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température extrêmes dans des régions également extêmes qui, avec leurs déserts de sable et de pierre, sans arbres, forment des environnements hostiles à l'homme. Une fusion du monde extérieur et intérieur est évitée consciemment. Le mur extérieur représente un rempart massif de protection contre la chaleur, la lumière aveuglante et les vents de sable. Il est muni d'ouvertures minimales qui servent surtout à l'aération. Cette fermeture vers l'extérieur est compensée par l'ouverture vers l'intérieur, vers la cour qui devient un paysage artificiel et rafraîchissant.
Cette cour intérieure représente un élément spatial caractéristique des constructions dans les pays chauds. La compression des bâtiments jusqu'à des formes extrêmes joue aussi un grand rôle. La colonisation du 19ème siècle a apporté une architecture occidentale négligeant totalement les données climatiques. Ces influences de la culture et de la civilisation occidentales ont eu des conséquences fatales sur le développement architectural et urbanistique dans les pays coloniaux d'Afrique, d'Asie et d'Amérique du Sud.

La construction d'écoles à Kowait

Ce pays qui est le royaume d'un Cheik, est situé dans le Golfe persique, en marge du désert d'Arabie séoudite. Il occupe une position particulière parmi les pays chauds. Sur 16 000 m² (sans la «zone neutre»), habitent approximativement 400 000 personnes dont la plus grande partie se trouve dans la capitale. Cette situation spéciale, Kowait la doit à ses gigantesques gisements de pétrole qui apportent une richesse colossale au pays. En plus, le gouvernement démocratique des cheiks a une attitude très ouverte et moderne. Tous les services sociaux sont gratuits. Il n'y a pas d'impôts. La construction d'écoles bénéficie également d'une aide considérable de l'état. Au cours des dernières années, beaucoup de bâtiments scolaires (des écoles primaires et secondaires et des écoles commerciales) ont été construits. D'autres suivront dans un proche avenir ainsi qu'une université. L'attitude positive du gouvernement s'est concrétisée par le désir exprimé il y a 2 ans de faire examiner les écoles déjà construites par un expert. Ses conclusions permettraient d'effectuer d'éventuelles améliorations et d'éviter, à l'avenir, des erreurs. Le choix de l'expert tomba sur l'auteur de ce texte. En octobre 1965, je me rendis donc à Kowait pour visiter, pendant quelques jours plusieurs bâtiments scolaires. Dans un rapport détaillé, je donnai mes impressions et critiques et fis également des propositions pour les futures constructions. Dans presque tous les cas, on n'avait pas assez tenu compte des conditions climatiques. Une année plus tard, je reçus l'ordre d'édifier des plans d'une école secondaire pour jeunes filles. Il s'agit ici d'un bâtiment fermé avec cours intérieures. locaux sont fermés vers l'extérieur. L'étage supérieur est occupé par 24 salles de classe tandis que le rez-de-chaussée abrite de nombreux locaux spéciaux, par exemple 2 auditoriums scientifiques, 3 laboratoires, une bibliothèques, 1 salle de musique, etc. A l'est du terrain, nous avons les appartements pour 48 institutrices. La constructions consiste en éléments préfabriqués en béton armé. Une série de bâtiments scolaires sera désormais construite d'après ce système d'éléments préfabriqués.

R. Buckminster Fuller, New York
Fuller and Sadao, Inc.
Cambridge Seven Associates, Inc.

Expo de Montréal, Pavillon des Etats-Unis

(Pages 399–406)

