original information available for input and that of the various types of output information which should be proved necessary or desirable. From this they would devise an efficient system for achieving the requirements, using the full range of equipment available. Carried to its logical conclusion, such an investigation should not consider the somewhat arbitrary divisions into which a business may be divided at present (for example, wages and salaries, cost accountancy, production and stock control, sales invoicing), but should include the whole scope of the business. This may sound a Utopian concept, but it is already being attempted by some, and is considered the essential goal by many others.

The essential element of such an approach is the open mind, uninhibited by existing manual or punched-card clerical systems. Some business organizations which have not yet installed mechanized systems of any kind have considered adopting a little-by-little approach; a gradual transition by introducing first a punched-card system, then a small-scale computer, and finally a fully developed large-scale computer system. To these the experience of one business organization may be of interest and provide some guidance. The spokesman of this concern explained that the computer system now being installed bears very little resemblance to the punched-card system which preceded it, although he acknowledged that the latter had provided some useful experience in planning.

It is true that the applications of a limited scope may sometimes be of outstanding importance. A saving of the order of £50,000 per annum for the expenditure of three or four hundred pounds was reported at the Symposium from the application of linear programming techniques to a problem of bulk transportation, and an account was given of how an hour or so a week on a small computer had made possible the introduction of a greatly improved method of production control. But in general, the most substantial benefits will come from a comprehensive system. This does not imply that an integrated system can be installed in one operation. The

system must be planned with the view of dividing it into phases which are of such a size and nature that they may be introduced in sequence over a period of many months. The transition, indeed, requires some of the most careful and detailed planning, for each phase must be introduced with the least possible disturbance both to work already on the computer and to procedures which are still carried out manually. It is normally advisable to run each new phase on the computer in parallel with the previous system until it is reasonably certain that all eventualities have been covered. Furthermore, it is prudent to prepare in advance an emergency procedure for adoption in the event of a serious breakdown of the equipment, however unlikely this may be.

Compared with strategical planning of such complexity, the tactical programming may well prove relatively simple. However, just as interpretive routines and automatic coding techniques permit the computer to assist the programmer, so may some of the computer techniques which are being developed in the field of operational research be of assistance to the planner. A paper on developments in this field was presented at the Symposium, and the speaker agreed with a suggestion that the simulation techniques which he had described could be used to study the feasibility of systems designed for a business electronic data-processing installation. A large organization might find it worth while to acquire a small computer initially for this purpose. If this machine were compatible with the peripheral equipment of the proposed large installation, it could later be used in conjunction with it, and would prove invaluable for carrying out those housekeeping activities such as sorting and merging which occupy so much of the time of a large computer while exploiting so little of its capabilities. This, then, may represent the pattern for the future use of electronic computers in business.

In conclusion, I wish to make it plain that the opinions expressed above are of a purely personal nature, and should not be construed as representing the policy of the organization with which I am associated.

W. L. C. GARRETT

SCIENTIFIC CENTENARIES OF 1959

By JOAN M. EYLES

ONE of the first requisites for the traveller is a good map of the country in which he proposes to travel. If none exists, then his travels will help to provide one. The launching of the First Crusade in 1095 by Pope Urban II marked the beginning of a series of mass pilgrimages across Europe which continued for nearly two centuries and must have given rise to a demand for maps, guides and charts to help the traveller on his way. The earliest medieval maps of Britain are those made by Matthew Paris, the great historian. Matthew, a Benedictine monk of the Abbey of St. Albans, died seven hundred years ago, in 1259, and his maps of Britain are believed to date from 1250. Their main object was probably to show the towns and monastic guest-houses where the pilgrim could rest on his way to Dover, the usual point of departure for the Holy Land. Many of the legends on the maps are of interest; Snowdon is both named and shown by an

outline of a mountain, a convention that survived on maps until the middle of the eighteenth century, when hachuring came into use. Other maps prepared by Matthew Paris which still exist include one showing the route from London to southern Italy.

When William Harvey described the circulation of the blood in his "De Motu Cordis" (1628), he referred to the Italian anatomist, Matteo Realdo Colombo, who died in 1559, and whose work, "De Re Anatomica", appeared shortly after his death. Colombo, a pupil of Vesalius, made a close study of the blood vessels of the lungs and discovered experimentally the pulmonary circulation, although he did not understand or recognize the general circulation. Colombo was appointed successor to Vesalius at Padua in 1545, but went to Pisa in the following year and taught there. Later he moved to Rome, where he was teaching when he died.

