Research Program on the

ORGANIZATION AND MANAGEMENT OF R AND D

How the U.S. Buys Research

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HOW THE U.S. BUYS RESEARCH

When you compete for a government R&D contract, what are your chances of winning? We know there is a formal contract award process, but does it really mean anything?

by Edward B. Roberts

IN BRIEF: *There is a formal contract award process that supposedly initiates all U.S. government research funding. But there are major differences between this formal process and the actual process by which the government buys research. The author analyzes these differences and shows that the actual process is far less competitive than government regulations would suggest it to be. In fact, there is a good deal of superficial competition.*

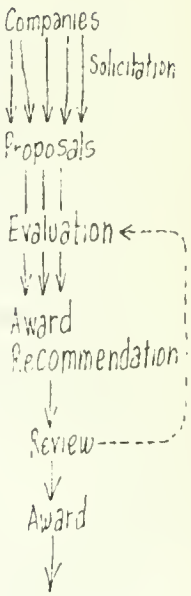
In this analysis of the multibillion-dollar contracting business, the author suggests how the research procurement process ought to be changed to rid itself of superficial competition and the wastefulness it causes. Your review of this document should increase your understanding of the actual process . . . and it may explain why you failed to get that last contract.—D.A.

■ How does the U.S. government buy research and development? We know it awards over seven billion dollars per year to industrial firms, plus another billion and a half to nonprofit corporations and universities. And we know there is a formal contract-award process that supposedly initiates all this funding. I have charted this formal process on the opposite page—and it does indeed look formal, even formidable.

But does it really work this way? Is it really a filtering process, as this sketch suggests?

From a series of management-research inquiries I have made, under general auspices of the NASA-sponsored MIT Organization Research Program, I have come to the conclusion that *actual* operation of the contract-award process does not correspond to that which one would expect from the formal regulations. In fact, I would go further and say that many aspects of the formal contracting system succeed only in increasing R&D costs, adding time delays, and producing other damaging effects on government-sponsored research and development.

In this article, I want to explain how the process really works. In doing this, I will compare this actual process with the formal process, so let me begin with a quick explanation of the rules and regulations that are supposed to dominate government-sponsored R&D. These rules and regulations are incorporated in the Armed Services Procurement Regulations. With only minor exceptions, the general principles of ASPR have been adopted by most agencies of the government, including NASA. In brief, the formal steps work like this: A government scientist or engineer files a Procurement Request for R&D services or equipment. In his request, he includes some specifications of what he wants to have "researched and/or developed," plus when, why, how, etc. . . . and he indicates what companies might be able to meet those specifications. Then the request goes through several stages of approval—financial, contracting, headquarters, legal—and during this process, the Facility Source Office at the government field center adds the names of other possible contractors to those recommended by the scientist or engineer who initiated the request. Next, evaluation teams are appointed, evaluation criteria established, and Requests For Proposals are sent to companies who have made the list. Responding to these requests—or noting the announcement of the pending procurement in the Commerce Department's daily newspaper—interested contractors submit their proposals. And finally, these proposals are evaluated, award recommendations are made, and the selected firm receives a contract.