Le pavillon des Etats-Unis est un dôme géodésique dont la sphère mesure 76,25 m de diamètre et s'élève à 61 m de hauteur. Ce dôme a un volume de 190.000 m³ et une surface de 13.600 m². La forme de l'appareil porteur spatial est le résultat d'un programme détaillé de recherches et d'améliorations en vue d'obtenir un appareil porteur léger avec une entrave visuelle minimale.
Dans ses constructions légères, Buckminster Fuller a mis au point un filet en métal tendu sur de longues distances et qui paraît peu pesant devant un arrière-plan de nuages et de ciel.
La charpente constructive est un appareil porteur spatial sphérique soudé en tubes d'acier. Le dôme est fermé au moyen d une peau transparente en résine acrylique formée de 1.900 panneaux. Ces panneaux sont jusqu'à présent les plus grands jamais fabriqués avec ce matériel. Ils mesurent 3,05×3,66 m. Dans la zone du sommet du dôme, il y a 250 panneaux munis d'ouvertures de 61 cm pour l'aération. Sur le côté intérieur de la peau du dôme, nous trouvons 4.700 parasoleils triangulaires en tissu revêtus d'aluminium pour protéger les plates-formes des rayons du soleil. 18 parasoleils triangulaires forment chaque fois des unités qui s'ouvrent et se ferment grâce à 261 moteurs réglés par un programme de bandes perforées. Il existe 6 programmes quotidient de base pour assurer le déroulement de l'exposition. Dans chaque programme, la disposition des parasoleils change toutes les 20 minutes. Cela permet une adaptation à la position du soleil. La combinaison de la peau acrylique transparente avec parasoleils triangulaires permet un réglage idéal du climat intérieur du dôme. Le contact visuel avec le monde extérieur n'est pas dérangé; en effet, le soleil, la lune, le paysage et le ciel demeurent parfaitement visibles. Mais les effets désagréables du climat, comme la chaleur, la poussière, les insectes, l'éblouissement, etc., sont retenus par la peau. L'intérieur du dôme est un véritable «Jardin d'Eden».
Ce pavillon peut être considéré comme le prototype d'une construction dont le volume est suffisant pour permettre aux générations futures une vie agréable dans un microcosme physique adéquat malgré un environnement parfois hostile. Ainsi, l'homme pourrait créer des agglomérations urbaines dans l'Artique, par exemple, ou installer des communautés entières sur la lune.
Le dôme est approximativement une sphère formée aux trois-quarts. Elle est construite comme appareil porteur spatial à deux couches. Il y a 3 différents membres qui composent l'appareil porteur: la couche extérieure, la couche intérieure et la couche intermédiaire pour la liaison des couches extérieure et intérieure.
Les tubes sont reliées au moyen de nœuds en acier fondu. Chaque nœud consiste en un noyau d'acier cylindrique massif avec des profils de raccord rectangulaires pour la liaison des barres. Il y a environ 5.900 nœuds intérieurs et extérieurs. La géométrie de la construction exigeait 83 variations de nœuds, 43 à l'intérieur et 39 à l'extérieur. Sur le chantier, les tubes ont été reliés aux nœuds en soudant les profils des raccords aux extrémités des tubes. L'acier pèse environ 53 kg/m² de la surface du dôme; les tubes pèsent 600 tonnes, les nœuds 120 t.
Le système de chemins de fer à voie étroite qui assure le transport des visiteurs à travers toute la superficie de l'exposition traverse le pavillon des Etats-Unis et débouche sur une de ses plates-formes principales.
Le système d'aération, de chauffage et de climatisation est automatique.

Summary

Gerold Becker, Göttingen

A new school construction

(Pages 367–372)

During the last 2 years the problems of primary schooling have become very timely in West Germany. The "world of tomorrow" will transform our life totally. Nevertheless, it demands, starting now, new schools. It is up to the educational sciences to explore and to define the necessary transformations which will affect the different disciplines, the teaching programs, teaching methods, the duration of the school day as well as school organization. We need new schools and, above all, different schools. In West Germany, 45 billion DM have been allotted for the construction of schools over the next 10 years. These enormous investments are calling for a serious examination of the problem. It has to be recognized that our public schools are greatly in need of being readapted to modern circumstances. For the future, it is necessary to build schools which are easy to transform and to adapt to new needs, schools to which can be added new classrooms without any difficulty and without damaging the architectural unity of the school complex.

A. Barth, H. Zaugg, Schönenwerd

Upper Primary School at Frauenfeld

(Pages 373–376)

This upper primary school, which will be inaugurated in the near future, includes Grades 7 to 9, the latter being optional. The school is reserved for less gifted pupils, and its activity is parallel to that of a secondary school. The envisaged 500 pupils will be grouped in mixed classes of 24, girls and boys. In addition to theoretical subjects, there will also be manual disciplines. Moreover, there will be a great deal of work in groups. This school will present, for the Canton, a unique solution as regards construction costs and technical resources utilized.
The spatial program comprises, in addition to classrooms and large utility rooms, workshops (wood and metal) for the boys, domestic science and handicrafts rooms for the girls, a music room, a teachers' room, the library and a gymnasium with changing-rooms.
It was necessary for the construction to guarantee a high degree of flexibility in the utilization of the rooms, for the teaching methods can vary enormously from one subject to another and from one teacher to another. In the case of this school, we find the conditions obtaining at the construction of industrial buildings. The volume and the design of the building lend themselves perfectly to later alterations.
The spatial program for the classrooms has been divided into 4 surfaces. On the basement level, there are exhibition rooms and storerooms; the ground floor accommodates the utility rooms and the handicrafts shops, and the upper floors are reserved for classrooms. The gymnasium is connected to the school by way of underground cloakrooms. The workshops have been installed in a separate building which can be easily enlarged.
The areas available can be adapted to different needs arising in connection with the various types of instruction, by means of movable partitions. A classroom, for example, which is twice as large in area as the conventional classroom, can be divided, as desired, by means of movable furnishings. Every modification in the plan of instruction entails an adaptation of the room involved. This new way of building and of distributing rooms opens up an unprecedented path of development for rationalized buildings composed of prefabricated elements.

