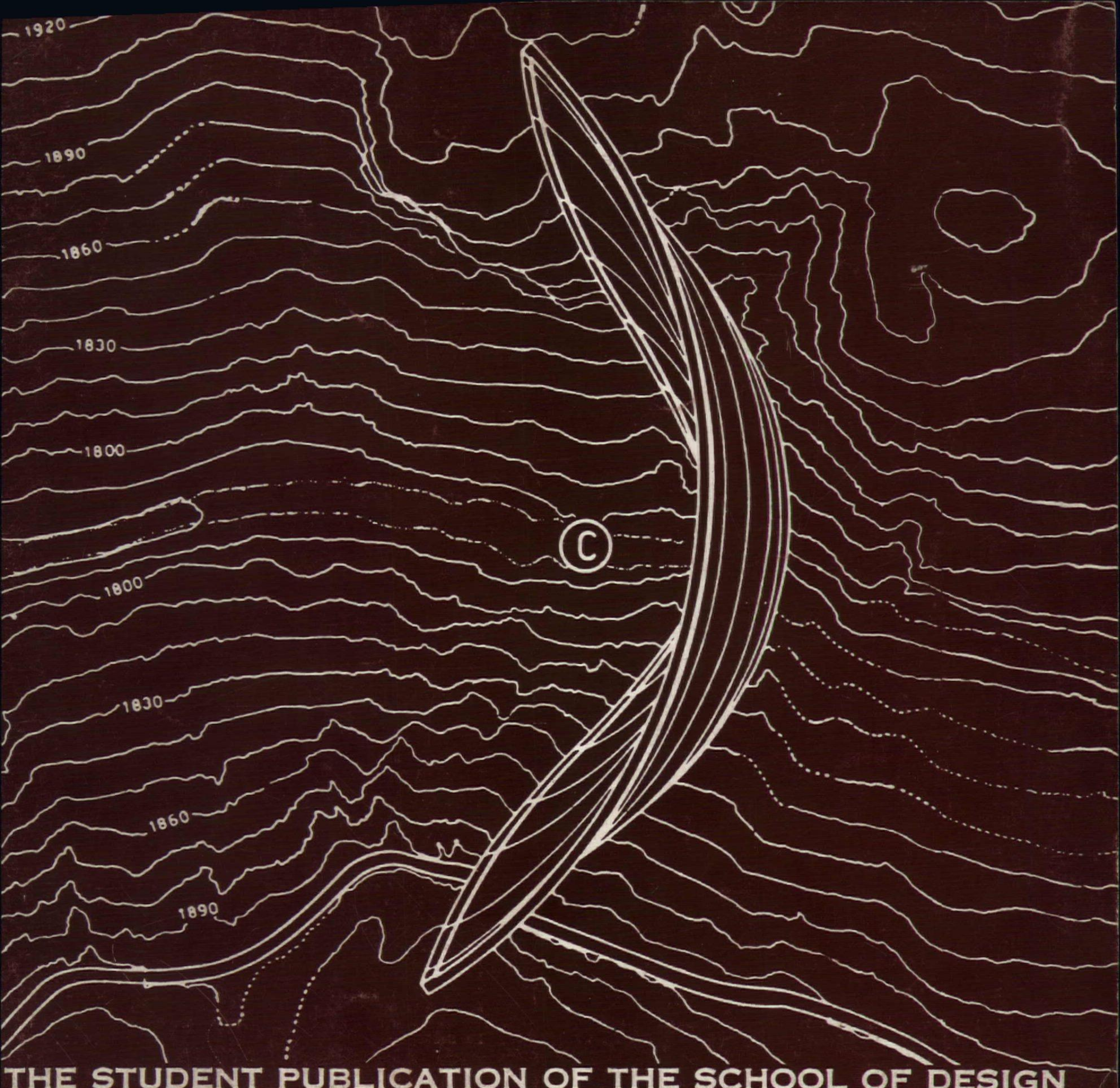
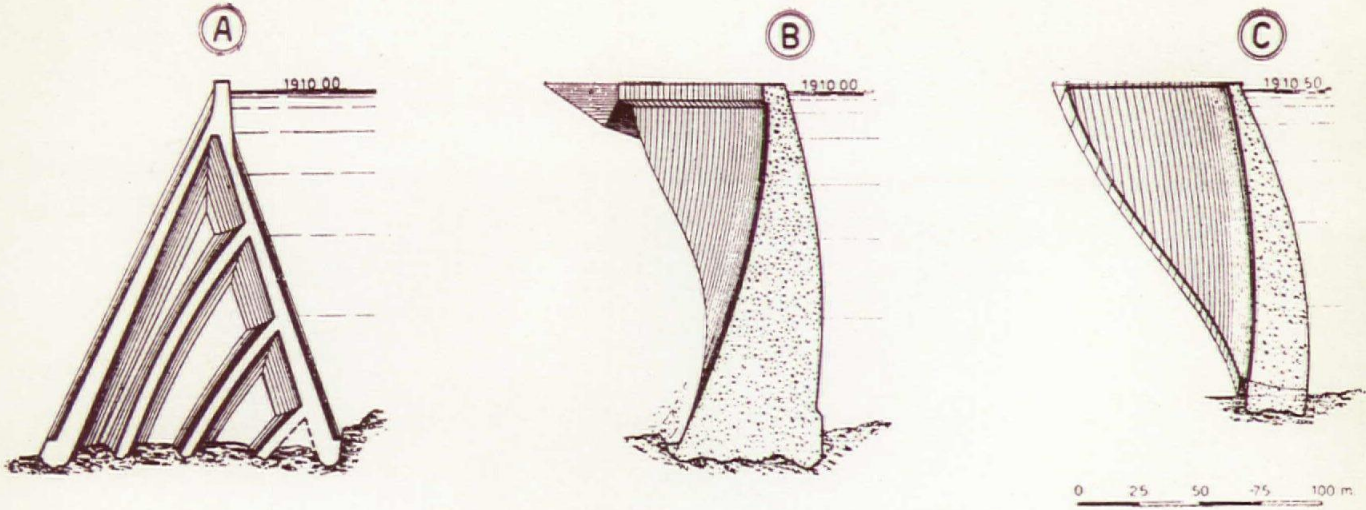


THE STUDENT PUBLICATION OF THE SCHOOL OF DESIGN

NORTH CAROLINA STATE COLLEGE RALEIGH NORTH CAROLINA VOLUME 8, NUMBER 2



The cover is a reproduction of the plans for three suggested designs for a proposed dam for Cancano under study at the Instituto Sperimentale Modelli e Strutture. The corresponding sections are reproduced above. These illustrations are reprinted from a paper by Dr. Ing. Guido Oberti.

PATRONS

Richard L. Aeck	Atlanta, Ga.
Architects Associated	New York, N. Y.
William W. Atkin	New York, N. Y.
Ballard, Todd, and Snibbe	New York, N. Y.
Harold Boericke, Jr.	Washington, D. C.
Leslie Boney	Wilmington, N. C.
Clark and Enersen	Lincoln, Nebr.
Clemmer and Horton	Hickory, N. C.
Sadie M. Craig	Hickory, N. C.
Joseph Cutler	Greensboro, N. C.
William Henley Deitrick	Raleigh, N. C.
William Dodge	Raleigh, N. C.
Fenno-Reynolds-McNeil	Kenmore, N. Y.
Gilleland and Strutt	Ottawa, Ontario
Charles M. Goodman	Washington, D. C.
Harrison and Abramovitz	New York, N. Y.
Douglas Haskell	New York, N. Y.
W. N. Hicks	Raleigh, N. C.
Watts Hill, Jr.	Durham, N. C.
Robert L. Humber	Greenville, N. C.
L. L. Ivey	Raleigh, N. C.
H. Creighton Jones	New York, N. Y.
Henry L. Kamphoefner	Raleigh, N. C.
Edgar Kaufman Charitable Trust	Pittsburgh, Pa.
Ketchum, Gina and Sharp	New York, N. Y.
Ketchum and Konkel	New York, N. Y.
Vincent Kling	Philadelphia, Pa.
Lashmit, James, Brown and Pollock	Winston-Salem, N. C.
Sheldon Leavitt	Norfolk, Va.
Jeffrey Lindsay	Beverly Hills, Calif.
Edward Loewenstein	Greensboro, N. C.
Robert S. Loomis	Windsor, Conn.
Anthony Lord	Asheville, N. C.
Lyles, Bissett, Carlisle and Wolff	Columbia, S. C.
Elizabeth H. Mack	Charlotte, N. C.
John Gaw Meem	Santa Fe, N. M.
Neil M. Nehrbass	Lafayette, La.
Richard J. Neutra and Robert E. Alexander	Los Angeles, Calif.
A. G. Odell, Jr.	Charlotte, N. C.
Oliver and Smith	Norfolk, Va.
Frei Otto	Berlin, Germany
Victor J. Papanek	Toronto, Ontario
School of Architecture, Princeton University	Princeton, N. J.
Nicholas J. Pyros, Jr.	Trucksville, Pa.
A. Carol Sanford and Assoc.	Ft. Lauderdale, Fla.
Sherwood, Mills and Smith	Stamford, Conn.
Small and Boaz	Raleigh, N. C.
Harry J. Spies	Clark, N. J
Edwin G. Thurlow	Raleigh, N. C.
Robert B. Tucker	Monroe, N. C.
B. O. Vannort	Charlotte, N. C.
William H. Wainwright	Cambridge, Mass.
Weihe, Frick and Kruse	San Francisco, Calif.
F. Carter Williams	Raleigh, N. C.
The Gallery of Fine Arts	Winston-Salem, N. C.
Lev Zetlin	New York, N. Y.

Editors: EUGENE LOWRY and HENRY MENZIES. Business Manager: DAVID HIPP. Circulation Manager: WILLIAM MOORE. Layout and Design: CLYDE RICH. Faculty Adviser: HORACIO CAMINOS. The Staff: ARTHUR COGSWELL, SAM MINTZ, NED REICH, MARIO SAGARO, CHARLES SAX, SIDNEY SWIDLER, ROBERT TURNER. This magazine was originated by the students of the School of Design of North Carolina State College and is maintained as an independent student project. It is published three times each scholastic year at the North Carolina State College Print Shop. Subscription rates: Patron—$10 per year; Regular—$2.50 per year; Single Copies—$1 each and 3 for $2.50. Address all inquiries to. THE STUDENT PUBLICATION OF THE SCHOOL OF DESIGN, Box 5273, Raleigh, North Carolina. This magazine is also available through: Wittenborn and Company, 1018 Madison Ave., New York 21, N. Y. and Alec Tiranti, Ltd., 72 Charles Street, London, W. I. England.

The line drawing of the tree on page 27 is reproduced from *Trees for Town and Country* (Lund Humphries, London) by S. R. Badmin. The section of the cathedral on the inside back cover is reproduced from *Dictionnaire Raisonne de L'Architecture Francaise du XI au XVI Siecle* Vol. II, by M. Viollet-Le-Duc (published in Paris). The photograph on page 26 is reproduced from *Greater London Plan 1944* by Patrick Abercrombie.

VOLUME 8 NUMBER 2 SUMMER 1958

THE STUDENT PUBLICATION OF THE SCHOOL OF DESIGN

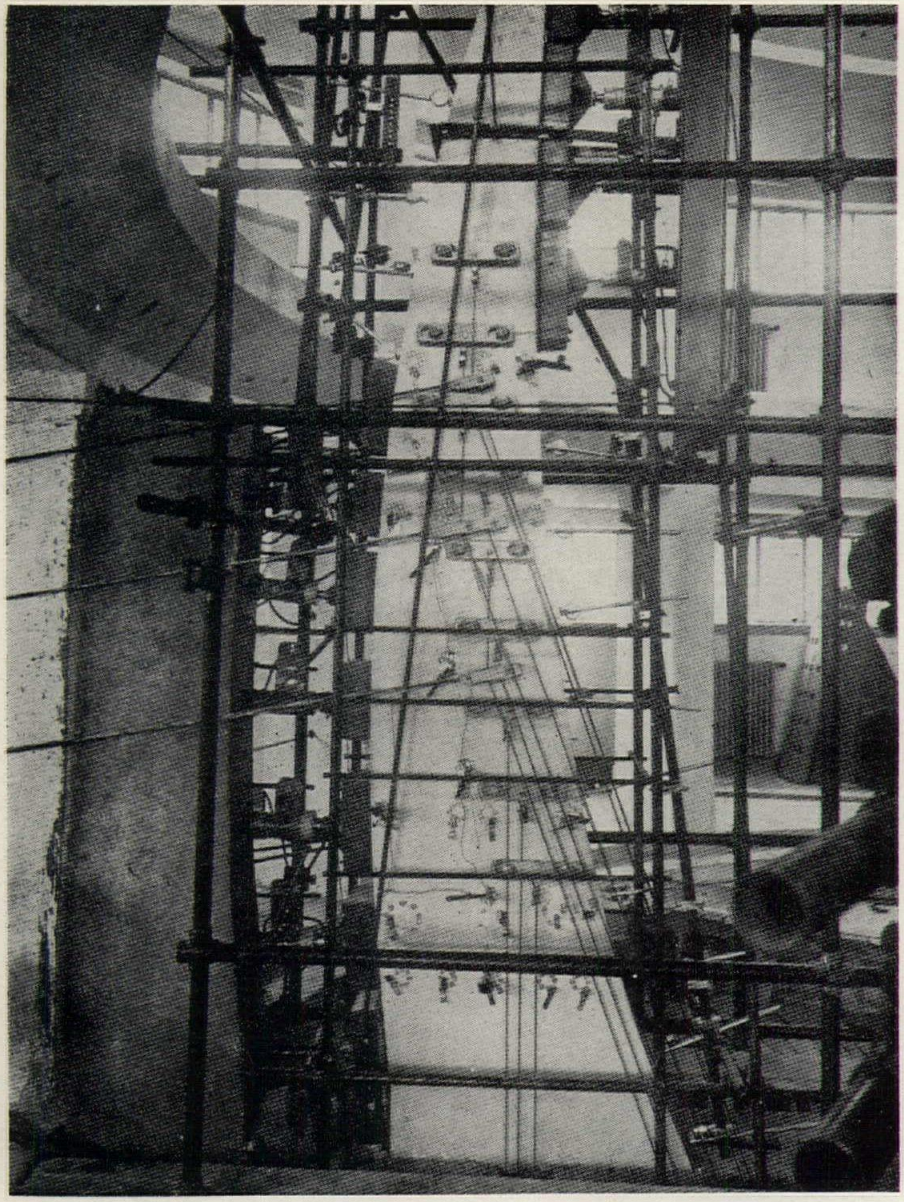


Fig. 1. Testing of a single cantilever model of a high arch dam designed for construction in two parts with an intermediate joint.

By Prof. Dr. Ing. Guido Oberti

Prof. Oberti is the Director of the Istituto Sperimentale Modelli e Strutture in Bergamo, Italy. Originally this paper was one of a group presented at the ASCE Symposium on Arch Dams, June 1956, at Knoxville, Tennessee. It was later printed in the *Proceedings of the American Society of Civil Engineers* (August 1957) and in the journal of the Istituto in December 1957. Experimental research on models in Italy have greatly contributed to the national design of arch dams. Actual possibilities of models based on the theory of similitude are discussed. Important cases of Italian arch dams studied by models are described and principal results obtained are reported.

THE DEVELOPMENT OF MODEL RESEARCH IN ITALY

I. PRELIMINARY CONSIDERATIONS ON STRUCTURAL MODELS

Research on models in the quiet atmosphere of a laboratory permits an accurate analysis of variables, and renders the experimental investigation simpler and less costly than on the prototype. Furthermore, it permits investigations of the static and dynamic behavior during the design of the structure, predicting its real degree of security and realizing the best economy.

The use of models is especially valuable when the mathematical solution of a problem is either unknown, extremely laborious, or difficult to define as to the boundary conditions.

The theory of models is based on a well-known principle of similitude which states that two systems are physically similar when there exists a geometrical correspondence between the points of the two systems, and the quantities of the same physical nature have a constant ratio at corresponding points. Complete physical similitude between prototype and model is reached when all the relations between the "scales" with which the model reproduces the physical quantities, on which the problem depends, are taken into consideration.

If there are n physical quantities upon which the problem depends and we choose the q functions which are fundamentally and dimensionally independent, corresponding to the degree of dimensional freedom of the problem (3 for mechanical problems), it is always possible to get $n - q = m$ dimensionless π ratios, which correspond to the m quantities relating each of these and the q functions assumed as fundamental. Having then chosen the dimensionless π_1 ratio relative to the quantity that one particularly wishes to know, this ratio becomes then the function of the remaining $m - 1$ dimensionless ratios $\pi_2 \; . \; . \; . \; . \; . \; \pi_m$. The model will therefore correspond to the prototype in all respects if the values of these ratios remain unchanged in passing from the prototype to the model, and the π_1' ratio for the model will then also be $\pi_1' / \pi_1 = 1$; a relation which permits, having measured the quantities on the model, to obtain the corresponding value on the prototype.

In addition, the inherently dimensionless physical constants and functions upon which the problem may depend must be conserved in passing from the prototype to the model, for example: Poisson's ratio, the coefficients of friction between the various materials, and so on.