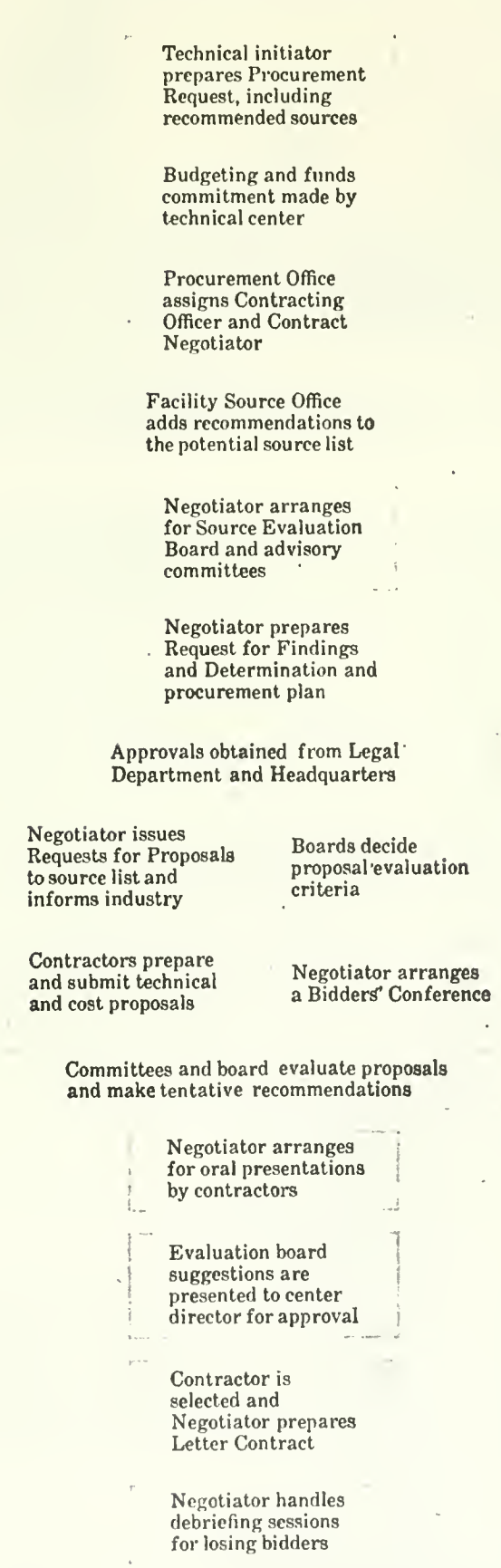


Examining the *letter* of these government procedures, one sees the principles that the formal process is intended to promote:

- maximum competition
- objective evaluation—through numerical proposal evaluation by teams of evaluators
- independent, multilevel review.

But one conclusion I have reached, from over six years of research on the government R&D process, is that these sought-after principles are *not* secured. Even more general is my conclusion that many government policies for managing contracted research and development are in major conflict with the government's own objectives.

My study of contract awards was made in two government agencies—one was a Defense



The flow of formal activities in a typical research and development contract award is supposed to work like this. The white boxes, in most instances, apply only to large contracts (exceeding $1 million). For things as they really are, see text.

Department center, where we examined 41 DOD awards, from $100 thousand to $8 million; the other was a nondefense agency and here we examined 10 contracts, from $1 million to $40 million. (Another 100 awards are now under study in a third government center.) I want to defer here to say that I was aided by Laurence B. Berger and J. Barry Sloat, graduate students in the MIT Sloan School of Management, and that we were given excellent cooperation in both government centers: We had complete access to the contracting files and personnel, and I felt throughout our extensive interviews that we were receiving *honest*—not just "cooperative"—answers. In the DOD office, we interviewed contract negotiators and some of the technical initiators and project managers. In the other agency, we interviewed the chairmen of the source evaluation boards, members of the technical evaluation committees and the business evaluation committees, and the contract negotiators, project initiators, project managers, plus others who were closely related to project award decisions.

The competition

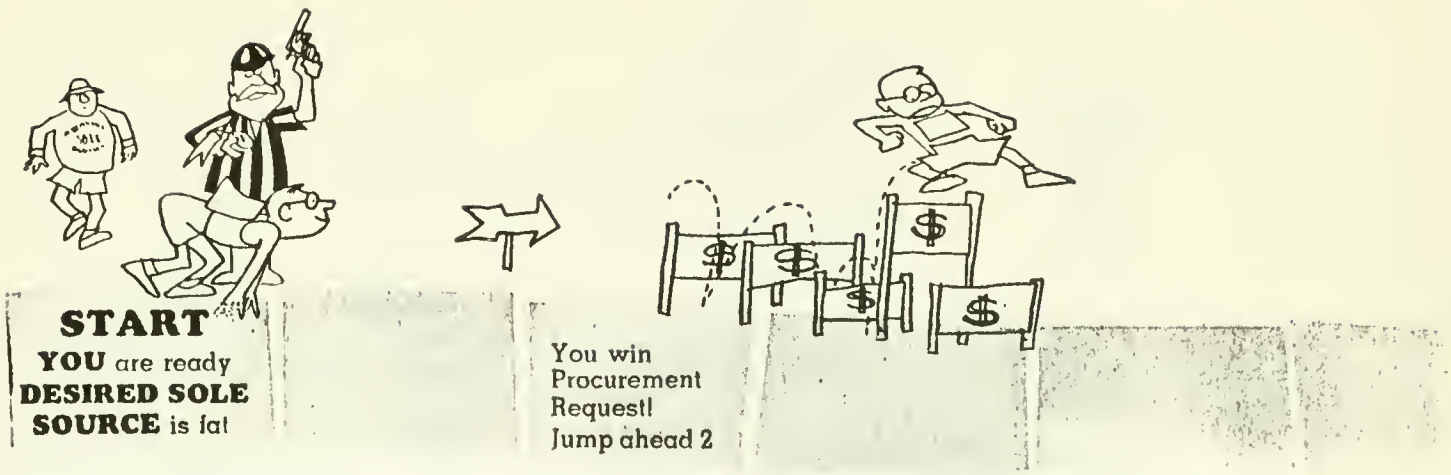
What did we find out?

