Tracking the shuttle's path(s) to orbit

NASA's space shuttles have been late, in sense, since before the first one ever took off. When the shuttlecraft Columbia lifted from Florida's Cape Canaveral on April 12, 1981, it was about two and a half years behind the originally projected date of its maiden flight. Now the shuttles are aiming toward a new beginning, rising from the year-old wreckage of Challenger. And already there are signs that the Feb. 18, 1988, target date of that rebirth, announced barely three months ago, may in fact be considerably later.

Failure to meet that specific date on the calendar is not being viewed as a potential black mark, however. Ever since NASA Administrator James Fletcher announced the goal early last October, he and other agency officials have been careful to add some version of ". . . but we're not going till it's safe to fly." High-technology efforts often experience delays, and NASA knows the world will be looking over the agency's shoulder this time as never before.

More to the point is what could be a reason for delay. One possible reason is reminiscent of a factor that was often cited as a key contributor to the whole shuttle program's slow beginnings. On several occasions over the years, NASA officials have laid part of the blame on early budgetary limitations, or "underfunding," that forced the agency to pursue major technological developments one after another rather than in parallel, so that a delay in one system slowed down everything waiting in line behind it.

Last week, two of the various panels charged with overseeing NASA's return of the shuttle to flightworthiness reported to Fletcher with remarkably similar concerns. "The test program is success-oriented," wrote H. Guyford Stever, a former director of the National Science Foundation and now in charge of a group evaluating the redesign of the shuttle's solid-rocket boosters. Rather than indicating that everything is going great guns, he meant that "the schedule for the program reflects an assumption that each test will produce results that are expected and understood; there is little room in the schedule for modifying the design if this does not prove to be the case."

A possible cause of the Challenger explosion, for example, is suggested to have been the loss of resiliency in the rocket boosters' O-ring seals, which was caused by the cold weather and which may have allowed the rockets' burning propellants to escape. An alternative material that kept its resilience better was tried, Stever's report notes, but it turned out to deteriorate from extended exposure to a rust-inhibiting grease being used with it. The original O-ring material was re-adopted, with heaters added to maintain the proper temperature, but the panel's report raises the question of "added complexities and potential reliability problems associated with the heaters." Furthermore, according to the document, "we are concerned that valuable time would be lost should it become necessary to turn to one or more of the alternatives as a consequence of something learned from the test program."

In another area, the insulation between adjacent booster segments, two variations of the design are being pursued, but the planned testing of the backup version "is not being carried forward on a schedule that would permit its inclusion in the program without a delay," says the report.

The lack of such options, however, can pose a problem in its own right. "Currently," notes the report by way of example, "there is no real alternative in the program for the baseline design of the case-to-nozzle joint [between the rearmost booster-rocket segment and its exhaust nozzle], which incorporates a large number of new bolts and bolt holes, hence complex stress patterns and potential leak paths. We consider the lack of an alternative to be serious since the joint is critical for safety, few tests of the final configuration are planned, and they occur late in the test program."

Just two days before the Stever panel's report, the report of another such group (both are under the National Research Council) had virtually declared that NASA will be unable to achieve its target launch date if any major redesigning turns out to be required by a two-element study that is now under way. The team is reevaluating NASA's "critical items list" for the shuttle, as well as a "failure modes and effects analysis" that focuses on what can go wrong and how the effects might cause problems that spread to other components. Both parts of the study are expected to be completed by this summer, but last week's report from committee chairman Alton D. Slay warns that the reevaluation may not adequately be able to consider all of the engineering changes, "nor will there be time to incorporate any substantial design changes that may be indicated . . . ."

Both Slay and Stever comment favorably on the cooperation and candor of the personnel with whom their respective panels have been talking. Still, notes a source (who asked not to be identified) close to one of the groups, "if there is a design factor in which you are not completely confident, but which could take a lot of extra time to fix, you might feel that as pressure to launch with what you've got." — *J. Eberhart*

Eastward slow, the sea slugs

Slow maybe, but not without direction — that is the way of *Tritonia diomedia*. No bread crumbs, North Star or mossy trees point this sea slug species toward shallow water to feed and mate. But it does have a special neuron that apparently uses the earth's magnetic field and the phases of the moon as guides, say scientists.

Using simple, elegant experiments, A. O. Dennis Willows and Kenneth J. Lohmann of the University of Washington in Seattle and its Friday Harbor Laboratories have manipulated the magnetic fields across tanks holding slugs from the Pacific Ocean. They found in the first series of experiments that most of the slugs faced east when exposed to the earth's magnetic field, but remained randomly oriented when that field was canceled.

Yet tests over the following months failed to prove that the slugs usually orient toward the east. The mystery was solved when the researchers incorporated the phases of the moon into their experiments, as reported in the Jan. 16 SCIENCE. A majority of the slugs turned east in the earth's magnetic field when there was a full moon. No such turning preference was seen during new-moon periods.

This is not the first finding of such a moon-magnetic field phenomenon in animals. Responses to magnetic fields by homing pigeons, fruit flies and flatworms also are apparently affected by lunar phase. But the lowly sea slug promises a significant contribution to this area of biology research.

"The real crux of the findings is . . . that they have an organ [that senses magnetic fields]," Willows told SCIENCE NEWS. "In virtually no case has the existence of such an organ been shown." He notes that there have been descriptions of small magnetic particles in bacteria (SN: 12/21&28/85, p.396) and of electric organs in sharks that detect changing magnetic fields.

But the accessibility and relatively large size of the sea slug's neurons make this model a prime choice for studies of the neurophysiology of magnetic field detection. Willows says more recent studies have confirmed suspicions that a single neuron is the slug's magnetic organ. Among the evidence for this was the finding that the neuron's electrical activity increases when magnetic fields are altered.

The scientists have not yet studied slugs from the Atlantic Ocean. But Willows says he suspects they would orient toward the west — and friendly shallow waters. — *D.D. Edwards*