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Defense Industrial Planning for a Surge in Military Demand

**Geneese G. Baumbusch, Patricia D. Fleischauer,
Alvin J. Harman, Michael D. Miller**

**A Project AIR FORCE report
prepared for the
United States Air Force**

Rand
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PREFACE

The research culminating in this final report was begun in early 1976 at the request of the Air Force Deputy Chief of Staff for Research and Development. The (then) Office of the Assistant Secretary of Defense for Installations and Logistics had expressed interest in whether the lower tiers--the subcontractors and suppliers--of the defense industrial base had become inadequate to meet the needs of the Department of Defense. Concern had been expressed, and some evidence had been presented to substantiate the proposition, that lower-tier firms were finding it increasingly less attractive to do business with the Department of Defense. The reasons offered included the following: defense business is less profitable than comparable civilian business; regulatory constraints are making it increasingly costly for some industrial firms and contractors to do business; and the paperwork and administrative burdens surrounding government procurement are unattractive to firms, which would rather deal in the commercial marketplace where such activities are much less burdensome. Previously reported research on the issue of *peacetime adequacy* of the industrial base indicated that the lower tiers were generally adequate to meet DoD's peacetime needs. See Geneese G. Baumbusch and Alvin J. Harman, *Peacetime Adequacy of the Lower Tiers of the Defense Industrial Base*, R-2184/1-AF, November 1977; and Geneese G. Baumbusch and Alvin J. Harman with David Dreyfuss and Arturo Gándara, *Appendixes to the Report on the Peacetime Adequacy of the Lower Tiers of the Defense Industrial Base: Case Studies of Major Systems*, R-2184/2-AF, November 1977.

Current research has examined the mechanisms that DoD uses to assess industrial capability for surge and has explored alternative approaches. The authors have tested their suggested alternative to the current system and, through this test, have acquired some information on the *surge capability* of selected industries.

The research on surge capability reported here was conducted during 1977 as part of the "Industrial Base Study" under Project AIR FORCE. For a more technical discussion of one part of this research, see the

companion report, M. D. Miller, *Measuring Industrial Adequacy for a Surge in Military Demand: An Input-Output Approach*, The Rand Corporation, R-2281-AF, September 1978.

This report should be useful to DoD staffs with responsibility for assessing the capability of industry to increase production in response to demand in a crisis. It should be particularly useful to the Directorate of Contracting and Acquisition Policy, the Directorate of Development and Programming, the Directorate of Operations and Readiness, and the Office of the Assistant Secretary of the Air Force (Research, Development and Logistics), Hq USAF. It should also be of interest to the decisionmakers in the Office of the Secretary of Defense (particularly the Under Secretary of Defense/Research and Engineering and the Assistant Secretary of Defense/Manpower, Reserve Affairs, and Logistics) who have responsibility for the development, production, and support of military equipment to protect this nation's interests in time of crisis. Finally, it should be of interest to a wider policy community--agencies of the Executive Branch as well as the Congress--concerned with supporting defense procurement requirements in crises as well as in peacetime.

SUMMARY

In the wake of post-Vietnam reductions in expenditures for military hardware, a concern arose that these reductions, together with certain supposedly perverse characteristics of defense business (such as purportedly low profitability) were eroding the lower tiers of the defense industrial base. As a consequence, DoD buyers were said to be having trouble getting adequate supplies of some products, to be paying monopoly prices for others, and to be in a position of extreme risk should demand increase in a crisis.

We first investigated this erosion hypothesis with respect to the question of *peacetime adequacy* of the lower tiers of the industrial base. Through an investigation of 13 major Air Force weapon system acquisition programs, we concluded that the lower tiers--the subcontractors and suppliers that provide parts and components used in the final assembly of weapon systems--generally do have adequate capacity to meet the Air Force's (and by implication, other DoD buyers') peacetime demands.