It is useful to distinguish between the cases that one may wish to study on a model, separating those for which one possesses a thorough mathematical theory, from those in which this is not so. A classical example of the first case is presented by a study of the behavior of any structure made in a homogeneous isotropic elastic material and bounded in a statically determinate way, as mathematics then offers the theoretically complete solution to the problem: a system of differential equations having as unknown functions the stresses.

Even though the numerical solution of such a system is often extremely laborious, as for example in the most complex problems of concrete dams; the knowledge of the theory simplifies the investigation with the model as the equations of the theory furnish a complete and precise list of the quantities which influence the phenomena studied. In particular, it should be remembered that such equations postulate the independence of the stresses from the physical-mechanical characteristics of the material (elastic modulus, yield point, with the exception of Poisson's ratio for three dimensional problems) therefore permits the use of model materials which differ from those of the prototype, as applied in photo-elasticity.

Without a theory and the relative equations which set out the physical problem to be studied, it is more difficult to realize a complete similitude, as naturally all the dimensionless ratios on which the phenomenon we study depends may not be identified. It is in these cases that dimensional analysis, as a precious resource, becomes of use; in fact, once the quantities which are present in the phenomenon are listed, it provides us with the independent dimensionless ratios which can be built with these quantities and thereby provides a guide to the proper use of the model to obtain satisfactory results.

It seems advisable to mention these preliminary fundamentals of the model theory in order to outline the difficulties that beset work on models. Such difficulties are often present in hydraulic, electric and aerodynamic researches.

II. THE STRUCTURAL MODELS

a) Structural investigations generally present favourable conditions since the independent fundamental quantities upon which the behaviour of a structure depends are generally three: the classical "length", "mass" and "time", or three equivalent dimensionally independent quantities and that these are reduced to two when only the static behaviour of the structure is studied, as in the case the variable "time" is missing.

If λ and χ represent respectively the ratios of similitude of the lengths and of the forces, the ratio of similitude ζ between the stress values, during the passage from the prototype to the model must be:

$$\frac{\chi}{\lambda^2} = \zeta \qquad (1)$$

All the other physical quantities occurring in the problem which have the dimensions of a stress (modulus of elasticity, yielding value, failure unit loads), must then have this same ratio. The materials of which the models and their foundations are built must generally conform to this same ratio, which we will call "effectiveness ratio." (In the elasticity problems only and within the limits of the mentioned theory, this dependency may be avoided. For example, photo-elasticity utilizes materials for models which are quite different from those of the prototype.

In the particular case of only superficial loads, with π indicating the ratio between the intensity of these loads the required relationship will be: $\chi = \pi\lambda^2$ and here π coincides with ζ, the latter is then independent of the scale ratio λ.

But if the stresses due to dead weight are not negligible, and ρ represents the ratio of the densities, then it will also be necessary that

$$\chi = \rho \lambda^3 \qquad (2)$$

and therefore the condition that is obtained by placing (2) into (1) must be considered. This is

$$\zeta = \rho \lambda \qquad (3)$$

The difficulties are increased by this requirement which may justify the expedient of using large scale models and also to increase—with artificial devices—the density of the model material.

In the particular case where the most important stresses are due to body forces, as for example, in dam problems (hydrostatic load and dead weight), only the relationship (3) is required.

When it is possible to find materials to build a model and its foundations for which the conditions of invariability of ζ are met, in the sense that the "intrinsic curve" of the model-material is similar to that of the prototype in the constant ratio ζ and the scale of the density ratios satisfy relation (3), similitude may be considered attained and it may be then considered effective not only within the limits of elasticity but as far as the breaking point.

This result, which the author reached some twenty years ago, permitted, with the use of convenient materials, study on models with tests up to the breaking point, the degree of safety of important structures and in particular that of practically all the big Italian dams designed and built in the last decade.

For several years plaster of Paris had been employed, but it was rather difficult to use, especially when the models were large and thick, because the plaster took a long time to dry and the interior was not uniform. That was the principal reason which led to the use of a special mixture for the most recent models. It was a special concrete in which the aggregates were volcanic pumice stone from the island of Lipari. Such stone is cheap in Italy and is therefore very useful for laboratory tests. Using volcanic stone, tests had been made with different percentages of cement, and it is now possible to construct a model of this special mixture having a large variation in the ratio of its modulus of elasticity to the modulus of elasticity of the concrete of the dam. In some cases the ratio is as low as one to twenty. Furthermore, in the large models it has been possible to include the natural rocks in the model, incorporating the same ratio as existed in nature. This was done by means of research made in the field by means of special devices, particularly for limestone. The necessary information having been gained by measuring "in situ" the deflections (in all directions) caused by pressure in a large tunnel which had been excavated in the interior of the mountain.

When one has to undertake experimentation on models of this kind it is convenient to begin the research work directly on the strains ϵ, assuming them as fundamental unknown quantities (instead of stress components); these being already dimensionless will insure that a complete similitude will be obtained when they are equal at the corresponding points of the prototype and of the model. All the precedent considerations of the case are still valid and, in particular, the relation (3).

Then the strains on the model, which it is possible to measure with a high degree of accuracy by the use of extensometers having a very high magnification, will be equal to those of the prototype.

It is thus learned that the displacements and in particular the deflections (that dimensionally are $\epsilon \cdot \iota$), will be proportional to the scale ratio λ between the prototype and the model (fig. 2).

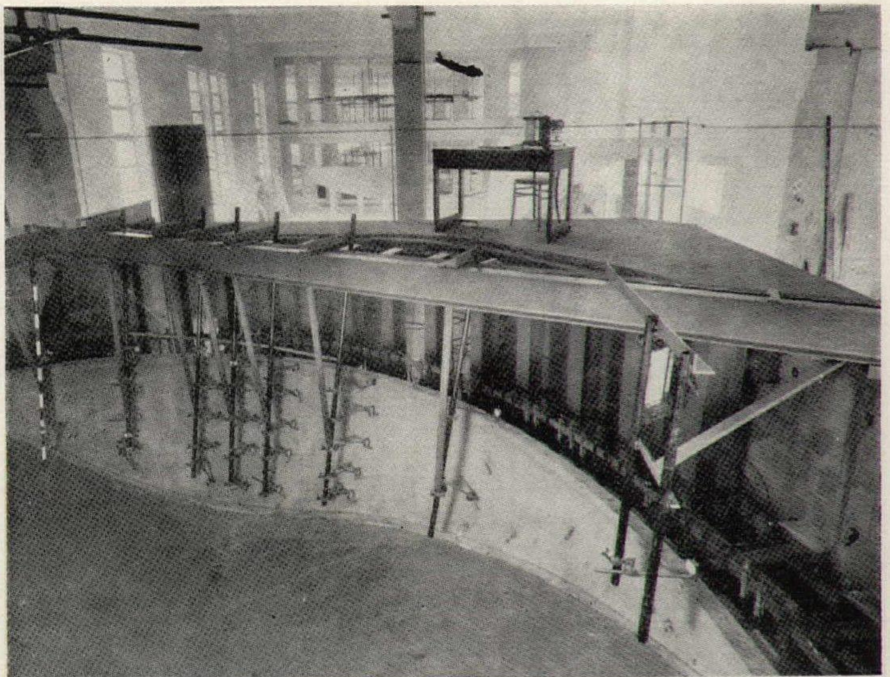
b) Previously when static problems alone were considered, deformations and stresses were not influenced by "time."

In reality the collapse of a structure may also depend, even if in a different degree, on the time of the application of loads because of the viscosity of the materials of which they are built.

It is known from theory that, in such cases, the stresses are linearly related to the corresponding velocity of deformation through a coefficient of viscosity, which is a constant providing the material is homogeneous and isotropic. It is then necessary to add a new fundamental quantity, such as "time", for which the non-dimensional ratio μ between the viscosity coefficients must be equal to $\chi \lambda^{-2} \tau = \chi \zeta$ with τ representing the ratio of times between the prototype and the model.

The variable, "time", comes into play again when the

Fig. 2. Application of dial gages on the downstream surface of a large arch dam model.



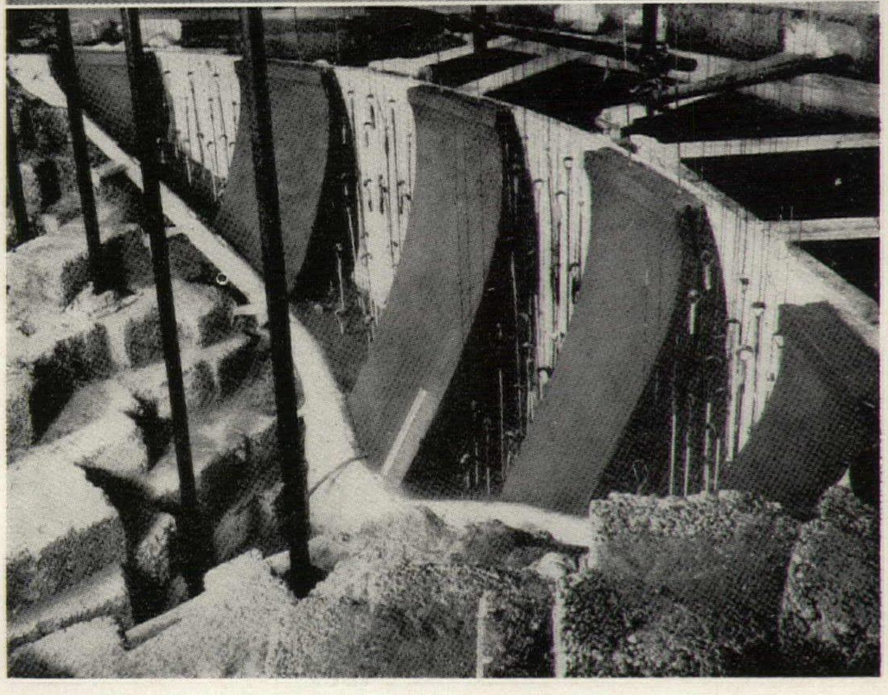


Fig. 3. Casting a model arch-gravity dam; tie rods for the application of the dead load may be seen.

dynamic behaviour of a structure must be studied. This is of particular interest for seismic effects. In such cases it is necessary to bear in mind that among the forces to be considered in the first place are those of gravity, and being unable, obviously, to alter the value of the gravity acceleration in passing from the model to the prototype, one is obliged to presume that this quantity is a fixed dimensional constant. It is useful therefore to consider acceleration as a fundamental quantity to add (instead of time) to the two preceding ones and the ratio between the accelerations acting on the prototype and in the model must be equal to one. The ratio of the times τ must then satisfy the condition:

$$\tau = \sqrt{\lambda} \tag{4}$$

It follows that the vibrations will reproduce themselves on the model with a higher frequency. For example, on a model having a scale of 1:100 the frequencies will be ten times as high as in the prototype (Froude-similitude).

It is useful to point out that in order to satisfy relation (4) it is not possible to work a model made of the same material as the prototype (or which has the same density) since, ρ (the ratio between the density of the prototype and model materials) must be in any case (the forces being dimensionally equal to the product of mass times acceleration):

$$\tau = \lambda \rho^{1/2} \zeta^{-1/2} \tag{5}$$

The equations (4) and (5) are satisfied by imposing the condition (3).

As an example, in the case of the model studies of the earthquake-effects on the Ambiesta dom-dam, by conforming to the requirements of these fundamental ratios, we have assumed

$$\lambda = 75 \qquad \zeta = 50 \qquad \rho = 2/3$$

using for the model a special mortar of litharge and plaster.

c) With regard to what is assumed in order to obtain by calculations and by direct research conducted on the real dam, models have been objected to on the grounds that internal stresses are not examined and that thermal effects are not studied.

For the first question it is pertinent to point out that—as a rule—the stresses of more interest are found on the surface. Presently, internal measurements at single points in models are possible with a good accuracy. Furthermore, if one limits himself to the elastic behaviour of plane structures, it is also possible to obtain by photo-elasticity, the stresses in the interior.

With regard to the second point, it may be interesting to remember that, should the thermal variations (or its equivalent as shrinkage) not be directly modelled but be linear functions of the coordinates, the thermo-elastic problem may be replaced for elastic condition, by the artifice of applying on the model suitable volume or surface forces instead of the thermal actions (and with the precaution to measure also the deformations, which the model, being free from redundant ties, would develop under the action of such ideal forces). Generally speaking, if the deforming actions are deduced to simple Volterra dislocations, it is possible to employ models.

Only if one passes to more general types of distortions, does the use of models become really arduous as it is then necessary to reproduce and to model the local physical causes which introduce such strains, as we have begun at the ISMES.

III. THE EVOLUTION OF EXPERIMENTAL METHODS ON MODELS

In Italy the experimental procedures on models have been progressively extended in these last years and I would divide them, following their chronological evolution, into three groups of substantially distinct methods.

a) With the methods used in the first group the plain elastic problems are studied: prevailingly with the aid of photo-elasticity and deformeters. Photo-elasticity is a particularly elegant system which permits us to obtain photographic reproductions of stress patterns, lines of uniform shear stress, and to deduce the stress-trajectories (isostatic lines) in the prototype by the experimental observation of the isoclinics obtained in the model. This method of research is now successfully used in many laboratories which deal with structures.

The deformeters, developed from the first Beggs types, are also tools of great utility.

b) The methods of the second group investigate three-dimensional elastic problems with extensometer measurements; this is by applying directly to the model mechanical, optical or electrical extensometers.

Many structures were thus studied in Italy (especially by the author in the laboratory of the Polytechnical School of Milan) by adopting model materials (celluloid, plexiglass, etc.), which are very different from those of the prototype provided that they are elastic. In these tests the continuity of the structure, the rigidity of the abutments or the elastic deformability of the ties were accounted for. In arch dam models the load was applied usually with quick-silver.

Under this condition the model functions as a "mechnical calculator" of stresses and gives results that may be usefully compared with those of the various calculations made for the study of the elastic behaviour of the structure.

c) Lastly, with the third group, having ascertained that some structures, particularly those of concrete, do not conform to the postulates of elastic theory; and that the non-compliance gives better results, it appears preferable to search for a more exact similitude with the prototype rather than for confirmation of elastic calculations. This is a decisive step towards conformity with nature which characterizes the considerable amount of work done by the ISMES in Bergamo in building models, which tend to substantially reproduce not only the behaviour of materials but also the particulars of the form and the performance of the prototype, of the bearing seats and the real deformability of the ties and of the foundations.

The tests made on the model may then be divided into two distinct and successive steps. In the first series of tests which we call "normal load tests", deformations are measured in order to obtain the values nearest to the condition of similitude, which will impose equality of the strains on the prototype and on the model, under normal load conditions corresponding to those of the structure in service. It is important to point out that during the application of the load various types of inelastic adjustments or permanent sets may take place which is good to stimulate, by repeating load cycles, reaching a regime working of the model which will be elastic, regular and suitable for the measurements of deformations and for useful controls. It is then possible to evaluate the stresses (knowing the stress-strain diagram of the material) and the static behaviour foreseeable in the prototype during normal service.

It must be observed that the stresses thus observed may not agree with those deduced by calculations, since the adjustments (which generally have a beneficial effect) are not taken into consideration.

Having finished these tests and the relative measurements one passes gradually to the destruction tests or ultimate load tests. It is convenient then to assume as the overall safety coefficient of the structure, the ratio k, between the value of the maximum load actually supported and that considered normal during service.

In the particular case of arch dams, having made the ultimate load tests on the model (conducted until collapse or until the first signs of cracks appeared on the upstream face), the safety factor will simply be the ratio between the maximum final value γ'_m of the specific weight of the liquid, fictitious or real, acting on the model and the value γ' relative to the liquid conforming to the foreseen "normal load", (which is realized in the dam for the designed maximum water level). If ζ is the "Ratio of Effectiveness" between the material of the dam and that of the model, λ is the scale ratio, $\gamma_0 = 1\ T/m^3$ is the specific weight of water acting on the prototype, the following relations will hold:

$$\gamma = \frac{\lambda}{\zeta}\gamma_0 \qquad \text{and:} \qquad k = \frac{\gamma'_m}{\gamma_0}\,\frac{\zeta}{\lambda} \tag{6}$$

In the case of gravity or arch-gravity type dams in which the effect of weight (also a volume load) has the essential function of maintaining stability, it is necessary to arrange the model for its increase and to maintain it at the correct ratio in respect to the hydrostatic load (fig. 3). It is with this precaution that we may proceed with the ultimate load tests. If in these tests a safety ratio, which is considered sufficient under normal conditions, is reached without collapse of the model, it may be interesting to continue increasing only the hydrostatic thrust and not the weight in order to learn the strength at exceptional thrusts (such as earthquakes, bomb effects, and so on).

These latter methods in our opinion represent a notable progress in comparison with the former which, on the other hand, are still useful especially as a means of comparison with the theoretical results. In fact the methods of the first two groups are based on a set of hypotheses that lead to results which may not conform to reality since they would only hold for an ideal structure which faithfully obeys the initial hypotheses.

Instead, our methods, rather than obeying preconceived idealizations come closer to the reality of a specific case. Thus we do not hesitate to introduce into the model materials, foundations, ties and joints and the general structural particulars, which may prohibit the possibility of an analytical check (and producing sometimes a certain dispersion of results) but, compensate by a better agreement with the real boundary conditions and therefore adhere closer on the true and final aim of the designer.

