stock, so that the full surplus may be taken for human use if desired.

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RESEARCH ON PHYSICAL CHEMISTRY IN THE U.S.S.R.

THE issue of *Zhurnal Fizicheskoĭ Khimii* (*Journal of Physical Chemistry*) 17: No. 5–6, 1943, released by the Academy of Sciences of the U.S.S.R. at the beginning of 1944, was received in this country a few days ago. This issue contains a review of the activities of the Karpov Institute of Physical Chemistry for the twenty-five years of its existence and carries an order of the Soviet government of October 20, 1943, decorating the institute, its director, Academician A. N. Bakh, and twenty-two co-workers for the proficiency and successes of their researches. Physical chemists will be interested in a bibliography given in that issue listing 825 publications of the Karpov Institute for the ten-year period 1933–1943, a substantial proportion of which are in English and German. The Karpov Institute comprises laboratories studying the following fields: (1) biological catalysis; (2) surface phenomena; (3) polymerization processes; (4) heterogeneous catalysis; (5) colloidal chemistry; (6) structure of matter; (7) chemical kinetics; (8) adsorption processes; (9) aerosols; (10) inorganic chemistry; (11) non-aqueous solutions; (12) solid and complex compounds; (13) x-ray; (14) physico-chemical methods of production control; (15) photochemistry; (16) technical electrochemistry; (17) a division exists known as the Kireev group.

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EDUCATION IN SCIENCE MUSEUMS; OR THE TEN PARTS OF THE FUNCTIONAL EXHIBIT

AS the influence of the common man increases in world affairs, the extent of his knowledge and understanding will influence the future of all peoples. He can guard against emotional exploitation of his prejudices by developing critical habits of thought. He can build a barrier against rash judgments and actions by assembling within himself an understanding of man and the world around him. The education of the common man, on whose shoulders may hang the future of humanity, is a challenge to all museums of science.

Museums may meet this challenge with the functional exhibit. It portrays significant facts while impressing critical habits of thought on museum visitors; it compares a familiar with a strange way of satisfying a basic human need; it reveals truths discovered in the scientific search for ways to satisfy basic needs; it rouses curiosity; it stimulates the visitor to do something constructive with his learning.

There are fewer than fifty fundamental discoveries, from which man derives the millions of articles he uses to satisfy three basic needs. So the story of human progress can be told within the space of any museum, and even within the space of a single room, when this story is told through functional exhibits.

At the entrance to a science museum, which tells the story of human progress in functional exhibits, the visitor meets something familiar, perhaps a coin, a button, a light, actively doing something he readily understands, and in which he can easily take part. Compared with the familiar object is an unfamiliar one, used by strange people to meet the same need. This comparison stimulates curiosity and proclaims the main theme of the museum to be systematic comparison, which is also the crux of scientific thinking. After this friendly introduction, which rouses curiosity, stimulates critical thinking and does not block thought with enervating awe, the visitor is told what lays before him in the museum, what the museum aims to do, and why it will do just that.

At the start a frame is presented into which the visitor can fit what he knows and what he will learn. The visitor is told why men learn, to better satisfy their basic needs, and how the museum aims to aid that learning, by comparing primitive and civilized ways of satisfying basic needs and by tracing crucial steps in the evolution of the more effective ways. The visitor is told how to proceed through the museum to benefit most fully from it, to look at one exhibit at a time and understand it fully before advancing. The visitor is told to pick out of each exhibit a crucial fact and compare it with what he knows; he is told to challenge anything that differs from his own experience, accepting nothing on unproved authority. He is told to approach each exhibit with thoughts about it and it alone, which is the objective or problem attitude that psychologists have shown, in systematic experiments, produces the swiftest solutions to puzzles and problems. He is told to look in each exhibit for two ways of satisfying a basic need, and after comparing them decide which is best, and why. He is told where, in exhibits and in libraries, he may find facts that will answer his questions.

At the start and at strategic places throughout the museum, the visitor may be confronted with a chart of basic human needs, raw materials, main transforming processes—the fundamental ideas, discoveries and inventions by which man has created useful goods—and the main habits, customs and institutions through which these goods are controlled and used to satisfy common human needs. This chart, summarizing the

main facts of human progress, may focus the thoughts of the visitor on fundamental facts, as he tries on his way through the museum to integrate the numerous facts of separate exhibits into a pattern of significant knowledge.