First, our file searches suggest that about 60% of the R&D awards were made on a sole source basis—*without* formal competition. This finding jibed with what M. J. Peck and F. M. Scherer had observed a couple of years ago, in their analysis of the weapons acquisition process: "In fiscal year 1959, some 53.8% by dollar volume of the $15.3 billion in domestic military contract awards . . . were negotiated noncompetitively with a single firm."

Now let me point out that we excluded such noncompetitive contracts from those contract awards we studied. We did this because we wanted to know how much real competition existed in that other 40%—in that segment of the R&D business that got done after competitive solicitation.

What did we find out here?

We found less *actual* competition than one might have expected. For instance, of the 41 Defense Department awards, we found that the technical initiator in six of these had recommended on his procurement request that only one company be approached to undertake the R&D task. (The jargon for such a company is "desired sole-source." I may lapse into the jargon now and again.) Now, acting under the procurement principle of *maximum competition*, the government agency did solicit other firms to compete for these awards: An average of seven firms got into the competition on each of these desired sole-source projects. But who got the awards? After all these proposals were evaluated—usually by small teams, dominated by the government technical initiator—five of the six awards went to the desired sole-source company anyway. (In



How to play **CONTRACT** the million dollar research game
Object of game - Beat **DESIRED SOLE SOURCE** to finish line and win million dollar contract

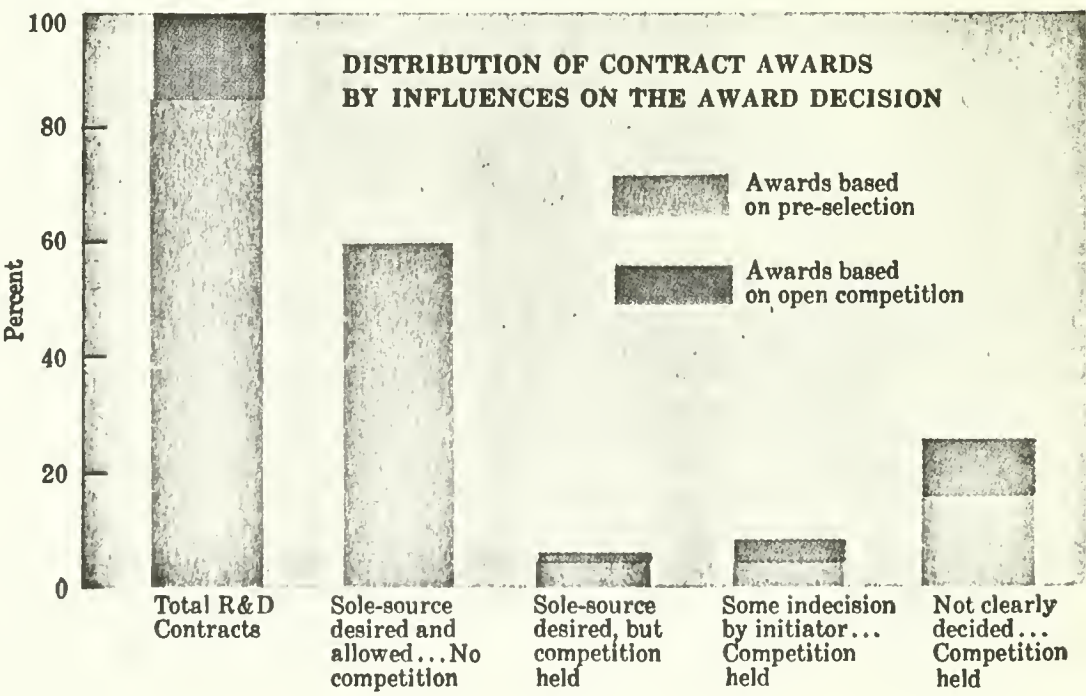
the sixth case—the loser—this desired sole-source was severely reprimanded by the technical initiator for having "insulted the agency by sending in an 'advertising brochure.' " Evidently, even a company that is "in" can sometimes get too cocky.)