This point of view permits and justifies the use, in these third methods, of useful devices which may produce local troubles which are negligible in respect to the final aim of the tests. Thus, for instance, the hydrostatic load on the upstream face of the dam models may be applied with hydraulic jacks provided with suitable diffusion plates instead of liquids; also the corrective addition to the dead weight may be concentrated in a number of points instead of being distributed continuously on the whole volume of the structure. With similar practical means (the influence of which is possible to check experimentally) the conditions of similitude are retained in the model and problems, which otherwise would be difficult or unsurmountable, are resolved.

This conclusive phase of experimentation which is more comprehensive and delicate than the preceding ones, requires a critical attitude of mind, a good experimental ability, a patient research on, and preparation of material

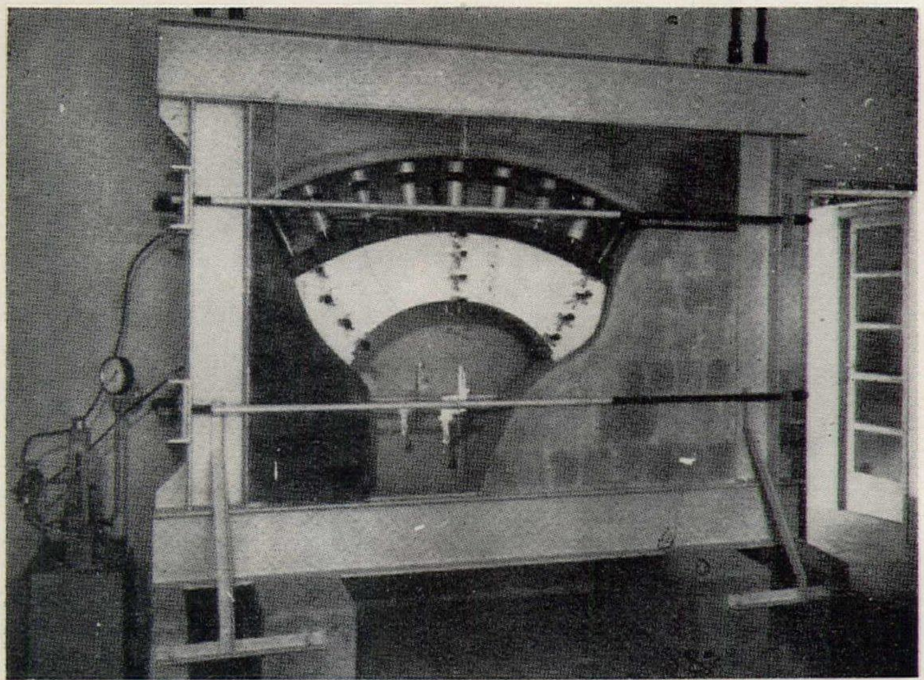


Fig. 4. A Hydrostatic Load Test, by means of jacks, on a single arch model with abutments on two different kinds of rock (modulus ratio 1:10): Preliminary tests for Beauregard Dam.

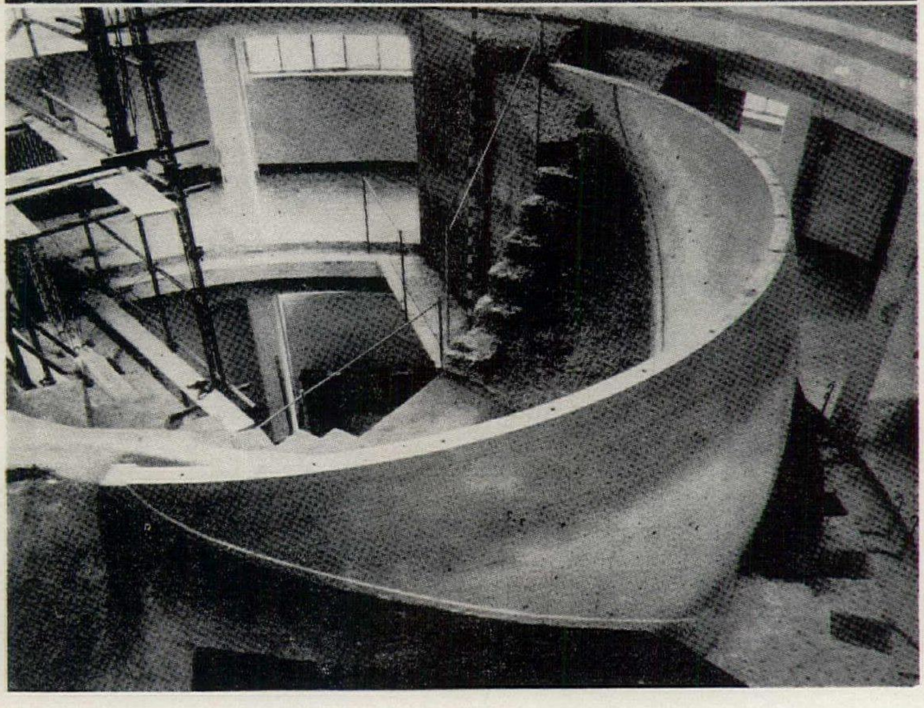


Fig. 5. The model (1:50) of the Beauregard arch-gravity dam immediately after casting. The holes for the grouting of the joints may be seen.

suitable for the construction of models, and coatings capable of preserving them, especially from shrinkage, during the tests. This is what has been developed and studied in these last years in the ISMES laboratories.

IV. MODEL AND STRUCTURAL TESTING AT THE I.S.M.E.S.

1. In order to fully appreciate the function performed by the Istituto Sperimentale Modelli e Strutture, "I.S.M.E.S.", (Model and Structural Testing Institute) of Bergamo (Lombardy Region), it should be noted that in Italy most of the study and research work in the field of civil engineering is done by University Institutes. Their work is largely theoretical, and in the field of experimental research it is confined chiefly to material testing, due also to the limited facilities and staff available for this work. The I.S.M.E.S., instead, is a private corporation established for the purpose of solving, with adequate financial means and the freedom of action which, by their own structure, University Institutes do not possess, specific structural problems arising for designers and builders. Therefore, I.S.M.E.S. carries out a technical-scientific activity which is, so to say, complementary to the activity which is carried out, or should be developed, in the Italian University Research Laboratories.

I.S.M.E.S. was established by a group of companies and contractors including: EDISON Co. of Milan, ITALCEMENTI Co. of Bergamo, Acc. FALCK Co., SADE Co. of Venice, SIP Co. "Societa Italiana Partecipazioni Industriali", of Turin, SME Co. of Naples, MONTECATINI Co., ROMANA ELETTRICITA' Co., SELTVALDARNO Co., TERNI Co., ACEA of Rome, AEM of Milan, AEM of Turin and the contractors: GIROLA, ITALSTRADE, LODIGIANI and Torno. The scope of the Institute's work extends to experimental research on the behavior of structures, by means of tests conducted on large three-dimensional models, or on the structures themselves at the construction site.

The experimental study of the structures by means of models has been gaining momentum in the last few years, as a result of the improvement of measuring instruments, and has gained increasingly wide acceptance as an effective aid by open-minded designers and builders.

The practical usefulness comes from the fact that it is possible to work out a solution for complicated structural problems even in the cases where calculations cannot provide sufficient assistance.

This process yields, in the design stage, valuable information making it possible to anticipate the static or dynamic behaviour of the structure and, if necessary, to select among several designs the solution which is likely to produce the highest efficiency and the lowest construction cost. In addition to tests under normal load conditions, the Institute usually carries out ultimate load tests intended to yield an indication as to the order of magnitude of the overall safety-coefficient of the structure modelled.

So much for what we can define as the "technical" work which the Institute is called upon to do for its customers in Italy and abroad.

In the field of pure scientific research the Institute studies improvements of the techniques for research on structural models. In this field, some results of fundamental value have already been achieved, such as the extension of model testing beyond the elastic limit, thanks also to the development of suitable materials and measuring instruments.

The Institute officially was established in 1951, and is in a phase of continuous development. Among its equipment are special structures of heavily reinforced concrete, built to contain large models or structural elements to be put through static tests, and to support without appreciable deformations the loads involved in the testing.

One of these structures is a rectangular-base tank measuring approx. 32 x 16 feet, particularly suitable for testing model dams; and the other is a circular-section tower, 32 feet interior diameter and 60 feet high, designed to hold high models (dams built in narrow gorges, skyscrapers, cement silos, etc.). The tests on models or structural elements exerting no thrusts above ground level, i.e., resting or anchored upon level ground (penstocks, floors, etc.), are conducted in a large shed-type building.

A new department for research on the physical-mechanical characteristics of concretes, including those with large-size gravel, has been activated last year. It is equipped with a 2,000-ton compression and bending materials-testing machine, which can also be used for studies on various structural elements (pillars, girders, etc.).

The Institute possesses an extensive set of loading devices (hydraulic jacks, springs, etc.) to apply on model or structures any kind of stress, such as dead loads corresponding to their own weight; accidental loads, hydrostatic loads, wind pressure, etc. Its laboratories are also equipped with a complete set of measuring devices (bending gauges, stress gauges, recording units, etc.) and with auxiliary equipment (including a photo-elastic section for research in two-dimensional elastic fields) which are used, in specific problems, to supplement the research on three-dimensional models.

A set of loading and measurement devices was developed for field tests. Particularly interesting is the equipment for the determination of the deformability of foundation rock by underground tests (special jacks, pumps, waterproof gauges), which is one of the fields in which the Institute specializes.

The Institute has ready for use from this year a set of equipment, the only one of its kind in Europe, which is used for studying on models the effects of seismic (or, generally, vibrating) actions on building structures and dams. The seismic testing devices include:

a) a metal platform, measuring approx. 10 x 15 feet, of highly rigid construction, upon which will rest the structure to be tested complete with foundations;

b) three vibrations-generating units, including:
   1. a variable-constant pendulum and spring system for the reproduction of shock waves;
   2. a centrifugal vibrodyne for the reproduction of unidirectional harmonic movements, capable of applying forces up to 10 metric tons;
   3. four electronic-controlled electro-magnetic vibrators, for the reproduction of both unidirectional and vortex-type movements.

c) an equipment for recording the strains and displacements of the model during the testing.

Better than any list of equipment, however, the capabilities of the Institute can be illustrated by the record of research work done.

2. Systematical tests on models, including some of very large size, have been conducted by the Institute, particularly for large dams.

The models of dams are built and tested in accordance with specifications which are the product of long experience, and therefore usually applied to different models. The following is a brief description of the proceses and specifications usually adopted for arch dam tests.

The first step is the construction of a preliminary model, of plaster or wood, which is used to study the design details required and for the construction of molds for casting the actual model. When necessary, this preliminary model is also used, on completion of tests, to reproduce the principal-stress trajectories.

The actual working model is laid on a foundation bed of the required "modulus", and its construction follows quite closely actual prototype to be grouted by injection when the setting process is completed (fig. 4). Concrete is reproduced by suitably dosed cement and stone pumice mix, approximating the mechanical characteristics of the actual rock and construction materials.

Before pouring, fastenings for additional own-weight loads are inserted at appropriate points in the body of the models (Fig. 3). On completion of the hardening process, vertical loads are applied by means of spring-loaded dynamometers. Water pressures are usually reproduced by means of hydraulic jacks, fitted with special attachments which distribute the load over a sufficiently wide surface. In elastic tests, local measurements are taken by means of extension gauges of various types when spot readings are possible or by centralised electrical indicating systems. Mechanical dials (deflectometers) are also used to measure deflections and overall shifts in the structure.

On completion of the normal tests, which lead to the determination of the stresses and, as a rule, to the tracing of the stress trajectories on the model structures, destruction (ultimate load) tests are conducted. The loads are gradually increased until the model collapses, yielding the value of the overall safety coefficient.

In the individual practical cases, the technical and financial importance of this research has always proved substantial. As for the financial side of the problem, we would like to mention here as an example the fact that the results of tests conducted with the first model built (Pieve di Cadore Dam) have led to reducing the overall volume of the structure by about 15%, with a saving in the order of $1,540,000.

In some cases the scope of the experimental research was extended to include a comparative study of different alternate solutions. This was done, for instance, in the case of Osiglietta arch dam (Acc. Falck Co.) and more recently for the SADE Company's Fedaia Dam, when model tests were conducted on two different designs of arch-gravity dams, and on a third (then actually adopted) for a buttress dam.

In other cases, model tests were conducted for the purpose of observing the influence of particular conditions on the static behaviour of the structure. Thus, for instance, in the case of SIP's Beauregard Dam, the Institute's research staff has reproduced, after overcoming considerable difficulties, the pronounced difference in elasticity of the two valley sides (with elasticity coefficients in the ratio of 1:10) (Fig. 4). In the case of the Cancano Dam (AEM), adjustments were made to allow for the heterogeneous structure of part of the rock on the right abutment, reproducing the precise lay of the rock layers.

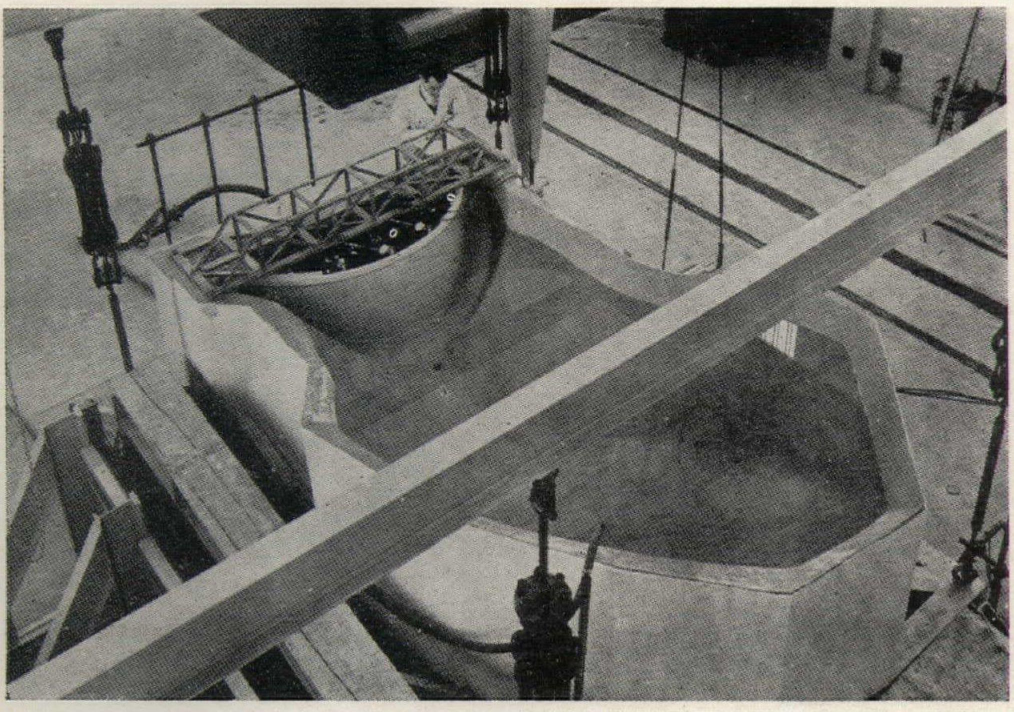
For the Val Gallina dome dam and for the arch-gravity Piave River Dam, a comparison has been conducted between the deflections observed on the model and that of the actual structure, and the results were found to substantially agree.

For the Giovaretto buttress dam, a study has been conducted, by means of model, of the stresses in the highest spur, extending it to the inner part around a lightening and drainage hole, around which the existence of tension stresses was feared. Studies of the same type were conducted on the arch gravity Cancano Dam mentioned above as regards the concentration of stresses around some large tunnels and the elevator shaft.

For the Falck Steel Company, studies have been conducted on three models representing the arch-gravity Frera di Belviso Dam, which is designed to be built in two separate stages (Fig. 1). Because of the particular shape of the joint between the successive construction stages, the static behaviour of the completed dam involved problems which could be studied only on an experimental basis.

Outside the sector of dams, different structures and structural components have been investigated. For instance, studies were conducted into the actual pushing action exerted by pulverulent materials (cement) in high storage silos. Researches were carried out, by laboratory and site tests, on the static behaviour of pre-stressed concrete penstock and aqueduct pipe, in different practical cases involving pressures from 50 to 350 tons per square meter. The Institute has already completed the experimental tests on a 1:15 scale model of the skyscraper which will be built in Milan for Pirelli Co. to a height of 450 feet above foundation level. The reinforced concrete structure was modeled in its essential lines, basically respecting cross-sections, moments of inertia of the individual parts and the rigidity of the joints. The model was built of a pumice-cement mixture reinforced with iron wire and mesh. For the foundation slab, the pre-stressing framing was also reproduced. Particularly interesting were the wind-pressure tests, conducted by measurements under static load by recording of the dynamic effects. In addition to the stress pattern, these tests made it possible to ascertain periods and accelerations involved in connection with bending and torsion oscillations.

The basis of this brief and incomplete review of the activities of I.S.M.E.S. is to show, in the light of facts, that testing structural models is not only useful towards the distant goals of progress, but also serves the cause of immediate economy. It is worth recalling—as written by Prof. Danusso, the Institute's President—that we are still forced to use but a small fraction of the actual resistance of the construction, since we must provide a wide margin of safety against our own ignorance. This margin can be largely reduced by using models, which come much closer to reality than any calculation, and therefore can give much better answers for many construction problems.