For our study of the issue of *surge capability*--the capability of lower-tier industries to make quick responses (one year or less) to increased demands--we first undertook a more detailed examination of DoD's current approach to assessing industrial capability, the Industrial Preparedness Planning program. Although the IPP program has emphasized mobilization more than surge planning, it does not provide very useful information for either purpose, because of what is chosen for planning and how the planning process is carried out once these choices are made. About 6000 end items are selected for data collection and planning. Manufacturers of these products are then asked to provide data about their ability to increase production. Information furnished usually has no direct input from lower-tier firms, and it is often based on a number of questionable assumptions about availability of inputs to the production process.

The shortcomings of the current IPP framework as well as other considerations suggest that to be effective for measuring lower-tier industrial capability for surge a defense industrial planning process should (1) be based on refined estimates of demand, (2) yield a good picture of lower-tier industrial activity, (3) provide useful information cheaply, (4) contain incentives for firms to participate and to supply complete and accurate information, (5) be constrained by as few arbitrary assumptions as possible, (6) take account of the effects of the regulatory and administrative framework surrounding defense contracting, and (7) provide insight into the total capability of industry, not just current defense producers.

Having suggested what characteristics an effective defense industrial planning process should have, we concentrate first on refining the estimates of demand--defining surge. In the absence of detailed definitions or scenarios from DoD sources, we identified a set of crisis characteristics that could be considered in combinations to assess what surge requirements for military equipment would be. The five characteristics--warning time, political constraints, intensity of conflict, duration of conflict, and U.S. military recovery time--considered in two likely combinations suggest that in almost any surge situation, products in the Munitions and Spares and Replacements groups will be required in large quantities, some of which will be available from inventory but some of which may have to come from new production. Whole Systems production will be important too, if not during the conflict, then as a critical element in determining the length of U.S. military recovery time.

Although knowledgeable sources in DoD need to refine our approach to defining surge, it is still useful as a framework for understanding what equipment would be required for surge. We then must determine how the economy functions to manufacture products that are part of the three defense groups--Munitions, Spares and Replacements, and Whole Systems. We chose the methodology of input-output analysis, which allows us to determine, for every dollar of delivery to the ultimate user of various products, what inputs are required (in dollars) from all links in the production chain of a particular product. Using a

breakdown of industry done by the Bureau of Economic Analysis of the Department of Commerce, we identified 13 industries as being the primary manufacturers of products in the three defense groups, and we identified another 86 sectors as being the important lower-tier suppliers of these 13 critical defense sectors. Our main purpose was to see what effect additional demands would have on these 13 sectors and on the 86 lower-tier sectors.

For our analysis, we adopted a parametric approach and assumed a 100 percent increase in demand in a year. The advantage of such an approach is that its results can easily be modified when more refined estimates of demand become available. We then used the technique of input-output analysis assuming 100 percent increases in demand on each of the individual 13 critical defense sectors, on all sectors constituting each of the three defense groups, and on all 13 sectors at once. The results enabled us to determine which sectors of industry would have to increase their total output by the largest percentage and therefore might be thought of as potentially vulnerable in a surge situation. A comparison of the increases required with Census Bureau data on capacity utilization in the relevant industries indicated that these industries should be able to reach the additional levels of production required. However, such an analysis provides only a very crude evaluation of the feasibility of industrial surge, because it is based on the questionable assumption that all unused capacity could be directed to defense production, and it provides no information about the operation of industry at the firm level. For a more technical discussion of this part of the research, see the companion report, M. D. Miller, *Measuring Industrial Adequacy for a Surge in Military Demand: An Input-Output Approach*, The Rand Corporation, R-2281-AF, September 1978.

The kinds of data necessary to make more accurate estimates of industrial capability are often not available from public sources or become dated very quickly; we therefore tested a method of information-gathering that DoD might use to evaluate productive capabilities in any industries determined to be potentially critical. We devised a data-gathering instrument and attempted to test it on all firms that we could identify as being members of each of three industries--nonferrous

forgings, optical instruments and lenses, and semiconductors and related devices--selected as targets for our prototype effort. We selected these industries because of their potential vulnerability as indicated in the input-output analysis and because they represented a variety of products, manufacturing processes, degrees of involvement in defense production, etc.

