possibility that a sizable earthquake, of magnitude 5.7 to 6, could be induced at the dam site within the lifetime of the structure by the reservoir itself. He put the probability of this happening at only 2 to 5 percent if it is assumed that the Oroville earthquake was not induced by the reservoir there but at 30 to 50 percent if the assumption is that that quake was so induced. According to one theory, in an area already under seismic stress the weight of the water triggers the quake; according to another, the water pressure actually "lubricates" the fault and triggers displacement.

Another bureau consultant, Roy J. Shelmon and Associates, Inc., of Newport Beach, California, is engaged in what the bureau plainly regards as a critically important effort to determine conclusively, through age-dating studies, whether any faults within the foundation are in fact active. Yet, even if this study does conclude that these faults are inactive (and some bureau officials say they are confident that it will), some competent geologists will remain unconvinced, especially given the possibility that the filling of the reservoir could have an effect on very old and previously inactive faults and cause displacement.

If there is a significant division of professional opinion as to the potential for fault movement within the foundation or abutment rock, the dam project will probably be doomed, at least as now designed. After a visit to the dam site on 30 June, the Consulting Board for Earthquake Analysis which advises the state Department of Water Resources and its division of dam safety, stated:

> The board is particularly concerned with the critical effects of possible fault movements in the foundations or abutments. . . . The potentially damaging effect of such movements depend in large measure on the type of dam constructed and its ability to safely withstand deformations. Such deformations are likely to have more serious consequences for a concrete arch dam than for any other types of dams. . . . Thus, although a concrete dam might well be designed to withstand very high levels of shaking, it might fail as a result of small fault movements occurring in the foundation rock.

Although no earthquake could shake the faith that some Bureau of Reclamation engineers seem to have in the Auburn project as now designed, the bureau has conceded that it might have to abandon it. "We would not propose to go ahead with the same design if there were active faults in the foundation," Larry Von Thun, chief of the bureau's geotechnology section at the Research and Engineering Center, has said.

In such circumstances, Representative John McFall and other ardent sponsors of the project have indicated that they would switch to a different type of dam. But this might well prove impossible. If obtaining 63 million cubic yards of material necessary for an earthfill dam looked economically and environmentally unattractive 11 years ago, it is not going to look any better today.

Similarly, to switch to a concrete gravity design for so high and long a dam might be out of the question. The volumes of concrete required would be far greater and the cost of the project would go up accordingly (compared to the Auburn Dam, the bureau's Shasta Dam in California, a gravity-type structure, is 690 feet less in crest length and nearly 100 feet less in height, yet it contains more concrete). Any large cost increases associated with a design change could make the project unacceptable, especially inasmuch as Carter Administration reviewers already see the project as economically marginal.

The project's fate will probably be decided at the highest levels in Sacramento and Washington. The final decision may still be many months away, but the project seems caught in an inexorable chain of logic and events that ultimately will undermine it.—LUTHER J. CARTER

Game Theorist Morgenstern Dies

Oskar Morgenstern, 75, one of the most prominent scholars in modern mathematics and economics, died of cancer on 26 July. He was a co-founder of game theory as well as a progenitor of institutions: the Institute for Advanced Study in Vienna; the Center for Applied Economics at New York University (NYU); and, in 1959, Mathematica Inc., a private think tank which studies subjects such as the space shuttle, the negative income tax, welfare, and arms control.

Economics is often praised as the most successful of the social sciences, but Morgenstern was one of its most persistent critics. He frequently attacked the accuracy of the data that economists use as the basis for their models and forecasts. He charged that, while imitating the physical sciences in other ways, most economists have none of the physical scientist's respect for measurement and margins of error. For instance, in a 1975 speech he argued that the data errors that go into calculating the gross national product (GNP) are larger than the fluctuations in GNP that most economists find significant. Although Morgenstern was often out of step with his fellow economists, he began to be recognized by them toward the end of his life. For example, at a 1975 economics meeting, he was listed among the likely future winners of the Nobel prize.

However, Morgenstern will be remembered less for his work on economics than as the co-founder of game theory. This happened with the publication in 1944, with John von Neumann, of *Theory of Games and Economic Behavior*. Game theory considers situations in which there are several participants, no one of whom controls all the variables, and one of whom can be chance. The behavior of the participants will vary according to the strategies followed by others and by other factors, including psychology. Because game theory is so complex mathematically, it has attracted many mathematicians who have joined with people in other disciplines to apply the concept to social behavior, voting, military strategy, and other situations. Morgenstern's collaboration with von Neumann continued until the latter's death in 1957. It was one of the most successful partnerships in modern science, but it dogged Morgenstern too, to be always known as von Neumann's boy.

Like many prominent scientists of his generation, Morgenstern was a refugee from the Nazis. He was not Jewish, but his liberal political views made him *persona non grata* in his native Vienna after Hitler's invasion. He fled to the United States in 1938, to Princeton, for an appointment meant to be for 3 years, which lasted for 32. In 1970 he became a professor at New York University.

A curious element in his background was that his mother was an illegitimate daughter of the Austrian Emperor Frederick III. When the emperor learned that his gardener's daughter was going to have a baby by him, he conferred on the family a handsome settlement, which was later dissipated. Of such misfortunes, sometimes, are famous economists made.—D.S.