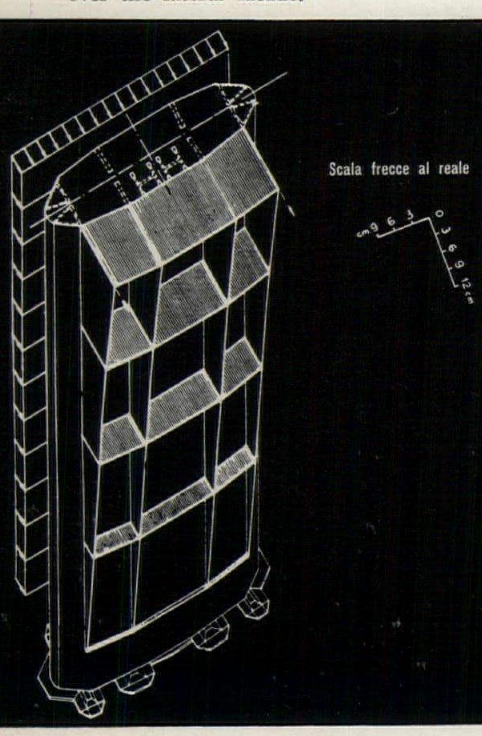
Vibrating table for Earthquake Test. Model (1:75) of the Ambiesta dome-type dam ready for seismic tests.

EXPERIENCE AND THEORY IN BUILDER'S TECHNICS

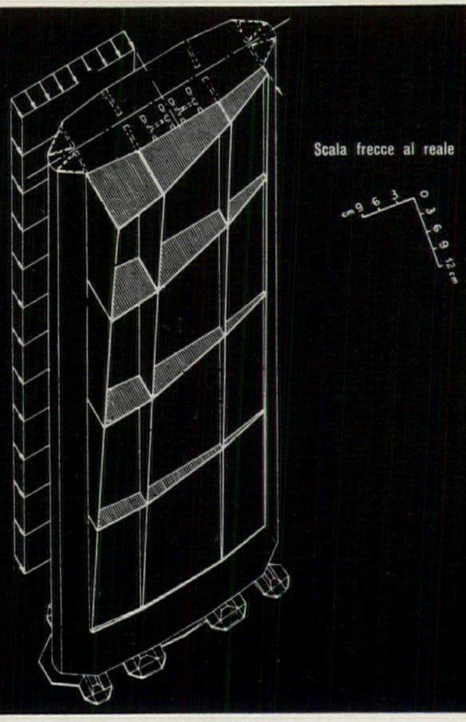
by Dr. Ing. Arturo Danusso

Dr. Ing. Arturo Danusso is the president of the Instituto Sperimentale Modelli. The following article appeared originally in a publication devoted entirely to the Pirelli Building.

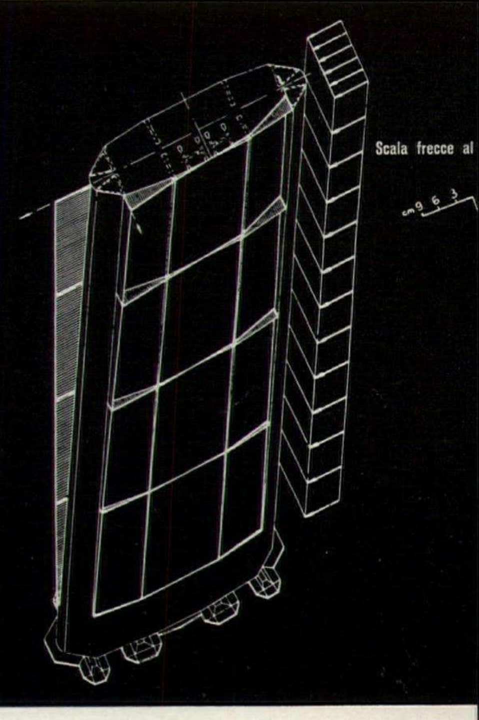
The Pirelli skyscraper model. Elastic deformation of the building due to a uniform wind pressure (112 kg/cm²) over the lateral facade.



Deformation similar to drawing at left but limiting the application of the wind to only half of the facade.



Wind applied normally to the precedent direction affects the building longitudinally. Because of assymetry (which results from the location of the elevator core), the deformations parallel to the wind direction are accompanied by torsional deformations.



The sciences of nature, which the engineer utilizes to solve the problems of technics are, like every other form of research, born in contemplative exercise. The student, who must above all have the thirst for truth, is stimulated by the perceptible revelation of nature, he observes it and seeks to adapt it to his own intellectual plane. Side by side with the objective reality of the phenomena there arises —and is perfected—a harmonious structure of thought which strives to mould these phenomena, to compare them with each other, to reduce them as far as possible to a simple and unitary chain of causes and effects. If it is not intended that the structure should degenerate into a fanciful dream of the intellect, which slips readily from the actual to the possible—for it finds them both compatible with inner logical discipline—it is necessary for the paths of thought to cross frequently those of experience, which in each case has the last word. The admonition, "First consult experience, and then reason," can also become accidentally inverted; but one cannot speak of true natural science until reason and experience have decided unanimously.

In the Land of Leonardo and Galileo this premise may seem superfluous. But it is in fact only so for those who fully understand the expressions of scientists of great worth, who in expounding the theories representing the phenomena never omit to mark very clearly the limits of the field of validity—often very narrow—within which these theories retain their expressive value. But the premise is necessary for those—and they are not few—who learn to apply the theories while losing sight of those limits, and they are aided in this by too much literature studied at second hand, which under the pretext of simplifying the applications, propagate processes and exemplifications without insisting upon the principles of the theories and their limits of validity.

Then, since it is maintained that a calculation—whatever it may be—must accompany every plan (this is drawn up as well as can be on the basis of current schemes) —even when these no longer remotely represent the complex reality of the problem under study. When the mantle of severe criticism is cast aside everything becomes possible. Unrestrained imitation arises to a place of honour, and with it is relinquished that bit of individuality which everyone should cultivate and which no scientific publication can ever supplant. One can readily understand why it is convenient for planners and checkers to find tabulated, regulated and rendered mechanical what others have discovered or gained through hard work. But the sense of criticism must also be present to advise what correspondence there is, if any, between the proposed scheme and the reality which it is intended to represent.

These remarks take no particular significance when the research touches on the stability and economy of building structures—a field in which, on the one hand the responsibilities of the technician pile up, and on the other the divorce is deepened between the attractive elegance of the classical treatments and their limited validity in relation to the problems propounded by modern technics. The characters which these problems set on the stage—stresses which strain the structure and the deformations attending them, regulating its resistant behaviour—give name to two numerous families whose members interfere profoundly with one another. Number and interferences disclose the wealth of the natural process whereby the construction, variously put to the test, is nevertheless assisted by a thousand resources in its resistant task; while they also explain the want of scientific interpretation, which cannot approach that process except in cases of extreme simplicity, ideally thought out, to which the true ones must be led back forcibly, with every kind of compromise, to end up somehow or other.

The fault is therefore at the root, and reveals the absolute need for finding the remedies by making direct contact with nature through experiment. And here a morphology and syntax are sketched as in the study of a language. On the one hand one must know the construction materials and test them singly on isolated samples to ascertain their qualities and resistant properties; on the other one must see whether the overall—I would say social—function of the buildings constructed with them will discharge, without waste or deficiency, the task of ensuring stability, of which the quality of the materials is a necessary, though not sufficient condition. This solution springs from the attitudes the structure becomes capable of assuming by virtue of constructive wisdom is designing and executing —a wisdom that, while aiming at functionality in the structure, defines it in beauty more than is usually thought, for in works commissioned not according to idle whim, but with a positive end in view, beauty accords with the proportioned fulfillment of this end.

To test structural behaviour, load tests and deformation readings are carried out on models similar to those customarily built by architects mainly for aesthetic purposes. The schemes in the forefront when the aid of experiment is not resorted to, now retire to a subordinate place and leave supremacy to the model which—when its resemblance to the prototype is accurate—is used to call on nature herself to reply with facts to the questions which, together with facts, are put to her. The student has no longer before him the tangled mass of a toilsome, not to say inadequate instrument of calculation, but the living picture of nature in action. Instruments afford him the analysis, while the eye gathers in its synthesis. The two stimuli merge in a restful vision of unity, solving the current problem and instructive for future ones.

To the objection that modelling merely shifts complication of the problem from analytical difficulty in calculation to the achievement of resemblance in the model, it can be argued that the multiplicity of actors intervening in the phenomenon, and their reciprocal interferences, chiefly obey only three directors: mass, length and time. When the scale is allotted to each of these the phenomenon is disciplined. This does not mean that practical fulfillment requires no due attention and presents no difficulty. The materials of the model must imitate the actual building in qualitative behaviour, and together meet the various demands of density and deformability. The instruments require continual care and improvement—and above all the experimenter must perfect his sensitivity and intuition unceasingly, for due to him is the honour of receiving the voice of nature directly and making himself its interpreter. This voice, listened to humbly, teaches many things, corrects forecasts, at times sends sky-high provisional schemes on which it was thought one must insist, and suggests fresh ones. One example among many: the 1:25 scale model of the metal trestlework pylons supporting the Calabro-Siculo electric cable was subjected to the equivalent of a regular synchronous earthquake, intensified with a view to breaking it, and disclosed an unexpected way to safety. At the beginning of the critical stage plasticizing of the joints slowed down the frequency of the pylon's sway and thus simply saved it from the serious coincidence of synchronization, which of all was the most feared.

Another example. The 1:40 scale model of the large retaining dam at Pieve di Cadore—originally planned according to the dictates of theory—revealed a wiser behaviour in the experimental test than was to be foreseen, consequently allowing economies, successfully achieved in a second model, which afforded a saving of around one billion lire (around $1,540,000) in the actual building.

This brilliant result assisted the formation of the Istituto Sperimentale Modelli e Strutture (I.S.M.E.S.) in Bergamo, financed by electricity companies, Italcementi and a group of building concerns—which has been in existence for six years, regularly testing large models of dams and various buildings. One of the more important of these is the Pirelli skyscraper, entirely reproduced in reinforced pumice concrete on a scale of 1:15. Vertical loads and horizontal thrusts were applied in proper scale, representing the effect of wind acting head-on or side-on—this latter totalizing or partializing the surface involved in order also to achieve torsional effects.

Application of the wind was first static or permanent, and then sudden to simulate a gust and thus promote the sway and estimate its frequency. The inflections for each type of load were measured, and then the local deformations, thereby giving the stresses in the supports. It is noteworthy, for instance, that the wind pressing on the entire side of the building at a rate of 100 kg. per sq. metre (approximately 170 lbs. per sq. yard), would shift the summit about 10 cm. (app. 4 inches) and cause it to sway with a complete period of little less than 4 seconds. This means that in the case of strong gusts, the occupants of the floor would take a walk of 20 cm. (app. 8 inches) in little less than 2 seconds, if the hypothetical conditions could be produced (regular, instantaneous gusts extending uniformly over the entire facade of the tower measuring over 7000 sq. metres (app. 77,700 sq. ft.), or a succession of gusts like this, rhythmical with the frequency of the tower itself.) In actual fact this supposed regularity can be considered as rare as the non-dangerous earthquake to which it could be compared.

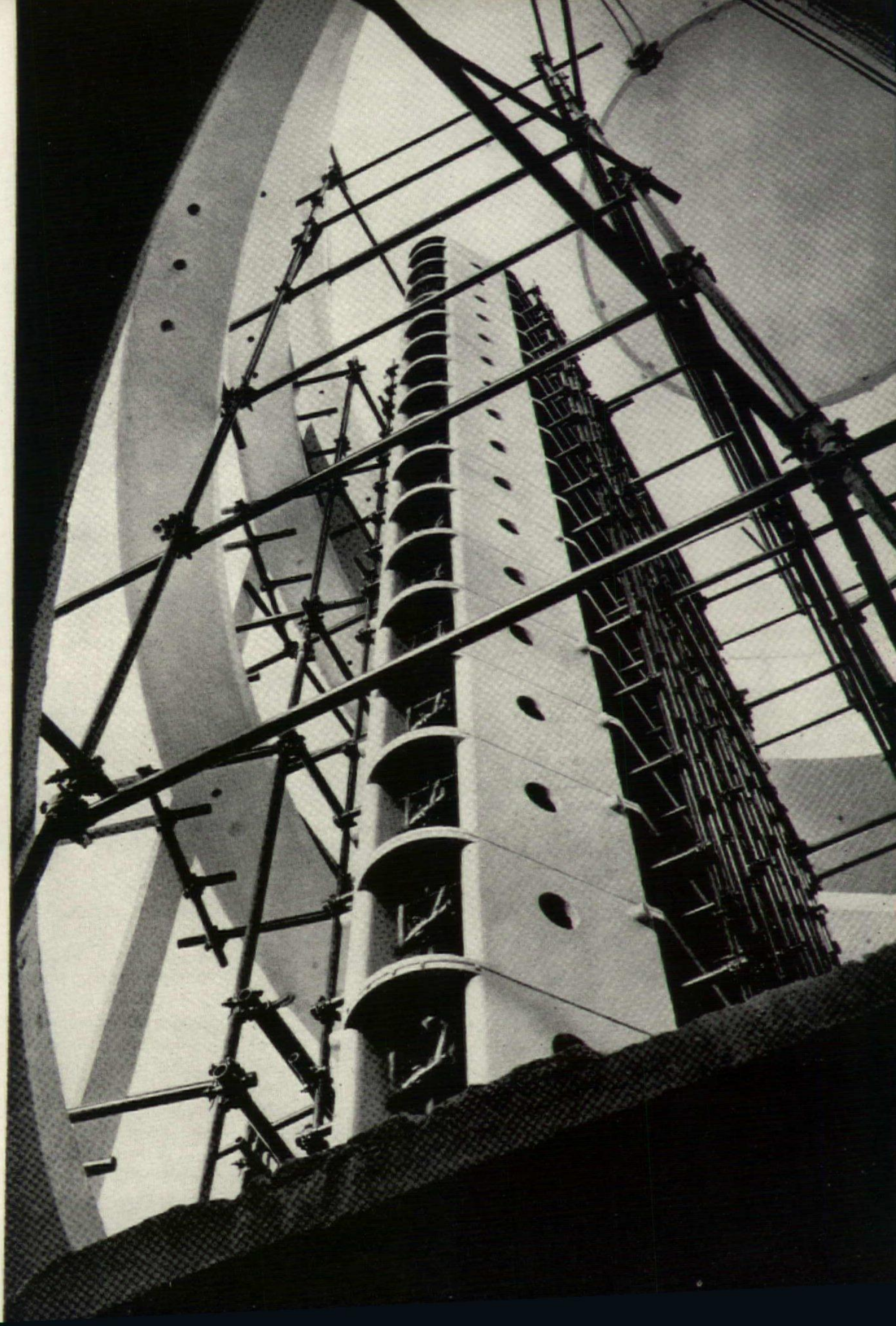
Having successfully concluded the test under the foreseeable loads, also for the extent of the maximum measured stresses, the model was then tested with higher loads to ascertain the margin of safety dividing the normal state from the state of danger. It was found that by applying the above-mentioned ideal wind with pressure increased to 170 kg. per sq. metre (app. 285 lbs. per sq. yard), the resultant maximum stresses would barely reach a third of those capable of crushing the supports.

The information provided by models is therefore valuable for the single case, or for its contribution to the general view of the problems, by disclosing dangers or useful resources concealed in the natural event, and by presenting new hypotheses of work for perfecting scientific theorization.

Yet despite these virtues, structural models are still widely underestimated and misunderstood. The now deprecated illusion persists that calculation has relegated the old building sense to empiricism and has validly replaced it. The creative idea and the static, which formed a whole in the mind of the architect, are artificially divided. The static is usually regarded as an accessory service with which the architect is not concerned and the contractor doesn't appreciate (as long as he gets into no difficulties) because he doesn't find it among the items in the invoice, which particularly attract his sensibilities. Rarely is he made to see that it is to his advantage to leave the static to the architect in planning, to obtain a more systematic solution and be sure of a delicate operation vouching for sound —or rather not dangerous—economies.

In this climate it is natural that the structural model should appear superfluous, or be considered unduly costly because it is underestimated. In actual fact the outlay is largely profit-bearing for the reasons we have shown. Even in his day Michelangelo stated this in a sentence as sculptural as was his entire mode of thinking: "The money most blessed by whoever wishes to build is that spent on the models."

Modern technics are confirming it.



The test model of the Pirelli skyscraper. Scale 1:15.

THE AESTHETICS OF PLENTY

By James M. Fitch

James M. Fitch, associate professor of architecture at Columbia, has contributed to a number of national magazines and has been an editor of *Architectural Record, House Beautiful* and *Architectural Forum*. He is also the author of *American Building: The Forces That Shape It*. The following article appeared originally in the *Columbia University Forum* and is reprinted here by permission of the Editor.

The stylistic distance between the antiseptic geometry of the new Seagram Building in New York and the absurd vulgarity of this year's Buick automobile is a measure of the crisis in American design today. It would be hard to find another period in all history which presented such esthetic antitheses. For these two objects do not even belong to the same spectrum of design: one is an aristocratic affectation of poverty, the other a *nouveau riche* ostentation of wealth. One draws its forms from Procrustean concepts of mathematical order; the other from the paperback literature of space-age warfare. And in between these poles, with no more apparent relation to each other than the constellations of the Milky Way, lie all the other artistic phenomena with which our landscape is littered—Tiffany glass and abstract-expressionist painting, wagon-wheel chandeliers and molded plastic chairs, Italian shoes and Danish furniture, Japanese screens and African sculpture, push-button electronic ranges and open-pit charcoal braziers.

