Most Effective Mechanisms for University-Industry Programs

Summary review: D.O.E. Workshop on Mechanisms of University-Industry Interaction, Reston, VA, 8 December 1978

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One of the remarks made by Arthur Kantrowitz in yesterday's discussion gives me a good starting point today. Arthur felt, if I may read between his words, that a precondition of the discussion of university/industry interaction should be an assessment of the general milieu in which such interaction can develop. He was particularly concerned with the growing anti-science wave in this country and suggested that in countering it, we should, in the words of Dylan Thomas "rage against the dying of the light." But rage isn't enough, especially if we rage only at ourselves. We must kindle some new lights. We must get mad enough to fight and to fight constructively to eliminate the social and other deficiencies which contribute to the present gnawing away of the foundations on which our work and future science and engineering interaction are based. Perhaps my subsequent remarks will help you reach this stage of madness.

What did I hear in our session of yesterday worth summarizing and critiquing? Let me begin by suggesting what I didn't hear. There seemed to be an implicit and sometimes explicit assumption that university/industry interaction should involve engineering. Perhaps this is because by far the largest part of past interactions has been of this character. But isn't this all the more reason to discuss and work on improving the interaction in non-engineering science areas? Also from the industrial side I got the understandable but unfortunate feeling that all university/industry interaction is viewed, again perhaps mostly implicitly, in terms of what we can get in the relatively short term, rather than what we can give that

will bear fruit in the longer term future. To change the metaphor slightly, has "bread cast on the water" gone out of fashion in our modern age?

As one who spent 21 years in an industrial R&D lab, two years in a government lab, and only the most recent four in academia, let me hasten to assure you that many faults exist on the academic side as well. Perhaps I'm in a good position to cast a stone at both your houses. Here's one for academia. Very recently Harrison Shull made some pleas for industry to better realize what a wonderful resource they have in people who receive their PhDs as a general purpose problem solvers par excellence. Apparently in his view, industry just realized this, but the PhD employment problem conflicts with this theory. While there is considerable truth in his assertions, his essay exemplifies a wholly one-sided view; his marketing is myopic. He is saying we have a great product, just realize that and you'l1 be sure to want to buy. But nowhere does he even imply that the customer, primarily industry, has a worthwhile and valid point of view as well, and can contribute usefully to help define, and even to some extent help to produce, products more germane to the customers needs. The idea seems to be, "Hey, look what we've got...," not, "Hey, come help us produce something even better." I will return to this general point a bit later.

Well, what did we hear yesterday? We heard some entertaining talks but was there rea11y much in them that wouldn't have been just as appropriate 20 years or so ago, or much that most of us didn’t already know, at least in general outline? There was a lot of popular and even necessary buzz words like champion, strategy, incentives, accountability, excellence, commitment, and so on. But there was damn 1ittle of the complement of motherhood--the fathering of new ideas.

We've been a batch of people here talking to ourselves, reiterating old truths and methods. At times yesterday, in spite of some excellent talks, I was tempted to call on T.S. Eliot and begin rolling up my

trouser cuffs. Don't you think even our seating arrangement is indicative--a closed circle? We need to open up, open the circle and open new doors. Unless we go away from this workshop changed at least to some degree by it, and resolved to change some aspects of the outside world with these interactions, we will have wasted our time, as well as the tax money that supports the meeting. The report of this workshop should include some important recommendations for action, such as Rustum Roy's dollar matching proposal, tax incentives to further encourage university/industry cooperation, and so on. We should all feel some commitment to ensure that the recommendations of the report get translated into useful actions and that the report doesn't just gather dust on a shelf.

By the way, I heard more about various government-supported programs to help university/industry interaction in Frank Press's short talk last night than I did in our whole first session yesterday. But we did hear a good deal about basic and applied research yesterday. And now I'd like to try to shed some light on one aspect of university/industry interaction in a research area which didn't get entirely covered yesterday.

Academia and industry interact in only one way--by the interaction of the people in these areas and endeavors. Let us subdivide the people category into two parts because interaction takes place in two primary ways: First by the permanent flow of trained people from one area to the other, with the dominant flow from academia to industry. Second is the flow of the high leaders in both directions, with the people themselves maintaining their own primary bases.

