of science that occurred from 1935 onward; even the pioneering article on the "Unity of Science" by Paul Oppenheim (1885–1977) and Hilary Putnam (*1926) of 1957 still deals with a conspicuously large spectrum of different sciences, albeit in a hierarchical sequence (Oppenheim / Putnam, Unity of Science 1957).
21. ^ On Popper (who described the falsifiability criterion in numerous texts, see, in particular, his *Logik der Forschung*, published for the first time in the German original in 1934) and Kuhn (see, in particular, his *The Structure of Scientific Revolutions* of 1962), see, for example, the comparison in: Newton-Smith, The Rationality of Science 1981.
22. ^ Merton et al. (eds.), The Sociology of Science 1973.
23. ^ Cf. for example: Barnes / Bloor / Henry, Scientific Knowledge 1996; Latour, Science in Action 1987; Collins / Pinch, The Golem 1993; Shapin / Schaffer, Leviathan 1985; Shapin, Never Pure 2010; Weingart, Wissenschaftssoziologie 1972; Felt / Nowotny / Taschwer, Wissenschaftsforschung 1995.
24. ^ Galison, Image and Logic 1997.
25. ^ General literature on the classification of science: Ziche, Wissenschaftslandschaften 2008; Kedrow, Klassifizierung der Wissenschaften 1975; Flint, Philosophy as Scientia Scientiarum [1904] 1975; Yeo, Encyclopaedic Knowledge 2000; idem: Encyclopaedic Visions 2010.
26. ^ A significant acknowledgment of the openness of the concept of science generally can be found in a text of the "popular philosopher" Johann Georg Sulzer (1720–1779) on the concept of science: Sulzer, Kurzer Begriff aller Wissenschaften 1759 (a total of six editions of this work appeared up to 1786). On p. 185: "Der Grund der Wissenschaften ist unerschöpflich, und der menschliche Verstand kennt in seinen Untersuchungen keine Gränzen. Mithin werden immer neue Wissenschaften entstehen, so lange die alten mit gehörigem Fleisse getrieben werden." ("The basis of the sciences is inexhaustible, and the human intellect knows no boundaries in its investigations. Consequently, new sciences will always emerge as long as the old ones continue to be conducted with the appropriate zeal", transl. by N.W.).
27. ^ See the texts of Wilhelm Windelband (1848–1915) and Heinrich Rickert (1863–1936) on the systematic comparison of the natural sciences with the humanities and cultural sciences: Windelband, Geschichte und Naturwissenschaft 1924; Rickert, Kulturwissenschaft und Naturwissenschaft 1986; idem, Die Grenzen 1921.
28. ^ On the structure of the universities and their role in the structuring of science generally, cf.: Schindling, Bildung und Wissenschaft 1994; Schwinges (ed.), Artisten und Philosophen 1999; Stichweh, Zur Entstehung 1984; idem, Wissenschaft, Universität, Professionen 1994.
29. ^ Two examples of famous scientists of the 19th century who were trained in medicine are Hermann von Helmholtz (1821–1894), whose professional career also covered physiology and mathematical physics, and the zoologist Ernst Haeckel.
30. ^ For an overview of the societies founded in the 18th century, see in particular: Zaunstöck, Sozietätslandschaft 1999. General texts on academies and learned societies: Dülmen, Die Gesellschaft der Aufklärer 1986; Döring et al. (eds.), Gelehrte Gesellschaften 2000–2002; Middleton / Edgar, The Experimenters 1971; Ornstein, The Role 1975; Hahn, The Anatomy 1971; Boas Hall, All Scientists Now 1984; McClellan III, Science Reorganized 1985; Voss, Akademien 1986; Grau, Berühmte Wissenschaftsakademie 1988.
31. ^ The "Second Royal Charter" of 1663 used this designation to refer to the Royal Society; the documents on the history of the Royal Society are available under http://royalsociety.org/about-us/history/ [07/03/2012].
32. ^ For a case study of forms and functions of networks in the sciences, see: Kanz, Nationalismus 1997.
33. ^ On the Göttingen academy, cf. the recent work: Smend, Die Wissenschaften in der Akademie 2002.
34. ^ Cf. Müller, Gerhard et al. (eds.), Die Universität Jena 2001.
35. ^ Kant, Der Streit der Facultäten [1798] 1917. The texts from around 1800 proposing university reforms are collected in: Weischedel, Idee und Wirklichkeit 1960; Müller, Ernst (ed.), Gelegentliche Gedanken 1990. On the role of philosophical concepts of idealism, cf.: Fehér et al. (eds.), Philosophie und Gestalt 2008; Frigo et al. (eds.), "Die bessere Richtung" 2011.
36. ^ In the context of the German university system, the word Seminar can refer either to a course module that is conducted in a conference style (similar to the English term "seminar"), or to a self-administered academic entity that is smaller or subordinate in status to a faculty (equivalent to "department" in English). Where "seminar" occurs in this article, it is intended in the latter sense.
37. ^ Cf. the case study: Olesko, Physics as a Calling 1991.
38. ^ The overview is essentially based on: Ridder-Symoens, A History of the University 1996; Rüegg, A History of the University in Europe 2004.
39. ^ Cf. for example: Clark, On the Bureaucratic Plots 2000; Jorink, Het 'Boeck der Natuere' 2006.
40. ^ On a typical "Wunderkammer", cf.: Müller-Bahlke / Göltz, Die Wunderkammer 1998. On natural science collections, cf. for example: Strano, European Collections 2009.
41. ^ A key figure in this context is Jean-Antoine Nollet (1700–1770); cf. Pyenson et al. (eds.), The Art of Teaching