Major themes may run throughout the exhibits of a great museum as they run throughout the movements of a great symphony. Two major themes for the functional exhibits of a science museum are: comparison, and value of facts in satisfying basic human needs. Each major theme may appear in each exhibit so the visitor may pick it up anywhere, no matter how widely he ranges or what order he takes in the exhibits. Minor themes, which are limited to single exhibits, tie the facts of the exhibit into something significant in the life of each visitor.

Each functional exhibit, which carries out two major and one or more minor themes, may consist of ten parts: (1) An experience common to all visitors, portrayed in a familiar object (*e.g.*, an electric torch) performing a familiar function (*e.g.*, lighting a path at night) by which visitors help satisfy a basic need (it makes the path a more predictable and a safer place on which to walk). The familiar object and way of satisfying a common need (*e.g.*, pressing a button to light a dark path) are (2) compared with a primitive tool and way of trying to satisfy the same basic need (*e.g.*, a reed torch used by the Loma in Liberian Africa).

The exhibit then traces the main steps of human progress in which man developed the familiar tool, by presenting (3) a fundamental idea (*e.g.*, freedom of search and expression which creates an atmosphere conducive to discovery), (4) a basic discovery (*e.g.*, electricity) and (5) crucial inventions (*e.g.*, the electric battery and generators, transmission of electricity by wires and resistance of some materials resulting in the electric light). The exhibit then presents the (6) main habits (*e.g.*, turning on a switch) customs (*e.g.*, politely shading the eyes of others from glare, reflected in the auto regulation controlling intensity and direction of headlights) and institutions (*e.g.*, laws, courts, patents) of control and use of the "tool" in satisfying a (7) basic human need (for predictable and favorable surroundings) and some advantages of the superior way of meeting the need (*e.g.*, the superior way of lighting a path at night produces less stumbling, fewer accidents and injuries).

The visitor indicates comprehension and alertness by (8) doing something about what has gone before (*e.g.*, presented with a question and a series of answers, the visitor may select a correct answer from the series before him by pressing a button or by some other action; the exhibit may then compliment him or, if he is in error, comment on his error and ask him another question). An arrangement, in which the visitor may participate, raises a question about the exhibit, and (9) indicates where an answer can be found in the museum, in a library or elsewhere. The exhibit ends by (10) stimulating the visitor to do something about what he has learned (*e.g.*, construct a toy, picture, poster or otherwise express a constructive reaction to what he has seen by describing in some way what he has learned for the benefit of others).

Learning from museum exhibits may be facilitated in a number of ways. The stimuli of the exhibit may be strengthened by tricks of lightning, use of colors and other art devices coupled with coordinated sounds and figures that move and speak. Movement not only of figures, but also of the background or the onlooker may enhance the effectiveness of the exhibit. Crucial meanings may be dramatized. Character portraits and personality profiles may help to impress ordinary visitors with the habits behind the triumphs and discoveries of critical thinkers. Plays, pictures and other artistic expression of the stories in exhibits may facilitate learning of the facts presented there.

Descriptive labels may tersely telescope thoughts pointing to crucial facts. Labels may also furnish the visitor with cross-indexes to sources and other aids to further search. The visitor should come away from each exhibit, and from the museum, thinking about a problem, its solution and its relation to larger problems, now before the citizens of the world.

Functional exhibits help the museum visitor understand strange ways of acting, strange habits, strange customs and strange institutions and strengthen within him constructive attitudes toward his neighbors. In functional exhibits numerous fundamental facts are related to three basic human needs and through them are related to each other, so they help create a reasonable uniformity of educated opinion, in spite of individual human differences. In comparing the ways in which men act functional exhibits may influence views of how men should act, and lay the groundwork of a scientific approach to the moral and political issues confronting mankind. None of the institutions of civilizations are better equipped than the science museum for educating the common man in the crucial facts of civilized life.

When science museums construct functional exhibits that rouse curiosity, encourage the making of comparisons and tell the story of human progress in significant patterns of crucial facts, then the museum will become the university for the common man, helping to shape the thinking and the future of all the peoples of the earth. This is worth doing.

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