Arbor

The Deutsches Museum: past, present and future

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1. The Deutsches Museum: A short overview

«If only it were possible that Germany, too, would have a major museum dedicated to science and technology—a place of knowledge, and one that would encourage learning, thus motivating young people to great deeds.» This was the greatest wish of the Bavarian engineer Oskar von Miller, after he had visited the South Kensington Museum in London in 1891 and seen the original machines built by James Watt, the first locomotives and many other exhibits from the treasure house that is the early industrial era. What most impressed him was how adults and children were so taken in by the exhibits.

His dream was to come true. In 1903, almost a century ago, the Deutsches Museum was founded in Munich. Dedicated to masterworks of the natural sciences and technology, it soon developed into one of the largest and most successful science museums in the world. The broad range of collections and exhibitions subsumes almost all the major areas of science and technology. Oskar von Miller and his staff successfully developed new techniques which not only supported learning but offered it in an entertaining way. These included fully functional original exhibits, experiments and demonstrations in which the visitor could take part, as well complete mock ups, replicas and dioramas. The museum as an experience became the watchword. Today, the Deutsches Museum welcomes annua-

lly over one million visitors from around the globe — more than any other museum in Germany. Other museums dedicated to special areas of knowledge, such as the large museum of aviation in Oberschleißheim near Munich, and a smaller museum in Bonn concentrating on science and technology in Germany since 1945, are but satellites of the central building on the «Museumsinsel». A third Munich-based branch designed to house the transport collections is currently being planned. The history of the Deutsches Museum has, over the years, been influenced by the political, economic and social developments of the Twentieth Century, along with the era's scientific and technical progress. The most important steps along the way, from conception to future ideas, are described below.

2. The early years

Oskar von Miller-Founder of the Deutsches Museum (see Figure 1)

The foundation and subsequent development of the Deutsches Museum is largely due to the efforts of one man: the engineer Oskar von Miller. He had the initial idea, worked it up into a concrete proposal, and managed to convince sponsors from industry, science and the State about its feasibility. For over 30 years, he remained personally at the helm, ensuring that his dream became reality. In 1903, at the age of 48, he presented his project in public for the first time. Thirty years later, on 31st March 1933, he gave up his post as director-not only because he was by then an old man, but also for the reason that he did not see eye to eye with the party functionaries of National Socialism, who had just come to power. Oskar von Miller died on 9th April 1934.

Oskar von Miller-A portrait

Oskar von Miller was born in Munich on 7th May 1855 as the youngest of ten sons to an ore foundry entrepreneur Ferdinand von Miller. His father was in charge of the Royal Ore Foundry, and created, for example, the monumental bronze statue «Bavaria». The family von Miller was well thought of in Bavaria and enjoyed access to the Bavarian Court.

Oskar von Miller studied railway engineering, hydraulic engineering and bridge building at the Munich Polytechnic, before entering the service of the State in 1873. In 1881 he found himself in Paris for the international exhibition of electrical engineering, taking the opportunity to pursue subsequent studies at the Conservatoire des Arts et Métiers. A few years later, the chance presented itself to visit London's South Kensington Museum —today's Science Museum— an experience that also left behind a deep impression.

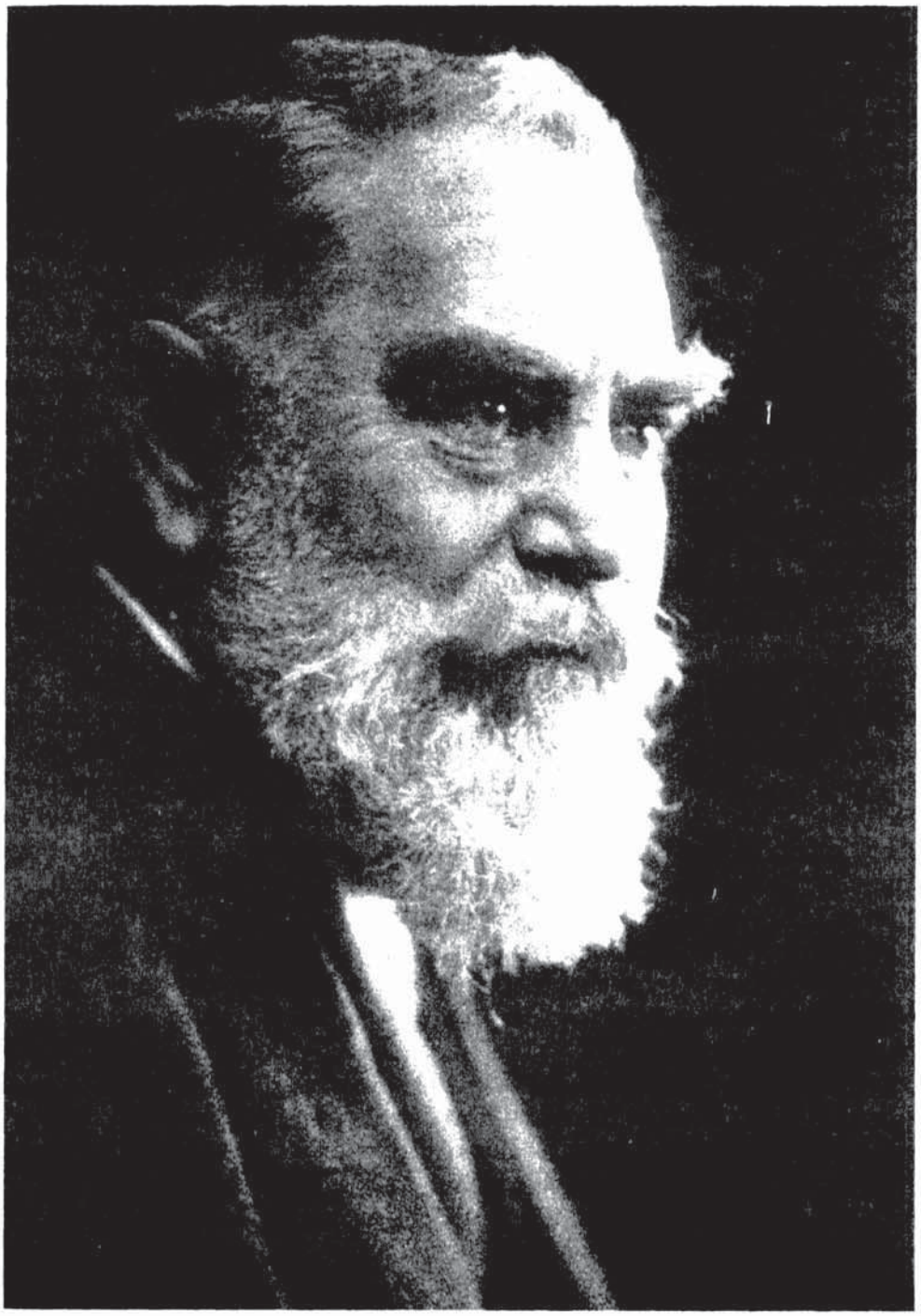

Figure 1. Oskar von Miller (7th May 1955-9th Aplil 1934), founder of the Deutsches Museum

His visits to international exhibitions and the World Exhibitions opened his eyes to the incredibly strong impression these events made on the general public. As early as 1882 he organised an exhibition in Munich on electrical engineering. Here, Miller was able to demonstrate the successful remote transmission of DC current over a distance of 57 km-a feat that gained the attention of experts in the field.

He gathered his industrial experience between 1883 and 1889 as the Director of Germany's Edison Gesellschaft, a precursor of the Allgemeine Elektricitäts-Gesellschaft (AEG). Von Miller then started up his own engineering office and directed his talents —with great success— to supplying Bavaria and the rest of Germany with electrical power. As a pioneer of inter-regional electrical power and supply systems, he achieved considerable recognition and built up a secure financial foundation. This allowed him to invest privately in the museum, a project to which he devoted much time and attention. His personal reputation as an engineer and businessman, as well as the high standing of his family within Munich's society, helped achieve an audience amongst influential circles.

A call to foundation

Oskar von Miller was the President of the Bavarian Section of the German Society of Engineers. On the 1st May 1903 he sent a letter to a number of influential figures in which he explained for the first time his ideas for, and conception of, a museum dedicated to the natural sciences and technology. Von Miller invited these individuals to a meeting to be held on the 5th May in Munich. His missive contained all the key thoughts about his project. We have taken the liberty of quoting the following excerpts:

«As the President of the Bavarian Section of the German Society of Engineers, I hereby take this opportunity of presenting to you an idea which, should it meet with the approval of the personages assembled here in Munich today at this Engineering Congress, could soon be put into operation. It hardly needs to be said that industry and the technical sciences have taken on an increased importance for the world at large, and that their influence can be felt in all areas of society and our culture. It is surely a legitimate consideration that, just as the arts and applied arts have their own temples in which they can display their wares, the natural sciences and technology should also be able to exhibit their masterpieces in collections held in a special museum located in Germany, just as England and France have managed to do with enormous success in their Musée des Arts et Métiers and the South Kensington Museum

respectively. It must be possible in the present climate to bring together many different instruments and machines which demonstrate the key stages in the development of modern technology, and before the aforementioned are lost, destroyed or forgotten. Thus, it would be feasible, I believe, to gather in the first scientific instruments of Fraunhofer and Steinheil, the first telephonic equipment of Reis, the first arc lamps and dynamos, or the epochal experimental equipment used for the early locomotives, either as original exhibits, or in the form of replicas and models.