We tried to structure our data-gathering instrument to yield useful information about (1) general firm operating conditions that would help us understand the particular industry and that would provide a cross-check on the plausibility of estimates of surge increases, (2) how much and by what means current defense producers could increase production in response to surge demand, (3) whether noncurrent DoD producers would participate in surge, and (4) the deterrents or impediments (an indirect measure of cost) to both groups in attempting surge production.

The results of our prototype data collection efforts indicate that current defense producers in all three industries could significantly increase defense-related output within 180 days of the levying of surge requirements. Even in as short a period as 90 days, firms estimate that they could produce about 50 percent more than 1976 base year (peacetime) levels. By the end of that defined one-year period, firms in all three industries would be producing at about double 1976 levels. Although we do not have quantitative estimates of the possible contributions of firms not currently doing defense business, we posed qualitative questions to them, and firms in all three industries indicated a willingness and ability to participate in DoD surge production. However, such participation would probably not be very extensive before at least 180 days have elapsed.

Firms currently doing defense business reported that they would rely most heavily on additional labor to increase production for surge but that better or different use of existing equipment and some purchase of new equipment once surge was under way would be important too. Although these results vary somewhat from industry to industry (e.g., nonferrous forgers have a much lower percentage of equipment in use than the other two and therefore would rely more heavily on existing

equipment), they are remarkably similar in conveying the simple message that availability of inputs to the production process would be the critical factor in determining whether surge is feasible. To the extent that any of these inputs are difficult or impossible to provide for in advance (e.g., skilled labor), expensive efforts to provide reserves of such other inputs as equipment and facilities are not likely to be very effective.

Responses concerning the deterrents and impediments to surge further emphasize the importance of needed input availability. Current defense producers often cited availability of labor, equipment and tooling, and materials as possible impediments to surge, and noncurrent producers indicated similar concerns about being able to recruit skilled labor on a potentially temporary basis. As would be expected, non-current defense producers expressed more concern about specialized military production requirements than did current defense producers, but many current producers also suggested that requirements for specialized production processes and testing and quality control would be an obstacle to their meeting surge requirements.

This assessment of deterrents provides only an indirect measure of the price DOD would have to pay for surge production. Although some factors that contribute to determining both the price and feasibility of surge cannot be provided for in advance, others, such as the effect of specialized production and contracting and administrative requirements, can be assessed prospectively. Such an assessment should suggest certain requirements that could be swiftly modified or suspended in a time of crisis or eliminated altogether even in peacetime, in order to increase the feasibility and lower the price of surge.

The ultimate goal of defense industrial planning, whether for peacetime or surge, is *risk reduction*. Our previous research on peacetime adequacy of the lower tiers suggests that because DoD's peacetime procurement programs are by and large not at risk as a consequence of a shortage of industrial suppliers, actions to reduce risks are uncalled for.

For surge, the picture is less clear, so it is important to determine how DoD can effectively insure itself against possible shortages

in time of crisis. It is first necessary to identify where the risks lie. We believe that the use of input-output analysis to understand industrial activity, and later sectoral studies using existing data or data gathered with an instrument similar to our prototype, will accomplish this identification process better and at a lower cost than does the IPP.

Any decision about whether or how any of DoD's budget should be allocated to defense industrial planning becomes a matter of informed political judgment. To make this judgment, decisionmakers might weigh such factors as the likelihood and characteristics of any future crisis as well as the likelihood that planning actions would reduce risk for the potential crisis. Although a considerable amount of uncertainty is associated with each of these factors, it is clear that a better evaluation of surge *demand* and procedures for a thorough and accurate assessment of potential supply problems are prerequisites to an effective defense industrial planning process.