Typical case: "Osterburken semi-boarding secondary school"

(Pages 377–380)

Within the scoppe of the planning program for education and school construction in Baden-Württemberg, the building of secondary-level boarding-schools is assuming ever growing importance. The aim is to prevent the decline now to be noted in education for certain social classes in this region. New sociological factors are reinforcing the demand for the construction of semi-boarding secondary schools. To create such schools, there is need for new teaching methods and school reforms. The Institute for school construction of the Institute of Technology in Stuttgart has been called on, by the Ministry of Education of the Land of Baden-Württemberg, to examine, in association with a group of planners and educationists, the new pedagogic and architectural aspects of a semi-boarding secondary school with the aid of the model of the Osterburken school.
The realization of this project (a school in operation throughout the day) will permit the application of new educational, instructional and organizational procedures. The semi-boarding secondary school will permit the instilling in the pupils of a spirit of independence and a sense of responsibility by means of teaching methods hitherto unknown in conventional schools. The teachers foresee that group projects will be much more frequent. The semi-boarding school will allow the pupil to develop his social sense to a much greater extent than in the traditional school.

Behnisch & Partner, Stuttgart-Sillenbuch

Droste-Hülshoff Secondary School in Freiburg im Breisgau

(Pages 381–388)

A relatively small site near a built-up area was available to the architects for the new Droste-Hülshoff Secondary School building, this school specializing in mathematics and natural sciences. The primary assignment was to incorporate in the landscape a roomy structure for 800 boys and girls as well as an athletic annex.
Owing to concentrated installation, it was possible to obtain large unencumbered surfaces. On a terrace, situated on rather broken terrain, there are 3 square buildings with different heights but with identical ground areas. On the inside of these 3 buildings the classrooms are each grouped around central halls with overhead illumination. These halls are spatially interconnected. They are employed in different ways, depending on their orientation. The first hall, rising for 4 floors, is the main distribution unit. It contains the stairway and is surrounded by large classrooms (capacity 36), small classrooms (capacity 24), natural science rooms and administrative offices. A 2-storey hall gives access to the intermediate level and lower level classrooms, whereas the 3rd hall, one floor high, is used as a work room. It is surrounded by art and handicrafts classrooms. Beneath the terrace, there are situated all the utility and annex rooms of the school: projection room, technical rooms, gymnasium, miscellaneous rooms and parking facilities for bikes and other vehicles. The open-air parts of the terrace are used as a recreation area. A playground and sports field is laid out on the ground to the west of the school. The built-over area of this entire school complex has a volume of 45,000 cubic meters.

C. U. Merten, London

Modern School Construction in England

(Pages 389–395)

Outline of Contents

1) England, an example in the field of school construction
2) The post-war situation
3) Measures: organization, planning, costs
4) New techniques
5) New methods
6) New plans
7) Future challenges

1. England during the last 20 years has made an excellent name for itself as an avantgarde architect in the field of school construction. English building in this sector is highly appreciated by the international press, and the results are being given careful study by interested specialists throughout the world. For example, the development program for school building in Mexico is based on experiences gathered in England. Since the end of the Second World War, England has created more than 4.5 million new seats in its schools, the total cost rising to 1.2 billion pounds.

2. In 1945 England was confronted with a very grave problem: the shortage of space in the schools was caused by the following factors: the war had destroyed 5000 schools, the installations were out-of-date and outmoded, the birth rate was rising sharply, the school-leaving age had been extended and there were considerable population movements. In 1955, after having made available 1 million seats, 79% of all British children were still attending schools erected before the war. Nevertheless, there was an obstacle standing in the way of school construction: The British building industry was almost completely paralyzed. Its technical development and its organization had suffered a 6-year interruption, its machines were decrepit, there was a lack of planning people, technicians and architects, and, finally, it was suffering from a shortage of traditional building materials. Emergency measures became imperative. The Government therefore formulated a number of programs whose realization has given Great Britain its high reputation in the field of school construction.