The training of people for industry could be improved if the trainers and the professors in academia were both more aware of the specific needs of industry; and most important, even if their awareness were raised adequately, they were willing to modify their teaching to make the overall training of their students more pertinent. This willingness, which may entail considerable work, is not

always forthcoming. In addition, since industry is a primary source of jobs for the people product of academia, it behooves professors to cease, consciously or unconsciously, downplaying the possibility of a first-rate career in industry as compared to one in academia. In my own field of physics, about half of the new PhDs produced each year don't get jobs in physics at all. Of the other ha1f, about half of these go into industry. The remaining get jobs in academia. Roughly a quarter of these (about $1/16^{th}$ of the original group) get tenure at the university level, the area where much, if not most of PhD training seems to be increasingly needed.

These figures alone suggest that training changes are in order. We've heard about some programs which allow some professors to work temporarily in industry, and it can all be valuable. But if there is no subsequent change in the professor's teaching, the programs have not lived up to their full potential. It appears in many instances that there needs to be a follow-up program as well, perhaps one that would give professors some release time on their return to academia, during which they would modify some of their current courses, or perhaps develop one or two new ones. The government has a stake in such modification and upgrading and could profitably help financially. But industry's stake is crucial in the long run, and new initiatives should be developed to allow industry to play an important role, both financially and non-financially, in the process.

For simplicity, let us restrict the other part of the interaction, the idea flow, to the areas of research and development. Before considering how this interaction could be improved, it might be well to ask what we are talking about? What are industry and academia labs doing in the R&D area? Shou1d their R&D be essentially the same? I think not. University research should be mostly long term, exploratory and basic, with a small quota of applied work in the realm of applied problems. Most government labs have, or should have, a definite mission, except those like FermiLab and parts of NBS where very

basic research work is in order. But they should primarily carry out medium-term applied research, some development, and only a small amount of undirected, exploratory basic research.

Finally, while we might feel it would be nice if industry carried out more basic research, only a very few top labs, often associated with very large quasi-monopolistic companies, do support much basic research--most industrial work instead being short-term applied research. With less basic research done in industry than in the past, and with more or most government labs being mission-oriented, it appears that most basic research must be done in academia. But basic research support in universities is in trouble, only partly because of galloping inflation.

Most basic research in academia has been done in the past by professors and graduate students. But with the current scarcity of jobs in many areas of science that have contributed greatly to basic research advances in the past, the number of graduate students is itself dropping. Thus, in the absence of any university growth, and in the absence of increasing post-doc research associates, the actual number of people in the universities doing basic research is probably slowly dropping. Since industry, and the country as a who1e, depend crucially in the long run on an adequate amount of basic research that will eventually lead to innovation and new products that can help the balance of trade and general living standards, it seems imperative that this weakness be addressed and ameliorated.

Thus it appears that even more jobs outside the universities need to be created so that the graduate student population can be increased, or perhaps more realistically in the medium and short run, new ways need to be evolved for providing the support for the people who work with professors on basic research in universities, without increasing the number of graduate students and thus producing more people who may not be able to remain in science. Here industry could help. One possibility would be for each industrial company

that depends appreciably on the output of academia to support several people at the MS and PhD levels doing non-degree basic research in academia.

There should be a commitment to share the results of the research, but no necessary commitment for industry to hire such people. If the university basic research were generally relevant to the company's area of R&D, however, these people would have had several years of university basic research experience and could be very valuable in the more applied R&D at the company itself.

Again the interaction involves, as it always must, people and good will. The training of people to foster the quality and quantity of information flow between industry and academia can and should be substantially improved. Perhaps there is a paradox here. Given that we need more basic research and that many, if not most, new PhDs are now in government and industry where there is little basic R&D, shouldn't we therefore train students more for applied work that they will do in industry? But if we do, there will be even less basic research going on in academia and in toto. This would therefore be a bad plan. But if we train more people in basic research, there will be too many who either won’t get jobs at all in general areas, or who will have to do applied work, possibly contrary to their expectations and desires. Perhaps we can discuss this quandary in more detail later.

In conclusion, I was strongly struck by one proposal in the keynote address. To paraphrase, "We must find ways to conquer the future." I agree, except that I think a better word could be found. Certainly the future is important to us individually and co11ectively since we're all going to live there the rest of our lives. But we mustn't just conquer the future. Shouldn't we ask what kind of future we want, and try to specify means to bring it about?

First we need to invent and imagine the future. We must dream constructively. Perhaps we need a new type of research which I'11 call Type III. Its practitioners will be dream designers, dream developers, dream engineers, and dream merchants. Remember that society can only do that which it first dreams of. May our dreams be both human and humane!