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Lt. Colonel Richard W. Burton of the Directorate of Contracting and Acquisition Policy, Office, Deputy Chief of Staff, Research, Development and Acquisition, Headquarters United States Air Force, and Mr. John Osterday, Staff Director for Industrial Preparedness Program, Office of the Under Secretary of Defense for Research and Engineering (Acquisition Policy), also made comments on this report, and their assistance is gratefully acknowledged. Mr. Osterday, however, disagrees with the authors' conclusions regarding the efficacy of the current Industrial Preparedness Planning Program.

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The authors alone are responsible for any errors of fact or interpretation that may remain.

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I. INTRODUCTION

THE CONCERN

The general decline in defense purchases of weapon systems since the phaseout of U.S. involvement in Vietnam has contributed to a set of concerns about the health and viability of the industrial base. Some have expressed the belief that firms are leaving the defense industrial base either involuntarily (through bankruptcy, merger, etc.) or voluntarily (by choosing to take only commercial work)¹ both because there is less defense business and because what there is has a number of disagreeable characteristics (low profitability, too much government regulation, etc.). DoD buyers were believed to be unable to obtain adequate supplies of some products, to be paying excessively high prices because of reduced competition, and to be extremely vulnerable should demand accelerate in time of international crisis.

The nature of this concern about crisis vulnerability has been influenced by recent international conflicts in which the United States has participated either directly or indirectly. For example, during the 1973 Mideast war, the United States was indirectly involved (as the supplier of an ally) in a short, high intensity conventional conflict. Concern was expressed about whether the defense industrial base had *surge capability* that would be of any use in such a short time frame (during the conflict itself) and how quickly (after the cessation of hostilities) it could replace the large amounts of equipment that had been consumed during the fighting. Indeed, it was the Army's attempt to replenish its stock of tanks after the 1973 war that brought to light the much publicized problem of inadequate supplies of castings for tank hulls and turrets. Insufficient business and a requirement for large capital expenditures to comply with clean air and occupational safety standards forced the closing of two of the three facilities that

¹See, for example, J. S. Gansler, "Let's Change the Way the Pentagon Does Business," *Harvard Business Review*, May-June 1977, pp. 109-118..

had manufactured these castings.² This case has become the one most consistently (and often *only*) cited example supporting the argument that the defense industrial base has rapidly eroded in the past few years.

Although the Vietnam conflict lasted several years, involved the commitment of over half a million American troops at one time, and consumed billions of U.S. dollars, the warfighting effort was conducted without any formal declaration of war. Throughout much of the Vietnam period, U.S. policy also called for a "guns and butter" approach--a deliberate attempt to conduct the war without negative effects on the civilian economy. The extra military equipment necessary to sustain the war effort had to be produced without the aid of governmentally directed diversion of resources from civil to military uses; that is, industry was simply asked to produce more and to do it without any special assistance in the form of emergency procedures. Of course, because of the length of the war, we would not define all production over peacetime levels as surge production. However, to the extent that production was increased within the first year after the establishment of the requirement, we could properly call such increases *surge* increases. The choice of the one-year period is somewhat arbitrary, but it is in line with current thinking in DoD.

The recent past experience combined with concern that future conflicts are also unlikely to repeat the World War II experience--declared national emergency, full national mobilization, and long duration--has encouraged policymakers to rethink existing approaches to assessing and maintaining defense industrial capability needed for increasing production in some kind of crisis. Policymakers have recently become convinced of the importance of understanding whether and how industry could "surge" production either in a very short time period or over a somewhat longer time period, but in the absence of emergency measures such as required industrial conversion from civil to defense production.

Fears about this possible erosion of the industrial base are most common with respect to the so-called *lower tiers*--those segments of

²Debbie C. Tennison, "The Foundry Industry--Achilles' Heel of Defense?" *National Defense*, March-April 1976, pp. 366-369.

industry that participate in defense business indirectly as subcontractors and suppliers that are usually not counted among the major defense-oriented corporations in the United States. Concern about the lower tiers rather than the prime contractors is at least partly a consequence of evidence that there is considerable extra capacity in most prime contractor sectors.³ For purposes of this investigation, lower-tier firms are defined as those that:

1. Usually have no direct contractual relationship with a government buyer for either development or production of components or parts for systems.⁴
2. Constitute the underlying industrial support structure that supplies products to the firms that do final assembly of aircraft, missiles, etc.