Physics 2002; Stafford, Kunstvolle Wissenschaft 1998.

42. ^ On the role of printing, the book market and the reading public, cf.: Frasca-Spada et al. (eds.), Books and the Sciences 2000; Darnton, Literary Underground 1982; Secord, Victorian Sensation 2000.
43. ^ Cf. Kronick, Toward a Typology 2004.
44. ^ On scientific journals cf.: Gascoigne, A Historical Catalogue 1985; Kronick, A History 1962; idem, Scientific and Technical Periodicals 1991; Morgan, Histoire du Journal des Sçavans 1928; Halleux, Les publications 2001; Kronick, "Devant le Deluge" 2004; Broman, Periodical Literature 2000; Meadows, Development of Science Publishing 1980. On the specific forms of scientific publications, see: Bazerman, Shaping Written Knowledge 1988; Gross / Harmon / Reidy, Communicating Science 2002.
45. ^ Morgan, Histoire du Journal des Sçavans 1928.
46. ^ An example: In 1671, Leibniz produced a "Theoria motus concreti" (under the general title of *Hypothesis physica nova*), which he dedicated to the Royal Society, as well as a "Theoria motus abstracti", which he dedicated to the "illustri academiae Regiae Franciae ad promovenda Mathematica, Physica, Medica studia, & augenda generis humani commoda recens instituta" (both texts in: Leibniz, Sämtliche Schriften und Briefe 1966, pp. 219–276).
47. ^ An overview of the society's history is contained under http://www.gdnae.de/media/pdf/Website_Geschichte.pdf [07/03/2012]; cf. also Pfannenstiel, Kleines Quellenbuch 1958. On Oken's political agenda, cf.: Ries, Wort und Tat 2007.
48. ^ A particularly interesting intermediate form between the specialist conference, general reflection on science and a technical exposition was the "Congress of Arts and Science" held in St. Louis in 1904, which complemented the "Universal exposition" held there – however, under the traditional terminology, which combined science and arts. The general theme of this congress were the relationships of the various fields of science to one another; cf.: Ziche, Wissenschaftslandschaften 2008; idem, 'Wissen' und 'hohe Gedanken' 2006.
49. ^ Cf. http://www.gdnae.de/media/pdf/Website_Geschichte.pdf [07/03/2012].
50. ^ Cf. http://www.archive.org/stream/congrsscientif01roue#page/n3/mode/2up [07/03/2012].
51. ^ Cf. http://iugs.org/uploads/images/PDF/1st%20IGC.pdf [07/03/2012].
52. ^ Radtke, Der Historikertag 2010.
53. ^ Cf. http://had.aas.org/aashistory/7meetings01.html [07/03/2012].
54. ^ Cf. http://www.cish.org/presentation/liste-congres.htm [07/03/2012].
55. ^ Parr, The Genesis of a Theory 1996.
56. ^ Cf. Shinn et al. (eds.), Expository Science 1985.
57. ^ On the role of pictorial strategies in the history of Darwinism, cf. also: Voss, Darwin's Pictures 2010; Bredekamp, Darwins Korallen 2006.
58. ^ Cf. Bayertz et al. (eds.), Weltanschauung, 2007. On the monist *Weltanschauung* movements specifically, cf.: Weber, Monistische und antimonistische Weltanschauung 2000; Ziche, Monismus 2000; Görs et al. (eds.), Wilhelm Ostwald 2005.
59. ^ Cf., for example, the case study: Radkau, Das Zeitalter der Nervosität 1998.
60. ^ Ziche, Wilhelm Ostwald 2009.
61. ^ idem, Wissenschaftslandschaften 2008, chapter III.
62. ^ On the history of philosophy of science, cf.: Moulines, Die Entwicklung der modernen Wissenschaftstheorie 2008.