A systematically organised number of collections would produce not only an interesting picture of, and give us a salutary lesson in, the development of technology and the technical sciences, but would, furthermore, engage any casual visitors in such a way that they would go out into the world and proclaim the message of the German fatherland. In order to bring this about, it is vital that such a museum be far removed from the usual industrial exhibitions, just as the National Museum is strongly differentiated from other institutions dedicated to trade and industry. A board of directors must also be called into being, in order that this house I envisage can contain such collections as will attract the very greatest of men from the scientific and technical community.»

In a second section of the letter, von Miller lays out specific plans for creating such a museum in Munich. There existed at the time a possibility of opening a provisional exhibition in a number of buildings he believed suitable.

A «national» institution in Munich (Bavaria)

It is perhaps salutary to note that at the time Germany was not a central governed nation state, but a so-called «Bundesstaat». The German Reich comprised 25 of these bodies, four of which were kingdoms in their own right. One such was the Königreich Bayern. To create a national institution of any sort, least of all in Bavaria, was not immediately an easy task. Over 60% of the population of the Reich lived in the State of Prussia. The capital of the Reich and most important scientific and industrial city was Berlin. Oskar von Miller was a thoroughly convinced proponent of the increasing significance of science, technology and industry, not just for a nation but for the entire world. In 1856 the Society of German Engineers (the Verein Deutscher Ingenieure, or VDI) was founded, one of the few organisations to offer a forum Germany-wide. This was the reason behind choosing to hold the society's Annual General Meeting on the day dedicated to the opening of the Deutsches Museum. The thinking be-

hind Munich as the appropriate venue was, he explained, wholly legitimate. Bavaria had, after all, done so much for recent scientific and technological progress. The main reason of course was that as a Munich citizen, he felt easily able to coordinate the desires of industry, science and the state.

The reasons for founding the Deutsches Museum

The history of the Nineteenth Century documents very strongly the importance of science, technology and industry for the cultural, economic and political development of a nation. England had become the leading industrial power and military global might. France had always been considered a country of culture and rational, scientific thought. Germany, on the other hand, was split into any number of minor states, and until the middle of the Nineteenth Century was still a developing country in terms of economic stature and scientific progress.

It was only from the mid-Nineteenth Century onwards that scientists and university staff such as Frantz Reuleaux and Hermann von Helmholtz began to restructure the training and education systems pertaining to science and technology, putting them on a much broader base. The aim was to catch up with competitors such as England and France. Another avowed purpose was to encourage the interest and enthusiasm amongst young people for the fields of science and technology. The Conservatoire des Arts et Métiers and the South Kensington Museum were leading institutions in this respect. Thus it was that during the second half of the Nineteenth Century the level of education offered by technical institutions of learning began to improve and new schools were founded. One such was the Königlich Polytechnische Schule in Munich, which opened in 1868, becoming in 1877 the Technische Hochschule and later on the Technische Universität München.

In spite of recognition of the important role played by science and technology, this did not lead to the participants taking on any enhanced status and thus achieving influence in society, regardless of whether they were involved in the natural sciences or the field of engineering. Technology was seen mainly as something that endangered cultural development. This fitted well the world of Germany's bourgeois middle classes, influenced as they were by the idealistic views and new humanistic tendencies of the Romantic era. In France, this was palpably not the case. The foundation of the École Polytechnique by Napoleon in 1794 meant that learning and education within the fields of natural science and technology were on a par with the classical studies traditionally garnered at univer-

sity. German engineering circles were among the first to register with envy whenever a French engineer attained the post of minister.

Although academic learning and the right of Germany's polytechnics and universities to grant doctoral degrees had their place, another useful strategy that could be employed to harness public recognition of science and technology was the foundation of a museum of national significance, one in which masterworks of technology could be displayed much in the way that artistic masterpieces and exhibits of applied art were presented.

Realisation of the project-Organisation and finance structures

The meeting called by Oskar von Miller for the 5th May 1903 was a complete success. All the participants invited were enthusiastic about the idea and pledged their commitment. Just a month later, on 28th June, a new society was founded at a special constitutional meeting: the «Museum für Meisterwerke der Naturwissenschaft und Technik». Due to the activities of the Bavarian Foreign Minister von Podewils, the Government of the Reich had also become involved, signalling from Berlin its support for the project. Throughout the length and breadth of the Reich, positions on the matter had been obtained, the great majority of which were positive. Moreover, the City of Munich provided at no cost an extremely attractive and spacious site on an island in the middle of the River Isar.

As soon as it became clear that the entire German Reich was ready to commit itself to the project, the name was changed simply to «Deutsches Museum», and the purposes of the institution —intimately bound up with masterpieces of science and technology— rendered in the form of a subtitle: «Meisterwerke der Naturwissenschaft und Technik». This nomenclature was designed to clarify the main functions of the museum, and was not to be understood as signifying that German technological developments were of central importance. On the contrary, von Miller and his colleagues, all scientists and engineers of international standing, were deeply committed to the interdisciplinary and international nature of their work.

Principles of organisation (see figure 2)

The success of the Deutsches Museum throughout all its phases of development is a direct result of the strategy pursued by Oskar von Miller and his partners, one which ensured that influential persons from science, technology, industry, as well as state and municipal organisations were won round to the idea and committed themselves to the museum's progress.