There are some odd and contradictory forces at work among us.

One increasingly popular explanation for this parlous state of affairs, is simply that of our wealth: our design is flabby because we are too rich. The corollary of this thesis is that our design would improve if we were poorer: art thrives only in a garret; artistic creativity requires the astringency of poverty. All this has a fine, mellow ring, but history, unfortunately, gives it no support. High levels of artistic accomplishment occur only in wealthy cultures. Far from being the enemy of artistic productivity, social wealth seems to be its indispensable base. But this proposition cannot be read backwards; great social wealth is no *guarantee* of great art. If it were, we would not face our present dilemma.

Perhaps we should phrase the question this way: if great wealth produced great art in Fifth-Century Athens, among the Ninth-Century Mayans, or in Fifteenth-Century Florence, why not in Twentieth-Century Detroit? Could it be that our problem is not wealth but the *conditions under which it is applied* to artistic production?

To ask the question is to answer it. Modern industrial civilization has produced unparalleled social wealth. It has, at the same time, introduced several new and entirely unprecedented factors into the process of design. Only consider:

1. Industrial civilization, through mass production, has robbed all of us of first-hand knowledge of how any object is made or how it works. It has correspondingly crippled our ability to evaluate critically the object's practical or esthetic values. It has made the citizen into an ignorant consumer, the designer into a powerless, isolated specialist.
2. We have, at the same time, been given a more imperious command of tools for making things and new materials out of which to make them than Pharaonic Egypt, Augustan Rome, or Victorian London ever dreamt of. These tools, these materials confront us with properties, potentialities, and limitations of almost stupefying complexity.
3. Pre-industrial limits of time and space have been destroyed. We are exposed to the stimuli of the art and artifacts of all times and places. Into our unready laps is hurled a torrent of dazzling images and objects, ranging the whole world and the whole product of human history and pre-history.

Any one of these developments, taken by itself, would have an unsettling effect upon the esthetic equilibrium of a culture: taken together, their impact threatens to be disastrous.

Esthetic standards, in any period before our own, were strictly conditioned by what one might call the politics of handicraft production. The consumer of the artifact came face to face with its producer. This producer was, at the same time, the designer of the artifact. Under such circumstances, debasement of workmanship or irresponsibility of design was difficult: opportunity for the one and incentive for the other were greatly restricted. The consumer was literate in these matters: if the roof leaked or the shoe squeaked, he knew exactly where to find the designer-producer. Moreover, he was apt to know exactly what was wrong. In a pinch, he could probably patch a roof or make a shoe himself. At the very least, he would know what the craftsman ought to do and how he ought to do it.

Here was a happy situation for the designer as well. He knew intimately the limits and potentialities of his tools and materials. He shared the esthetic standards of the consumer. Any change or modification in design had to be worked out within these mutually acceptable limits. There was thus a constant, personal, and lively interchange between them—a very fruitful relationship for both.

With modern mass production, this relationship is radically altered. Milton W. Brown, the art historian, has described the change most succinctly: "The producer, who is more precisely designated by the old-fashioned term *entrepreneur,* takes over one of the functions of the earlier consumer, that of ordering and paying for production. The craftsman becomes a designer whose function it is to create an object that can be mass-produced. The consumer is confined to the truncated function of simple consumption through the process of rejection or acceptance of the finished product."

Under such circumstances, both consumer and designer suffer: each becomes progressively more ignorant of the other's requirements and limitations. For the designer, surveys and market analyses replace the give and take of personal encounter. Less and less able to comprehend the complexity of modern technology, his design becomes more and more superficial, more vulnerable to the pressures of fad and fashion. And the consumer—removed by the same specialization from any first-hand knowledge of what he is buying—can only rely upon somebody else's word. He can only express his contentment (or discontentment) by buying, or refusing to buy, from among the range of artifacts offered by mass production. In real life it is difficult for this consumer to refuse forever to buy essentials—a house, a bed, an automobile: so he is forced ultimately to make his choice from available products, some or all of which may be unsuitable or unworthy. In doing so, he abdicates his power—first his voice in design, then his esthetic standards for judging design.

One of the characteristics of contemporary taste is its intense interest in the art forms of the pre-industrial past —folk, primitive, and prehistoric. The reasons for this interest are clear: these objects display a kind of "organic" unity of form and content, an acute respect for their materials, an integrity of line and color, which is in refreshing contrast to the sleazy eclecticism of so much of contemporary design. These objects are admired for their "honesty" and it is easy to assume that this is a direct expression of a poor and backward culture.

But the fact is that any culture which can produce a thrown pot, a woven blanket or a carved stool is already, by anthropological standards, an advanced and wealthy one. Nor are the admirable qualities of this art due to what V. Gordon Childe, the British archeologist, has called "a penury in raw materials." There was never any shortage of limestone in Yucatan, of potting clay in Etruria, or of wood in Japan. The "penury" confronting the primitive craftsman lay not in the amounts of materials available to him but in their narrow range and variety.

In truly primitive societies, trade and transportation restricted artists and artisans to materials locally available. The desert peoples built of mud, the Siberians of skin and felted hair, the Melanesians of palm leaf and bamboo simply because that was all they had. Their energies and talents were focused on a very narrow range of materials and techniques: the unity and coherence of their designs express this fact. Though the commerce and technology of the Classic world greatly expanded the range of raw materials available in its centers, the employment of imported materials was largely restricted to luxury goods by the difficulties of transportation. For example, the import of ivory and silk, gold and tin, by the Roman empire did not free most Roman craftsmen from the necessity of working in local materials, nor Roman architects from building of local brick or stone. And while Roman technology was very advanced for its time, it served largely to produce increased amounts of traditional materials; waterproof cement was one of the very few authentically new materials; small amounts of very expensive window glass may have been another.

Under such conditions, design could develop within a fixed palette of materials and techniques. Craftsmen were familiar with both its potentialities and its limitations as —from long exposure to it—were the consumers. Everyone's critical capacities were thus operating over an esthetic terrain which he knew exceedingly well; and the rate of esthetic change was so slow that accommodation to it was relatively easy.

All this has been altered by modern industrial production. The sheer range of materials and techniques with which it confronts the designer is staggering. Mechanized transportation and communication have, for all practical purposes, made the material resources of the whole world available to him. He can use Italian marble, African mahogany, Javanese teak and rubber as easily as Alabama cotton or Louisiana pine. And this plentitude of known materials is, of course, the least result of the modern revolution; technology has also supplied the designer with an ever-widening range of brand-new synthetic materials: steel, concrete, glass, aluminum; magnesium, rubber, and the whole family of the plastics.

This vastly increased range of materials—natural and synthetic, imported and local—is not a luxury line. Such materials have become the basic stock in trade, often supplanting completely the older, more familiar materials. They are available everywhere, to everyone: not a craftsman or designer alive can be unaffected by their presence. Yet their presence is by no means fully understood. Their physical properties are very complex and their esthetic properties are even more subtle and less explored. And they are dumped upon him in such an accelerating flood that the designer has little opportunity to explore and master them in either practical or esthetic terms.

Though the condition is probably transitory, some areas of the world are still "poor" enough in raw materials to enable us to observe the benign effect of such poverty upon design. For example, it is not accidental that the most brilliant use of reinforced concrete in architecture occurs precisely in those countries which have no steel or wood and plenty of sand and cement—Italy, Brazil, and Mexico. Nor is it accidental that in those design fields where metal is indispensable—e.g. typewriters, autos, trains, etc.—a metal-poor country like Italy leads the world. Here the high cost of metal *forces* responsibility in design; every ounce of material must be exploited to its fullest capacity. Anyone familiar with Italian auto body work must be struck by the extreme care and imagination with which the metal is manipulated. The elegance of the final form is arrived at directly through a responsible handling of its raw materials. It is almost unkind to compare these cars with their American counterparts. The metal out of which these 4,000 lb. monsters are built, and the gas with which they are propelled through the streets, are both so cheap that any design, no matter how preposterous, is perfectly practicable. Since neither economy nor efficiency of design are permitted him, the designer is forced into irresponsibility —as foot-loose and fancy-free with his forms and ornaments as any pastry cook.

The traffic in raw materials has, of course, never been as culturally fructifying as the traffic in concepts and ideas. All societies, past and present, have always been subject to the cultural irradiation which follows trade. For artists and artisans the significant instrument of this irradiation is always the art form, whose visual stimulus is stronger than 10,000 words. Thanks to modern archeology, the flux of these stimuli from one culture to another can now be traced in all its richness and diversity. And it seems apparent that few designers have ever worked in absolute isolation from their neighbors: even in prehistoric times, the extent of cultural intercourse is amazing. Nevertheless, the designers of the ancient world worked under conditions quite different from our own. The Etruscans afford an excellent demonstration of this difference. This gifted people, because they possessed at Elba and Populonia the largest metallurgical complex in the Mediterranean, were the focus of a lively commerce with Greece, Phoenicia, and Egypt. The impact of the art and artifacts imported from these more advanced cultures is readily apparent in the development of Etruscan art. Yet the impact was always successfully absorbed and digested: the rate of irradiation from foreign design was never great enough to overwhelm the Etruscan artists. We may speak of Hellenizing or Orientalizing periods in their art: but the objects themselves remain indisputably Etruscan.

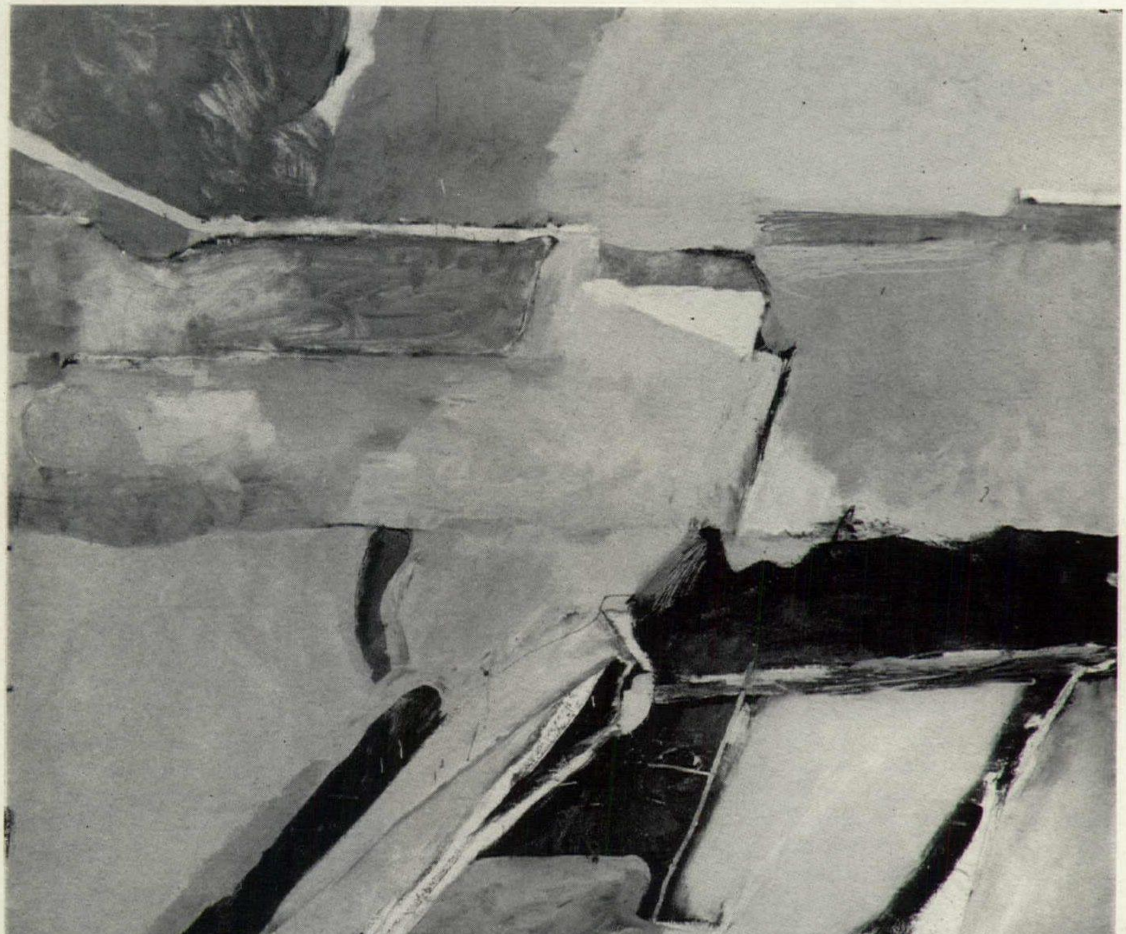
Though this irradiation was steadily to accelerate in Western history—witness the speed and thoroughness with which the idiom of the Italian Renaissance was stamped upon the whole of Europe during the sixteenth and seventeenth centuries—it continued to be more or less successfully absorbed by the cultures involved. Even as late as 1800, a balance was somehow maintained. The architecture of Boston, Philadelphia, or Baltimore, for example, was still a model of esthetic homogeneity at this time. Despite increasing trade with such exotic areas as Africa and Asia, despite a technological revolution by then already well advanced, architects and craftsmen were still confined to a narrow range of familiar forms (Greco-Roman and Renaissance), as well as to a very restricted list of traditional materials (wood, brick, stone, and plaster). All this has changed today: those same cities are now models of visual anarchy. And the change began precisely at this time, when modern technology—allied with modern scholarship—began to make available to American designers not only the world of contemporaneous art but also that of the past.

The development of travel and communication in the nineteenth century was shattering enough. The steamship and railroad, the cable and telegraph, the illustrated book and magazine, the photograph—all of these began to bombard the retina of the American eye with a dazzling range of stimuli. No Etruscan had ever been so bedazzled. And no man of the ancient world had ever been exposed to such unnerving influences as the art museum, the art critic, the art historian, and the archeologist. Their discoveries, like acid, ate away the very foundations of esthetic provincialism, introducing the concept of relativity into what had been absolute esthetic standards. Nor was this experience peculiar to the designer: on the contrary, literate and prosperous consumers were reading the same books, making the same tours, visiting the same museums. Esthetic standards had been, as the chemist would put it, "placed in solution."

Contemporary scholarship continues the process, extending our literacy to unprecedented dimensions. We can be equally familiar with (and fond of) the paintings of the prehistoric caves at Dordogne and those of Caravaggio, with the Japanese farm house and the Pompeiian villa, with Incan cast gold and Victorian cast iron. And anthropologists and sociologists have dissolved another set of provincialisms: we can no longer reject a war club because it was once the instrument of a cannibal nor disdain a Mayan temple merely because of a difference of opinion over human sacrifice. The majesty of these accomplishments of scholarship is apparent; but their effect upon contemporary design is not always benign. To be sure, this cultural irradiation has invigorated giants like Wright or Picasso: we lesser men are often paralyzed. We are told, for instance, that Detroit designers, in styling the 1959 automobile, are turning for inspiration to "a pre-Incan vase . . . a Pennsylvania Dutch cookie mold, the leaf of a tropical plant . . . the art of Michelangelo and a wooden food grater from the Orinoco Indians"! Any of these images might, of itself, be beautiful, though their applicability to autos may seem remote :their superimposition can lead only to anarchy.

To diagnose the sources of our present dilemma in design is, unfortunately, much easier than to prescribe the cure. The accomplishments of our industrial civilization are too real and too profound to relinquish. In the light of modern scientific knowledge, it is clear that the independent artisan cannot adequately feed and clothe and house the world: he cannot now and never could. We cannot very well outlaw new materials or proscribe new techniques: penicillin and space ships are not produced by peasants. Least of all can we censor art or license museums, since these are among the noblest accomplishments of our culture.

It is, apparently, *ourselves* that we must change. And to accomplish this, we must educate ourselves—educate so much more profoundly than we presently do that the imagination boggles at the task. It is quite beyond the capacities of this writer to attempt the definition of what this new educational process might be: but where design is concerned, a few things are already clear. In a world of increasing specialization, where working hours are more and more devoted to the narrow and special, the rest of life must be devoted to mastering the broad and general. The deep but limited wisdom which comes from first-hand experience must be supplemented by first-rate theoretical understanding. And if industrialism has ruptured the traditional relationships between artist and audience, artisan and consumer, specialist and layman—then new and improved relations must be evolved to replace them. For an age which has split the atom, this should not be impossible: but a rocket to the moon will seem both simple and unimportant by comparison.



Richard Diebenkorn (American, born 1922), *Berkeley No. 8*. Oil on canvas, $69\frac{1}{4}$ x $59\frac{1}{4}$ inches.

THE GIFTS OF DR. WILLIAM R. VALENTINER

One of the greatest champions of the arts in our time and the first Director of the North Carolina Museum of Art died on September 6, 1958. Dr. William R. Valentiner was a world-renowned authority on universal art, a distinguished art historian, and a noted author of books and articles on various aspects of art.