Two authors of arithmetic books died in 1559. One was Cuthbert Tunstall, Bishop of London and friend of Sir Thomas More, whose "*De Arte Supputandi*", written in Latin and first printed in 1522, was the earliest arithmetic by an English author. The other was Adam Riese, born in Bavaria in 1489, who wrote a popular arithmetic and a treatise on practical geometry. His arithmetic was so widely used that "*Nach Adam Riese*" can be looked on as equivalent to the English expression "according to Cocker".

Among the bicentenaries of the year, that of the French scientist, P. L. M. de Maupertuis, who died on July 27, 1759, is particularly interesting. De Maupertuis was leader of the French expedition to Lapland in 1736 to measure the length of a degree of longitude, achieving results which verified Newton's theory that the Earth was an oblate spheroid. He became president of the Royal Academy of Sciences in Berlin, and was afterwards involved in a bitter controversy with Voltaire. It is worth recording that he also had ideas about evolution and made an early attempt to explain the origin of new species.

Jacob T. Klein, born in Königsberg in 1685, and author of several zoological works, also died in 1759. Klein visited England in the course of his travels, and in 1728 was elected a Fellow of the Royal Society.

A significant event of 1759 was the establishment of a botanic garden in the grounds of Kew House, on the instructions of Augusta, Dowager Princess of Wales and mother of George III. Some thirty years later, Erasmus Darwin wrote:

"So sits enthron'd in vegetable pride
Imperial Kew by Thames's glittering side;
Obedient sails from realms unfurrow'd bring
For her the unnam'd progeny of spring;"

From these beginnings arose the magnificent Royal Botanic Gardens at Kew which we know to-day.

Several well-known naturalists were born in 1759. In particular, we note Sir James Edward Smith (1759-1828), founder and president for forty years of the Linnean Society of London. The story of how the young botanist was breakfasting with Sir Joseph Banks and seized the opportunity of purchasing the collections of Linnæus has often been related. This memorable purchase was followed by several years travel in Europe, and on his return Smith founded the Linnean Society. This was not the first Society started by Smith, for some years before, when a student at Edinburgh, he and a few friends with similar interests had formed a Society for the pursuit of natural history, which was attended by men as prominent as Black the chemist and Hope the botanist.

Born on August 12, 1759, a few months before Smith, Thomas Andrew Knight, a country gentleman, also became known as a botanist and founder of a Society. Knight was another member of the Banks circle, and one of Sir Joseph's many correspondents. He became a Fellow of the Royal Society in 1805 and in the following year received the Copley Medal for his investigation of tropisms in plants. He also carried out extensive researches into the improvement of fruit trees by crossing. One of the founders of the Horticultural Society, he became its second president in 1810, a position he occupied until his death in 1838.

Another enthusiastic naturalist was the Rev. William Kirby, rector of Barham in Suffolk, whose name appears on the first list of Fellows of the

Linnean Society. Kirby's chief interest was in entomology, and he is remembered as joint author with Spence of a popular introduction to entomology.

Three French naturalists born in 1759 were L. A. G. Bosc, who travelled extensively in North America, J. B. Audebert, artist and author of several beautifully illustrated books, including "*L'Histoire Naturelle des Singes*", and P. J. Redouté, the famous flower painter.

An interesting chemical anniversary is that of the birth of Thomas Cooper, free-thinker and student of the natural sciences, who emigrated to America in 1793. He was a close friend of Priestley, who bequeathed to him his chemical apparatus, including the historic burning glass used in the discovery of oxygen. Cooper taught chemistry and mineralogy in the United States for many years, first in Pennsylvania, then in Virginia, and later in South Carolina. His advanced thinking and love of free speech, which had led to his leaving England, brought him into further trouble in America, and in 1833, after writing to Silliman that "the Old as well as the New Testaments were by no means infallible guides in mineralogy and geology", he was forced to resign his position as president of the College of South Carolina. Cooper did much to spread the knowledge of the new chemistry of Lavoisier in the United States, and edited a number of chemistry text-books; but he was an unorthodox character, whom an English geologist described as "a most remarkable man some of whose screws were uncommonly loose".

