

**On “The Challenger Launch Decision” by Diane Vaughan
Submitted to Op-Ed: The Washington Times**

March 28, 1996

Poor Diane Vaughan. Her incredibly well researched book, *The Challenger Launch Decision*, was attacked by Malcolm Ross (Commentary, January 28, 1996) who declared the change of putty in the now-popular booster joints to be the cause of the tragedy. Ms. Vaughan demolished his critique (Letters, March 18) noting that “the worst field joint erosion ... occurred” when the old putty was in use in 1981. Now, the book is assailed mercilessly by Marin Sieff (Books, March 24), who finds it “more misleading than any tabloid headline.” This is the mild side of the review. Mr. Sieff seems to be safe from criticism; he uses big guns: The late Richard Feynman and Carl Sagan.

Sieff and Ross note that Vaughan is not an expert. Early in her book, Vaughan admitted that she initially thought the O-rings to operate like a “Nurf ball.” It takes guts to admit that. The rest of her book shows that she eventually thoroughly understood the nuances of the infamous joints. How do I know? I did many analyses and tests of joint rotation in the early 1970s, long before NASA discovered the effect in the boosters after 1978.

Vaughan struggles with contradictions in the massive record. She recognizes that erosion and blow-by occurred in cold and warm weather. Temperature may not be the true issue. Sieff does not grant the possibility.

She recognizes that many serious “anomalies,” other than erosion and blow-by plagued the Shuttle from the start. The experts tell her that the anomalies are the result of the “developmental” nature of the Shuttle. On a typical early Shuttle mission, the record shows that in addition to erosion, there were cracked, bent, sheared, and broken parts in the orbiters, boosters, separation motors, and even 20 foot cracks in the thick steel of the launch platform. She does not pursue the anomalies, but Feynman didn’t. She resolves that the anomalies reflect “routine aspects of daily engineering work.” Else, she would have had to find umpteen causes for the umpteen anomalies. I spent many years dealing with failures in space systems, and anomalies are signs of incompetent engineering and wrong design.

Vaughan tries to put a dent in the widely accepted deadly *formula* that supposedly caused the Challenger disaster, i.e., **Cold Temperature + Joint Rotation + Orings = Tragedy**. The deadly formula was adopted by the Presidential Commission, the House Committee and NASA. But, the formula was not initially developed by them. It was first proposed by the New York Times only twelve days after the accident. It was not based on the kind of “hard science” that Sieff demands in his review. It was simply based on the power of leaked memos, and worse, by non-experts. It, in my opinion, derailed the Challenger investigation.

According to Sieff, Sagan found Feynman's O-ring in ice water demonstration a "mischievous but brilliant little act" that "produced unambiguous results." Who can dispute a Nobel Prize-winning scientist and a renowned astronomer? The facts can. Feynman blew a unique opportunity to uncover an egregious error in Shuttle design, and I doubt that Sagan went beyond the sensational media stories. There was a brilliant demonstration that Feynman could have done to demonstrate the serious error. You can try it.

Go to a supermarket. Pick up a 10-lb bag of potatoes. Hold it over a weight scale that you find in the vegetables-fruits section. Slowly release the bag on the scale. You will see that for every pound weight or force that you release, the dial moves one increment, or 1-lb increment. Now, hold the bag so as to barely touch the scale, and let go of it suddenly. You don't want to drop the bag from any height, the height should be zero. If you watch the dial carefully, you will see that it overshoots and then returns to indicate 10 lbs. The maximum overshoot possible from zero height is 10 lbs, or 100% of the applied force. If the clerk made you pay for 19 lbs because that was the overshoot indicated on the scale, you will be outraged. To you, the extra 9 lbs are fictitious, but the overshoot in the case of the Space Shuttle is real, even though it is ephemeral, lasting for only a split second.

The Shuttle engines produce about 1 million lbs force at liftoff – not slowly, but suddenly. Get the point. The parts of the shuttle feel nearly 1.9 million lbs, but the Shuttle was initially designed to withstand only the maximum applied forces plus safety margins, without overshoot. We paid dearly for the excess 900,000 lbs.

In 1983, the engineers measured the 1.9 million lbs effect. Expecting to measure only about 1 million lbs, they expressed incredulous astonishment in writing, in several pages. Vaughan missed those pages in her scrupulous search. Feynman did not notice them either. He did not recognize the reality of the devastating overshoot.

During the Commission hearings, Feynman asked one of Thiokol's experts, Alan McDonald, what happens when the boosters light up: "Isn't the laws of elasticity such that everything is proportionate to the force and all of the space are proportional to the force?" To the novice, these are highly technical words. But, Feynman and McDonald were comparing the sudden start-up of a rocket booster to the slow release of a bag of potatoes on a supermarket fruit scale. In the diagram they used, the pressure rises one step, and joint rotation rises one step. To add insult to injury, all the loads, deflections and joint rotations presented to the Commission by all the experts gave only the maximum applied values. No overshoot. No one noticed.

I said Feynman blew it. He could have done a truly brilliant demonstration using a supermarket scale, a postal scale, an old bathroom scale, or, in his free spirit approach to science, he could taken the Commission, the experts and the hungry

reporters to a bungee jump location, to demonstrate how the first-order overshoot effect can cause anomalies in *all* parts of the Shuttle.

I don't mean to single out the late distinguished scientist for criticism. Dr. Wernher von Braun did not recognize the effect, and his writings show the sudden rise of thrust to only the maximum applied value. This may explain why all rockets explode during the development stage.

Several years ago, the media and the Congress criticized the Bush administration for passing pink slips around NASA. In his book, "Standing Firm," the former Vice President Dan Quayle exposed the extent to which some NASA managers would go to scheme and cover up facts. Those mighty space experts disguised the devastating overshoot effect from scrupulous scholars such as Ms. Vaughan. The NASA Select Station continues to produce video programs that teach the proportionality of force and effect. The pundits then wonder what is wrong with our economy and education. Anyway, Vaughan did put a dent in the deadly formula. Borrowing a recent metaphor from Mr. Steve Forbes, a stake must be driven in the heart of the deadly formula; it is deadly wrong.

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