Two issues relating to the question of possible erosion of the industrial base were considered. We first addressed the most immediate issue of *peacetime adequacy* of the lower tiers. During 1976 we conducted research to determine whether the lower tiers of the industrial base were becoming inadequate to meet the Air Force's needs, even in peacetime. The results of that research have been reported⁵ and will only be discussed briefly here. Our second objective was to undertake research on the issue of *surge capability* of the lower tiers of the defense industrial base. The remainder of this report will present the results of that research.

³See, for example, the *Joint Department of Defense/Office of Management and Budget Aircraft Industry Capability Study*, DW77-1, January 1977.

⁴For more discussion of the definition of lower tiers, see Geneese G. Baumbusch and Alvin J. Harman, *Peacetime Adequacy of the Lower Tiers of the Defense Industrial Base*, The Rand Corporation, R-2184/1-AF, November 1977.

⁵*Ibid.*, and Geneese G. Baumbusch and Alvin J. Harman with David Dreyfuss and Arturo Gándara, *Appendixes to the Report on the Peacetime Adequacy of the Lower Tiers of the Defense Industrial Base: Case Studies of Major Systems*, The Rand Corporation, R-2184/2-AF, November 1977.

PEACETIME ADEQUACY OF THE DEFENSE INDUSTRIAL BASE

Our goal for the initial phase of the industrial base research was to conduct a reasonably broad inquiry into the problem of possible erosion of the lower tiers. Given time and resource limitations, we wanted to structure our research design so as to ensure maximum breadth of investigation, even though we recognized that this would lead to a sacrifice of depth of analysis in some cases. Also, we wanted to avoid any approach to information gathering (such as in-depth examination of one or two industries in which "erosion" was believed to have occurred) that might lead to a distorted perspective on the general condition of the lower tiers of the defense industrial base.

For these reasons, we decided to conduct a survey of ongoing Air Force major system acquisition programs. We would attempt to determine whether their prime contractors were encountering problems getting or keeping suppliers, and if so, why. Our investigation led us to reject the erosion hypothesis: The Air Force (and by implication, other DoD buyers) can almost always get qualified suppliers. Where the number of suppliers of particular products has been reduced in the recent past, this shrinkage was usually attributable to a decline in the amount of business available rather than to perverse government contracting practices. At least it was not usually attributable to those practices (i.e., forcing firms into bankruptcy by not paying a reasonable price for products) most often mentioned by proponents of the erosion hypothesis. However, our analysis also indicated that the DoD could probably get more suppliers and lower-priced products if certain characteristics of its behavior as a buyer did not effectively limit the number of firms willing or able to do its business.⁶

The inability of military buyers to recognize the effects of certain of these characteristics of their behavior (e.g., apparent preference for sole source suppliers, requirements for specialized production and administrative procedures) combined with difficult conditions that prevailed throughout the economy in the early 1970s led to incorrect judgments about the adequacy of industrial capacity for defense-related

⁶ See Baumbusch and Harman (1977), Secs. III and V, for elaboration.

production. It also led to the promulgation of supposedly curative policy changes, such as more frequent use of an Armed Services Procurement Regulation (ASPR) provision that permits restriction of competition in the interests of preserving the industrial base.⁷ If these new measures are fully carried out they will merely compound the real problems (need for broadening the defense industrial base, lowering prices, etc.) by further restricting participation in the defense marketplace.

SURGE CAPABILITY OF THE DEFENSE INDUSTRIAL BASE

Beginning in 1977, we shifted the focus of the research to the question of whether the base could support the increased defense procurement needs resulting from an international crisis. Because our interest is in *surge* rather than in *mobilization*, we have studied the capability of the lower tiers of the defense industrial base to make quick responses (one year or less) to increased demands in situations that might or might not involve the application of the emergency measures that are part of a longer, more comprehensive mobilization effort.⁸ In other words, can the lower tiers make a *quick* response to defense requirements for additional supplies of the products that might be needed in a future international crisis; and if not, what are the costs of providing the necessary reserve capability?