The first practical demonstration of aerostation in England was made by Vincenzo Lunardi (1759-1806), a daring young Italian diplomat, who ascended in a balloon from Moorfields, London, on September 15, 1784. He travelled some twenty-four miles in two and a quarter hours, touching down at North Mimms on the way to land his cat, which was suffering from the cold. This aerial voyage was watched by thousands of people, including the Prince of Wales and prominent politicians.

Passing to 1859, undoubtedly the most eminent of the scientists who died in that year was Alexander, Baron von Humboldt. Born in Berlin in 1769, he studied first at Göttingen and later at the School of Mines at Freiberg. On leaving the latter he received an appointment in Berlin as superintendent of mines. For four years he carried out his duties, visiting mines and studying geology. In 1796 he gave up his post and devoted himself to further scientific studies in order to prepare himself for travel. After several disappointments, in 1799 he set sail for South America with the botanist Aimé Bonpland, having obtained special permission from the King of Spain to travel in and examine Spanish territories in the New World. It was five years before he returned to Europe, having travelled some 40,000 miles, bringing back with him more than thirty cases of geological and botanical specimens. During 1808-27 he made his home in Paris, which he regarded as the centre of the scientific world, and devoted himself to preparing detailed accounts of his travels and the collections he had made. In 1827 he moved to Berlin, and he remained in Germany until his death in 1859. He had hoped to travel in Asia as extensively as he had in America, but the realization of his hopes was limited to a nine-months journey across Russia and Siberia in 1829.

Humboldt made many contributions to science, in the fields of geology, geography and climatology, but he is also remembered for the inspiration he was

to others, and in particular to Charles Darwin. The latter wrote in 1845: "I never forget that my whole course of life is due to having read and re-read as a youth his 'Personal Narrative'". A. R. Wallace, too, wrote of the influence this book had upon him. When Humboldt died, on May 6, 1859, he was within six months of his ninetieth birthday, and ten years later the centenary of his birth was celebrated with enthusiasm on both sides of the Atlantic.

Karl Ritter, the geographer, who also derived inspiration from Humboldt's writings, died only a few months later, in September 1859. Ritter did much to establish the science of comparative geography, and endeavoured to show that the physiography of a country had a direct influence on the life and progress of the nation inhabiting it.

Another scientific traveller who spent many years in the United States was Thomas Nuttall (1786-1859), a Yorkshire printer who emigrated in 1807. He was persuaded to take up botanical studies, and underwent many hardships during his solitary travels in the interior of the United States in search of specimens. He is said to have discovered an almost unequalled number of new genera and species. During 1825-34 he was curator of the botanic gardens at Harvard, but in 1841 returned to England to occupy a family estate at Nutgrove, near Liverpool, where he cultivated many rare plants. He died on September 10, 1859, and his herbarium of more than 5,000 species was purchased by the British Museum.

The British Museum also acquired the herbarium of Javanese plants belonging to Thomas Horsfield (1773-1859), a Pennsylvanian-born physician who practised in Java and Sumatra from 1799 until 1819, when he became keeper of the East India Company's Museum in London. Yet another botanist who died in 1859 was K. A. Agardh, born in Sweden, who published the first general account of diatoms. His "*Systema Algarum*" (1824) entitles him to be regarded as a pioneer in the classification of the algae.

In the field of geology, Denison Olmsted (1791-1859), a Yale graduate who became professor of chemistry, mineralogy and geology at the University of North Carolina, was one of the first to appreciate the value of a State geological survey. He laid a plan for one before the State legislature in 1821, and an Act authorizing such a survey was passed two years later. Olmsted received no fees, but expenses of 250 dollars a year. His preliminary reports were published in 1824 and 1825. He was then recalled to Yale as professor of mathematics and natural philosophy. Later he became professor of astronomy at Yale, and observed the return of Halley's comet in 1835, making the announcement long before confirmation arrived from Europe.

Four years after this event, Harvard decided to establish an observatory, and William Cranch Bond (1789-1859) was appointed 'observer', later becoming its first director. Bond was an instrument-maker in Boston with a taste for astronomy, who had constructed his own instruments and built an observatory at his home. When he died in 1859, he was succeeded at Harvard by his son, George Phillips Bond.

Three mathematicians of some note also died in 1859. The most senior, Louis Poincaré, was born in Paris in 1777. He was particularly interested in statics, but published a number of works on geometrical and mechanical subjects. The theory of couples is largely due to him, also that of the motion of a body in space under the action of no forces. J. L.