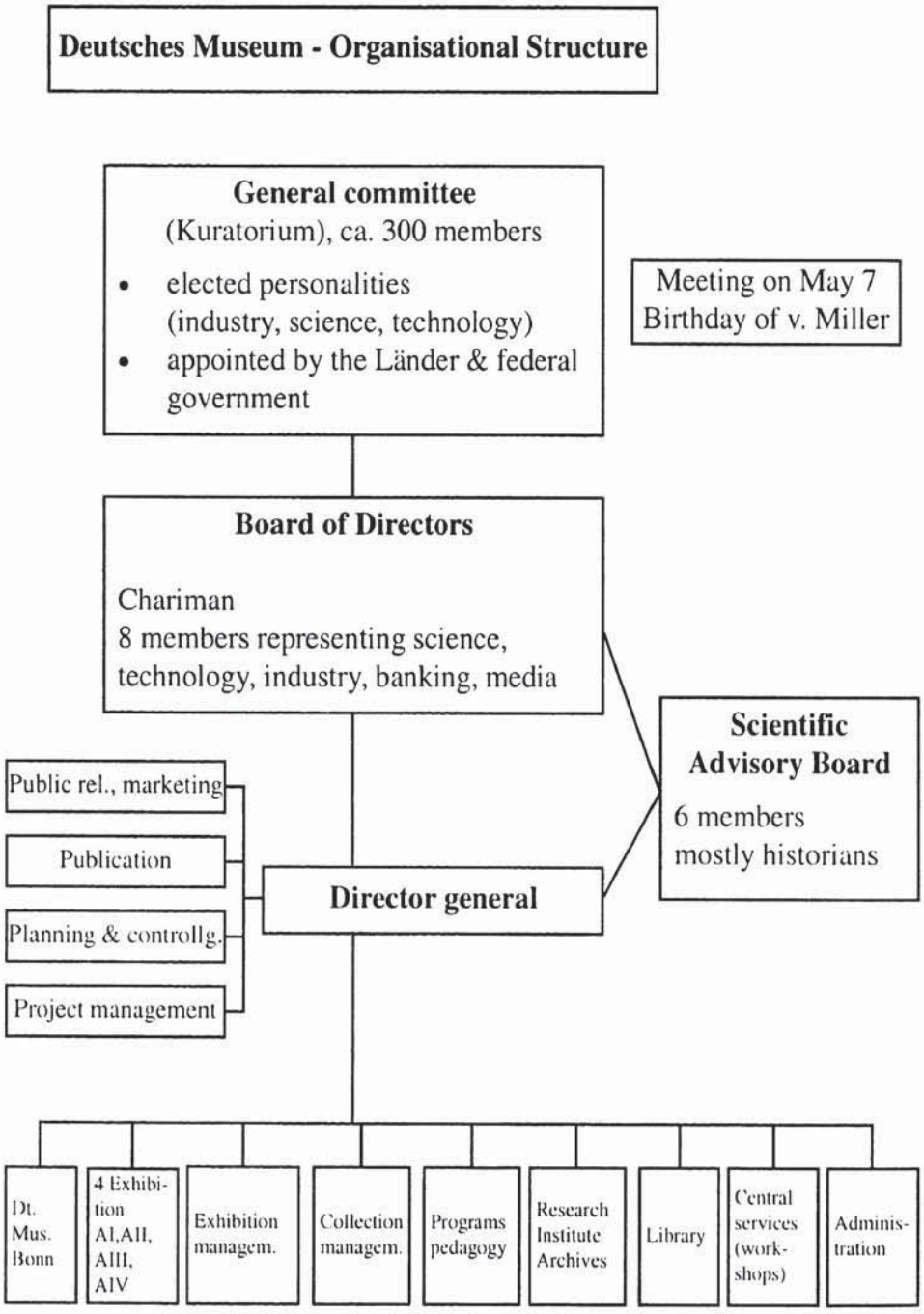

Figure 2. Organisational structure of the Deutsches Museum today

In order to secure the long-term interest of these patrons, an appropriate organisational structure was developed: The chancellor of the «Reich» and several ministers formed an «Honary Directorate», thus providing political relations and support. Three high-ranking personalities were as «Board of Director» responsible for the management of the museum, in reality for 30 years, until his retirement in 1933 Oskar von Miller was the leading and acting person, followed by the well-known physicists Jonathan Zenneck.

A smaller (100 members) and a larger committee (200 members) consists of delegates or the federal and states governments and elected influential representatives of the scientific, technical and economic community. The purpose was to provide nation wide support and interest.

In practice, this structure fulfilled the aims of Oskar von Miller. The number of members and the structure of the governing bodies has changed down the years; but the basic principles of involving all interested parties and individuals from various circles of influence remains. Today, the museum is led by a General Director, whose activities are supervised by an administrative body (the «Verwaltungsrat») of eight members, which is in turn monitored by a Board of Trustees (the «Kuratorium»). The year 1990 saw the foundation of a new Scientific Advisory Committee (the «Wissenschaftlicher Beirat»), whose purpose is to provide advice on research matters and other basic questions regarding potential future developments. The specific tasks of the individual departments —when planning a new exhibition for example— are supported by these advisory bodies.

Financial matters (Figure 3)

The on-going financial support for the museum was provided equally by the State of Bavaria and the Government of the Reich. The City of Munich supplied electricity, water and heating free of charge.

The present budget is around DM 50 million. DM 33 million are public funds, of which 85% comes from the State of Bavaria and the remaining 15% from the Federal Government. The latter participates because the museum is also a research institute of national importance. Normally, the financing of museums and other cultural institutions is a matter for Germany's «Länder». In 1992, the City of Munich reduced its financial commitment to DM 1 million, a figure that meets around 60% of the museum's energy requirements. Around 20% of the entire budget is covered by income generated by admission and the other internal initiatives, such as the leasing of restaurant facilities and bookshop licenses. In addition, contributions for special exhibition projects are received from industry.

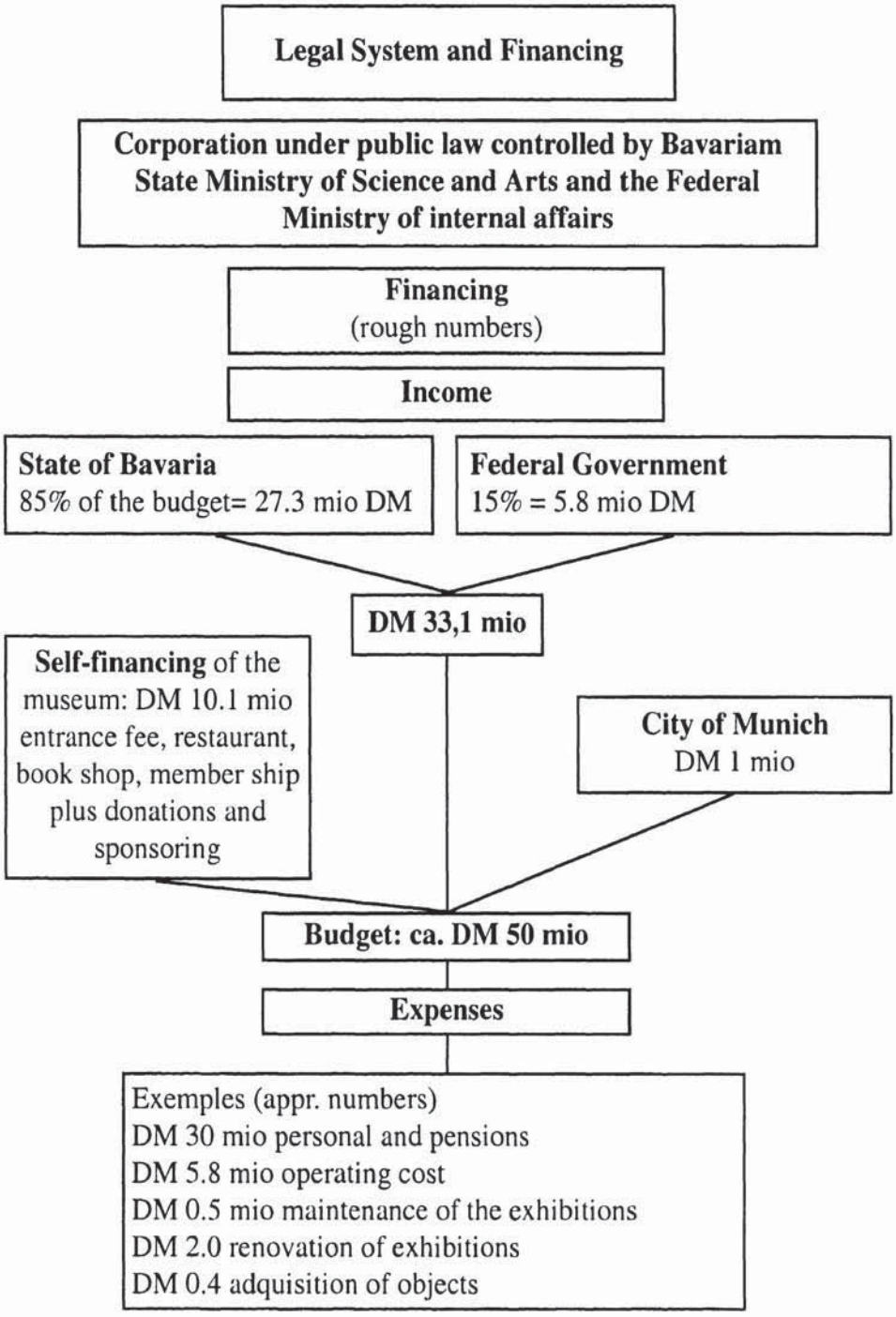

Figure 3. Legal structure and financing of the Deutsches Museum today.

Methodology and layout-The tripartite structure of the museum (Figure 4)

What makes the Deutsches Museum so special —if one compares it to other museums— is the tripartite structure of the institution's activities, which are reflected in the actual layout of the building (see diagram).

Collections and exhibitions	Housed in the main building
Library and archive	Housed in the «Bibliothek»
Congresses, symposia and educational events	Held in the «Kongreßbau»

Initial reaction to this enormously ambitious scheme, with its huge demands for building space, was sceptical, many believing such a project could not be realised. The concept survived unscathed however, the dogged determination of Oskar von Miller playing a key role once again. It was only in 1935 that cessation of works was official.

On 13th November 1906 Kaiser Wilhelm II laid the foundation stone. Construction halted because of World War I and was only restarted after the war under immensely difficult circumstances. Generous contributions of building materials alone made this possible.

On 7th May 1925 the main collections on the «Isar-Insel» were opened. The Library and Archive were opened on 7th May 1932, followed by the Congress Buildings in 1935 . All these events, it will be noted, took place on the 7th of May, the birthday of the founder of the Deutsches Museum.

The Library is designed to act as a central service organ, holding the entire technical literature and publications in the natural sciences deemed to be of interest to individuals involved in research, from industry, and who are still studying, as well as company managers and their employees. Today, the Library's holdings extend to around 850,000 books and magazines.

The Library is purely for reference purposes. As a rule, publications may not be taken out of house. Some of the books and magazines may be consulted in the large reading room. Here, too, the emphasis is on providing access to all sections of society, including youth and ordinary working people.

Engineers and scientists from around the world are able to work here as well, receiving delivery of the requisite literature speedily and without any hitches.

The Archive is in essence a collection of original documents from the fields of natural sciences and technology. It holds manuscripts, literary estates, plans and technical drawings. From the early days, it was a key part of the original concept. Today, it is the largest archive of this sort in German-speaking territories.

