Book Reviews

Book and Film

Shape and Flow. The fluid dynamics of drag. A volume in the Science Study Series. Ascher H. Shapiro. Doubleday, Garden City, N.Y., xv + 186 pp. Illus. Paper, $0.95.

The Fluid Dynamics of Drag. A film. Part 1, *Some Curious Experiments* (21 minutes); Part 2, *Fundamental Concepts* (31½ minutes); Part 3, *The Laws of Drag in Fluids of High and Low Viscosity* (37 minutes); Part 4, *How to Reduce Drag* (29 minutes). Educational Services Incorporated, Watertown, Mass., 1962. $500; rental print available for limited use at no charge.

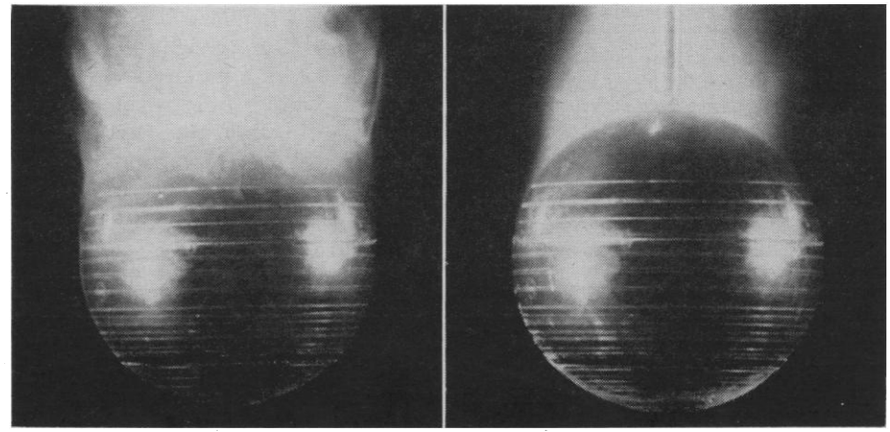
Ascher Shapiro's purpose is the same in both the film and the book: to present some fundamental ideas in fluid dynamics which are of great practical as well as scientific interest. The organization is also the same in both—in fact the book is recognizably "the film in print"—and each supplements the other because each takes full advantage of the possibilities of its own method of communication. Both begin with a brief introduction, after which there are some paradoxical experiments, performed for the film and described and illustrated, with "stills" from the film, in the book. Thus it is shown that, although the drag on a sphere moving in air ordinarily rises as its speed increases, there is a certain range of speeds for which the drag decreases as the speed increases and also that, while at low speeds the drag on a smooth sphere is less than that on a rough one, at high speeds it is just the reverse. Finally, the drag-reducing effects of streamlining on an object moving in air are demonstrated, but a subsequent demonstration proves that streamlining *increases* drag when the same object is moving through glycerine. These convincing demonstrations of paradoxical behavior set the stage and serve as motivation for the introduction of the fundamental concepts and principles of fluid dynamics.

The fundamental concepts themselves are demonstrated by models and actual experiments as they are introduced: the types of forces involved, the role of pressure gradient and viscosity, dynamical similarity, and the importance of the Reynolds number, not only for the definition of dynamical similarity but also for determining the main characteristics of different types of flow. The Reynolds number is derived with so little mathematics that the general reader will hardly be frightened and can actually follow the argument in terms of the relations of physical concepts.

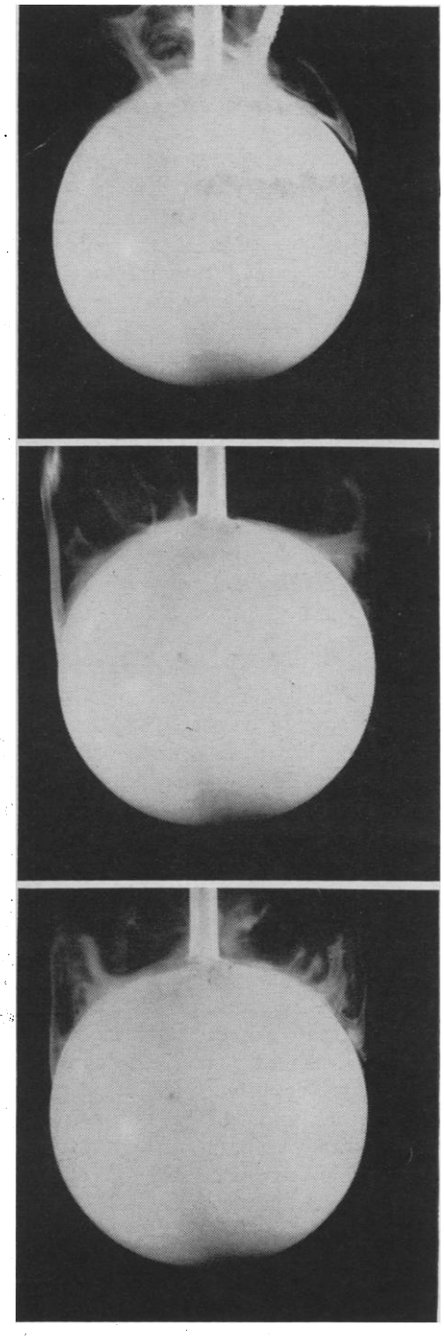
The laws of fluid dynamics, unlike the Reynolds number, are not derived, but they are dramatically illustrated. Stokes's law is stated and tested for conditions of viscous flow, and the contrasting behavior of flow at high Reynolds number is shown. The importance of viscosity even at high Reynolds number, because of the boundary layer and the dependence of the boundary layer on speed and viscosity, is made beautifully clear. Laminar and turbulent flow are distinguished, and the concept of streamlines is introduced. Bernoulli's principle and d'Alembert's paradox for streamlined objects in an ideal fluid are developed, and again the effect of viscosity (however low) because of the boundary layer is demonstrated.