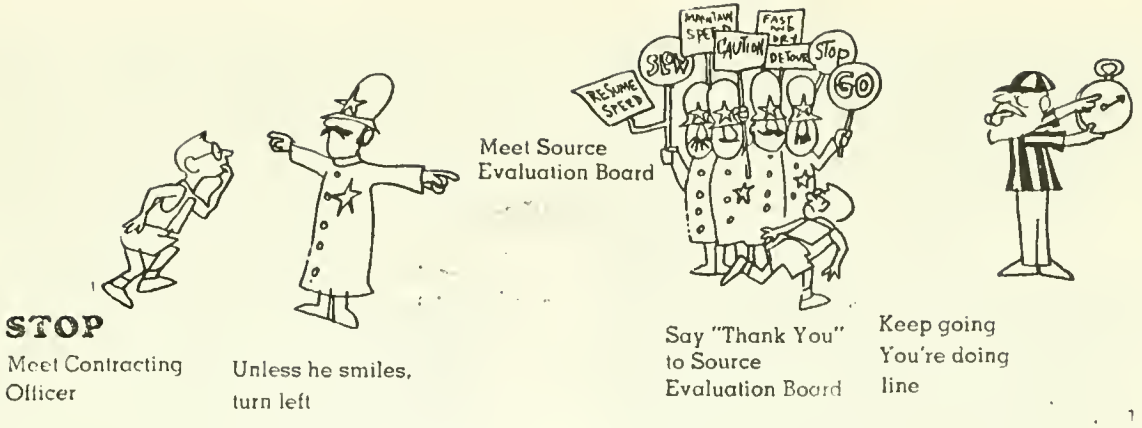
In nine other cases, the government project initiator recommended two or three companies in each case. In six of these nine, the award went to one of those recommended companies—after ten to forty companies had been solicited in each case.

Now we have covered 15 of the 41 DOD awards. What about the other 26? In these cases, the initial recommendation lists—prepared by the project initiators—contained more than three company names, ranging up to 21 suggested sources. It was no longer as easy to assert that a narrow solicitation was desired by the project initiator. But we discovered that 22 of the 26 were *not* in alphabetical order. Did these lists, in fact, contain a preference indication? Our hypothesis claimed that if the project initiator had his way—with formal procurement regulations absent—he would award the contract to a firm that was high on his list.

When we checked our hunch, we found that 10 of these 22 awards went to the first company listed; three went to the number two firm; one award went to the only recommended company that bid; five other awards went to companies the initiators had recommended. So, of the 22 awards, 19 were made to firms on the recommended lists. I do not say this is "unfair," or that initiators ought to be "more objective." I will come to the point of this in a minute, with some discussion of "objective evaluation," but I want to point out some additional facts before winding up this discussion: Over twice as many companies were solicited, in all, as had been rec-

"In reviewing a series of Defense Department contracts, we found that more than 85% of the R&D awards were 'pre-selected,' or based on factors that existed prior to any formal proposal solicitation."





Has anybody seen
DESIRED SOLE SOURCE?
You're winning.

ommended by the technical initiators; in three cases, the company that appeared at the top of the list did not even bid on the job; in only three cases did the award go to a firm that had not been recommended by the project's initiator.

But what about the four lists that *were* made alphabetically? Again, there were about twice as many companies solicited as were recommended by the initiators, but in *all four* cases the award went to a firm that had been recommended by the initiator. In two of these four cases, we found from interviews that the initiator had been strongly biased in favor of the ultimate winner, and in a third case the contracting officer said the winner could have been made the sole source. Thus, it is possible that alphabetical source lists were established merely to give the appearance of an impartial recommendation.

I must caution that these data were drawn from R&D contracts in the range of $100 thousand to several million dollars and, further, that all of these 41 awards were made by the same agency in the Defense Department. Hence, it is possible that less "preselection" may take place in other agencies and with larger contracts, though the evidence of Peck and Scherer shows a very high percentage of *formal* sole-source awards on large-weapons systems.

But with R&D contracts of less than $100 thousand, it is likely that even *more* preselection occurs. I believe this because fewer formal reviews are required and decision-making authority exists at a lower level of the governmental organization. I intend to check out this hunch in the near future.