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Indices

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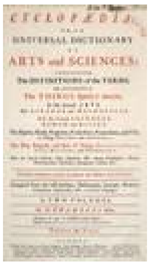
-  (http://www.ieg-ego.eu/en/mediainfo/title-page-of-the-cyclopaedia-of-ephraim-chambers?mediainfo=1&width=900&height=500)
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- Immanuel Kant (1724–1804) VIAF (http://viaf.org/viaf/82088490) DNB (http://d-nb.info/gnd/118559796) ADB/NDB (http://www.deutsche-biographie.de/pnd118559796.html)

Link #ar
-  (http://www.ieg-ego.eu/en/mediainfo/rene-descartes-159620131650-en?mediainfo=1&width=900&height=500)
  René Descartes (1596–1650)

Link #as
- Karl Popper (1902–1994) VIAF (http://viaf.org/viaf/88801921) DNB (http://d-nb.info/gnd/118595830) ADB/NDB (http://www.deutsche-biographie.de/pnd118595830.html)

Link #at
- Thomas Kuhn (1922–1996) VIAF (http://viaf.org/viaf/22144060) DNB (http://d-nb.info/gnd/118567918)

Link #au
- Robert Merton (1910–2003) VIAF (http://viaf.org/viaf/34521128) DNB (http://d-nb.info/gnd/118783424)

Link #av

- Peter Galison (*1955) VIAF (http://viaf.org/viaf/110050924) DNB (http://d-nb.info/gnd/123873428)

Link #aw

-  (http://www.ieg-ego.eu/en/mediainfo/various-classifications-of-sciences?mediainfo=1&width=900&height=500)
  Various Classifications of Sciences

Link #ax

- Herman Boerhaave (1668–1738) VIAF (http://viaf.org/viaf/61555409) DNB (http://d-nb.info/gnd/118660829)

Link #ay

- Dutch Anatomy and Clinical Medicine (http://www.ieg-ego.eu/en/threads/models-and-stereotypes/the-dutch-century/rina-knoeff-dutch-anatomy-and-clinical-medicine-in-17th-century-europe)

Link #az

- Albrecht von Haller (1708–1777) VIAF (http://viaf.org/viaf/49234879) DNB (http://d-nb.info/gnd/118804790)

Link #b0

- Albrecht von Hallers Korrespondenz (http://www.ieg-ego.eu/de/threads/europaeische-netzwerke/intellektuelle-und-wissenschaftliche-netzwerke/europaeische-korrespondenznetzwerke/hubert-steinke-gelehrtenkorrespondenznetzwerke-im-18-jahrhundert-albrecht-von-haller)

Link #b1

- Marcello Malpighi (1628–1694) VIAF (http://viaf.org/viaf/85044) DNB (http://d-nb.info/gnd/119403099)

Link #b2

- Giovanni Borelli (1608–1679) VIAF (http://viaf.org/viaf/14869558) DNB (http://d-nb.info/gnd/118659359)

Link #b3

- Frederik Ruysch (1638–1731) VIAF (http://viaf.org/viaf/14937238) DNB (http://d-nb.info/gnd/11671235X)