Raabe, of Zurich, born in 1801, chose higher algebra for his field of research, and discussed the convergence of series; while Peter Lejeune Dirichlet, born at Duren in 1805, became a pupil of Gauss, and succeeded him at Göttingen in 1855. He is best known as an interpreter of Gauss and of Jacobi, his father-in-law, but is also remembered for having introduced into the calculus of variations the so-called Dirichlet principle.

The tubular girder railway bridge spanning the Menai Strait in North Wales and the High Level bridge across the Tyne at Newcastle both stand as memorials to the famous engineer, Robert Stephenson, son of an equally famous father. Stephenson died in October 1859, and was buried in Westminster Abbey.

Passing on to more recent times, and the centenaries of scientists who were born in 1859, we note first two who were awarded Nobel Prizes, Pierre Curie and Svante Arrhenius. Pierre Curie, born in Paris on May 15, 1859, married the young Polish chemist, Marja Skłodowska, in 1895. Six months later Röntgen discovered X-rays, and so began that well-known chapter of scientific history in which is recorded the Curies' joint investigation of the radioactive elements. Pierre had already studied the behaviour of crystals in electromagnetic fields, and had discovered the piezo-electric effect. To the joint research he brought a familiarity with delicate electrical instruments which proved of great value in determining the physical properties of the newly discovered elements. In 1903, the announcement by Pierre Curie and his pupil, Laborde, that radium emits heat rendered valueless Kelvin's estimate of the age of the Earth, based on its rate of cooling, and paved the way for an entirely new method of estimation, based on radioactivity.

In the same year, the Curies and H. Becquerel shared the Nobel Prize for Physics. Three years later, a street accident brought a tragic end to Pierre's life, though, as all know, the work on radioactivity was carried on valiantly by his widow, who herself received the Nobel Prize for Chemistry in 1911.

While Pierre Curie was studying the passage of electricity through crystals, Svante August Arrhenius, born near Uppsala on February 19, 1859, was investigating its passage through dilute solutions. His theory of electrolytic dissociation, first embodied in the dissertation for his doctorate in 1883 and published in full in 1887, received more support abroad, particularly from Ostwald and Van 't Hoff, than in Sweden. Recognition eventually came, and with it the Nobel Prize for Chemistry in 1903, and the establishment in 1909 of a Nobel Institute in Stockholm, which he directed until his death in 1927. His bold and original ideas were not confined to physical chemistry, but extended to the fields of serum therapy and cosmology, volcanism and the cause of glacial periods. Appreciation of his work was shown in British scientific circles by the conferment of foreign membership of the Royal Society and of honorary degrees by the Universities of Oxford, Cambridge, Edinburgh and Birmingham.

Two men born in 1859 both occupied prominent positions at the Rockefeller Institute for Medical Research in New York. One was Jacques Loeb, biologist and biochemist, born at Mayen in Germany, who left his homeland for the United States in 1891. He spent ten years in Chicago, seventeen at Berkeley, and was then made head of the Division of General

Physiology in the Rockefeller Institute, a position which he held until his death in 1924. Founder of the modern school of physiology, his early experiments in artificial parthenogenesis startled the scientific world by producing the fatherless sea-urchin and the fatherless frog. He investigated the effects of various stimuli upon living matter, and followed this by extensive research on proteins. Although a brilliant experimentalist, his philosophical ideas, particularly as stated in his "Mechanistic Conception of Life", aroused considerable criticism and opposition.

Loeb's contemporary, Theobald Smith (1859–1934), of Albany, New York, occupies an honoured place in medical science for his pioneer work investigating the transmission of disease and immunization. Inspired by the work of Koch, in 1889 he discovered the parasite responsible for Texas fever in cattle, and in his classic report of 1893 gave the first account of the transmission of a parasitic protozoan by a blood-sucking parasite. Later, he clearly differentiated between the bovine and human types of tubercle bacilli. He was the first occupant of the chair of comparative pathology at Harvard, and was eventually appointed director of the Department of Animal Pathology in the Rockefeller Institute. He was elected a foreign member of the Royal Society in 1932.