We will first discuss the method DoD currently uses to answer these questions. We will also suggest what characteristics an industrial assessment and planning process should have, given current conditions in the economy, the likely nature of future international crises, etc. Finally, we will describe a methodology tested by Rand during this research that should provide more useful information than the one currently used by DoD.

⁷For more discussion of this ASPR provision and the other policy changes, see *ibid.*, Secs. III, IV, and V.

⁸See Sec. III for more discussion of surge. Such emergency measures might include rationing or federally mandated conversion from civil to defense production.

II. MEASURING INDUSTRIAL CAPABILITY

CURRENT APPROACH--INDUSTRIAL PREPAREDNESS PLANNING

The DoD is required by law¹ and administrative procedure² to plan for maintaining enough industrial capability to support this country's needs for defense equipment in time of crisis. Several other federal agencies have complementary responsibilities for emergency preparedness and management for wartime or natural disasters. The Federal Preparedness Agency (FPA) of the General Services Administration is charged with helping the President make and coordinate policy for coping with emergencies. Among the responsibilities of FPA is advising on requirements for the National Stockpile of Strategic and Critical Materials. President Carter has recently reorganized FPA plus five related agencies of DoD and the Departments of Commerce and Housing and Urban Development into the Federal Emergency Management Agency. The reorganization is intended to cut duplicate activities and to consolidate authority and responsibility for planning for civil defense, natural disaster, and other emergency conditions. The reorganization does not appear to affect DoD's responsibility for industrial planning.³

Despite the reorganization, other agencies and departments besides DoD will still be involved in preparedness planning. For example, the Bureau of Domestic Commerce of the Department of Commerce is supposed to assist in the process of making sure manufacturers of critical defense products have access to adequate supplies of material.

How IPP Works

DoD carries out its responsibilities through the Industrial Preparedness Planning (IPP) program, the purpose of which is "to provide

¹The Defense Production Act of 1950 and the Defense Industrial Reserve Act of 1973.

²Executive Order 11490, October 1969.

³*Reorganization Plan No. 3 of 1978*, House Document No. 95-356, reprinted from the *Congressional Record*, June 19, 1978.

a means for correlating industrial capabilities and military requirements for the orderly retention, improvement, and rapid application of industrial capability to military production during an emergency."⁴ The program is coordinated by officials of the Office of the Under Secretary of Defense/Research and Engineering (formerly a component of the Office of the Assistant Secretary of Defense/Installations and Logistics). However, major responsibility for answering the questions about whether the industrial base can meet crisis demand requirements, and at what cost, rests with the individual services. In the Air Force, the focal point of IPP activities is the office of the Deputy Chief of Staff for Research and Development, Directorate of Planning, Programming and Analysis (Production Resources Division). Under guidance that has recently been tentatively modified to provide for some more narrowly focused surge planning,⁵ each service including the Air Force has been directed to use IPP for about 2000 items, including no more than 35 major weapon systems.⁶ IPP activities also involve some renovation of equipment for peacetime uses and modernization of government-owned ammunition production facilities.

Production planning for individual pieces of equipment is the most important part of the program for discussion here. A total planning effort involving 6000 items divided approximately equally among the three services does not permit crisis production planning of all important military equipment that might be put to use in a future international conflict. Some system to assign priorities for selection is necessary. Thus, according to guidance from OSD, items to be planned

⁴ASPR 1-2202.

⁵As this report is being written, a review of IPP policy is in process and some tentative changes have been made in the program. Because we cannot keep day-by-day track of minor or proposed changes, we must necessarily deal with the policy framework that existed while this research was under way and note important or proposed changes that we know about.