Assuring objective evaluation

The second key principle in the procurement regulations is that award decisions should be based on objective evaluations of the proposals that are submitted. Following the formal procedure, one seeks such objectivity by getting quantitative assessments from several competent and unbiased evaluators. But our research results show that many aspects of this principle are denied.

I said earlier that the project initiator is often biased in favor of one or two companies —firms with whom he has had contact and experience. Why do I say this? The project initiator is always a technical man. And any experienced person in the position of project initiator will have had some previous encounters with some of the potential bidders. It is hard to imagine that the initiator's judgment will be unaffected by such experiences.

Because he is almost always a member of the project's evaluation team, the initiator can exercise his "predispositions." Indeed, one whose judgment *is* unaffected is probably not suitable to handle evaluation responsibilities. Hence, I would say two things: Not only is lack of some bias *impossible* of attainment; it is probably even undesirable.

Only the naive nontechnical man can believe that technical performance and—more difficult—technical proposals can be "objectively" evaluated. In all areas worthy of the "R&D" designation, only subjective evaluation is possible. Even technical "facts" are subject to dispute by competent evaluators. Certainly, technical "opinions" on yet unproven research and development projects can be debated still more. We can expect honest appraisals by competent men, but these must reflect their experiences, judgments, technical prejudices, and other factors of a subjective nature. After-the-fact contract performance evaluations in the contracts investigated often showed that award decisions had been based on incorrect technical evaluations. One project initiator admitted that he had been "sold a bill of goods by Company X." Another project, awarded to Company Y because of its unique technical approach, was canceled when the approach proved unusable. At best we can expect competent subjectivity, not some mystical objectivity.

What about using numerical point scores in evaluating proposals? In nine of the ten nondefense R&D awards of over $1 million, the source evaluation board members revealed that general discussion, leading to general agreement on the recommended source, *preceded* final assignment of numerical point scores. In other words, the numbers are not the measures that produce the award; rather they are after-the-fact representations of general agreements. They are justifications for decisions, rather than the causes.

I challenge other aspects of the objectivity principle. For example, company evaluation, not proposal evaluation, is the paramount consideration. Furthermore, two or three key people, at most, dominate the award decisions —not the 20 to 100 who staff all evaluation committees. One might even question the relative competence of government engineers and scientists to evaluate large system proposals, where the main criteria often relate to organization and management of a several thousand man, multicompany, contractor team.

Independent multilevel review

The final premise of the formal government R&D contracting system is that several levels of review and approval ensure effective and honest award decisions. This principle also seems more an illusion than a reality.

In contracts of less than $1 million, formal source evaluation boards are seldom established. An award recommendation is made by the technical evaluation group, consisting usually of the technical initiator, his supervisor, and perhaps another scientist/engineer in the same group. Their recommendation goes to the contracting officer, a member of the agency's procurement organization who rarely has a technical background or technical review capabilities. He looks at the budget, the relative bids, and perhaps at some recent agency experiences with the recommended contractor. If he is concerned about large apparent cost differences in the bids, he might ask the technical evaluators if a lower bidder would be acceptable. But so long as budgeted funds cover the recommended bidder, the technical evaluators can have their way.

For the larger contracts, technical and business evaluation committees report to a source evaluation board, which recommends action to the center director, who (in very large awards) forwards his recommendation to Washington for a formal decision. But do these multiple review levels mean anything?

Our interviews indicate that decision making is done—effectively, if not formally—in the technical evaluation committee or the source-evaluation board. In some cases, the technical initiator "stacks" the board with people predisposed to accepting the initiator's recommendations. Here, the real power resides with the technical initiator, acting through his technical-evaluation committee; higher-level groups in effect "rubber stamp" his recommendations.

In other cases, we found that the source-evaluation board was doing the decision making, with the supposedly independent committees under the board continuously being called upon to revise their reports until the senior group agreed with it. As one procurement official who had chaired such a business-evaluation committee explained, "They tell me that when I'm on an evaluation team, I'm supposed to be Joe Independent. What they forget is that for the rest of the year I'm Joe Subordinate, and if my boss says 'Change it,' he's the boss."

In only one case of the ten large nondefense awards was the source-evaluation board's recommendation reversed at the Washington level. The situation was one of a board split between two competitors; the board's disagreement resulted from different interpretations of the job requirements. Headquarters had to resolve this dispute, but in no other case did headquarters' interference or review appear to be important.

