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aggression and the enslavement of more states? If we weaken ourselves, will the Russians follow suit? Have they ever? What do the Russians themselves say about their purposes for arming? Is it just for defense of the homeland? For socialist imperialism? Does Russian Marxism–Leninism in fact hold that conflict, including war, with capitalistic countries is inevitable?

Delta-factor. With great erudition and arithmetic detail, authors have calculated what might happen in various military or confrontational scenarios. However, they all seem to omit an important factor, a factor so incredibly small and preposterous that it would deserve instant disbelief were it not so repeatedly found in military conflict. This factor is the probability, call it δ, that people or events in a war, a battle or even a skirmish will actually go as planned. Allowance for this factor is therefore of the utmost importance in deciding how much munitions or how many troops are enough. Extreme danger occurs when planners unconsciously assume the factor to be of the order of 1.

Examples, incredible examples, of small delta abound. We need only mention two. For those sentient in the 1940s, the Pearl Harbor debacle jumps to mind as a classic case with $\delta \ll 1$. In brief (and vastly oversimplified), Washington, having knowledge, did not clearly and effectively inform the Hawaii commanders that war was imminent. (In fact, an army message was sent by Western Union! It arrived a few hours after the attack was over.) The military was, in any case, not prepared. In fact, it was unbelievably, inconceivably unprepared and complacent. Finally, what local warning military leaders did have, to wit radar and sub contacts, were ignored.

More appropriate as an analogy (not an identity) to present missile reliability was the Navy experience with torpedoes in the Pacific in early World War II. In short, they didn't work. And submarine commanders who reported that fact or who altered the torpedoes so they would work were summarily relieved of command. Great loss of life in the submarines and in the torpedo bombers (and consequently to Americans generally) ensued. Again $\delta \ll 1$.

In ballistic missiles and multiply targeted re-entry vehicles together with their launching and control devices, we have an enormously more complicated munition, (I hope forever) untested in combat. This weapon system is properly under very tight control. But tight control also inevitably

decreases δ. (There is an apocryphal story of an ammunition sergeant at Hickam Air Field in Hawaii, 7 December 1941, under actual Japanese air attack, who refused to release anti-aircraft ammunition without proper authorization.) The strategic nuclear stakes are the highest possible—civilization itself—again leading properly to caution, but also perhaps to indecision, consequently to a yet smaller δ. What then is δ for this entire weapon system? For example, if δ is even as large as 0.05 then a ten times "overkill" in vehicles calculated on target is not sufficient. Calculation-on-target is itself a smaller number than the vehicles available before conflict in the US, and a much smaller number after a first strike against us. What if $\delta < 0.01$? What if $\delta \ll 0.01$? Unfortunately the delta factor includes such imponderables as errors, stupidity, ignorance, unexpected contingencies, military rigidity, peacetime attitudes, battle confusion, inaction in novel stressful situations, and hesitancy, not to mention poor, ambiguous or absent communication.

So estimates of δ are both difficult and unreliable—extremely so. But for truly realistic planning for peace it appears essential, absolutely essential, to estimate and conservatively allow for δ.

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3/84   Los Alamos, New Mexico

PT as recruiting device

I thought that some of your readers at academic institutions might be interested in a use we at George Mason University have found for old issues of PHYSICS TODAY. We have placed a large display poster, using PHYSICS TODAY covers to illustrate numerous reasons

students might want to major in physics, in the front lobby of the physics building. Students can often be found reading the poster, which is probably an effective and inexpensive recruiting device.

ROBERT EHRLICH
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2/84   Fairfax, Virginia

Early days in heavy elements

Commenting on C. P. Snow's *The Physicists*, Ruth Sime (December, page 84) remarks that nobody "saw through" (Snow's phrase) the problem of interpreting Fermi's experiments on uranium bombarded with neutrons. There is danger of forgetting that Ida Noddack did "see through" it, but was ignored.

Fermi[1] reported that the bombardment produced several β-active nuclear species, including one with a halflife of 13 minutes. Chemical procedures that resulted in precipitation of this species did not have a similar result when applied to known elements near the end of the periodic table. Fermi concluded that the investigation "suggests the possibility that the atomic number" of the 13-minute β-rayer "may be greater than 92." That interpretation was widely accepted.

Noddack,[2] however, having repeated Fermi's chemical manipulations and having found that many elements could by that process be carried down in the precipitate, asserted that Fermi's line of reasoning was not convincing. Instead (my translation),

One can just as well suppose that, in these new kinds of nucleus-smashing by neutrons, "nuclear reactions" take place that are significantly different from those observed up to now in the action of

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