Two well-known British geologists were born in 1859, namely, Alfred Harker and G. W. Lamplugh. Harker, while retaining his lectureship at Cambridge,

was for ten years attached to the Scottish Geological Survey. This period was devoted to mapping the volcanic rocks of Skye and other islands of the Inner Hebrides, and his descriptions of these rocks became classics in geological literature. His later more general works on igneous rocks and metamorphism also exerted a lasting influence on petrological thought. He died in 1939, six months after the celebration of his eightieth birthday. G. W. Lamplugh had his first geological paper, on glacial drift in Yorkshire, published when he was only nineteen. He joined the Geological Survey in 1892, and during the next five years completed almost single-handed the mapping of the Isle of Man. Afterwards he carried out an extensive examination of the Irish glacial deposits. He retired from the Survey in 1920 and died six years later. Both Harker and Lamplugh were Fellows of the Royal Society and each had occupied the presidential chair of the Geological Society.

A rather controversial figure in the history of science is that of the Russian physicist, A. S. Popov (1859–1905), a pioneer in the field of radio telegraphy, whose success in signalling has been claimed as antedating that of Marconi. Others born in 1859 include the organic chemists, J. B. Cohen and L. Knorr, the American chemist H. Y. Castner, whose name is associated with the Castner-Kellner process for the manufacture of chlorine and the extraction of sodium, and Florian Cajori, historian of mathematics.

NEWS and VIEWS

Contributions to *Nature*

DURING the first year of the publication of *Nature* (November 1869–November 1870), the number of original communications (mainly "Letters to the Editor", together with some special articles, though not the general ones) was 378. These came from 17 different countries. In certain selected years afterwards, the number of original communications were as follows (number of countries in parenthesis): 1910, 285 (19); 1920, 422 (17); 1930, 568 (27); 1937, 648 (31); 1949, 1,066 (35). During last year (1958), the number of such communications was 2,362, and these were submitted from 59 different countries. These were distributed as follows:

Argentina	2	Japan	80
Australia	128	Kenya	13
Austria	2	Malaya	7
Belgian Congo	3	Mauritius	1
Belgium	41	Mexico	1
Brazil	6	New Zealand	53
British Borneo	1	Nigeria	9
British Honduras	1	Norway	14
British West Indies	11	Pakistan	2
Canada	67	Philippines	1
Ceylon	3	Poland	18
Chile	3	Portugal	1
China	1	Puerto Rico	1
Costa Rica	1	Roumania	5
Czechoslovakia	53	Sarawak	1
Denmark	14	Sierra Leone	3
Egypt	8	South Africa	37
Finland	4	Spain	7
Formosa	1	Sudan	2
France	16	Sweden	44
Germany	25	Switzerland	10
Ghana	4	Tanganyika	3
Greece	5	Uganda	18
Hawaii	6	United Kingdom	959
Holland	48	United States	407
Hungary	24	U.S.S.R. (Russia)	10
India	96	Venezuela	2
Indonesia	1	Yugoslavia	6
Ireland	18	<i>Total No. of countries</i>	<i>59</i>
Israel	19	<i>Total No. of communications</i>	<i>2,362</i>
Italy	40		

New Science Officers for American Embassies

SEVEN distinguished scientists have been appointed by the U.S. Department of State to serve as science officers in the American Embassies in London, Paris, Rome, Bonn, Stockholm, and Tokyo. Although assigned to a specific embassy, the science officer will also provide scientific assistance in embassies in adjacent areas. The men selected are: Dr. Thomas H. Osgood, dean of the School for Advanced Graduate Studies, Michigan State University, for London; Dr. Edgar L. Piret, professor of chemical engineering, University of Minnesota, for Paris; Dr. Edward H. Cox, retired head of the Department of Chemistry, Swarthmore College, as deputy science officer for Paris; Dr. Walter Ramberg, chief of the Mechanics Division, National Bureau of Standards, for Rome; Prof. Ludwig F. Audrieth, professor of chemistry, University of Illinois, for Bonn; Dr. Julian E. Mack, professor of physics, University of Wisconsin, for Stockholm; and Prof. Willis R. Boss, professor of zoology, Syracuse University, for Tokyo. The appointments, which will be for a period of two years, constitute the first of a series for the Science Programme of the Department of State under Dr. Wallace R. Brode, science adviser to the Secretary. Still to be appointed are science officers for the U.S.S.R., India and South America, and deputy science officers for all the posts with the exception of Paris, to which Dr. Cox is being assigned. Leaders in science who have had experience as educators, research workers and administrators have been especially selected for these posts because of their international scientific reputation, and their knowledge of the status of science and acquaintance with scientists in the country of assignment. Each of those appointed