⁶*Restructuring Needed of Department of Defense Program Planning with Private Industry for Mobilization Production Requirements*, GAO, May 13, 1977, p. 2.

must be essential to combat operations and require one or more of the following:⁷

1. A long lead time.
2. The development of new or additional capacity to meet the emergency production requirements.
3. Continuous surveillance to make sure that the emergency requirements are met.
4. Critical labor skills or specialized production equipment.

With this guidance each service then tries to determine what items (whole systems, spares and replacements, consumables, etc.) that have one or more of these characteristics will be required in large quantities in the event of an emergency. Estimated wartime or consumption patterns, repair times (where appropriate), etc., are used to calculate at what rate a given item will be required. This quantity is then compared with the quantity available from inventory and anticipated regular new production to determine if any shortfall needs to be made up by additional new production for which advance planning actions should be taken.

This selection process obviously narrows the range of choice of items for possible planning, but planners still have to exercise considerable discretion to make choices among the large numbers of items that pass these initial tests. And there is no evidence that the final selection process is logical--i.e., based on a ranking system or on a random selection process assuming it is equally likely that each of the items passing the initial test could be the most critical. Once the choices have been made, however, contractors producing those items are asked to provide data on their ability to meet increased production requirements. Participation in the IPP program is voluntary and is generally not compensated except by reimbursement through overhead accounts.

The data are supposed to provide the basis for estimating a contractor's ability to meet certain specified production requirements as

⁷Department of Defense Instruction 4005.3.

well as the facility's maximum capabilities to provide a certain item or items. They also suggest what types of advance planning actions (e.g., provision of government-owned equipment) might enhance a firm's ability to respond to crisis demands for needed products. These actions are called Industrial Preparedness Measures (IPMs). This information is supplied in a standard DoD form that is completed by the contractor, the Armed Services Production Planning Officer (ASPPPO) who is a part of the contract administration group likely to be resident in a particular plant, and, in some cases, representatives of the procuring activity that is buying the product. The information supplied by the contractors is used by DoD and the services to determine what kind of reserve capacity is available and what kinds of advance planning actions they should fund to ensure that capacity is adequate. Also, under certain emergency conditions the promises of production made by participating firms can be negotiated into contracts for delivery of the planned items.

Shortcomings of IPP

Our analysis indicates that the current IPP program does not provide the information necessary to assess the capability of the lower tiers of the industrial base to meet crisis demand requirements.⁸ We have reached this conclusion for reasons pertaining to *what* is selected for planning and *how* the process is carried out once the choices have been made.

The even distribution of those items across the three services suggests that IPP program activities⁹ are carried out according to rather arbitrary goals and targets rather than any refined estimate of likely increases in the *demand* for products.¹⁰ Also, because IPP has traditionally been geared to support mobilization, it is not necessarily

⁸Other recent studies have reached similar conclusions, e.g., the one by the GAO.

⁹The GAO reports about \$9 million in administrative costs for the 15-month period ending September 30, 1976. The costs incurred by contractors in providing the data are reimbursed through overhead, so they are not known.

¹⁰As a consequence, the GAO study group concluded that representatives of industry do not take the program seriously and are either not

directed toward planning for the most critical items in a surge situation. Indeed, some recent efforts have been made to do surge planning (for production increases within one year) as well as mobilization planning (for production increases in periods of up to three years) for a subset of end items being planned for mobilization. However, there is still no evidence that the selection process is being guided by any careful consideration of what demand will be if the United States becomes involved in a short, highly intense conventional war in Europe, in supplying our allies in another Mideast conflict, or in some other potential crisis.¹¹

The GAO study was sharply critical of IPP for being done on "too large a scale with too little funding."¹² Yet even in the context of fairly large-scale efforts, selection criteria are not stringent enough to identify the most critical items. To be sure, data on use rates etc. play a part in the selection process, but the information derived simply narrows the universe of possibilities somewhat. One possible solution to this problem is just to spend more money on the current IPP program, thus reducing the need for more refined judgments about what priorities should be. For reasons that we will discuss more in detail below (importance of other defense needs, questionable efficacy of increased expenditures, etc.) we *do not* believe increased funding would be desirable.