Link #b4

- William Harvey (1578–1657) VIAF (http://viaf.org/viaf/29584187) DNB (http://d-nb.info/gnd/118546481)

Link #b5

- Galileo Galilei (1564–1642) VIAF (http://viaf.org/viaf/2470550) DNB (http://d-nb.info/gnd/118537229) ADB/NDB (http://www.deutsche-biographie.de/pnd118537229.html)

Link #b6

- Isaac Newton (1643–1727) VIAF (http://viaf.org/viaf/22146457) DNB (http://d-nb.info/gnd/118587544)

Link #b7

- Gottfried Wilhelm Leibniz (1646–1716) VIAF (http://viaf.org/viaf/9849392) DNB (http://d-nb.info/gnd/118571249) ADB/NDB (http://www.deutsche-biographie.de/pnd118571249.html)

Link #b9

- Laboratory (http://www.ieg-ego.eu/en/threads/crossroads/knowledge-spaces/henning-schmidgen-laboratory)

Link #ba

- Universitätssammlungen (http://www.ieg-ego.eu/de/threads/crossroads/wissensraeume/cornelia-weber-universitaetssammlungen)

Link #bb

- Johann Gottlieb Fichte (1762–1814) VIAF (http://viaf.org/viaf/29533830) DNB (http://d-nb.info/gnd/118532847) ADB/NDB (http://www.deutsche-biographie.de/pnd118532847.html)

Link #bc

- Friedrich Wilhelm Joseph von Schelling (1775–1854) VIAF (http://viaf.org/viaf/88933257) DNB (http://d-nb.info/gnd/118607057) ADB/NDB (http://www.deutsche-biographie.de/pnd118607057.html)

Link #bd

- Friedrich Schleiermacher (1768–1834) VIAF (http://viaf.org/viaf/95158417) DNB (http://d-nb.info/gnd/118608045) ADB/NDB (http://www.deutsche-biographie.de/pnd118608045.html)

Link #be

- Wilhelm von Humboldt (1767–1835) VIAF (http://viaf.org/viaf/100183995) DNB (http://d-nb.info/gnd/118554727) ADB/NDB (http://www.deutsche-biographie.de/pnd118554727.html)

Link #bf

- Napoleon Bonaparte (1769–1821) VIAF (http://viaf.org/viaf/106964661) DNB (http://d-nb.info/gnd/118586408) ADB/NDB (http://www.deutsche-biographie.de/pnd118586408.html)

Link #bg

- Alexander I of Russia (1777–1825) VIAF (http://viaf.org/viaf/4938543) DNB (http://d-nb.info/gnd/118501852) ADB/NDB (http://www.deutsche-biographie.de/pnd118501852.html)

Link #bh

- Karl Gustav Jacob Jacobi (1804–1851) VIAF (http://viaf.org/viaf/27114024) DNB (http://d-nb.info/gnd/118775766) ADB/NDB (http://www.deutsche-biographie.de/pnd118775766.html)

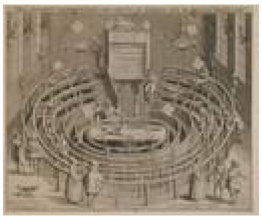
Link #bi

- Franz Ernst Neumann (1798–1895) VIAF (http://viaf.org/viaf/61626300) DNB (http://d-nb.info/gnd/118786008) ADB/NDB (http://www.deutsche-biographie.de/pnd118786008.html)

Link #bj

-  (http://www.ieg-ego.eu/en/mediainfo/the-museum-wormianum?mediainfo=1&width=900&height=500)
  The Museum Wormianum

Link #bk

-  (http://www.ieg-ego.eu/en/mediainfo/the-anatomical-theatre-in-leiden?mediainfo=1&width=900&height=500)
  The Anatomical Theatre in Leiden

Link #bl

-  (http://www.ieg-ego.eu/en/mediainfo/an-experiment-on-a-bird-in-the-air-pump-en?medi-

ainfo=1&width=900&height=500)
An Experiment on a Bird in the Air Pump

Link #bm

-  (http://www.ieg-ego.eu/en/mediainfo/experiment-by-abbe-nollet-on-electrostatics?mediainfo=1&width=900&height=500)
  Experiment by Abbé Nollet on Electrostatics