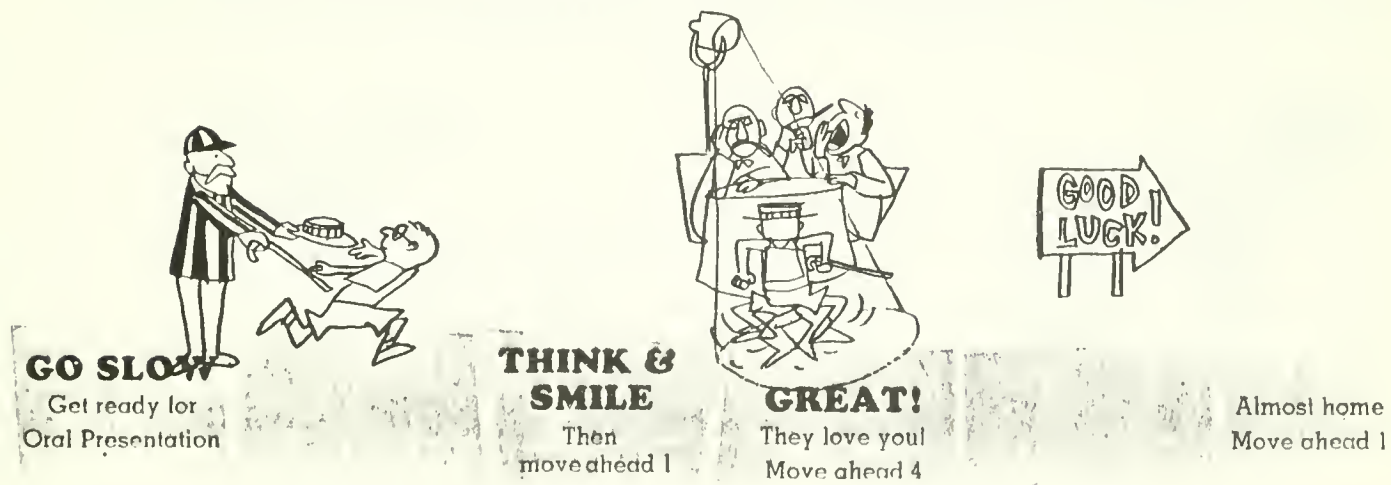
Real award process

The real award process is one involving long-term person-to-person contacts between technical people in government and industry. They build up common experiences, attitudes, aspirations, confidences. And ideas are generated in this interchange. These are the ideas which later become government-sponsored R&D projects. When he is convinced that an idea has solid merit, the government scientist/engineer initiates a procurement request. He often feels, naturally, that the work should be carried out by the people in whose capabilities he has faith. Acting in what he believes to be the nation's best interest, he tries to secure "his" contractor. (He usually succeeds.) If he is confident of his judgment, he thwarts attempts to saddle his project with another contractor. Only when he regards several companies as being highly qualified does real competition prevail.

I do not mean that all proposals are not carefully studied for their technical content. They are. But the evaluators also consider the companies: their experience, their key people who will staff the job, and so on. What the evaluators must really look at are the contractors as potential sources of work, not just at their glossy brochures. And award decisions are reached after careful consideration, discussion, and argument have resolved the issues. Yes, these resolutions are quantified in numerical evaluation forms—but, as I say, the numbers *follow*, not precede, the point of award decision. Occasionally, a unique technical proposal or a large cost difference in the bids upsets the expected results. But far more often, the predetermined decision proceeds unmolested through the several formal stamps of approval, pausing for review only when a major unsettled dispute rears its head.

Does this process lend itself to political pressure? We looked for this, but found *no* instance of it. And I doubt that our interview subjects, who were indeed candid on other touchy issues, tried to hide information from us on this question. It may be that because the awards we examined were fairly small—mostly less than $1 million—they did not merit such pressure. But Peck and Scherer's study, of bigger contracts, came to pretty much the same conclusion: "Political considerations have not played a really major role in the choice of contractors for advanced weapons programs." They found a lot of political "activity," but concluded that the effort did not have a corresponding effect. They said that much of the activity is "ritualistic" and that political pressures tend to cancel out one another.