He was also a true patron of the arts. He not only encouraged many of the best artists of this century, but he also did pioneering work in acquiring the work of these artists for American museums. He bought the first Matisse in this country for the Detroit Institute of Art in 1922, and he has given works by Nolde to the Museum of Modern Art and by Francis Bacon to the Detroit Institute. His gifts to the North Carolina Museum have been extensive. Recently he gave several works by Kirchner to the Museum after holding an exclusive Kirchner exhibit. He has also given works by such Raleigh artists as Duncan Stuart, George Bireline, Enrico Montenegro and many others. Several of these recent gifts to the Museum are reproduced here.

BIOGRAPHICAL SKETCH

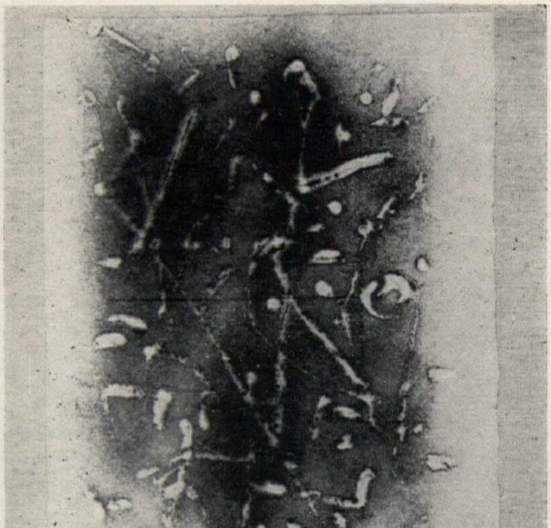
William R. Valentiner was born in Karlsruhe, Germany on May 2, 1880. He attended the Universities of Leipzig and Heidelberg. In 1919 he married Cecilia Odefey and they had one daughter, Brigitta. He was the curator of the decorative arts at the Metropolitan Museum of Art (1908-14), adviser (1921-23) and then Director of the Detroit Institute of Art from 1924 to 1944. He was Director General of the Masterpieces of Art Exhibit at the New York World's Fair in 1939. From 1946 to 1949 he was Director-Consultant and Chief Curator of the Department of Art, Los Angeles County Museum, and later he became Consultant to the Board of Directors of the Los Angeles County Museum (1949-53). He served as the Director of the J. Paul Getty Museum at Malibu, California (1954-55). In 1955 he became the first Director of the North Carolina Museum of Art.

He was the author of the following:

Rembrandt und seine Umgebung, 1905; Rembrandt in Bild und Wort (with Dr. W. von Bode), 1906; Catalogue Raisonné of the Works of the Most Important Dutch Painters of the Seventeenth Century, Vol. I (with Dr. C. Hofstede de Groot), 1907; Handzeichnungen altholländischer Genremaler (with W. von Bode), 1907; Rembrandt-Des Meisters Gemalde, 1909; The Art of the Low Countries, 1914; The Late Years of Michelangelo, 1914; Umgestaltung der Museen, 1919; Zeiten der Kunst und der Religion, 1919; Schmidt-Rottluff, 1920; Georg Kolbe, 1922; Rembrandt Handzeichnungen (vol. I), 1923; Rembrandt, Wiedergefundene Gamalde, 1923; Frans Hals, 1923; Nicolaes Maes, 1924; Jacques Louis David, 1929; Pieter de Hooch, 1930; Rembrandt Paintings in America, 1931; Rembrandt Handzeichnungen (vol. II), 1934; Tino di Camaino, 1935; Frans Hals paintings in America, 1936; Letters of John B. Flannagan, 1942; Origins of Modern Sculpture, 1945; Studies of Italian Renaissance Sculpture, 1951; also catalogues of Johnson, Goldman, Mackay, Widener and other important private collections, Hudson-Fulton Exhibition, 1909, Rembrandt Exhibition, 1930, etc.

He was the Editor of the following: Unknown Masterpieces, 1930; Frans Hals Exhibition of 1935; Leonardo da Vinci Exhibition of 1949; Catalogue of Paintings, North Carolina Museum of Art, 1945, and *Art in America,* 1913-31. He was Co-Editor of *Art Quarterly* from 1938 through 1956.

Robert Motherwell (American, born 1915), *Ile de France*. Ink with water color, 7 x 10 inches.



Mark Toby (American, Born 1890), *Calligraphic III*. Monoprint, 18 x 11¾ inches.

Emerson Woelffer (American, Born 1914), *The Sea*. Oil and collage on canvas, 36 x 29½ inches.

C. S. Price (American, 1874-1950), *Two Heads.* Oil on board, 15½ x 20¼ inches.

PARAPSYCHOLOGY

THE SCIENCE OF A NEW REALM OF THE MIND

The author of this article is an Associate Researcher at the Parapsychology Laboratory at Duke University.

INTRODUCTION

Parapsychology is the branch of inquiry which deals with non-physical personal phenomena. It is the scientific study of "psi" which is popularly called "psychic phenomena". These phenomena can be either subjective experiences or physical effects. The subjective experiences are called Extrasensory Perception (ESP for short) and are defined as the awareness or response of something outside of one's self which is acquired without the use of the senses. It includes: (1) clairvoyance, or the ESP of an object or objective event, (2) telepathy, or the awareness of the thought or mental state of another person, and (3) precognition, the foreknowledge of future events by means of ESP.

ORIGINS

Since the beginning of recorded history, stories of these phenomena have been recorded in the various civilizations of the Orient and the Occident. A fairly considerable literature was devoted to the subject. The Stoic School, in particular Chrysippus, collected innumerable responses "all with reliable authority and testimony" (Cicero). Plutarch wrote that the Temple at Delphi "is accustomed to the delivery of certain oracles instantly, even before the question is put."

But the first "checking" was carried out in the fifth century, B. C. by Croesus, King of Lydia, who sent messengers to different oracles with the instructions to ask the same question on the same day. The question was, "What is the King of Lydia doing at this moment?" On that particular day Croesus went through the most improbable thing a king could do: he cut up a tortoise and a lamb and cooked them in a brass cauldron. The famous oracle at Delphi is said to have guessed the correct answer.

Later Saint Augustine gave a careful and sober description of a clairvoyant, Albicerius, who once was simply told that "someone has lost something", and he then quickly gave the name of the man, said that he lost a spoon, and described correctly the place where it could be found. Augustine recorded many other phenomena and claimed that even though there had been some failures the super-normal powers of Albicerius had been demonstrated.

More recently there is the famous case of Emmanuel Swedenborg who, among many other phenomena, wrote a letter to John Wesley naming the precise date of his own death. And Mark Twain, who searching frantically for an old article which he had published years before, was stopped by a stranger on Fifth Avenue and told: "I have been saving these clippings for you for years, and this morning it occured to me to find out and give them to you". The package contained the article for which Twain had been searching.

Those phenomena happened spontaneously and are still happening today. They are classified under the name of "spontaneous cases", and are defined the "natural unplanned occurrence of an event or experience that seems to involve parapsychical ability". Thousands of them are reported. Here are a few examples:

"July 1951. Awoke sitting straight up in bed at 4:00

a.m. and had foreboding that something serious was about to happen. At 4:10 a.m., my husband turned over in the car he was driving."

"My husband and I were visiting in Raleigh, at about 8:30 p.m. I had an unexplained, strong urge that I must come home but I was unable to get my husband to leave. Upon arriving home we found a neighbor had had a serious accident in his home. Since my husband is a physician the wife had come to our house first to get help. From what I have been told the accident occurred between 9:15 and 9:30 and about this same time my strong desire to go home subsided".

"Could not sleep and a friend's name (Mrs. A. . . .) flashed into my mind. I had not seen nor heard of her in over a year. Then there was a definite feeling that this friend was in some sort of trouble and that I must contact her. The next day before I could call Mrs. A. . . , Mrs. B. . . . called to tell me that Mrs. A. . . . had had to leave her husband and that he was being placed in an institution".

There is a great collection of reliable experiences such as these when facts can be checked. But, while they suggest some unexplainable ability of one mind to reach another, they do not prove it conclusively.

The first serious investigation was made in 1882 when a group of eminent English academicians decided to have a closer look at these psychic phenomena and to see if they constituted an evidence of a reality that transcended the physical explanations of Nature. They founded the Society for Psychical Research in London, and began to collect the "spontaneous cases". They were followed by different societies in America and in Europe, but, in spite of their best efforts, it proved impossible to make from them a case so sound that it would refute the engaging but simplified concept of Nature that the natural sciences had universally favored. This concept held that reality had to be defined in terms of the principles of nature filtered through the sensory motor system which was physical. Consequently, the need for experiments was felt and they began to spring up in different countries.

Although the experiments conducted at that time can be criticized by our present standards, they nevertheless accomplished their main purpose, and gave evidence that some "thing" beyond mere chance had been operative. Their reports, published in the *Proceedings of the Society for Psychical Research* and in various books, presented a new claim on the intelligent interest of mankind and a challenge to the current mechanistic thinking on the nature of man. Some of the pioneers in those experiments were themselves distinguished physicists, such as Sir Oliver Lodge, Sir William Crookes, and Sir William Barrett. Later a few psychologists of distinction, like Professor William James, Professor G. Heymans, Professor Henry Bergson and Professor William McDougall gave their attention to the problem.

The experimental work was carried out in psychology laboratories at Harvard, Stanford, and Groningen (Holland), during the first quarter of the twentieth century. They turned out to be short-lived. They were lacking the systematic research program centered in an established laboratory which would elevate them to the rank of a science. To fulfill this need a laboratory was created at Duke University.

ESP EXPERIMENTS AT DUKE

In 1930, under the sponsorship of Professor William McDougall, a parapsychology laboratory was founded at Duke University with Dr. J. B. Rhine at its head. The first problem was to improve the methods of testing. A special deck of cards was designed for the easier investigation of ESP. It consisted of five symbols: circle, cross, waves, square and star. Five of each made up the ESP deck of twenty-five. These cards with the dice (as it will be explained later) play the same role as the T-square and triangle for the architect. In the proper use of the cards, it can be taken for granted that an average score of 5 or 20% rate of success was to be expected by chance alone.

The second logical step was to design an experiment that would be crucial to meet the criteria of evidence. This milestone was reached in 1933 when the Pearce-Pratt experiments were completed. The cards were handled by J. G. Pratt, who isolated them one by one. They were guessed by Hebert Pearce, a Divinity School student who was in another building situated 100 yards away. In the total of 300 trials which were made in the series, the number of hits expected on the theory of chance was 60 or 20%. Actually 119 hits or approximately 40% were made by Pearce.

Such a result could hardly be considered as chance for it would not be expected once in more than a trillion of such experiments. If this result is compared to most scientific experiments, odds of 100 to 1 are considered significant and odds of a few thousand to one are regarded as equivalent to a proof that some factor other than pure chance had been present.

A total of more than 90,000 single trials had been made at the Duke Laboratory in the first three years of operation and the report was published in 1934 in a monograph entitled "Extrasensory Perception". This study brought forth much controversial discussion as well as a fair amount of repetition by other experimenters in America and England. In London, a mathematician, Dr. S. G. Soal of Queen Mary College, carried out an experiment elaborately controlled with a remarkably gifted subject, Basil Shakelton. Starting with a professed skepticism, Soal had his attention directed to evidence of ESP which he had overlooked in his analyses as he was about to report negative results. Along with Mrs. K. M. Goldney he then repeated his experiment under improved conditions and they resulted in an impressive harvest of ESP evidence as a result. In more than 11,000 trials, he scored so high that the odds against the results having been due to chance alone were about one to 10^{35}.

When the reports of the Duke experiment appeared in 1934, orthodox psychologists questioned the soundness of the statistical methods used. This criticism was soon cleared up by a group of members of the American Institute of Mathematical Statisticians. At their annual meeting in 1937 the president released a report that concluded:

> "Recent mathematical work has established the fact that, assuming the experiment has been properly performed, the statistical analysis is essentially valid. If the Rhine investigation is to be fairly attacked, it must be on other than statistical grounds."

After this decisive statement, critics limited their attacks on the experimental set-up. In response an elaborately controlled series was conducted in 1939 at Duke by two psychologists, Dr. Pratt and Dr. J. L. Woodruff. It was probably the most completely controlled experiment ever carried out in a psychology laboratory. The test yielded significant evidence of ESP even though the procedure was burdened with complicated precautions. A total of 32 subjects made 60,000 trials with results that would be expected on a chance basis about one time in a million of such series. The conclusion was reached that "perception without the use of recognized sensory channels" is the only principle which can reasonably account for the results.

In 1937 the Journal of Parapsychology started with Prof. McDougall as one of its editors and has continued publication to the present.

ESP AND SPACE-TIME

How was this ESP effect to be classified, first of all with regard to the field of physics?

One point that had stood in the Pearce-Pratt results was that the average score Pearce had made when he was 100 yards distant from the card was not below that which he had made in experiments in which shorter distances were involved, and even those in which the cards were on the table in front of him. This and other work that followed gave rise to the suggestion that in this kind of test distance was not an important factor, a suggestion that had already been given by earlier work and by the large collection of spontaneous cases in which the persons concerned had been, in many instances, hundreds and even thousands of miles away from the events they clairvoyantly or telepathically perceived.

It seemed to follow logically that if space is not a limiting condition, ESP should be independent of time also. So the next attempt was to discover if the subject in ESP tests could identify a future order of cards in the pack. On this point, too, the collection of spontaneous material offered very definite and clear cut support. In the Duke collection of spontaneous cases made by Dr. Louisa E. Rhine, almost half of the items reported are instances of prophetic or precognitive awareness, most of them premonitory dreams, but many of them waking experiences in which some scene was perceived in advance of its actual occurrence.

On the level of actual testing it was necessary to arouse the subject's interest, and then he was asked to predict the sequence of symbols as it would be after the cards had been rearranged by shuffling. Significant extra chance scoring was produced and the first actual experimental testing of the old claim of prophecy became a matter of record in the Parapsychology Laboratory in December, 1933. But as in the case of telepathy, there was a long development between the exploratory stage in precognition and the definitive experiment.

Even today the state of the precognition research is still a fluid one. The present case for the occurrence of precognition rests on experiments in which the packs of target cards, in addition to being shuffled mechanically in a routine way, were then cut in accordance with a design involving the use of temperature readings published in a specified newspaper on a designated date. The purpose of this complicated ritual by which the target order was arrived at was to exclude any alternative possibility by which significant scoring might be secured; if the results were significantly different from chance and the design was sufficiently sound, the case for precognition would be confirmed.

Evidence of precognition has been obtained in the Duke Laboratory under the conditions described, first by Dr. Rhine and then in a confirmatory series by Dr. Betty M. Humphrey. No other systematic effort, however, has been made to investigate precognition except in the Duke Laboratory, but even here there is not complete satisfaction that the case is water-tight. The reason for this extreme open mindedness to alternative interpretations is the fact that precognition probably represents the most revolutionary hypothesis ever raised in science. It challenges the whole concept of casual determinism as nothing has ever done. For that reason some investigators find it easier to make much of the possibility that a psychokinetic factor might enter into the manipulation of the thermometer or that some other alternative to precognition might have played a part in influencing the weather or the meteorologist who recorded it.

In any case, more experiments in precognition are needed and those which are in process have already been additionally safeguarded. In determining the randomized target order now, a calculation far more complicated than anything yet achieved by the human mind (one that requires an electric computing machine to transact) has been introduced. This is intended to provide a roadblock against any alternative except direct precognition.

PK OR THE INFLUENCE OF MIND ON MATTER

The investigation of PK (psychokinesis) began in an effort to see if the mind can influence matter directly. A suitable test for this hypothesis was provided by a gambler, in February 1934, who recalled that many people believe they can influence the fall of dice by direct action of the will. Here was a method that could be adapted to the purposes of the experiment. Methods of handling the dice could be introduced that eliminated the possibility of manual skills. The test could be so designed that any possible error introduced by inequalities in the structure of the dice could not introduce an error into the interpretation of the results.

After eight years of investigation in which many different individual experimenters took part, the staff of the Parapsychology Laboratory arrived at a crucial type of demonstration of the case for the occurrence of a psychokinetic effect and the result was published in 1943.

These records were the result of eighteen different research series representing different experimenters and different subjects although there was some overlapping. In genral, too, in the different series there were variations in the way the dice were handled, whether thrown from cups or released and allowed to roll by gravity or rotated in electrically driven cages; there was even one series in which they were thrown by hand. In some cases different numbers of dice were thrown at a time, the dice were of different sizes in many series, and different types of record sheets were used. Again, the target face or combination of faces which the subject tried to reproduce with each throw of the dice was determined by different procedures or systems from one series to another. The point is, these were all exploratory experiments, some of them conducted by university psychologists, some by students, and some by others of the university community or its group of friends. They had served their purpose of helping the experimenter to decide whether the dice-throwing technique of testing PK was promising enough to justify further interest.

In 1942, however, Dr. J. B. Rhine and Miss Betty M. Humphrey, looked into the records of all these experimenters for certain declines of scoring rates that had proved to be fairly persistent in the records of the experiments in ESP. They discovered that there was a tendency on the record sheet, no matter what the method or target face or number of dice per throw, to show a falling off in percentage of hits from left to right across the page and from top to bottom down the column. It was a simple matter then to take all of the homogeneous pages, quarter them equally, and compare the percentage of successes. A strong cumulative effect was found as they went from series to series showing that the upper lefthand quarter showed the highest and the lower right the lowest scoring on the page. It was necessary only to evaluate the differences between these two quarters, the first and fourth, series by series and for the entire eighteen series, to see that here was something not reasonably attributable to chance.