Link #bn

- Christoph Jacob Trews Korrespondenz (http://www.ieg-ego.eu/de/threads/europaeische-netzwerke/intellektuelle-und-wissenschaftliche-netzwerke/europaeische-korrespondenznetzwerke/thomas-schnalke-wissensorganisation-und-wissenskommunikation-im-18-jahrhundert-christoph-jacob-trew)

Link #bo

- Christoph Jacob Trew (1695–1769) VIAF (http://viaf.org/viaf/17366406) DNB (http://d-nb.info/gnd/118802712) ADB/NDB (http://www.deutsche-biographie.de/pnd118802712.html)

Link #bp

- Lorenz Oken (1779–1851) VIAF (http://viaf.org/viaf/61620688) DNB (http://d-nb.info/gnd/118589717) ADB/NDB (http://www.deutsche-biographie.de/pnd118589717.html)

Link #bq

- Standardisation in Europe (http://www.ieg-ego.eu/en/threads/transnational-movements-and-organisations/internationalism/roland-wenzlhuemer-the-history-of-standardisation-in-europe)

Link #br

- Felix Klein (1849–1925) VIAF (http://viaf.org/viaf/24603438) DNB (http://d-nb.info/gnd/11856286X) ADB/NDB (http://www.deutsche-biographie.de/pnd11856286X.html)

Link #bs

- Georg Cantor (1845–1918) VIAF (http://viaf.org/viaf/39412881) DNB (http://d-nb.info/gnd/118518887) ADB/NDB (http://www.deutsche-biographie.de/pnd118518887.html)

Link #bu

- Max Weber (1864–1920) VIAF (http://viaf.org/viaf/100180950) DNB (http://d-nb.info/gnd/118629743) ADB/NDB (http://www.deutsche-biographie.de/pnd118629743.html)

Link #bv

- Georg Simmel (1858–1918) VIAF (http://viaf.org/viaf/39384262) DNB (http://d-nb.info/gnd/118614436) ADB/NDB (http://www.deutsche-biographie.de/pnd118614436.html)

Link #bw

- Ferdinand Tönnies (1855–1936) VIAF (http://viaf.org/viaf/18242) DNB (http://d-nb.info/gnd/118623095) ADB/NDB (http://www.deutsche-biographie.de/pnd118623095.html)

Link #bx

- Ernst Troeltsch (1865–1923) VIAF (http://viaf.org/viaf/71404752) DNB (http://d-nb.info/gnd/118624024) ADB/NDB (http://www.deutsche-biographie.de/pnd118624024.html)

Link #by

- Albert Einstein (1879–1955) VIAF (http://viaf.org/viaf/75121530) DNB (http://d-nb.info/gnd/118529579) ADB/NDB (http://www.deutsche-biographie.de/pnd118529579.html)

Link #bz

- Niels Bohr (1885–1962) VIAF (http://viaf.org/viaf/64014369) DNB (http://d-nb.info/gnd/118661051) ADB/NDB (http://www.deutsche-biographie.de/pnd118661051.html)

Link #c0

- Louis-Victor de Broglie (1892–1987) VIAF (http://viaf.org/viaf/4927396) DNB (http://d-nb.info/gnd/118674293) ADB/NDB (http://www.deutsche-biographie.de/pnd118674293.html)

Link #c1

- Hendrik Antoon Lorentz (1853–1928) VIAF (http://viaf.org/viaf/68984502) DNB (http://d-nb.info/gnd/118780484) ADB/NDB (http://www.deutsche-biographie.de/pnd118780484.html)

Link #c2

- Max Planck (1858–1947) VIAF (http://viaf.org/viaf/34487615) DNB (http://d-nb.info/gnd/118594818) ADB/NDB (http://www.deutsche-biographie.de/pnd118594818.html)

Link #c3

- Paul Dirac (1902–1984) VIAF (http://viaf.org/viaf/17350683) DNB (http://d-nb.info/gnd/118679775) ADB/NDB (http://www.deutsche-biographie.de/pnd118679775.html)

Link #c4

- Arthur Holly Compton (1892–1962) VIAF (http://viaf.org/viaf/51769421) DNB (http://d-nb.info/gnd/118676695)

