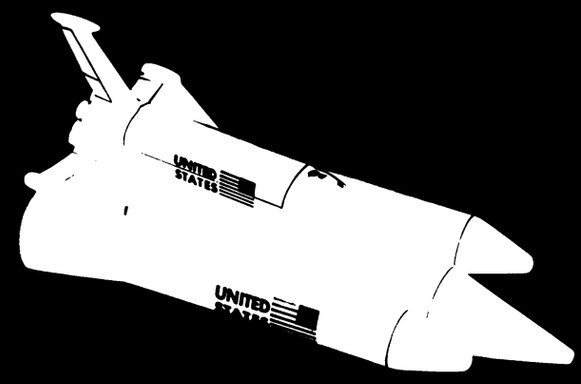

The decision on the shuttle is 'go'

President Nixon's announcement last week of the decision to begin development of a space shuttle system may prove to be nearly as crucial to the future of the manned space program as the 1961 Kennedy challenge to land a man on the moon. "The space shuttle program is the right next step for America to take in moving out from our present beachhead in the sky to achieve real working presence in space . . . ," he said in his Jan. 5 announcement.

Compared with the Apollo decision, the shuttle may not appear as politically glamorous or imperative, but it will save the National Aeronautics and Space Administration as it now exists. Without the shuttle there would be no manned space flights after Skylab in 1973. And the shuttle development will send 50,000 unemployed aerospace workers back to work.

Although the shuttle will be a new system and concept, the development and testing costs are estimated to be $5.5 billion over the next 6 years—about one-fourth of that for Apollo. Apollo carried a crew of 3 men to the moon; the shuttle will carry into earth orbit up to 12 passengers, or spacecraft or maintenance equipment, and a crew of 2 or 4. Apollo equipment was used only once; the shuttle's orbiter and perhaps parts of the booster will be used many times. And finally, whereas Apollo costs were absorbed solely by the United States, and the scientific instruments and program controlled largely by the American scientific community, the shuttle's development costs and its eventual use promise to involve at least the European space community's financial support and participation and perhaps other nations' as well.

Leaders in the aerospace community were naturally quick to express pleasure. "This decision by the President is a historic step in the nation's space program—it will change the nature of what man can do in space," said NASA administrator James C. Fletcher.

But while the Administration's strong stand on the shuttle triggered a collective sigh of relief among the NASA centers and the aerospace community, opponents were loading their guns. The next big hurdle will be Congressional approval of the $200 million or so expected to be requested in Nixon's budget for fiscal year 1973 for the shuttle's initial development. Sen. Walter F. Mondale (D-Minn.) was among the first opponents to respond, calling the announcement an example of "perverse priorities" and the shuttle a "senseless extravaganza." He compared it to the SST and promised a similar defeat.

Shuttle backers, however, cite factors favoring Congressional approval of the shuttle program. For two consecutive years opponents have lost in efforts to delete shuttle funds from the NASA budget—last year by an overwhelming defeat. Also, one rationale for the shuttle is economy. "The space shuttle is needed to make space operations less complex and less costly," says Fletcher.

Currently all spacecraft, hardware, instruments and boosters are expendable—used only once. The shuttle would replace all existing boosters, and all hardware woud be taken to earth orbit in the shuttle's cargo bay. The shuttle would then be able to make periodic checks on the space platforms for repair and service. According to NASA, payload costs alone would be reduced by the shuttle from the current $700 or more per-pound per-launch to $100 per pound. The Mathematica study of the shuttle (SN: 7/24/71, p. 56) cited additional savings in payload design and operational costs.

Both President Nixon and Fletcher cited another justification for the shuttle—useful things that can be done with it in space. Among the missions envisioned are planetary observations (telescopes could be taken in the shuttle above the earth's atmosphere) and

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NASA's Fletcher with Nixon: The next big step in manned space program.

studies of the earth's resources.

Not forgotten are the military uses of the system. For example, says Fletcher, "when something strange happens," the Air Force would be able to move into space to take a look—possibly with 48-hours notice. (Currently 3 to 4 months are needed to prepare an Apollo spacecraft for launch.) Such a quick reaction capability is said to be very appealing to the current Administration.

Another element high in the Administration's hopes for the shuttle is the inherent international possibilities. "The shuttle will encourage greater international participation in space flight," says Fletcher. The Europeans have been studying the shuttle now for several years and are reportedly interested in participation (SN: 8/29/70, p. 165). The shuttle would have a universal docking collar that would permit it to dock with Soviet spacecraft (SN: 9/11/71, p. 167). Other nations, according to George Low, associate administrator of NASA, will have one more year to decide what their level of participation in the development phase will be and at least five years to decide what payloads, experiments or astronauts they would like to fly. "Everyone in the world will have to come to us," boasts Fletcher of the potential prestige the shuttle would provide.

Still undecided are the location of shuttle ports—the launching and landing sites—and the booster design and type. Most likely Cape Kennedy would be the first port. But at a later time additional ports could be built elsewhere.