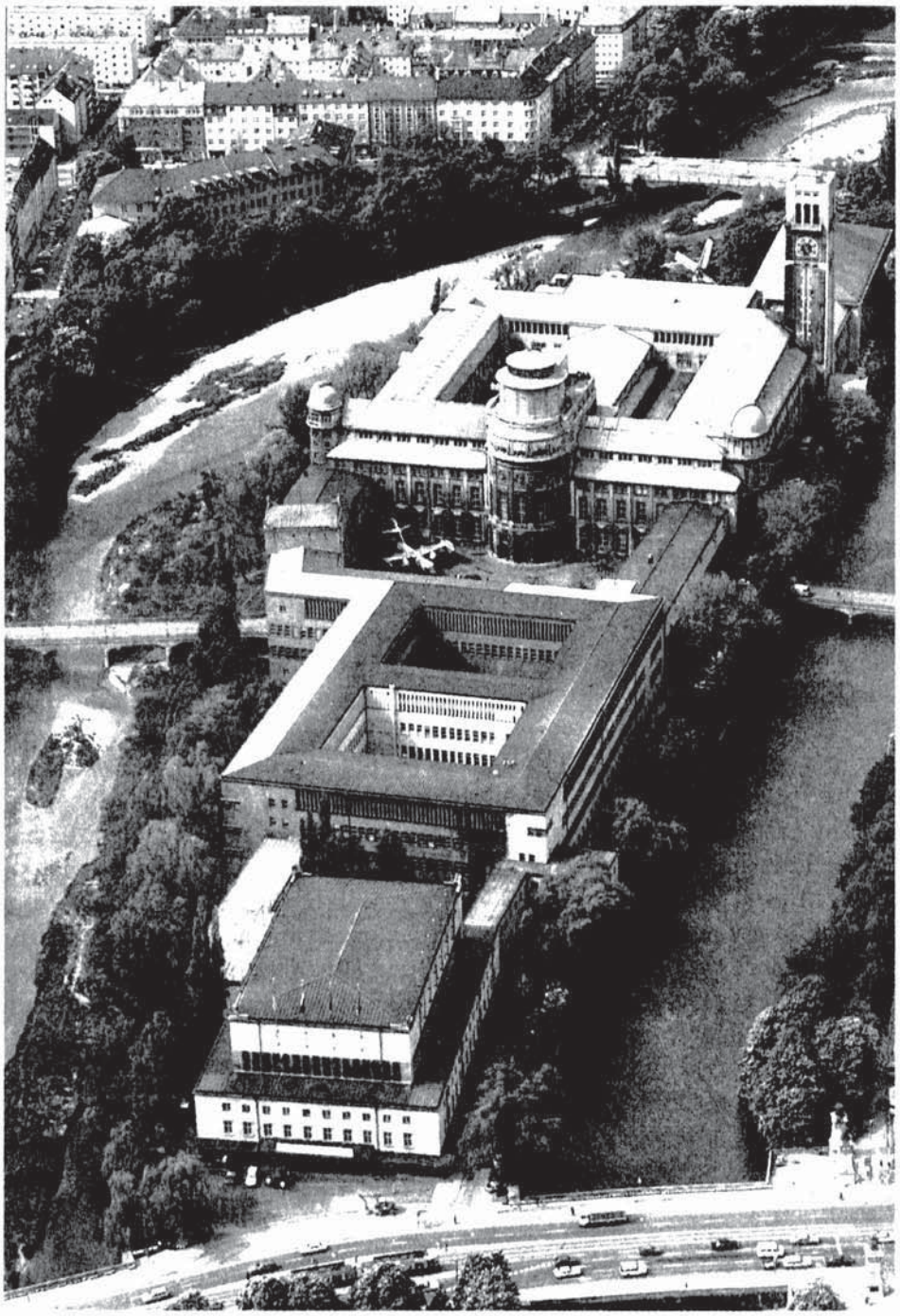

Figure 4. The Deutsches Museum: Collection / Exhibition (above), Library and Archive (center part), Congress Hall, now Forum der Technik (below).

The «Kongreßsaal» had seated 2400 people and opened its doors not only to scientific congresses, but was also one of Munich's most important concert halls, at least until the new Gasteig was opened in 1984. At the beginning of the 1990s, it was completely refurbished and opened again on 5th November 1992, albeit as a venue for alternative events. The hall is now divided into two spaces. It houses a modern planetarium with 269 seats, and an IMAX theatre with room for 329 people. The «Kongreßzentrum» is now known as the «Forum der Technik». It is run as a private business, is profit-oriented, but must adhere to the educational guidelines of the Deutsches Museum itself. This institution represents an early example of privatisation in the field of museums-a hotly debated subject but one of increasing relevance.

The underlying concept of the collections

The aims and tasks of the Deutsches Museum are set out in its constitution. According to §2.1:

«The avowed purpose of the Deutsches Museum is to carry out research into the historical development of the natural sciences, technology, and industry, to make apparent their cultural significance, and to document and render accessible their most important developmental stages in an educational and lively representational form with special emphasis on outstanding and exemplary key technological achievements.»

As to the «why and wherefore» pertaining to the exhibitions and their «target groups», accord had been struck early on: all sections of society should be addressed, especially youth and ordinary working individuals. Each exhibition must be easily comprehensible, vital and entertaining. The museum was to be a real place of education for the people. In order to reach these aims, no effort was too great and no expense spared.

At the core of each exhibition are —then as now— the milestones of technological development. Many of the most important examples of what may be seen as breakthroughs in the fields of natural sciences and technology were successfully secured for the house. These included the Magdeburg hemispheres, used by Otto von Guericke to prove the existence of a vacuum, the world's first automobile (built by Carl Benz), the first diesel engine, the first aircraft (by Otto Lilienthal), the first submarine (the U1), and many other masterpieces besides.

Most of these exhibits were contributed only too generously. The Deutsches Museum was soon enjoying a reputation as a true technological Mecca: to be represented in these hallowed halls was seen as a great honour.

Technical museums are confronted with a completely different problem to those concerned with art and applied arts. The latter institutions are attractive because of the aesthetic nature of the exhibits on display, their form and colours. Technical artefacts, on the other hand, are interesting because of their function and effect. The «packaging», or housing, of such items is rarely attractive; one just has to call to mind contemporary tools such as the ubiquitous personal computer. And also the costs and the amount of work needed to creating an exhibition about technology are much higher than a fine arts exhibition.

In order to put across to the visitor the way a particular exhibit functions, a completely new methodology had to be drawn up. The initial solution was a fully-functioning original; and efforts were made to employ one if at all possible. In cases where the historical significance of an invention forbade such a usage, replicas of working models were built. Some impressive demonstrations may be watched in the Hall of Power Machinery. Almost all power machinery —including the replica of James Watt's steam engine— is in use on a daily basis, in this case powered by compressed air or an electric engine and not by steam.

The question of displaying the inner workings of a machine was solved by removing encasing structures, and cutting away the housing of bearing and cylinders. If a machine was too large for the exhibition —and this is the case with many factory production units, furnaces, grinding machines, ships and aircraft— a model was built, one true to every last detail. And in order to place machines and technical instruments in their true historical context, i.e. the environment in which they actually operated, entire rooms were given over to life-size reproductions. The most spectacular example is the Mining Exhibition. Over a length of almost one kilometer, the visitor can walk along tunnels and peer into shafts. These underground caverns are full of the technology used to mine ores, coal and salt. Compressed air jacks are turned on, producing a deafening din. And the visitor begins to receive an impression of the conditions in which miners are forced to carry out their daily work.

Replicas of the laboratories of the alchemists, of Lavoisier and Justus von Liebig, demonstrate the apparatus and working methods of chemists. The experimental space-station SPACELAB has many original parts, and does much to inculcate an understanding of the experiments carried out by astronauts.

To see how technology functions in practice we must turn to the «dioramas» of the Deutsches Museum. These models are complex representations that harness the element of perspective in order to exemplify the three-dimensional aspect of a large area, such as hydraulic power stations in mountainous regions, a factory, or the lunar landing.