For the total accumulated difference the odds were of the order of a million to one that such a result would not be producible from a chance series. Here was an effect that could only be psychological. The dice were the same and the methods of throwing and recording were the same throughout the page. Yet here, as in the ESP records, were evidences of this curious falling off of scoring rate which had become a kind of earmark of the functioning of psi under test conditions.

As in the case of research in ESP, the conclusion regarding PK reached at the Duke Laboratory has been confirmed by results obtained elsewhere. This confirmation has occurred many times over and with certain angles of improved design added to the experimental procedure. For example, Dr. R. H. Thouless (in a series of dice-throwing in which he, himself, was the subject as well as the experimenter) introduced a method of selecting the target face by a complicated design based on the Latin Square method that eliminated the possibility that he used precognition of the way the dice were going to fall in selecting the most favorable target face for a given series of throws.

Dr. Robert A. McConnell of the University of Pittsburgh, using apparatus borrowed from the Parapsychology Laboratory, conducted a series of PK tests in which the dice were handled completely mechanically, and a photographic record was taken of the way the dice fell. His results showed the same type of downward and rightward decline in the set which previous work had shown, and they produced an internal difference of statistical significance that justified the conclusion that PK was a factor.

Just as we came from the experiment in clairvoyant perception over to an experiment in precognition and obtained confirmatory evidence of the prediction, so by similar logic and subsequent experiments we made the jump from the same clairvoyance experiment to the test of psychokinesis, and the effect of mind on matter was indicated. The whole rational network, illustrated by these two cases, has given to the findings in parapsychology a highly integrated interrelationship. A rationale has emerged that to the inquiring scientific mind is the most reassuring aspect of the research. This growing concept of relation led to the hypothesis that in the psi functions we are dealing with one basic subject-object interaction, reversible in type and broad in its scope of range of application, independent of space, time and mass, but lawful and orderly in its own way of operation.

PROGRESS TOWARD RECOGNITION

The revolutionary character of the findings naturally makes for slow acceptance, especially in psychology. It is not surprising, then, that the larger part of the interest and support given the investigations in parapsychology has come from other professions and divisions of inquiry. Psychologists, however, have played their part and the role of this minority is an important one.

Nothing, however, in the history of psychology hitherto has represented the Copernican order of revolution that the introduction of psi phenomena represent. Psychology, following the mechanistic modes of scientific thought patterned after the more successful sciences of the material universe, has attempted to find the entire explanation of human personality in the dynamics of the nervous system. This brain-centered approach to man, this cerebrocentric psychology, has attempted to sweep under the rug the things it could not explain by such means, particularly those occurrences in human behavior that definitely challenge physical explanation.

Now that the issue between the cerebrocentric and psychocentric views of the nature of man has been reduced to experimental test, these school divisions are slowly yielding to the solvent action of factual clarification. ESP is making headway, even among psychologists. Published surveys of the attitudes of younger psychologists toward ESP indicate that progress toward acceptance is much more rapid than among the older men.

Now that the issues that were once so controversial are settled there has been little or no overt expression of criticism. There has even been some progress toward recognition expressed in the holding of conferences, like the International Congress of Parapsychology held at the University of Utrecht (Holland) in 1953 (under the sponsorship of the Parapsychology Foundation of N. Y., the University of Utrecht and the Minister of Education of the Netherlands), the Ciba Foundation's symposium held in 1955, and the like. A center of parapsychology research has been established in the Department of Biophysics at the University of Pittsburgh and a Chair of Parapsychology at the University of Utrecht.

THE PSYCHOLOGY OF PSI

The chief psychological fact about psi that has emerged during these years has been the completely unconscious way in which it operated. At least in the experimental situation, the subject was unaware of how well he was doing even when he was making long sequences of hits in perfect order. He had no introspective guide as to when a true cognitive effect took place or whether or not in any given trial he was right or wrong in the response that he felt impelled to make.

This unconscious nature of psi rendered many of the difficulties and peculiar results hitherto encountered more understandable. For example, the spotty character of the successes in a sequence of trials, the decline in scoring rate as a subject continued through a long sequence of trials, and the tendency shown by some subjects to "displace" in their responses by hitting the card ahead or lagging one card behind as they went through the run of trials in the tests.

During this same period, the effort was made by some psychologists to find a correlation between psi capacity and some personality states and traits. Without attempting to summarize the experimental data some of the general impressions can be mentioned. It is probable that everyone has psi capacity but there are individual differences in the way it functions. The late Dr. C. E. Stuart of the Duke Laboratory pioneered in the study of these associated personality states, and others, particularly Dr. Gertrude Schmeidler and Dr. Betty Humphrey, considerably extended the range of personality correlates included in the program of research. A test situation came out of this broad program of inquiry, but it left the impression, nevertheless, that psi itself is a more basic and more deeply embedded function of the organism than had been supposed.

By the early fifties the accumulated psychological fndings concerning the nature of psi pointed to the necessity of a biological study that such a project was initiated. Preliminary surveys of animal behavior pointed to the dog, cat and pigeons as perhaps the best species to use as starting points for exploratory investigation.

Exploratory tests with cats got under way first, since this species proved to be a more feasible one with which to work. As a result Dr. Karlis Osis and his associates at the Duke Laboratory have now obtained experimental evidence of the operation of psi in the domestic cat. Experiments with the other two species are under way and may be characterized as at least promising, although still inconclusive.

THE MEANING OF THE RESULTS

There are many areas to which it has been applied or some attempt has been made to apply it. Efforts to foretell the future, to obtain knowledge of faraway events, to locate lost objects or underground substances ranging from water to uranium, are only actual visible examples of the manifold possibilities of its application.

Beginning only 75 years ago, with a study of loosely identified puzzling phenomena, parapsychology is dealing already with the essential question of whether or not there are in human life or life at large operations that transcend the boundaries of what is called physical. It is true that the discrimination between the physical and the non-physical is not likely to prove to be a profound one in the long run, as most efforts to divide nature into nice curricular classifications have eventually given way to the essential unity of nature. Just now, however, as the problem is to find what is distinctive about personality, this difference is very important.

Human institutions have been founded on a non-physical concept of man. New ideologies, which have been progressively emerging from the sciences, are derived largely from materialistic and cerebrocentric concepts of man. These ideologies are gaining the ascendancy in our civilization. By using the same scientific methods, parapsycholgy has proved that a non-physical aspect too is a reality. They at least make a beginning for a scientific solution to the great question of the nature of man.

References

Cicero, de Div. i. 3.6; 18.37; 20, 39.
Journal of Parapsychology, Vol. X, p. 290.

"Telepathy and Clairvoyance in Classical Antiquity" by E. R. Dodds.

Contra Academicos L vi sq (Migne xxxii, 914 sq.)

Journal of Parapsychology, Vol. X, p. 307.
"Size of Stimulus Symbols in ESP," J. G. Pratt and J. L. Woodruff.
Journal of Parapsychology, Vol. III, p. 121.

Proc. Soc. Psychical Res.
1940 46, 152, 198
1943 47, 21, 150
949-52 49, 107, 130.

The Reach of the Mind, J. B. Rhine, New York, Wm. Sloane, 1947.

Psychical Research Today, D. J. West, New York, The Macmillan Co., 1954.

New World of the Mind, J. B. Rhine, New York, Wm. Sloane, 1953.

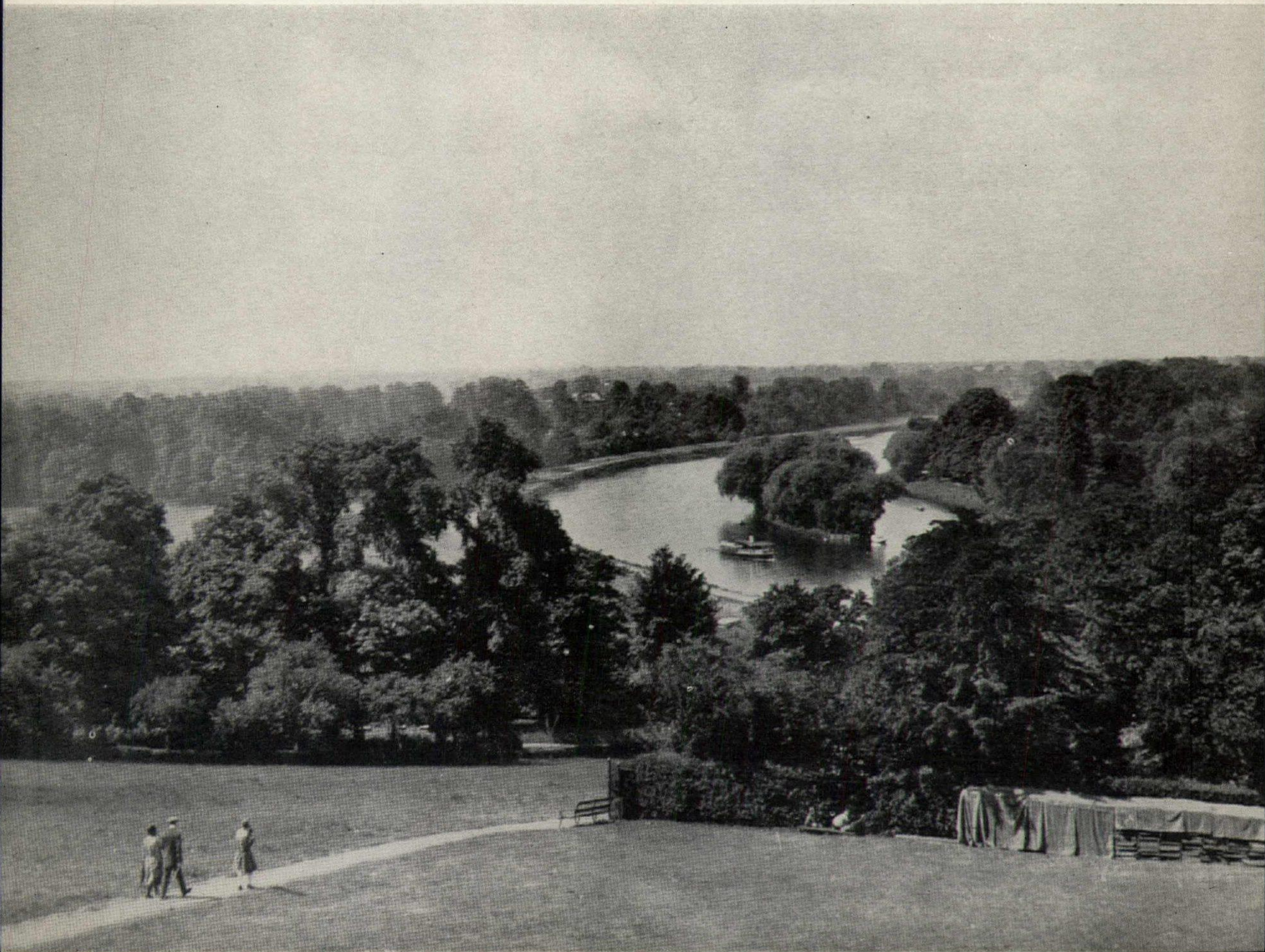
Ciba Foundation Symposium on Extrasensory Perception, Boston, Little, Brown and Co., 1956.

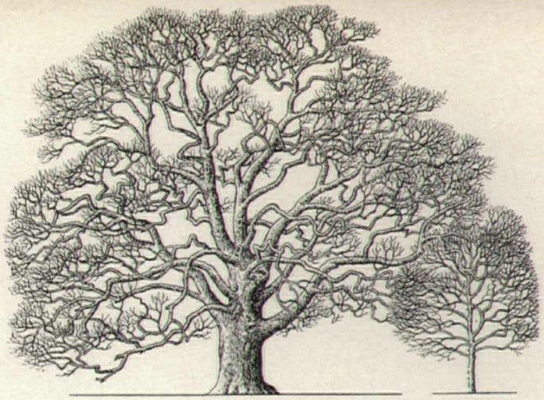
Extrasensory Perception After Sixty Years, J. G. Pratt, J. B. Rhine, B. M. Smith, C. E. Stuart, and J. A. Greenwood, New York, Henry Holt, 1940.

Parapsychology: Frontier Science of the Mind, J. B. Rhine, J. G. Pratt, Charles C. Thomas, Springfield, Ill.

Journal of Parapsychology
1940 6 111, 143, 190, 219.

The Thames from Richmond Hill





THE NEW LANDSCAPE

By Sylvia Crowe

It is a truism that the landscape of a country reflects its civilization. Looking at much of our landscape in Britain, and I dare to say, much of your landscape here, that is a sobering thought. We may pride ourselves on our standards of living, our well-run houses, our hygiene, and yet look at our slag heaps, your dust bowls, both of our litter of unrelated wires, posts, placards, shacks and dirty wasteland.

It is obvious that we have failed to come to terms with our environment and with the rest of nature. For man is a part of nature, despite all his machines, all his double-glazing and central heating. He may get away from the cold and the heat, but he cannot contract out of ecology.

Our biggest job as landscape architects is to find an adjustment between the machine age and the rest of the ecological team that goes to make up the landscape of the surface of the earth.

We have outworn our environment. Just as surely as a plague of rabbits wears out a field of pasture and leaves it a wilderness of thistle and ragworth, so man outwears his habitat.

In primitive times he does it by nomadic agriculture, burning the forest, snatching a quick crop and passing on. In this century he has done it in the dust bowls.

Now we are applying the same technique to our visual landscape. We rip holes in it, thrust in our machines, our buildings, our litter of mechanical toys, our industrial wastes and effluents and do not bother to mend the holes or to clear up after ourselves.

However, there is one big difference between the plague of rabbits and ourselves.

The rabbits can do nothing about it except eventually to develop myxamatosis and die.

But we, if only we will use our sense and our imagination, can do a great deal about it.

We know enough and we have the power to adjust our ecology, to remake our environment into a new landscape pattern. Here and there, in both our countries, there are pilot projects which show how this may be done. T.V.A. is perhaps the most outstanding. But for the most part, we continue tearing ragged holes in the background of the established landscape and being content to avert our eyes from the result.

Here you still have vast areas of self-renewing landscape, but in Britain this background is fast diminishing, and the problem, which even here is serious, with us is becoming desperate.

Why have we got into this mess?

Part of the reason is obvious. There are a great many of us, and, not content with our natural size of about twelve cubic feet, walking around over a few square miles, we have clothed ourselves in tin boxes of about 450 cubic feet operating over hundreds of square miles.

Not content with our eyes, which nature built in for us, we have extended our vision with television masts hundreds of feet high, and our ears with poles and miles of wire.

Instead of using our limited but compact muscles, we use power stations of colossal size.

All this is progress, opening up new realms of human experience and discovery.

But should we not also use some of our new-found power to fit all these extensions of human life into a pattern of landscape which will allow the rest of creation to continue unharried, and which will build for all of us an environment which will give as much pleasure to our eyes as the new machines do to our love of speed and discovery.

We have two choices before us.

We can either build a world in which man is in sympathy with nature and in which he may become the most powerful partner in natural ecology; or we can lose interest in everything which is not made or controlled by us, and trust to our own cleverness to build a world independent of nature.

In my opinion this latter course is madness and the dream of megalomaniacs.

Fortunately it won't work. The forces of nature are far too strong and relentless. They have already given their warnings. In floods and dust-bowls, in falling water tables and contaminated streams.

I say fortunately it won't work, because if it were physically possible, it would leave us spiritually impoverished, without our greatest source of inspiration and without the sense of peace which only harmony with nature can give us.

Therefore, let us see how we may implement the other choice, and go into partnership with nature.

I am not advocating that we should follow Thoreau's example and return to the life in the woods.

Our new discoveries for the extension of our consciousness are a part of evolution to be accepted, used and enjoyed to the full.

Our problem is how to make our new machines good neighbours to the organic landscape.

We must seek a new balance in life, which will be reflected in a balanced landscape, one which includes old and new, art and science, man and the rest of nature.

Because landscape architecture is both an art and a science, and because, in its dependence on organic growth, it recognizes the value of continuity, it has a special role to play in finding this new balance. It is concerned with the relationship of one object to another, and with the creation of that overall harmony which is the hallmark of all great landscapes, whether natural or man-made.

Just as in our lives today, we tend to over-specialization, to the division of science from art, of pleasure from work, so we tend to see all these objects which we are thrusting into our landscape, as separate objects, as things which we can put against some inexhaustible background which we call the landscape, and which we expect to be able to look after itself.

Fifty years ago when the machines for living were comparatively few and tended to be gathered together into urban areas, this attitude was understandable.

But now that the objects are sprinkled thick upon the ground and the backcloth of the old landscape is punched full of holes, we must change our attitude.

Each object must be looked upon as an element in the overall design. Its essential shape must be considered in relation to neighbouring shapes, and, above all, in relation to the landscape as a whole. (I use the word "landscape" here in its widest sense, to include townscape, wirescape, suburbia and all other types of environment.)

Instead of each object being designed from the drawing-board and then transferred to the site, it should be designed from the context of the site, and evolve as the synthesis of its functions and surroundings.

Landscape architecture begins with an assessment of the site and continues as the art which reconciles the object with the site and forms the whole into one composition.

What are the guiding principles in making this composition?

First, a recognition of the basis of good landscapes.

Whether entirely natural or partially man-made, all the finest landscapes have a unity of character. This dominant characteristic may be one of tranquillity or of grandeur, of movement or of domesticity.

