entirely qualitative, while the one quantitative chapter relies almost entirely on the strongly empirical results developed by a single investigator.[2] No attempt is made at understanding basic physical processes.

Much more disturbing is the apparently highly popular book on *Naval Architecture of Planing Hulls* by Lindsay Lord[3] who "has probably taught Naval Architecture to more students than any other man." This book is an incredible document of fuzzy pseudo-scientific thinking and practice—ranging from the physically unsound to the mathematically bizarre! Lord's fundamental thesis regarding dynamic longitudinal stability (which influences many of his design recommendations) is based on an entirely erroneous formula for the longitudinal pitching period. His "physical explanations" of this and related phenomena make fascinating reading. It would be amusing, if the implications were not so serious.

Fundamental concepts such as dynamic equilibrium and stability of straightahead motion, the relationship between banking on turns and deadrise angle, and many other performance characteristics have apparently never been framed in basic hydrodynamic terms. The obviously nonlinear limit-cycle phenomenon of "porpoising" has never been analyzed correctly (Murray's qualitative "explanation"[2] is incorrect, being nothing more than a description of linear stability—not even instability!).

If the relative amount of space devoted to planing hulls in Lafrance's article is any indication of recent advances in the "state of the art," then it appears that planing hull design indeed remains an art and has a long way to go before becoming a science.

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2. A. B. Murray, "The Hydrodynamics of Planing Hulls," in Transactions of the SNAME, 1950, pages 658–692.
3. L. Lord, *Naval Architecture of Planing Hulls*, 3rd ed., Cornell Maritime Press, Cambridge, Maryland, 1963.

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6/30/78

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Pierre Lafrance has dealt exclusively with mechanically-propelled ships. The hydrodynamics of sail-driven ships and boats are equally interesting, more critical, and could prove to be of greater economic importance if energy becomes very expensive.[1] For good performance with a head wind a sailing hull must develop a high horizontal lift–drag ratio whether upright or heeled, in calm water or rough, and over a wide speed range. This has been the subject of research[2] in the model-towing tanks at Stevens Institute of Technology, MIT and elsewhere. The speed record for a sailboat is 33 knots, achieved in a 25-knot wind. (A knot is 1.15 mph.) Many small high-performance boats reach planing speeds in a fresh beam wind or stronger following wind. A few sail boats have been "flown" on hydrofoils. More common is partial replacement of buoyancy by aerodynamic vertical lift wherein the principal function of the water is to furnish horizontal lift.

References

1. J. B. Woodward, R. F. Beck, R. Scher, C. M. Cary, *Feasibility of Sailing Ships for the American Merchant Marine*, report 168, Department of Naval Architecture, University of Michigan, February 1975.
2. C. A. Marchaj, *Sailing Theory and Practice*, Dodd, Mead, & Company, N.Y., 1964.

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7/6/78

Proliferation again

In my recent letter (December, page 84) your staff introduced an error in the printed version that jeopardizes the validity of my technical argument and is potentially a source of considerable embarrassment to me.

On page 84, third column, third paragraph, the word "impossible" has been substituted for "possible." It should read, "Although it is possible for an explosion to occur. . . ." Your rewording associates me with a technically untenable claim that is being hotly debated.

Rejoinders by Ernest Moniz and Thomas Neff in December fails to recognize the disservice done by the proliferation of articles with "limited scope," yet convenient for interpretations extending beyond their range. Furthermore, their repetition of distorted technical information cannot be condoned.

That the critical mass for Pu^{240} is less than weapons-grade uranium is a red-herring. High concentrations of any fissile isotope can theoretically be made into nuclear explosives; low fissile isotope fractions (under 20% U^{233}, U^{235}, or $Pu^{239/241}$) are equivalently denatured for all practical purposes.

Moniz and Neff fall into a common trap: they equate denaturing to the absence of a critical mass. There is no threshold, technical or semantic; all fissile isotopes are progressively denatured by isotopic or chemical adulterants. An order of magnitude dilution of fissile material is nothing to brush off; diversion of more material simply to meet a minimum criterion, means a corresponding gain in detectability.

Much more significant virtues of denaturing are improvements in risk-consequence. Reductions in achievable explosive yield and other factors associated with denaturants strongly diminish the weapons-suitability of plutonium (and uranium). I have identified eight physical effects that degrade the yield of plutonium mixtures.

Latent proliferation can occur not just because of the plutonium cycle. More important, international development is resulting in a universal technological substrate that can support many avenues for potential abuse of science and technology.

Neither misstatements regarding my letter in December, nor avoidance of quantitative risk-assessment procedures regarding proliferation, will alter the need for a comprehensive antiproliferation strategy that covers more than the "limited scope" of Moniz and Neff.

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12/8/78

Archimedian telescope?

Your article on the multiple mirror telescope (September 5, page 30) reminded me of my unsuccessful attempt to build one five years ago, during my school days. It consisted of several six-inch parabolic mirrors. I immediately encountered insurmountable alignment problems.

The idea of a multiple-mirror telescope occurred to me when I read that Archimedes has used a multiple-mirror lens to set afire the invading Roman fleet during the siege of Syracuse. It is rather unfortunate that the multiple-mirror lens was born under such ominous circumstances. One hopes that under more favorable conditions Archimedes would have found a peaceful use for his invention.

I humbly suggest to the successful designers that the multiple-mirror telescope be dubbed "Archimedian Telescope"; one would then refer to an "Archimedian Telescope" in the same way one speaks of Newtonian or Galilean telescope. In so doing, we would be honoring the ingenuity of a great scientist.

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4/17/79

Corrections

October 1978, page 9—the photograph should have been identified as the work of photographer Kenneth Dunkley.

May 1979, page 9—the illustration should have been identified as the work of Helmut K. Wimmer.

May 1979, page 83—Lay Nam Chang has been named associate professor of physics at Virginia Polytechnic Institute and State University, not assistant professor as stated. □