The final film of the series and the final chapter of the book are both devoted to resolving the paradoxes exhibited at the beginning. This resolution is inevitably uneven: the concepts and principles presented are convincingly used to explain why streamlining increases drag at low Reynolds number, but the effect of roughness and the change from laminar to turbulent flow, which account for a break in the drag-versus-speed curve ("Why an increase of speed sometimes reduces drag"), can only be demonstrated, not actually explained, at least at the level of this book and film.

The Fluid Dynamics of Drag, as a film, is part of a combination of materials to be used in a much larger program on fluid mechanics designed primarily for use in engineering schools. The purpose to be served by the continuing series is to demonstrate the fundamental concepts and principles of fluid dynamics presented in courses on the subject. "Live" demonstrations for this purpose are expensive to build and to store and are not easily visible to all occupants of lecture rooms, so filmed demonstrations have many advantages. Shapiro is remarkably talented in designing and performing such demonstrations, and his accompanying verbal exposition is very clear. To an audience of mature scientists the relative pace of the various parts of the film on drag and flow may seem unsatisfactory, since simple things are presented painstakingly and things more difficult to under-



Upward flow of air past sphere, with smoke produced by a drop of titanium tetrachloride at the nose. [From *Shape and Flow*]



Successive frames from a motion picture illustrating back flow in the stalled boundary layer. Air flows vertically upward past the sphere. Top, A drop of titanium tetrachloride is placed near the support rod on the rear by means of a pipe cleaner. Note smoke beginning to move upstream (that is, downward in the photograph) toward shoulder and then curling around. Middle, Smoke from aft end of sphere has reached the shoulder and, on the left-hand side, is flowing downstream in the interface between the main flow and the wake. Bottom, All the smoke here seen in the wake originally came from the rearward position of the sphere, thus verifying the existence of backflow and showing that there is a good deal of mixing in the wake. [From *Shape and Flow*]

stand theoretically are only demonstrated, and briefly. We must note, however, that this particular combination of film sequences and the parallel "film in print" is designed for pre-college students and others with little background in mathematics. For physicists and engineers a subsequent film on vorticity, already available, will tend to allay doubts on the appropriateness of level.

For the sequence on the fluid dynamics of drag, it is the "package" of book and film which is significant. The demonstrations are magnificent in the film, but they go by quickly, and the availability of the printed page for repeated reference is invaluable.

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Preformation or Epigenesis?

Oogenesis. The storage of developmental information. C. P. Raven. Pergamon, New York, 1961. viii + 274 pp. Illus. $8.50.

Again the question of preformation versus epigenesis is raised, this time by C. P. Raven, who, armed with a primer on information theory, succeeds only in distracting the reader from the central issues of development. In the first and in the last two chapters, which sandwich the meat of the book but remain organically unrelated to it, Raven contends that the egg holds a set of instructions "encoded" in the nucleus, cytoplasm, and cortex, which is read out during development.

Although many recent as well as early contributions to the study of oogenesis are assembled in the middle chapters, the author adduces no evidence from them to support his theory.

Is there within the egg a set of self-contained causes from which the various steps of embryogenesis are predictable (in the sense of being understood, rather than simply occurring), or is development in part the result of emergent rather than coded causality? To say yes to the second question is to lay oneself open to Raven's charge: "vitalist." Risking the charge, the reader might reply that since the egg first and then its descendent cells undergo self-replication, a community is created within which an individual cell or a group of cells may be treated as "open systems." Thus, without violating the laws of physics, he may invoke emergent or epigenetic causality to contend that the relevant causes for any given phase of development may not be predictable from the single-cell egg, but only from the elaborate complex of interactions in a community whose genetically similar members are at once protagonist and antagonist, individual and environment.

Is the egg as unique as Raven would have us believe? One wonders why he has not, for example, considered the striking similarity of planula and planuloid in the coelenterates. Both develop into polyp but, while the former derives from a zygote, the latter stems from somatic cells. Raven might well have tackled the question asked by N. J. Berrill, ". . . how many of the more general developmental phenomena of the relatively specialized types of eggs . . . are inherent in the egg cell as a cell rather than as an egg?" [Berrill, *Growth, Development, and Pattern* (1961)].

Aside from feeling compelled to defend those who have not abandoned material causality despite their disagreement with the author's argument, the reader will wince when Raven formulates *ex cathedra* a theory of development in the notation of information theory which, although useful for computer design and network analysis, has so far not found a significant place in biology.

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Crystal Measurement

Crystallometry. P. Terpstra and L. W. Codd. Academic Press, New York, 1961. xv + 420 pp. Illus. $12.

Much of this book, which is a modernized version of Terpstra's *Kristallometrie* (1946), was translated from the original volume, and most of its approximately 250 figures were also used in the earlier version. The aim is highly specialized: to provide thorough instruction in the mathematical and graphical techniques associated with crystal measurement, by means of the two-circle reflecting goniometer. The book begins simply enough with the description of an experiment for dem-