

The expedition's head claimed success (2), although subsequent reports were in conflict with this (3). In any event, the rain of ridicule that followed the expedition seems to have dampened the voters' and Congress's enthusiasm for the project. Simon Newcomb suggested a cheaper variant of the experiment: "If [the most powerful bomb] can condense vapor a quarter of a mile away, then anybody can condense vapor in a room by slapping his hands. Let us therefore try slapping our hands, and see how long we must continue before a cloud begins to form" (2).

From Carter's account of the Colorado debate, it is clear that to the general public, today's weather modification techniques are as unreliable as were those of 1891, and there appears to be little scientific evidence to contradict this view.

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#### References

1. E. Powers, *War and the Weather* (E. Powers, Devalan, Wis., revised ed., 1890).
2. R. G. Dyrenforth and S. Newcomb, *N. Amer. Rev.* **153**, 385 (1891).
3. Unsigned editorial, *Nation* **53**, 309 (1891), attributed to S. Newcomb by R. C. Archibald in *National Academy of Sciences, Memoirs* (National Academy of Sciences, Washington, D.C., 1924), vol. 17.

### University-Industry Interaction

Rustum Roy (1 Dec. 1972, p. 955) considers several modes of university, government, and industrial interaction. His goal is the improvement of these interactions to fill an assumed national gap in the areas of "applied science" or "applied research." It is unfortunate that such an important subject is again treated in a superficial manner. One national problem may indeed be that of increased industrial productivity, and this "national" problem is certainly mirrored in specific industries where foreign competition, environmental considerations, and "consumerism" place such strong demands on productivity. However, the industrial sector is not as monolithic as agriculture, and cooperative schemes involving elite "troikas" of government (they have the money), universities (they have the brains), and industry (they have management and money) are just too simplistic to cover the diversity of U.S. industry. Consideration has to be given to the size of the company,

the nature of the industry, its rate of change, and a variety of other economic, historical, technological, and sociological considerations.

To many of us in electronics, the problem is not that of a more effective use of the universities, but rather that of transferring technology, products, and insights to manufacturing divisions which are necessarily concerned with short-time scales. The problem is to understand both technological trends and business trends so that the necessarily longer-range view of research can be properly phased with the planning and performance of a company. It is not an easy task and requires intimate knowledge of both the company and its industry. That kind of insight does not arise from any of the models described by Roy. Indeed, I can only see Roy's models of use in two ways. The first is simply manufacturing "fire fighting," where a simple idea or experiment can often solve a serious problem. The specific industry then benefits from the intellectual capital of the university. Another way is to supply an "intellectual front" for industries that lack the understanding, conviction, and funds to adequately support their own industrial research. I fail to see either the educational or industrial returns from such roles for a university.

Finally, I am not aware of any "shutdown" at RCA that could be associated with its "withdrawing, from fundamental research, even from research applied to its own problems, the support it had been giving for two decades." At the end of 1972, RCA left the main frame computer business, and the whole corporation reacted to this large loss. The reduction of research (less than 10 percent) at RCA Laboratories can be completely related to a specific business problem and not to major changes in philosophy.

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We wish to protest vigorously the comment in Roy's article concerning the research activities of the Ford Motor Company. We cannot speak for the other industrial organizations cited, but we wish to note for the record that research at the Ford Motor Company has not been shut down; in fact it is increasing. While the level of non-oriented fundamental research support has been decreased somewhat since the

mid-1960's, such research still occupies a respectable and legitimate fraction of our overall research program. Numerous business pressures, resulting in part from governmental regulations for environmental quality, safety, crash-worthiness, and so forth, have required reorientation of some of our research activities. Within these problem-oriented areas our fundamental research has expanded and plays a very significant role.

We agree with Roy's thesis that university-industry interaction needs to be enhanced, consistent with the roles, missions, and objectives of academic and industrial research organizations. We ourselves are strongly committed to developing and implementing new modes and patterns of effective interactions between our own staff and our academic colleagues.

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I apologize to Cody and Compton if they felt that my term "shutdowns" was too sweeping in describing the changes at Ford and RCA. There seems, in any case, to be little disagreement that there has been a marked shift (reorientation?) in the distribution of research support within U.S. industry, away from the more fundamental end of the spectrum.

While Compton notes that Ford is committed to developing new modes of interaction with academe, Cody's rather hopeless view of coupling is more representative of the reaction I find among large, high-technology companies, who (regrettably, in my view) have so far influenced national science policies not only for themselves (where they may be applicable), but also for companies with low and middle technology and for small companies. The tragedy of it all is not that such coupling has failed, but that it has never been seriously tried by any industry (and I would sincerely appreciate hearing from any reader who can supply data on exceptions). It will be exceedingly valuable if Ford's new models of university-industry coupling were described in the literature, and if more industrial research managers would lay out their rationale for using, or avoiding, such coupling.

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