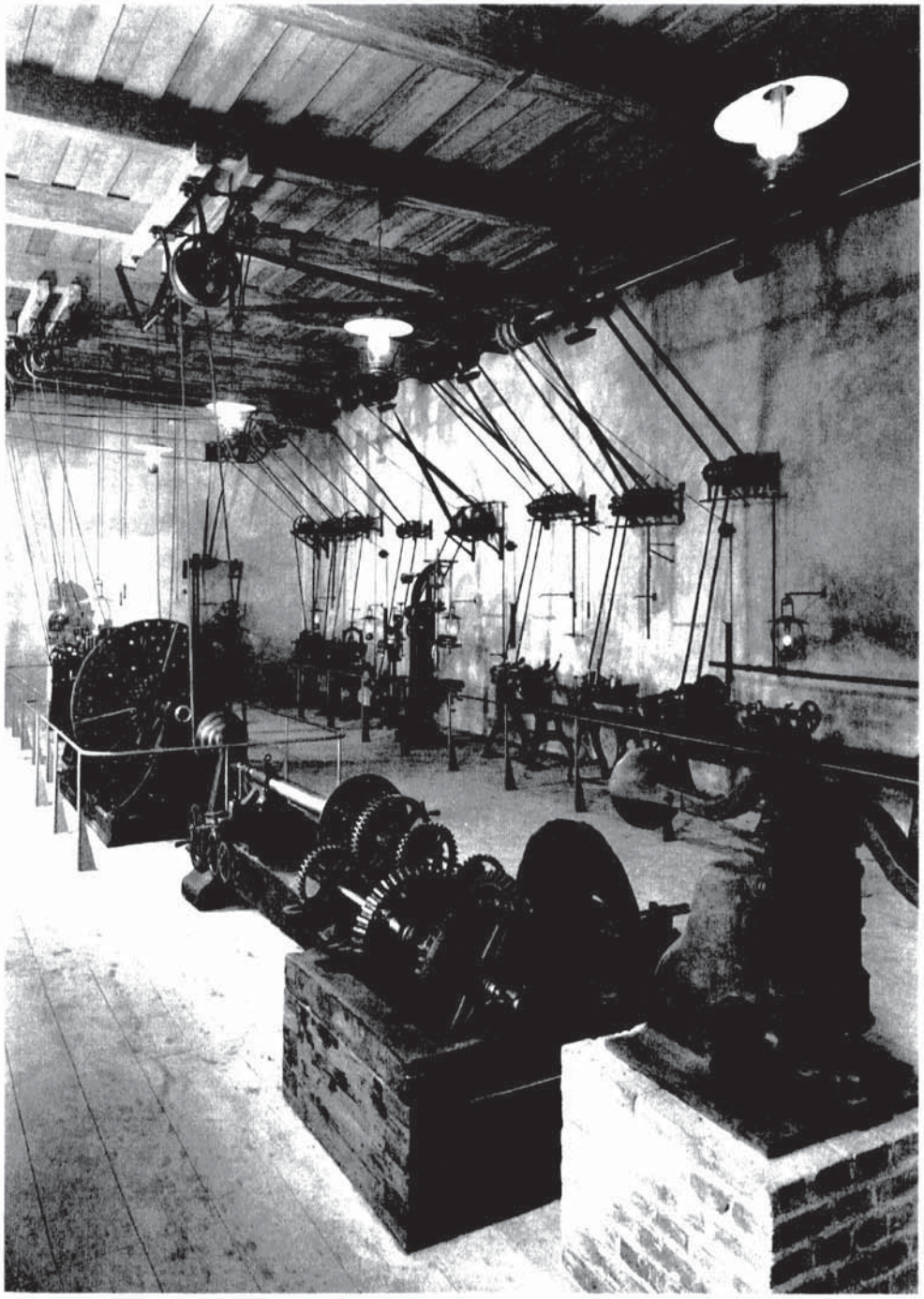

Figure 5. Workshop 19th century, all machine tools are in running condition and can be demostrated by museum staff.

During the first year of its existence, the Deutsches Museum received a major collection of scientific instruments from the Bavarian Academy of Science. They had mainly been employed in the fields of physics, chemistry, geodesy, mathematics, astronomy, and meteorology. It was not long before other institutes of higher education contributed instruments built by Fraunhofer, Reichenbach, Röntgen, Hertz, van't Hoff and Liebig.

Thus it was that the chance presented itself of depicting not only the historical development of the natural sciences as evinced by original instruments and apparatus, but also the phenomena identified in these scientific fields.

Two distinct paths may be traced that offered the visitor insight into these phenomena:

The visitor was able, at the touch of a button, to start an experiment and follow its course. Wherever possible, appropriate parameters could be chosen and the results studied.

The exhibition «custodians» offered daily guided tours at fixed times and explained to the visitors how various objects functioned. These custodians carried out demonstrations, and were in reality experienced scientific and technical personnel well versed in technical matters.

During the evenings, lectures were held and papers given in the Congress Building by renowned scientists, who reported on their recent research and developments in their chosen discipline. Although many a contribution verged on the extremely technical, the guest speakers had been invited because of their ability to capture an audience.

These principles have stood the test of time and remain valid today.

The exhibitions are organised in cooperation with many leading scientists and engineers. They contribute their knowledge with great enthusiasm, developing demonstrations and experiments, and helping acquire exhibits. This collaboration with research institutes and industrial companies was an important element in the working methodology of the Deutsches Museum and ensured its success. It brings with it not just advantages however. It is not hard to imagine that a key personality in a particular field of research, or a leading engineer, may judge the relevance and effectiveness of a particular subject or demonstration differently to an experienced staff member of the museum. It soon becomes quite difficult to find a compromise that meets the needs of the visitor. This problem often arises when working with important figures from industry, who often see in their support merely the aspect of advertising their particular area of activity or even a chance for their company to gain a better profile. At a directorial level, the museum needs to follow skilful negotiations, in order to maintain its reputation as a competent and independent institute of learning.

The choice of exhibition themes within the natural sciences and technology

In an opening address at the Annual General Meeting held on 20th June 1904, Oskar von Miller set out his criteria for choosing the areas of knowledge to be treated in the form of a collection or exhibition. According to him:

«Assuming that the very reason for a museum of this sort is to explain how research in the natural sciences has influenced technology, we must first come to terms with the so-called «exact» sciences, those of mathematics, physics and chemistry for example. The sciences that carry out a more descriptive as opposed to prescriptive role, such as botany or zoology already have pride of place in many museums of natural history and will only be included in our institution in as far as they have a direct bearing on technological development -the field of mineralogy comes to mind here. The choice of technical themes, on the other hand, is concentrated on those areas which are especially supported by scientific endeavour. Examples are heavy engineering, which draws strongly on the laws of mathematics and mechanics; electrical engineering, relying as it does on the laws of physics; the fields of technical acoustics and optics; hygiene, which incorporates a knowledge of chemistry as carried out in the chemical industries; printing and reproduction, and many others. We exclude here the area of the arts, whose products are not based on natural scientific laws but are generated for aesthetic reasons.»

Despite all these riders, around 40 separate fields of scientific and technical knowledge remained: from mining to astronomy, from marine technology to industrial chemistry.

As science and technology and the museum continued to develop, certain subject areas were dropped in favor of new ones like atomic physics and new energy technology, computer science and microelectronics, astronautics and environment technology.

In future more disciplines of life sciences will be taken into account.

Criticisms of the concept

Leaving aside for the moment that the areas of municipal hygiene and physiology were missing, a leading figure was to levy some intense criticism: this person was Alois Riedler, the Rektor of the Technische Hochschule Berlin-Charlottenburg. For him, the planned collections were

oriented too much towards technical and scientific progress, a fact that, according to Riedler, did not necessarily guarantee that such developments could be evaluated properly. As he stated:

«At the end of the day, all machines, apparatus, bridges and instruments, and everything that they are capable of presenting within their own systems, remain merely tools of technology. The inner world of their development is never or only rarely opened up, because the depiction of their effect on technology is itself missing either completely or to a large degree. The most important thing is the broad effect such a tool has, not its narrow technical contribution.»

Of course, all scientific and technical inventions can only be properly understood within their own historical context. Not only must the industrial conditions first influenced by technological change be analysed, but also the needs which lay behind these developments. Finally:

«A technical museum must act as point of collection for the representation of the true history of mankind and the human community.»

These critical views still echo around the halls of the Deutsches Museum today. Time and again this hallowed institution is accused of reducing one exhibition or another to the story of technological progress and failing to show the effects on society.

Then as today, this criticism is not rejected out of hand, and the difficulties have been noted:

The need for a completely new concept
Extensive studies aimed at researching societal effects
Problems of presenting exhibits and exhibitions

Oskar von Miller remained true to his ideas. They were simple and capable of realisation under the circumstances that prevailed.

Today, an exhibition such as «The Environment-Mankind and Technology on the Planet Earth» has adopted very much a holistic approach, being concerned with the effects of technology. In the future, the «non-technological» aspects of technology will be dealt with at an early stage of exhibition planning.