In only one of the large (≥ $1 million) awards did we encounter any political activity and it was not really "pressure": Two Congressmen indicated their interest in the contract; one asked that two competing companies from his district be considered, in light of high unemployment there; the other Congressman, extolling the merits of small business, gained an audience with the center director for the president of a small company. The agency responded by tightening up internal documentation on all phases of the com-



petition "in case of any trouble." Two of the three "Congressional" companies would have been disqualified at an early stage of the evaluation, but this was not done, so as not to insult the Congressmen. (Both companies were ranked near the bottom in the final evaluation.) The company that did receive the contract was not one that a Congressman had recommended. When the award was announced, the Congressmen were notified simultaneously with notification to the bidders. Thus our only incident of political activity appears as appropriate actions by Congressmen in behalf of their beliefs and constituents; we note the somewhat ritualistic flavor, the partial canceling effect, and the ultimate lack of influence on the award decision itself.

Policy questions

The Department of Defense under Secretary McNamara has gone in heavily for the use of cost-effectiveness analyses in evaluating weapons systems. Similarly, I believe that the research and development contracting policies of the Defense Department, and other government agencies, would be strengthened if similar cost-effectiveness criteria were applied.

Let us examine both the costs and benefits of the present system of R&D contracting: We now know that the real process underlying R&D awards is informal and highly selective. But the pressure of the procurement regulations and fear of the General Accounting Office and Congressional inquiry has forced us to take the formal solicitation approach to contractor selection. This approach is bad on two counts: It is costly and it is superficial. Let me substantiate my argument, first, by citing some facts that others have uncovered.

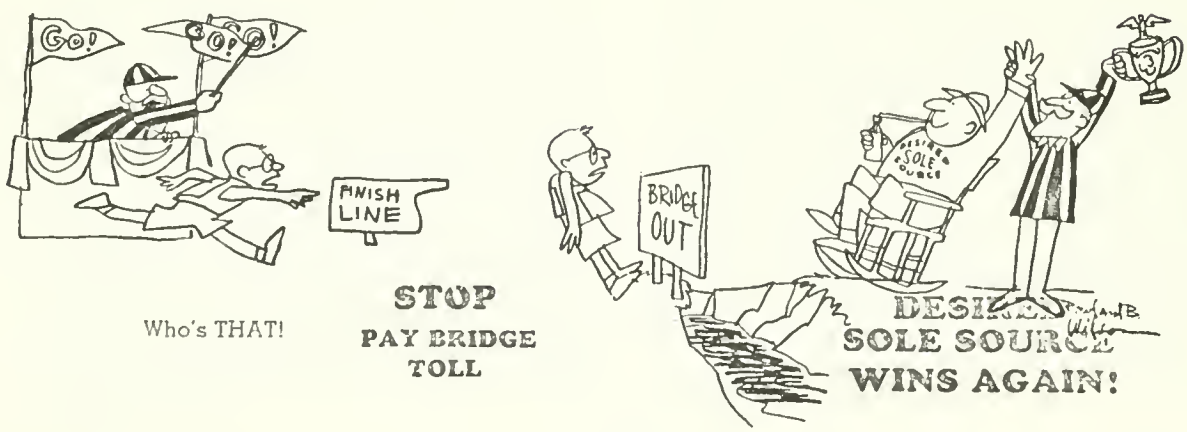
In a study of proposal efforts on small R&D tasks—from $30 thousand to $150 thousand—Thomas Allen of MIT gathered data on 14 contract awards. He found that the total cost of all company-proposal efforts in each competition ranged from 3% to 150% of the direct cost of the contract awarded. The total proposal effort in those 14 competitions was not a function of the size of the job, but was related, rather, to the number of bidders: the more bidders, the higher the total proposal preparation cost. I am now gathering similar cost data on the contracts in my sample.

Another study tells of 36 firms competing for a single large R&D contract: Each of the 36 bidders spent an estimated 3000 to 4000 engineering man-hours on its proposal. Add these together and you have 45 to 60 man-*years* of engineering effort. And these figures represent only the effort expended at the *prime* level. Then you must add the technical manpower expended by various tiers of subcontractors, who must generate technical data for the prime contractors, the bidders themselves.

And government people must also expend great effort, what with extensive source solicitation and the ritual of "going through the motions" on the proposals submitted. The key people on technical staffs often serve for weeks and months on the evaluation teams, distracted from project work in which they might otherwise be engaged.

The direct financial cost of this process is high, and government bears the entire cost of the evaluation and most of the cost (through allowed contract overheads) of the company proposal preparation. More important than this direct cost is the resulting reallocation of people: The best technical personnel, in industry and government, are pulled off into proposal preparation and evaluation. This detracts immeasurably from progress and effectiveness of the ongoing projects. It establishes a situation in which the best industry people propose and try to sell the jobs, while the mediocre are left to do the work. Furthermore, significant time delays are added to the contracting process by the necessity of the 3 to 12 months needed to prepare proposal requests, to solicit proposals, to evaluate them, and, finally, to make the awards.