Link #c5

- Max Born (1882–1970) VIAF (http://viaf.org/viaf/27126854) DNB (http://d-nb.info/gnd/118513621) ADB/NDB (http://www.deutsche-biographie.de/pnd118513621.html)

Link #c6

- Marie Curie (1867–1934) VIAF (http://viaf.org/viaf/76353174) DNB (http://d-nb.info/gnd/118523023)

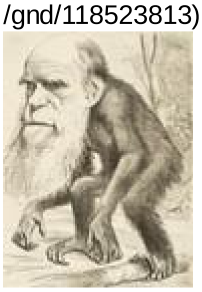
Link #c7

- Jonathan Swift (1667–1745) VIAF (http://viaf.org/viaf/14777110) DNB (http://d-nb.info/gnd/118620193)

Link #c8

-  (http://www.ieg-ego.eu/en/mediainfo/caricatures-from-gullivers-travels?mediainfo=1&width=900&height=500)
  Caricatures from "Gulliver's Travels"

Link #c9

- Charles Darwin (1809–1882) VIAF (http://viaf.org/viaf/27063124) DNB (http://d-nb.info/gnd/118523813) ADB/NDB (http://www.deutsche-biographie.de/pnd118523813.html)
-  (http://www.ieg-ego.eu/en/mediainfo/caricature-of-charles-darwin-180920131882?mediainfo=1&width=900&height=500)
  Caricature of Charles Darwin (1809–1882)

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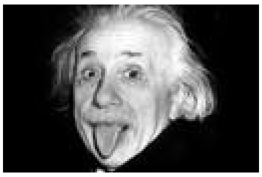
-  (http://www.ieg-ego.eu/en/mediainfo/albert-einstein-with-his-tongue-out-en?mediainfo=1&width=900&height=500)
  Albert Einstein with his Tongue Out

Link #cc

- Industrialization (http://www.ieg-ego.eu/en/threads/backgrounds/industrialization/richard-h-tilly-industrialization-as-an-historical-process)

Link #cd

-  (http://www.ieg-ego.eu/en/mediainfo/address-by-ernst-haeckel-in-the-volkshaus-in-jena-in-1907?mediainfo=1&width=900&height=500)
  Address by Ernst Haeckel in the Volkshaus in Jena in 1907

Link #ce

- Auguste Comte (1798–1857) VIAF (http://viaf.org/viaf/100176623) DNB (http://d-nb.info/gnd/118521748)

Link #cf

- Ernst Haeckel (1834–1919) VIAF (http://viaf.org/viaf/73923565) DNB (http://d-nb.info/gnd/118544381) ADB/NDB (http://www.deutsche-biographie.de/pnd118544381.html)

Link #cg

- Wilhelm Ostwald (1853–1932) VIAF (http://viaf.org/viaf/44372577) DNB (http://d-nb.info/gnd/11859057X) ADB/NDB (http://www.deutsche-biographie.de/pnd11859057X.html)

Link #ch

- Auguste-Henri Forel (1848–1931) VIAF (http://viaf.org/viaf/9892282) DNB (http://d-nb.info/gnd/118534327) ADB/NDB (http://www.deutsche-biographie.de/pnd118534327.html)

Link #ci

-  (http://www.ieg-ego.eu/en/mediainfo/templo-positivista-in-brazil?mediainfo=1&width=900&height=500)
  Templo Positivista in Brazil

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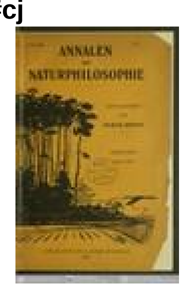
- 

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  Title Page of the Annalen der Naturphilosophie

Link #ck

- Ludwig Wittgenstein (1889–1951) VIAF (http://viaf.org/viaf/24609378) DNB (http://d-nb.info/gnd/118634313) ADB/NDB (http://www.deutsche-biographie.de/pnd118634313.html)

Link #cl

- Ernst Mach (1838–1916) VIAF (http://viaf.org/viaf/12324232) DNB (http://d-nb.info/gnd/118575767) ADB/NDB (http://www.deutsche-biographie.de/pnd118575767.html)

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