3. The state school system in England comprises mainly primary and secondary schools. It also includes commercial schools, which are not dealt with here.
The Ministry of Education is responsible for school policy in England and Wales. It shares with the local authorities and the churches the costs of administering and financing state schools. In 1948 a development group was designated by the Ministry of Education. Its task was to come up with new ideas and to discover solutions to the problem of teaching in modern conditions and of school construction. Thanks to this group, the Clasp system could be introduced. This system is based on industrial construction.

4. The technological improvements of the last 20 years have contributed to the introduction into the builder's language of a large number of new expressions. At the present time, we talk easily of "industrial", "traditional" and "conventional" construction without forgetting that one category often merges with another. As regards the construction of schools, the publications of the Department of Education and Science make a distinction among the traditional manner of building, the prefabricated system and the mixed system. The industrial organization designates the measure utilizing methods and techniques as means with a view to increasing productivity. In Hertfordshire a group of architects developed a steel supporting system, a system which, a few years later, was complemented by structures of concrete and masonry. For its part, the development group invented a system of construction in concrete, a system known under the name of "Intergrid". Another system of concrete skeleton construction, called "Laingspan", resembles "Intergrid" but constitutes an improvement from the technical point of view.

5. The introduction of new methods for the planning and the organization of the construction process constitutes the 2nd stage with a view to increasing productivity. The development of a system of construction is partially a process of construction and partially a process of developing an industrial product. Such development proves to be costly and slow to apply. The economic aspect represents, there is no doubt, a basic factor in the success of the English schools. During an analysis, there is examined the costs of projects already finished, so that the results can be applied to future projects. The cost schedule gives a bird's-eye view of the total cost break-down ranging from a building as a whole down to its isolated elements.

6. The great shortage of space in the schools obliged England to take effective steps. These measures, added to experiments carried out in the field of psychology, in educational theory, etc. have permitted the application of specific construction plans for schools. The English schools have not simply become cheaper, but better. They now offer more creature comforts. With a view to holding costs within well defined limits, prestige architecture and excessively large tracts for communications have been avoided, which likewise represents an advance. The passageways and corridors could be reduced by 40% thanks to multiple utilization and more highly articulated planning. Owing to simplification on the administrative level, certain areas have been saved for the real purposes of the school.

7. English architecture finds itself confronted by enormous challenges in all fields of construction. Between now and 1970 there is foreseen a necessary building volume increase of between 30 and 35% as compared with 1964. At the same time, difficulties are mounting up on account of wage increases for workmen and masons and on account of the decline of available workers in all the building trades. It is estimated that, with the rise in the birth rate, there will be, in 1985, 50% more pupils than at the present time. The British have realized that they will not be able to cope with these problems by relying solely on traditional methods and resources. Only new methods, techniques and plans will lead to the solutions demanded by this situation.

Alfred Roth, Zurich

School construction in exotic climates

(Pages 396–398)

Problems of constructing schools in developing countries, with Kuwait as an example

The movement to build schools on the basis of modern educational and architectural principles began in the temperate zones of Europe and North America. There are several reasons for this: active assistance from the general public and public support for the idea of popular education, the firmly based and stable economy, well developed technology as well as the foundations of modern concepts of architecture and townplanning. Climatic conditions offer a wide range of liberties to the spatial and technical conception of buildings. Thus they increase the desire to create a close relation between the outdoors and the interior. All this applies to conditions in the temperate zones. Conditions are very different in the hot zones. Here, the builder has to do with extreme temperatures in extreme landscapes, with their sandy and stony deserts, treeless, an environment hostile to man. Any fusion of exterior and interior is deliberately avoided. The external wall is a massive rampart against the heat, the blinding light and the sand storms. It is furnished with tiny window apertures serving mainly for ventilation. They make up for this external enclosure, the whole interior opens into the patio, which becomes an artificial and refreshing landscape.
This interior courtyard is a characteristic spatial element of houses in hot countries. The architectural compression of buildings into extreme designs also plays a great role in this connection. The colonization of the 19th century brought in a Western-style architecture which totally neglects the given climatic factors. These influences of Western civilization have had fatal consequences for the architectural and townplanning development of the colonial countries of Africa, Asia and Latin America.