These factors do not contribute to the ultimate success of R&D projects, yet current government pressures are pushing for an expansion of formal competition, and for an increase in the number of companies solicited for each project. This tendency will increase still further the direct and indirect costs of



R&D procurement to both government and industry, and will draw even more engineers away from contract work toward proposal efforts.

Benefits of R&D procurement regulations

How effective is the current regulatory system? Though hard to measure, it scores positively on several counts: For instance, one index of effectiveness might be the number of "surprises" resulting from the enforced broad solicitations. We saw earlier that seven of the 41 DOD contracts were awarded to companies not on the initiator's recommended list; five others went to firms that had been recommended, but not necessarily preferred, by the initiator. Now some of these 12 proposals were more outstanding than those submitted by preferred firms. These were the surprises. And this is one benefit of the current system: Broad solicitation occasionally uncovers someone with a better approach to the problem solution.

But note that at least four of these twelve awards were made because of apparent cost differences in the proposals, not because of better technical approaches. And in two of these four cases, it turned out that the assumed cost benefits had been grossly misleading, and the government project monitors regretted the awards. Hence, we can say that cost savings do result in *some* instances, due to the present system of widespread solicitation. But this benefit cannot be evaluated with precision.

A final assumed benefit of the existing regulations is the built-in system of checks to ensure honesty in contractor selection. This is intended to prevent mishandling of government funds for research and development. I will speak to this point in a minute.

How to improve the system

Do these benefits justify the burdens? I think not. Particularly with awards of under $1 million, I believe the costs of the regulations far outweigh the rewards. The misallocation of talent and the added time delays are more disturbing here than are the large, direct proposal costs. Further, the internal checking provided at present is both ineffective (as shown by the high degree of preselection) and unnecessary. I am convinced, from our interviews with project initiators and contracting officials, that these people are highly motivated "to get the most for Uncle Sam." The honesty of these government scientists and engineers is unquestionably high; their ethical standards have not been corrupted by the intentional-low-bidding game that current procurement regulations encourage industry to play. It seems foolhardy to continue buying insurance when the premium is more costly than the value of what is being insured.

Precedents already exist that indicate a path for improving the R&D award system. For example, the Atomic Energy Commission has visited company plants when determining the award of a contract. The Army also has relied heavily on such visit-interviews in evaluating contractors for its Sprint program. Indeed, DOD regulations permit the use of oral proposals as a means for source selection; formal encouragement to apply this approach was provided recently in a memo from Assistant Secretaries Fubini and Morris of the DOD. Other informal or less formal means of industry solicitation and evaluation are possible and can be used by technical evaluators.

For R&D awards under $1 million, technical initiators should have official authority and *real* backing to solicit industry informally and to select sources without the requirement of openly solicited written proposals. The initiator, if he wishes, should be permitted to use any mix of methods, including oral proposals, plant visits, restricted solicitation, as well as the broad solicitation approach currently used. In turn, the initiator and the other evaluators should be required, after the fact, to write up and justify their method of evaluation, including a written assessment of the companies considered. Numerical evaluation should not be required, though it could be used if desired by the evaluation team. I make these suggestions in order to encourage more flexibility in source selection methods and to place greater trust and responsibility in the government evaluators. I believe these changes are in the direction in which the entire government contracting system should move.

At all levels of R&D contracting ($\geq$ and $<$ $1 million) a criterion for the source selection approach used should be that the "costs to procure" should relate to the costs of the procurement itself, and to the added value believed achievable by the selection method. For example, we now ask as many as 100 companies to submit proposals on R&D contracts valued at under $100 thousand. This practice is foolish and should be abandoned. Courage is needed in the DOD, NASA, and other agencies to resist the current trend to write cost-savings reports based on the number of contracts written "competitively," instead of as sole-source awards. Our evidence indicates that total costs may well be *increased*, rather than reduced, by such a forced changeover to superficial competition. Instead of attempting cost reduction in research and development, far more gain is possible by striving for effectiveness increases, and these increases are only possible by ridding ourselves of the constraints of the current formal regulations.

For more information on the processes of governmental R&D contract awards, see the references on p. 103.