Secondly, a true landscape holds together in one rhythmic pattern. If the pattern is broken by a contrast, it is one note of contrast, one focal point, or it may have a pattern or progression of punctuations, like the skyline of New York, or the masts of ships sticking up from a harbour.

Always one element of the pattern is dominant.

Now let us see how this relates to present problems.

In the truly urban town, architecture is dominant, and forms the pattern; trees and parks are subsidiary.

In the old type of country, trees and fields are dominant, buildings are subsidiary.

But now the car has caused us to scatter our buildings far out from the town centre, while in many modern towns the amount of open space is so great that the buildings are no longer dominant.

We therefore have to create a new pattern of landscape in which trees, open space and buildings interlock to form one harmonious whole, combining to form that continuity and rhythm which is essential to the true landscape.

In most of the successful examples of this type of development, trees are the unifying factor, linking the separated buildings together to form the solids of the composition and defining the contrast of the open spaces.

Grouped industry will also form its own landscape, whether it be the almost arcadian landscape of trees and gay buildings found in clean, light industry, or the powerful shapes of heavy industry, whose proper landscape complement is the broad mass of woods, the exciting shapes of carved land-form and the quiet expanse of water. These accentuate the magnificence in the shape and bulk of cooling towers, of reactors, retorts and derricks. Any attempt at pretty landscape and garden features in relation to these huge concerns is a contradiction of their character. All these are the landscapes of grouped activities, but a harder problem arises when the emanations of the machine age have to be sited in a landscape which is primarily natural or agricultural. In these cases, it is more than ever necessary that the landscape architect should be called in before the object arrives on the site. For the first step is to assess the dominant character of the landscape which is to be invaded, and then the character and extent of the new development.

From this we can decide whether the existing character of the landscape should be retained and the new development fitted tactfully into it, or whether a new character should be developed.

A few examples from England may illustrate the problem.

A nuclear power station was proposed for a part of the Snowdonia national park in Wales.

The landscape is wild and rugged; hills, small by your standard but of beautiful configuration, surround a lake.

The only buildings are small farms built of local stone and slate.

The question arises, which is to dominate the view? The old landscape of hill and rock, or the new colossal building?

Shall the building be encouraged to exaggerate its size and magnificence; shall its aura in the shape of a man-made landscape spread out into the surroundings? Or should the building remain subservient to the hills? It is not an easy decision, and in different conditions, either course might be right. But in this case it seemed to me that the latter was the right course, for the following reasons.

The reactor is one construction in a wide natural landscape of one prevailing character, and it is an area where people come to seek solitude and natural beauty. If the proposal were for several giant constructions to be set about the lake, or for a small town to be constructed, then probably the whole character of the landscape should be re-created.

The methods proposed to keep the mountain landscape dominant here are to design the building to lessen its impact of size, and to bring the rugged landscape right up to the building without interposing a zone of urbanization, of rectangular fenced enclosures, trim concrete-curbed roads and garden surrounds. Small ancillary buildings, fencing, switch-gear and car parks will all be absorbed within the wooded platform, augmented by the use of foundation spoil and new planting.

The new building will then rise cleanly like a natural growth from rock and woods, showing its affinity in scale with the breadth of the wild landscape.

The same care in bringing the elements of the old landscape right up to the new constructions, without an intervening zone of waste-land, fences and litter, can help to absorb those ubiquitous transformers that alight in our fields, while the continuation of a whole unbroken landscape beneath pylons and radar masts, can accentuate the fact that these graceful structures belong, not to the earth, but to the sky.

This quiet knitting together again of the torn covering of the earth would make the greatest contribution to a new landscape on the ragged outskirts of our towns, bedding down the fiilling stations, the roadside cafes and the shacks, into a background of uniting landscape.

The two great elements available to form this background are land-form and planting. Between them they can form a sculptural composition, clothing the surface of the earth and containing within their pattern the new constructions.

This type of quiet, unaggressive plastic-surgery landscape is immensely valuable where the old organic character of the landscape is to be retained.

But where the new constructions are to be dominant, we need a more creative approach. Here, completely new landscapes can be designed, new in scale and in form. The new machines take exciting shapes bearing no relation to traditional buildings. The scale is no longer related to the human body but takes on the vastness of the human mind. These are new conceptions for which we must find a new expression.

The speed of light, the immensity of the universe, has to be related to a landscape in which we, and the other inhabitants of the earth, can live without being overpowered by our own creations.

We have found the same patterns running through atoms and constellations; we have discovered machines which will reveal these patterns to us.

Now we must find a habitat which will express these discoveries. This expression, I think, must take the form of an overall pattern, free, flowing and rhythmic, expressive of the fluidity of our new ideas, the scale of the universe, and, within this pattern, cells reduced to a scale which is compatible with the human individual.

Translated into the terms and materials of the landscape, I see this as a broad composition of the new shapes, contained within a pattern of sculptured landform, water and broad woodlands. A basic pattern expressing continuity, rhythm and movement, a pattern of interlocking shapes. No ragged holes, no sudden interpolation of an old-world garden, no niggling scale.

The place for the human cell, the Glorietta, is within the broad framework, as the Spanish patio lies within the building, and the small-scale flower garden lies within the enveloping woods in the English landscape park.

We have two things to guard in our landscape: the old organic pattern of nature, and the new exciting shapes of the machine age.

We can have both, if we decide which is to be dominant where, and if we give up, on the one hand, an insensitivity which allows us to destroy the old, and, on the other hand, a timidity which leads us to hide and to trim, where we should accept and create.

The cathedral has been built to the image of a living body. Its concordances and its balances fit exactly into the order of nature because they are generated by physical laws. The great masters who erected these marvelous monuments possessed the science and they were able to apply it because they extracted from the original sources and because it was alive.

The motion of the human body obeys the principles of unstable equilibrium which is reestablished successively by means of compensations. The leg that supports the body is the only pivot of sustentation and performs alone in this instant the sole total effort. The other leg, which is free, only serves to modulate the degree of stability, only modifies this stability slowly or rapidly, if necessary, until it substitutes and relieves the leg that was supporting the weight. In popular language this is called resting . . . moving the weight of the body from one leg to the other; or it is like a caryatid that is able to change a bundle from shoulder to shoulder.

Such observations have great interest when applied to cathedrals. These perpetual and unconscious gestures of life, such as the compensated unbalance, explain very well the principles which the architects of the vault-supporting arch used when they propped up the heavy roofs of the cathedrals.

* * *

Any rational application of a right principle has healthy consequences in all of the related fields beyond the immediate provisions of learned technicians and artisans. So, the Gothics were great painters because they were great architects. They were painters in a vast and general sense . . . the colors which these artists used were lights and shades at dawn, noon, and dusk. The planes obtained by the great contrasts which the builders of the cathedrals were seeking have not only the interest of solidity and stability, but they also determine the deep shadows and bright lights that provide the building with a magnificent wrap. Because in all cases the smallest elements of truth call for the complete truth, and beauty is not different from usefulness despite what the uninformed may say.

These enormous shadows and these enormous lights are produced by the essential planes and they are the only ones which count from a distance, they are the only ones that are not weak and poor because of the medium hue dominating in them. And despite its vigor or better because of it, these lines and these planes are simple and ethereal. Do not forget, it is the force that produce grace. There is perversion in the taste and spirit of those who seek Grace by way of weakness. The details were made to delight closely and to fill the lines from the distance.

* * *

There were no effects as such in the cathedrals, but effects of such intensity that they resounded far away. In those days the cathedral was raised to dominate the city gathered around as under the protection of its wings. The cathedral was the focus of unity and the refuge of wanderers from remote lands. It was the beacon that reached their weary eyes on the pale horizon, just as the angelus reached their ears at evening. Nature knows also that the perfect equilibrium of volumes is enough to attain beauty. Nature offers even to the greatest beings only the essential . . . but the essential is everything.

* * *

Architecture is at the same time the most intellectual and the most sensible of all the plastic arts. It is the art which requires in a deeper way the cooperation of all human faculties. In no other art concur so actively invention and reason, but no other is more tightly subdued to the laws of the atmosphere, which incessantly bathes the monuments. In order to use light and shade according to nature, and to achieve his purpose, the architect merely disposes of certain combinations of geometrical planes...but what intensity of effects can be obtained with such exiguous means! Are the effects greater when the means are reduced? Yes, because the supreme goal of art is to express the essential. Everything that is not essential is foreign to art. The difficulty consists in discerning between the essential and the non-essential. The more abundant the means, the more complex the difficulties and therefore the harder it is to evaluate the hues in time without violating their natural freedom or betraying the thought whose expression we seek.

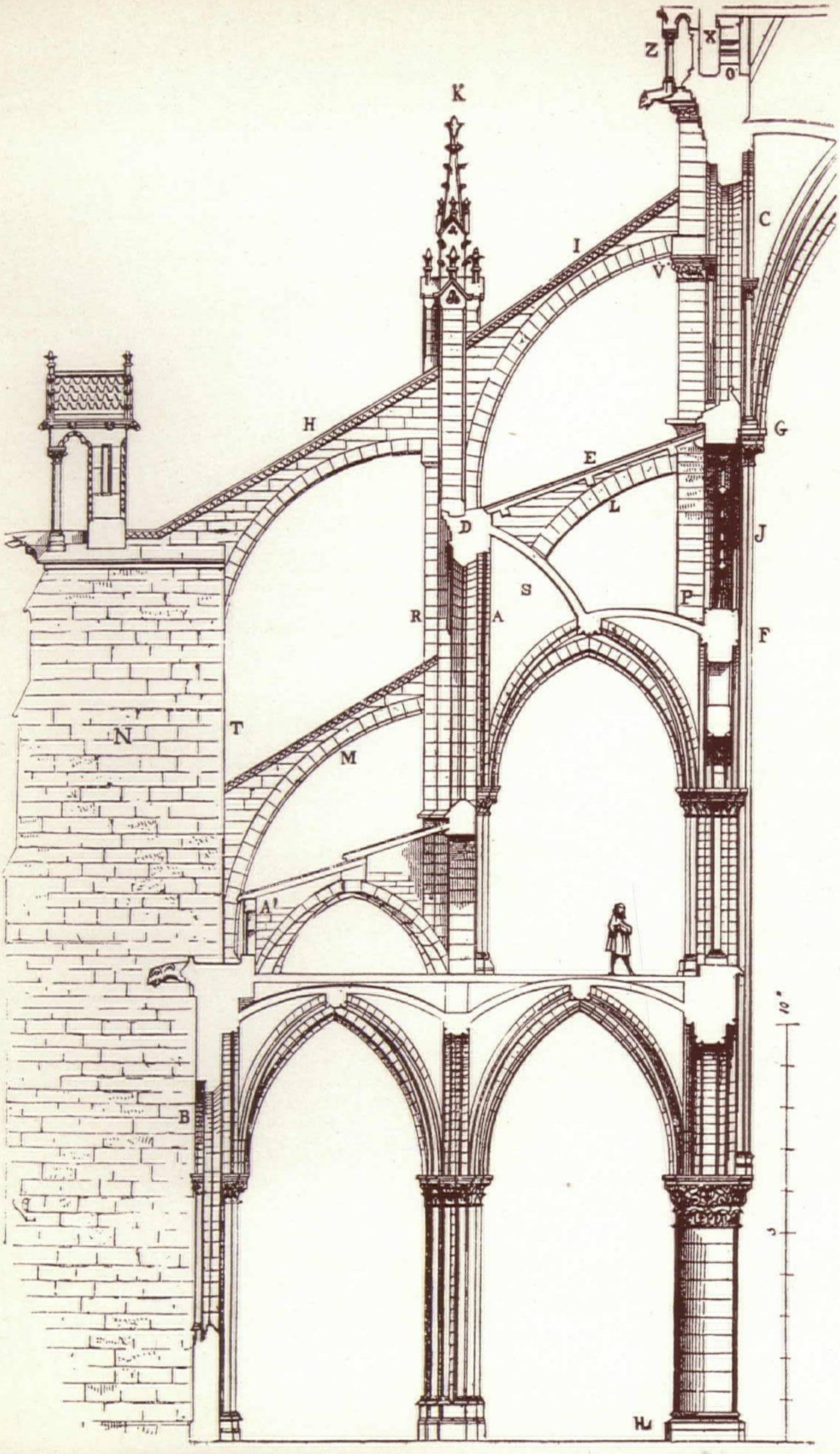
* * *

I know to what extent a master piece is a Masterpiece and I have the joy of knowing it! It is exactly for the same reason that great souls are great souls. It is in ascending up to the indispensable level in the expression of their thoughts and feelings that men and artists achieve dignity. A Masterpiece is necessarily an extraordinarily simple thing that requires only the essential. All of the Masterpieces would be naturally accessible to the people if they had not lost the spirit of simplicity. However, even in times when the people are incapable of understanding, the artist must live with the feeling of the people . . . with the soul of the masses . . . to be able to conceive and to create. He must feel with the multitude even though it is only ideally present. He must understand this with his masters who also became transformed through the people to retake with the heart, by love, what they had discovered by the spirit.

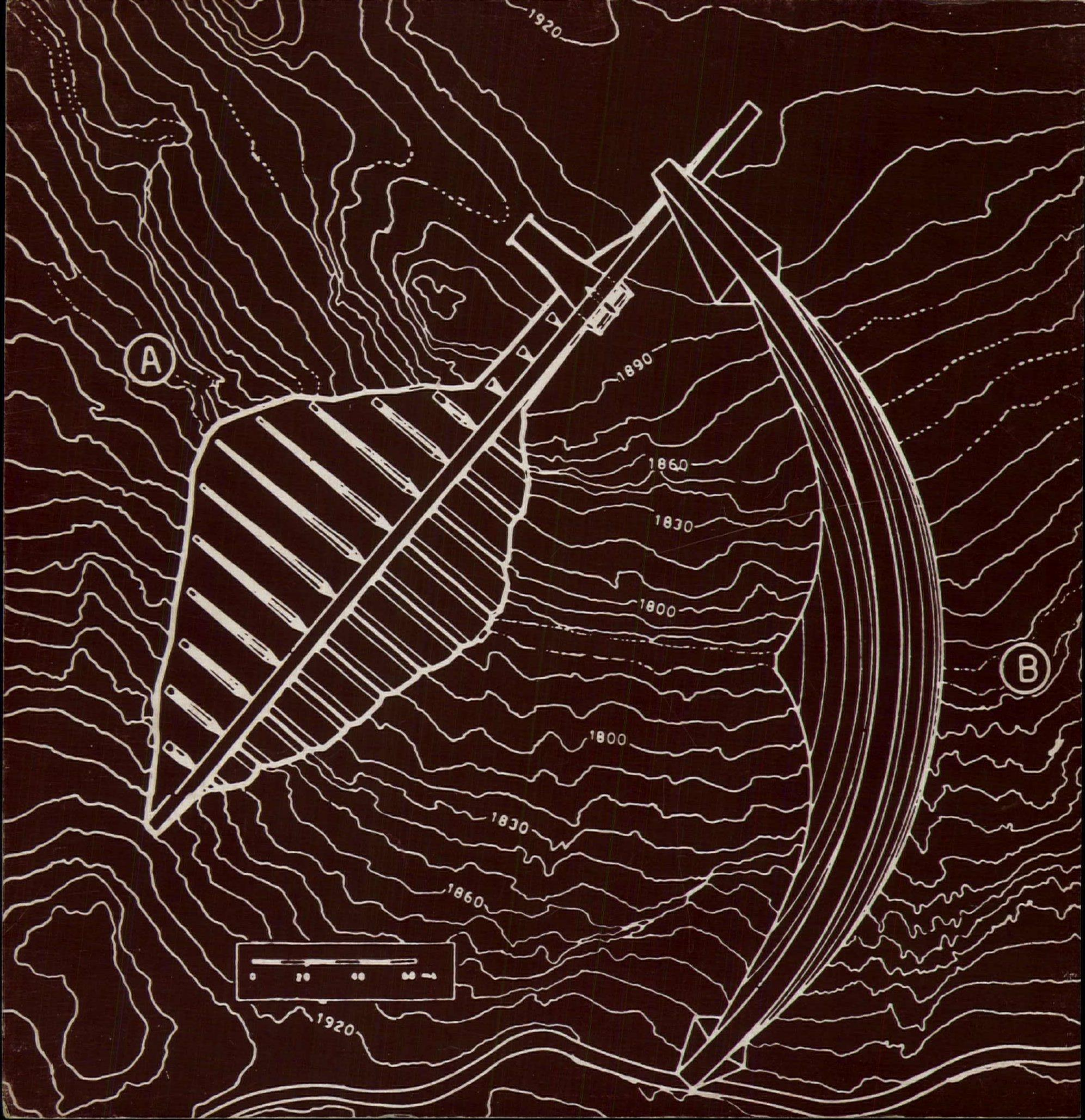
* * *

The most difficult thing is not to think with the primitive naivete of childhood; but to think with tradition, with acquired strength, and with all the results treasured by thought; because the human spirit can not go still farther if it does not accomplish the condition of adding quietly and patiently the thoughts of the individual to the thoughts of past generations.

(Excerpts from **LES CATHEDRALES DE FRANCE** by Auguste Rodin)



AUGUSTE
RODIN



1920
A
1890
1860
1830
1800
B
1800
1830
1860
0 20 40 60
1920