School construction in Kuwait

This country, which is the realm of a Sheik, is situated on the Persian Gulf on the edge of the Saudi Arabian desert. It occupies a very special position among the hot countries. On an area of 16,000 square miles (not including the Neutral Zone), there is a population of approximately 400,000, the great majority of which live in the capital. Kuwait owes this special circumstance to its enormous petroleum fields which afford the country a colossal income. Moreover, its democratic government has a very open-minded and modern outlook. All social services are free. There is no taxation. School construction also enjoys considerable aid from the state. Over the last few years, many school buildings (primary, secondary and commercial schools) have been erected. Others will follow in the near future, as well as a university. The positive outlook of the government was given concrete form in the wish expressed 2 years ago to have an expert examine the schools already erected. His conclusions would allow for future improvements and for the avoidance of mistakes in the future. The choice of expert fell upon the author of this article. In October 1965, I went therefore to Kuwait to spend several days visiting a number of school buildings. In a detailed report I included all my impressions and criticisms, and at the same time offered suggestions for future constructions. In nearly all cases, not enough account had been taken of the given climatic conditions. One year later, I was commissioned to draw up the plans for a girls' secondary school. This is a closed-in building with interior courtyards. The rooms have no windows facing the outside. The upper level is taken up by 24 classrooms, while the ground floor accommodates numerous special rooms, e.g., 2 auditoriums for science, 3 laboratories, a library, 1 music room, etc. To the east of the site, we have the living quarters for 48 teachers. The construction consists of reinforced concrete prefabricated elements. A series of school buildings will in future be built in accordance with this system of prefabricated elements.

R. Buckminster Fuller, New York
Fuller and Sadao, Inc.

Montreal Expo, Pavilion of the USA

(Pages 399–406)

The pavilion of the United States of America is a geodesic dome, the sphere having a diameter of 76.25 meters and a height of 61 meters. This dome has a volume of 190,000 cubic meters and a surface area of 13,600 square meters. The shape of the spatial supporting structure is the result of a detailed research and improvement program with a view to obtaining a light supporting apparatus with maximum visibility.
In his light structures, Buckminster Fuller has achieved a metal network structure stretched over wide spans and appearing light in weight against a background of clouds and sky.
The structural framework is a spherical spatial supporting apparatus of welded steel tubes. The dome is made up of a transparent resin skin divided up into 1,900 panels. These panels are the largest ever constructed of this material to date. They measure 3.05 × 3.66 meters. Around the summit of the dome there are 250 panels furnished with 61 cm ventilation openings. On the interior face of the skin of the dome there are 4,700 triangular sunbreaks of aluminium-covered fabric to protect the platforms from the direct rays of the sun. These triangular sunbreaks are grouped in units of 18 each, which open and close by means of 261 motors controlled by a punched strip program. There are 6 daily programs. In each program, the arrangement of the sunbreaks changes every 20 minutes. This allows for adaptation to the changing angle of the sun. The combination of the transparent acrylic skin and triangular sunbreaks permits an ideal regulation of the interior climate of the dome. Visual contact with the outdoors is not disturbed; in fact, the sun, the moon, the landscape and the sky remain perfectly visible. However, the disagreeable features of the climate, such as heat, dust, insects, glare, etc. are repelled by the skin. The interior of the dome is a veritable Garden of Eden.
This pavilion can be considered as the prototype of a construction within which future generations can live an agreeable life in an adequate physical microcosm despite a sometimes hostile climatic environment. Thus, man could create urban agglomerations in the Arctic, for example, or instal entire communities on the moon.
The dome is roughly a three-quarter sphere. It is constructed as a spatial supporting apparatus in two layers. There are 3 different members composing the supporting apparatus: the outside layer, the inside layer and the intermediate layer to connect the other two.
The tube sections are connected by means of welded steel junctions. Each junction consists of a cylindrical steel core, which is solid, with rectangular union sections for fitting the bars. There are around 5,900 inside and outside junctions. The geometry of the construction called for 83 junction variations, 43 on the inside and 39 on the outside. On the work site, the tube sections were joined to these junctions by welding the union sections to the ends of the tubes. The steel weighs approximately 53 kg./sq. meter of dome surface; the tubes weigh 600 tons, the junctions 120 tons.
The narrow-gauge railway system providing transportation for visitors over the whole area of the Expo passes through the USA Pavilion and serves one of its main platforms.
The ventilation, heating and air-conditioning system is automatic.