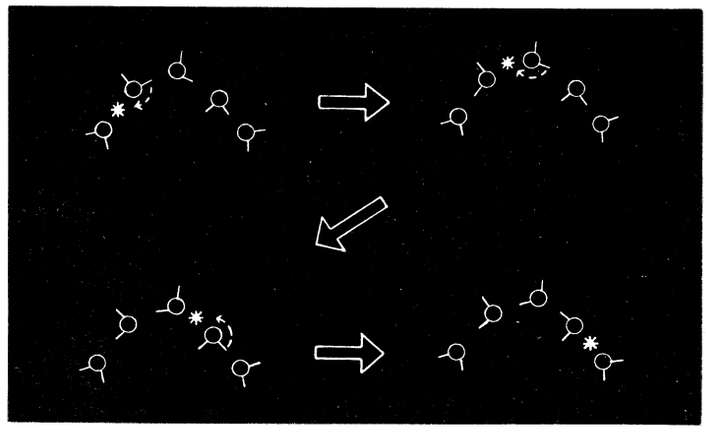
The shuttle that will eventually go into orbit in 1978 is not the one originaly planned by NASA. Because political priorities prohibited a $10 billion to $12 billion initial investment in a two-stage fully reusable shuttle, NASA decided on a "phased approach." Originally both the booster and the orbiter would have been launched vertically, then return to earth, land as an airplane and be reused (SN: 8/29/70, p. 178). The initial investment would have been twice the $5.5 billion now requested, but each launch would have cost less. The phased approach is a compromise to stay within NASA's current annual budget range of $3 billion to $4 billion. The "phased shuttle" will still have a reusable orbiter that looks like an airplane, but the booster will be similar to current boosters. The booster could be partially reused but would have to be recovered from the ocean to be refurbished. Only when and if the political support were found in the 1980's would the fully reusable booster be built.

Whether NASA can build a shuttle within the current budget restraints without hurting other scientific programs proposed for this decade (SN: 9/18/71, p. 187) is another question that the President's budget message late this month may answer. Scientists who tend to favor unmanned space science efforts over manned activities will be watching closely.

But whether the shuttle package is attractive enough to weather the Congressional storm is the major issue. President Nixon in his shuttle statement last week quoted Oliver Wendell Holmes: "We must sail sometimes with the wind and sometimes against it, but we must sail and not drift, nor lie at anchor." Then he added: "So with man's epic voyage into space—a voyage the United States of America has led and still shall lead."

NASA believes the only ship for the 1970's and beyond is the shuttle—and all of its hopes have been placed on deck. □

Explaining water: Focus on broken hydrogen bonds



Minton's water model: Asterisk locates the broken bond. As molecules rotate, it moves from one to another.

Minton/Nature

The bulk physical properties of liquid water depend on the molecular structure of the liquid and the interactions of molecules within the liquid. The bulk properties can be measured; the task for chemists and physicists interested in the subject is to devise models of the structure of water that will explain them.

The problem has been a fruitful source of controversy for years, and several schools of thought have grown up. Some models make the bulk properties depend on the physical states of the molecules within the water. One group, which can be designated mixture models, sees water as made up of clusters or groups of molecules in distinctly different physical states differentiated by some criterion that the modeler considers important. A single molecule is not bound in a given state but changes rapidly with time. The bulk properties arise from averaging the states contained in the model and change as the proportions of molecules in different states change. Opposed to this is the uniformist view, which says that the physical states of the molecules vary gradually and cannot be separated into sharply defined clusters.

The two approaches lead to differing views on the chemical bonding in water. The uniformists tend to believe that all the water molecules are bound to each other by hydrogen bonds, connections in which a hydrogen atom holds two molecules together by sharing its electron with them. In the mixture models the amount of hydrogen bonding varies, but is usually not complete.

In the Dec. 27 NATURE, Allen P. Minton of the National Institute of Arthritis and Metabolic Diseases at the National Institutes of Health presents a new model in which the bonding is more important than the states of the molecules. The important feature is a broken hydrogen bond that migrates through the liquid in the presence of a lot of unbroken ones. The model comes as an extension of yet a third school of thought, computer models. These models start out with individual water molecules interacting with each other according to some force between them. The computer follows their activity to see what sort of structure comes out of it and what bulk properties it leads to. Computer models have had a fair amount of success, says Minton, but "I thought these models didn't sufficiently account for the dielectric depolarization of water."

In water molecules, as in many others, electric charges are not symmetrically distributed. The asymmetry is called an electric dipole moment. If an electric field is imposed on a sample of water, there is a tendency, a very small one, for the dipole moments to orient themselves in line with it. This bias in the otherwise random orientation of the molecules causes a bulk dielectric polarization in the sample.

When the external field is turned off, the molecules tend to return to random orientation. The way this relaxation takes place and the time it takes are what Minton's model was first designed to explain. "I don't talk about states of molecules," he says. "I distinguish be-