Exhibiting is not enough-collecting and maintenance of exhibits remains paramount

The exhibiting of machines, technical apparatus and scientific instruments and the presentation of their workings and effects remained

the greatest aim of the first few decades. The enthusiasm and cooperation of individuals involved in research, engineers and key industrial personalities was successfully harnessed. The populace was just as excited. In the first few years —during which the exhibitions were still very provisional— between 200,000 and 300,000 visitors came annually. The Deutsches Museum was soon the most frequently visited museum in Germany. After the official opening in 1925, over 1 million people came to the museum each year, the highpoint being reached in 1984 with a total of 1.5 million visitors. Today, the figure is around 1.2 million annually.

From the very beginning, the aim was to collect «masterworks» of technology. Exactly how such a masterpiece is to be defined remains unclear. Brilliant processes of manufacture or scientific discoveries are not necessarily bound up with a masterwork. During the first decades, collecting activities were generally directed to identifying suitable objects for an exhibition, ones that would illuminate the field concerned. Additional holdings for exhibits that were not on display were not originally planned. But the march of technological progress is swift, and important historical artefacts cannot simply be thrown away when they are no longer required in the exhibition. Each year, the number of «collectibles» grows within every field of knowledge in museums around the world.

Thus arises the simple problem of space. Every technical museum is confronted with this issue and it remains a bone of contention for the Deutsches Museum even today. Sufficient storage space is a necessity and must sometimes be rented. The branch museum at Oberschleißheim is a good example of this policy -the lower ground floor is used entirely as a depot. Keeping an object for an unspecified length of time requires conservation and restoration. The rule used to be that the closer an artefact could be brought to its original state and the more it gleamed —just like new as it were— the better the restoration must have been. The growing awareness that restoration does not necessarily mean the recreation of the object in new condition, but an attempt to fix in time the scars gathered by an historical artefact, only developed much later, actually only over the last few decades. Today, the Deutsches Museum can count on the services of a number of specialised workshops, ones active in the fields of musical instruments, automobiles, engines, as well as mechanical and aeronautical instruments. Cutting away the housing of a large exhibit is generally no longer acceptable.

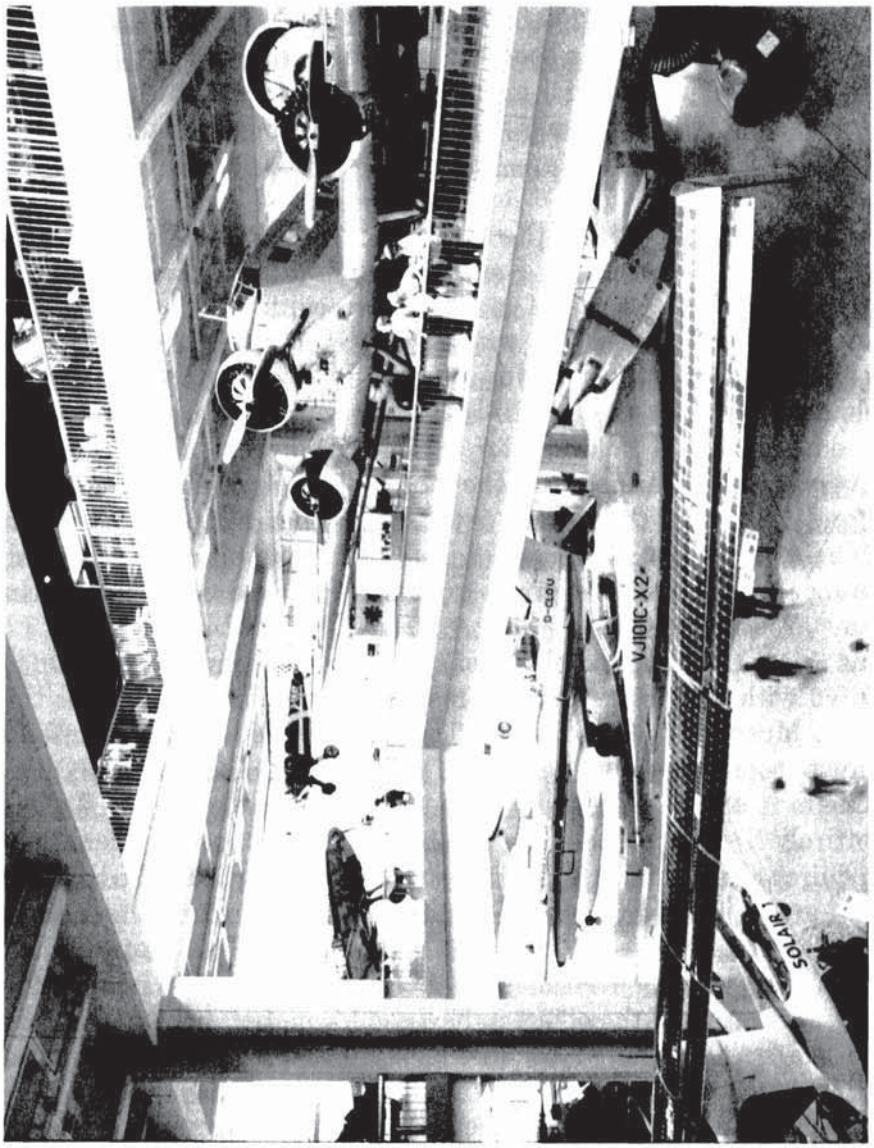

Figure 6. Hall of Aeronautics with airplanes of the jet era

From the opening of the museum to its destruction-the Deutsches Museum in the Third Reich

Oskar von Miller had taken great pains to ensure the political neutrality of the museum, but after Adolf Hitler assumed power on 30th January 1933, this became increasingly difficult. Miller resigned his post on 31st March that year, stating reasons of age. In reality, he wished to cause no harm to the museum which might arise out of his increasingly outspoken views on the national socialists. His successor as General Director was the renowned physicist Jonathan Zenneck, who attempted to steer a course between alignment and distance. He was not able to prevent exhibitions such as «Der ewige Jude» (The Eternal Jew) from being held or from party officials taking a place on the boards of trustees. Although the state kept the museum on a tight financial reign, the planned Kongreßsaal was duly completed in 1935 and, as the only new building of this era, the Hall of Powered Vehicles built and opened in 1938. Throughout 1944 and 1945 the buildings of the Deutsches Museum — which up to now had been spared damage— were almost 80% destroyed, with 20% of the exhibits being lost.

Milestones along the way

The development of the Deutsches Museum

5th May 1903	Oskar von Miller presents his plans to a circle of influential figures.
28th June 1903	Special constitutional meeting of the Society «Museum of masterworks of the science and technology».
12th Nov. 1906	Opening of a provisional exhibition in the former Nationalmuseum over an exhibition area of almost 9000 m^2.
13th Nov. 1906	Foundation stone laid for new museum buildings on the Isar-Insel. Further, provisional exhibitions opened in the Isar-Kaserne.
5th Oct. 1911	Dedication of the building. Official opening of new buildings set for 1915.
1914-1918	First World War. Temporary cessation of works.
7th May 1925	Exhibition Building opened with over 23,000 m^2 of exhibition space. Over 1 million visitors annually. Pictures of the opening taken.

7th May 1932	Library Building opened.
7th May 1935	Congress Hall opened.
7th May 1938	Hall of Automobiles opened.
1944-1945	Almost 80% of the buildings destroyed by bombing, 20% of the exhibits lost.
By 1948	Library, Congress Hall and the first new departments of the museum reopened.
From 1948	Each year, new departments are opened in fully modernised form.
1 July 1963	Research Institute for the History of the Sciences and Technology founded.
1965	The museum reaches its pre-war state and continues to expand.
25th Nov. 1976	Foundation of the Kerschensteiner Kolleg, where continuation courses for multiplicators —teachers and instructors— are held.
1977	The magazine «Kultur und Technik» goes to print. All members of the Deutsches Museum —currently around 15,000— receive free subscription.
6th May 1984	Aeronautics and Astronautics Hall opened.
12th Sept. 1992	Branch opened at Oberschleißheim, near Munich. Known as the «FlugwerftSchleißheim», it is dedicated to aeronautics and astronautics. Extensive storage spaceand restoration workshops also fitted out.
5th Nov. 1992	The Congress complex reopened as the «Forum der Technik» IMAX Theatre and with an planetarium. Official opening at the end of 1993.
3rd Nov. 1995	New branch opened at Bonn. The Deutsches Museum Bonn comprises over 1400 m^2 exhibition space. Subject areas limited to the scientific developments and technical achieve ment in Germany post-1945.
5th Dec. 1997	Unification of the Research Institute for the History of the Natural Sciences and Technology and all three of Munich's universities: the Ludwig-Maximillians-Universität, the Technische Universität and the Universität der Bundeswehr.

9th May 1999	Historic exhibition halls handed over to the Deutsches Museum. A branch museum for transportation is planned.

3. The Present-Developments over the last decade

Keeping pace with scientific and technical advances

Over the last decades, the Deutsches Museum has continued to expand at roughly the same rate as the post-war phase or reconstruction. It was important to keep pace with scientific and technical developments. New areas of collection have been addressed and fields such as astronautics, atomis physics an paticle physics explored. In 1984 the new. Exhibition of Aeronautics and Astronautics was opened in its new building with almost 7000 m^2 floor space and directly adjoining the main one. Another branch museum was opened in 1992: the Aeronautical Museum «Flugwerft Schleißheim». Also extending over an area of 7000 m^2, it is located on an historical airfield on the outskirts of Munich, but one that is still active. Thus, the Deutsches Museum fulfils the joint roles of a national museum of aeronautics and astronautics, comparable perhaps to the Air and Space Museum in the USA.

Most existing departments have since been completely renovated, both regarding the existing exhibits and their architectural layout. The question of content, and the limited space available, led to many a favourite exhibit or diorama being sacrificed in order to present a field of knowledge in a contemporaneous way. The interior design of many rooms has also changed over the years. In the 1960s, architects would black out the windows, thus achieving certain desired lighting effects. By the 1980s, windows let in so much natural light that some exhibits had to be protected from the effects of the sun. This change of policy was initiated from a directorial level. In view of the amount of technical appliances and equipment in the museum, there seemed to be a longing for natural light, in the belief that constant contact to the outside world would prove a salutary experience. The museum is located on an island, and the outstanding views from many of the exhibition rooms remind us of our natural surroundings.

The confrontation with technological advance and historical research

In connection with the display of military aircraft in the Aeronautics Exhibition and whilst planning to include representations of atomic power stations in the exhibition of New Energy Technologies, the muse-

um became the focus of heated public discussion. Critical voices were raised —those of the peace movement for example— and the Deutsches Museum was accused of promulgating just the achievements of technology at the cost of negative or even dangerous aspects being addressed. On the other hand, some representatives of industry started to believe that a number of scientific curators were developing a too critical position on technical progress. What emerged was that the Deutsches Museum could easily land between the devil and the deep blue sea when propounding its views on controversial issues. One soon realised that when expressing beliefs on these subjects it was first necessary to carry out detailed research and to prepare carefully any written responses. An editorial department was called into existence. It was to formulate the museum's answers to these questions in a comprehensible way and one based on a secure scientific foundation. Quality had become the watchword. Rules for the production of what were essentially press releases were drawn up according to the latest research into the field of sociological communication. Once again, it became clear that when planning a collection, detailed and wide-ranging historical research was indispensable. Only thus could the Deutsches Museum aspire to intellectual competence.

As early as 1963 the museum had concerned itself with historical research, founding three research institutes on the «Museumsinsel». One came under the auspices of the Ludwig-Maximillians-Universität München, one under the Technische Universität München, and one formed part of the Deutsches Museum itself. In the 1990s the research capacities of the museum were extended, albeit not to the level desired, as the institution was forced to shed personnel. In 1997 a further step was taken, all the relevant institutes of Munich's higher education bodies deciding to form a central research organisation: the Münchner Zentrum für Wissenschafts- und Technikgeschichte. Along with the rich holdings of the Library and the Archive, it has grown into one of the world's most productive and prestigious research institutes.

The Deutsches Museum's constant aim is to build each new exhibition from a solid scientific base, whilst ensuring that ease of comprehension and a degree of entertainment offered by a «science centre» is not lost. Such centres sprung up around the world towards the end of the 1960s. Their aim was to encourage amongst young people an enthusiasm for science and technology, without assuming an understanding of or placing any value on the acquisition of expert knowledge pertaining to scientific and technical developments. History and historical artefacts never belonged in these science centres. And although they did not steal

visitors from the museums, these centres were eagerly compared —often critically— with the more august institutions. After all, a science centre apparently offered a much simpler explanation of complex phenomena, and laced it with a degree of fun.

Lecture series offer a chance for dialogue

It was not only through exhibitions, but also with the help of lecture series that the Deutsches Museum opened up an opportunity for critical public debate. Many controversial subjects were covered, including contraception, organ transplantation, and climatic change. In the lecture series «Science for everyone», papers were read by many a prominent scientist. The lectures and discussion offered a much better opportunity to discuss difficult and hotly debated issues than exhibitions and guided tours. They enjoy immense popularity.

Instructing those acting as multipliers of information-The work of the Kerschensteiner Kolleg

An important addition to the educational work of the museum was the Kerschensteiner Kolleg, founded in 1976. Courses for the so-called multipliers of information —teachers, instructors and trainers— are offered here. Each participant lives for one week at the «college», attends lectures on the history of the natural sciences and technology, receives instruction in related didactic issues, and studies intensively the exhibitions and collections. At the end of this time, these individuals are considered capable of acting as multipliers of information, passing on their understanding and knowledge to their own students.

The branch museum-specialised subjects come into their own

As mentioned above, the first branch museum was dedicated to aeronautics and astronautics (Figure 7). It was completed in 1992 on the oldest existing airfield in Bavaria and comprises a number of historical hangars and a new hall. It was christened Deutsches Museum-Flugwerft Schleißheim.

A small but fascinating museum was built in the 1990s in the then capital of Germany, Bonn. With over 1400 m^2 of exhibition space it covers technical and scientific developments in Germany after 1945. The opening of this museum also makes apparent that the Deutsches Museum is not just a Bavarian museum, but a national one, too.

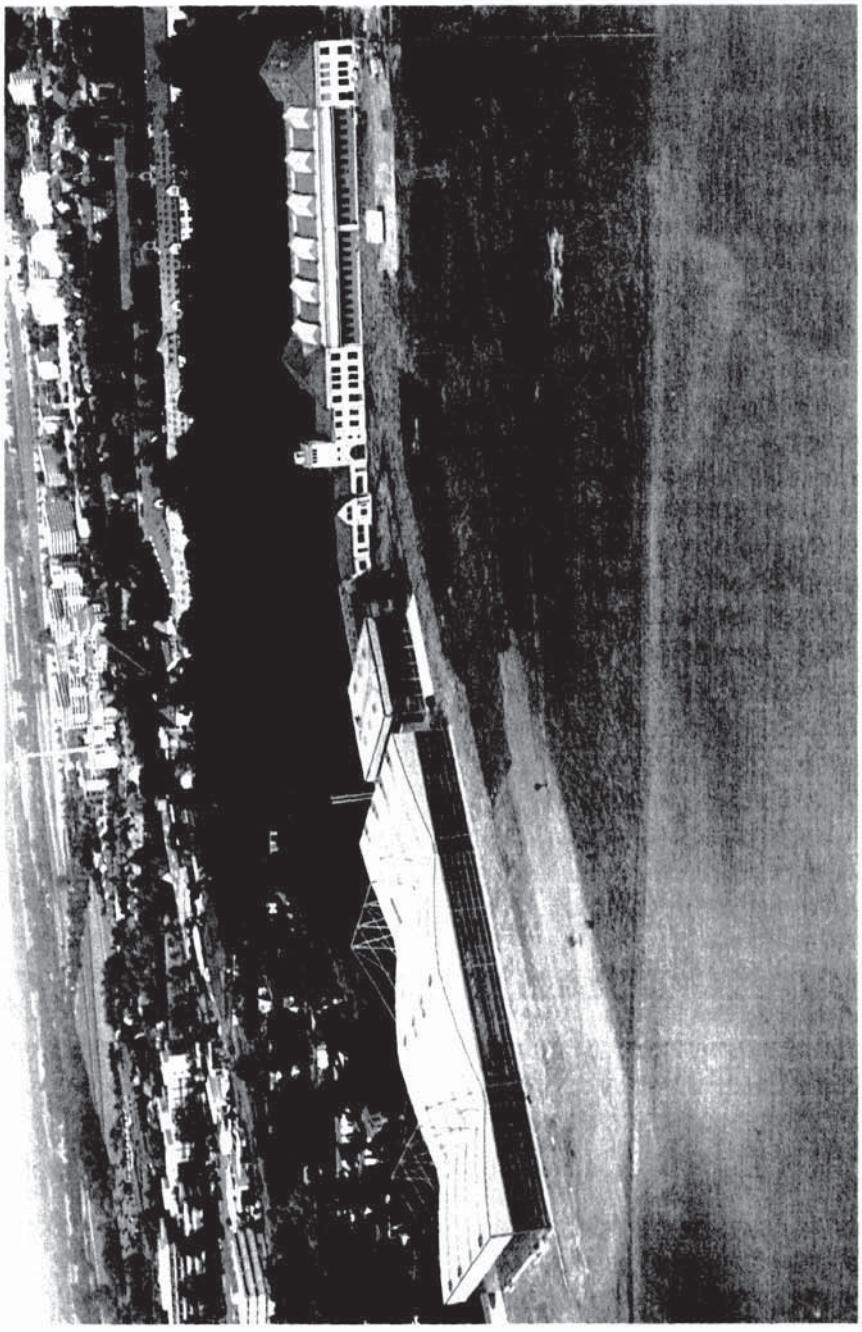

Figure 7. The branch museum or aeronautics in Oberschleßheim, with restauration workshop (middle part) and storage area (underground floor).

A new branch will open in the future in the city of Munich itself. Three halls of historic importance that used to house the city's exhibition centre, the «Münchner Messe», became available after the decision was taken to relocate the new trade and exhibition buildings on the outskirts of the city. Land transportation is the theme of this new museum, to be called the Deutsches Museum/Verkehrszentrum, and many of the vehicles currently in the main building will soon find a new home. This will free up space in the complex of buildings on the Museumsinsel for exhibitions on new technologies. The Deutsches Museum/Verkehrszentrum is the greatest single undertaking since the original museum was built. It will require great demands on financial resources and the personnel of the Deutsches Museum for a while to come, arriving as the project does during a time of financial and budgetary constraints.

4. The future of the Deutsches Museum-Moving into the millennium

Education and training

As the present century draws to a close, we are already looking forward to the 100th anniversary of the Deutsches Museum, which falls in 2003. But to disregard such historical dates for a moment (ones that require long-term planning and financing), it is the upheavals caused by science and technology with which a museum of technology must increasingly concern itself.

On one hand, it is humanity that profits from scientific and technological progress -one just has to consider the recent developments in the field of medicine, or the possibilities offered by information and communication technologies, or even personal mobility; whilst on the other, we are confronted with the threatening consequences of our actions, ones that have recently taken on increasingly global dimensions. The pressure on the environment along with diminishing energy resources and amounts of raw materials, caused by profligate use by the industrialised nations, is today felt by all, even those not directly involved in conspicuous consumption. The unrelenting exploitation of information through technology, coupled with the enhanced mobility made possible by the aircraft, only support the globalisation of economic systems and help individuals in one part of the world to achieve wealth while simultaneously causing unemployment in other global regions. This issue has itself produced a mountain of literature, one that threatens to become a landslide in the next century.

Whilst science and technology have undoubtedly helped create the turbulence mentioned above, the truism remains that they are vital to solve new problems. Certainly, a culture must be created that aims at avoiding problems as well as solving them, and one in which politicians and industrialists are called to responsible and sensible action. The documentation relating to Agenda 21 is more than sufficient. A sensible and sensitive relationship to the new technologies demands an informed, educated society-one which is interested and willing to participate in a democratic decision making process. The broad aims of education will thus take on an ever increasing significance; it is in this area in which scientific and technical museums offer a unique potential. Where can one find such a level of professional competence, experience, relevant exhibits and the necessary channels of communication? An audience of millions is out there to be reached.

How should a museum structure itself and adapt to change in order to fulfil these tasks in the future? There are no clear and simple answers, except to admit that openness is called for, as is the desire to try out the many possibilities and to react with alacrity and a degree of fantasy to events and developments. The tried and tested methods that have ensured the Deutsches Museum's position in history will still be implemented in the future, just as will various newer strategies first introduced in science centres. If one could sum up the work of the Deutsches Museum and other museums of technology in a single word, it would be «development». This was true for the Deutsches Museum in the past and remains true for the future.

Other mottoes come to mind - ones that help point out the directions the museum might take in its next phase.

Inter-relatedness of subject areas within an exhibition

Permanent exhibitions and important historical artefacts will remain at the core of the museums brief. The underlying concept of these exhibitions will however certainly concentrate on the mutual influences of science, technology and industry on the one hand, and societal-cultural developments on the other. The boundaries between classical technical areas will disappear, making way for interdisciplinary fields of technology.

To take one example: the former areas of expert knowledge relating to telephony, radio, television, computer science, data processing soon became integrated into information and communication technology; and the areas of ship building, aeronautics, road and rail transportation were eventually subsumed under transport technology. The same process took place within the natural sciences-physics, chemistry and biology. Here, too, it

was the border areas of these disciplines in which progress was measured. And new strategies are developed to include societal issues through art.

All these trends now have to be incorporated into the exhibitions. A prime example is provided by the new exhibition «Pharmacy». The mutual influence of physics, chemistry, biology, technology, industry and health-care is explored in detail and the aims of disease prevention and control become clear to the visitor. The exhibition will open in May 2000 and for the first time, the so-called «Life Sciences» form the focus of the Deutsches Museum's work. Just as the fields of atomic physics and space exploration brought about in the Twentieth Century a fundamental change in our understanding of the nature of material, and our planet, so it will be the turn in the Twenty-first Century of biological sciences to influence our thinking about life in general and the environment in particular.

Special (temporary) exhibitions cover knowledge in depth

Up to now, special exhibitions have not played a major role in the activities of the Deutsches Museum. This is to change soon. They offer the chance for specialised scientific and technical subjects from science and technology to be covered in depth. In Autumn 1999 a touring exhibition on pioneering methods of imaging in medicine was opened, which was designed and built by Deutsches Museum personnel in collaboration with clinics, research institutes and industry. Such touring exhibitions help increase the visibility of the museum, extending its outreach to the population. By the way this exhibition is a precursor to the planned permanent exhibition «Mankind —Technology— Health».

Technology for children

Children of pre-school age have, up to now, rarely had the chance of benefiting from «standing exhibitions», although research has shown that children should be exposed to technological matters at a very early age, not in order to inculcate a blind belief in the benefits of technology, but to encourage a critical understanding of technical progress, and one not coloured by fear. An exhibition dealing with technology and young people is currently in the planning stage.

Service orientation increases despite budgetary constraints

Just as with all state-run cultural institutions, the Deutsches Museum has to reckon occasionally with cuts to its budget and personnel, also

having to take on board modern management methods. New exhibitions are planned and built up by teams of curators, coming from different disciplines bringing in a widespread experience and knowledge, the internal cooperation is thus forced to be improve.

To keep the exhibitions open to the public, although staff personnel has to be reduced, many volunteers, mostly retired engineers, have already been engaged.

Market and service oriented approaches must be adopted even when state support is shrinking. Internal initiatives must generate income. Renting some of the more attractive halls for receptions and events is just one example. The collecting of historical objects is only possible if strict criteria are met, as the holdings for objects not displayed can not be extended indefinitely. Cooperation with other institutions and museums at home and abroad is a central issue and has been followed with great success to date.

Over the last few years, a close cooperation in the area of object-oriented research has been built up with the Science Museum in London and the Smithsonian Institution in Washington. Some Paris museums have now entered this collaborative network. The cooperation between European science centres and museums is also on the right track. The General Director of the Deutsches Museum is currently President of EC-SITE (European Collaborative of Science, Industry and Technology Exhibitions) and is forcing through joint projects in order to incorporate specialised experience and save costs. The project «Chemistry for Life» was promulgated by 16 separate institutions which developed demonstrations on special phenomena, ideas that may be copied by any organisation wishing to open an exhibition on chemistry. An especially close and harmonious relationship, by the way, has been built up with the Museum of Science in Barcelona.

It is also important to attempt to find concord in discord. Thus it was that a management consultancy (one generally known for recommending cuts in personnel) identified a critical insufficiency of staffing levels, especially in the field of marketing. The scientific committee set the task by the Federal Government of examining the quality of scientific research also pointed out the severe lack of scientific personnel, recommending that 12 new employees be added to the staff. The problem is obvious: on one hand our marketing activities must be enhanced in order to raise visitors' numbers and generate income; on the other, the quality and quantity of research has to be improved, so that the Federal Government does not reduce or cancel its 30% contribution to the Deutsches Museum's budget, a financial grant made on the basis of the museum's stature as a research institution of national importance.

But it is research and the intense focus of scientific personnel on the developments in science, technology and within society that unavoidably remains the credo of the museum. These facets of the museum's own nature point up its competence and guarantee its authority, helping this institution of learning to be taken seriously and ensuring that even the non-specialist will achieve orientation within a field of knowledge.

As the Twenty-first century dawns, and the 100th anniversary of the foundation of the Deutsches Museum draws near, we are called to take on tasks of monumental proportions. A new branch museum with 10,000 m^2 must be built; permanent exhibitions relating to new subjects mounted on the «Museumsinsel», and existing exhibitions brought up to date. This, despite dwindling financial resources.

The directorate and staff at the Deutsches Museum are certain that these tasks will be fulfilled to the best of their abilities, even if the results do not always match with original intentions. The museum has survived some difficult times in the Twentieth century; it was the sympathy and support of thousands of people involved in science and technology which helped it through. They were there at its foundation and were present also during the several phases of reconstruction after the terrible damage the house suffered in the Second World War. We are sure that we can rely in the future on the support of such good friends.

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