The other problem with *what* is selected for assessment and planning is the end item orientation of the process. The services each choose some whole systems, spare parts, consumables, etc. for planning in a process that largely ignores the role of demand on the underlying industrial support structure (or lower tiers) that is likely to be the source of any bottlenecks. A methodology for understanding industrial activity involved in the production of military equipment would enable planners to predict what parts of the lower tiers would have particularly

inclined to participate or, if they do, are often not very conscientious about providing complete information.

¹¹For more discussion of our approach to refining the concept of surge demand, see Sec. III.

¹²*Restructuring Needed*, p. 17.

large extra requirements levied on them in the event of surge demand for final goods in a crisis.

That such a methodology is not used in the selection process for IPP would be less of a deficiency if the way the planning is carried out yielded useful information about the activities of the lower tiers. However, because IPP gathers data on final products, it must rely on their producers for information about lower-tier activities. The prime contractors may provide this information by estimating subcontractors' capabilities to meet increased demands, and, in some cases, they may ask the subcontractors to participate in the planning process. According to data gathered by the GAO study, however, this "vertical planning" is rarely done.¹³ One reason is that firms in the lower tiers of the production process are less likely to have the government-supported overhead structure to pay for planning costs. Another is that firms preparing IPP forms have routinely assumed that critical inputs to production (labor, parts, capable equipment, materials, etc.) will be available. An Army report cited in the GAO study described this as a process of "assuming away virtually every problem area encountered."¹⁴

Still another failing is the inability of the current process to recognize the cumulative effects on the lower tiers of simultaneous increases in demand for products. For example, a participant in the IPP program might indicate that a particular supplier could meet his firm's requirements for additional supplies of a particular product. Such an estimate might be correct, *assuming no competing demands* were simultaneously levied on this supplier. But what if several customers for the product require additional supplies? Or what if the types of equipment required by the crisis levy increased demands on this supplier for items in other product lines? Currently IPP is of little use in answering these questions because it gathers data item by item and it does not incorporate adequate devices for assessing the cumulative effects of increases in demand for a variety of end products.

¹³ *Restructuring Needed*, pp. 4-5.

¹⁴ *Ibid.*, p. 5.

Because it does not provide a complete picture of these cumulative effects, IPP data probably *overestimate* lower-tier capability to increase production. However, because IPP information comes from only those firms that currently make defense-related products, it probably *underestimates* the total capability of all tiers to meet increased production requirements. Although it may be reasonable to assume that firms currently in the defense business could make the most timely and cost effective response to surge demands, it is not reasonable to make estimates of industrial capability that ignore the potential contributions of other firms in the industry.

In summary, our analysis suggests that IPP has not been effective in estimating or planning to exploit the capability of the *lower tiers* of the industrial base. We have reached this conclusion because of *what* is planned and *how* the planning process is carried out. It gathers little or no information from lower-tier firms currently in defense business that relates either to individual increased requirements or to the cumulative effects of several increases, and it provides few insights into the latent or potential contributions of industrial firms not currently doing defense business.

NEW DIRECTIONS--DESIRABLE CHARACTERISTICS OF A DEFENSE INDUSTRIAL PLANNING PROCESS

If IPP is not useful for answering the critical question of whether there is adequate industrial capability for surge, what kind of a system would work better? Our analysis suggests several characteristics that a defense industrial planning process should have.

First, the planning should be done on the basis of some more refined *estimates of demand* than are currently in use. This is particularly critical as it relates to surge because only a short time is likely to be available and some types of equipment (munitions, for example) may be required in very large quantities; other equipment (entire weapon systems) might have too long production pipelines to make increases possible. The more specific the estimates of demand, the more useful they will be in an analysis of industrial capability.

Second, a defense industrial planning process should use some methodology that yields a *good picture of the lower tiers'* industrial activity for the production of defense equipment. The methodology should enable planners to understand what industrial activity will be required throughout the production chain to support defense demands. With this understanding, planners could be more selective in their use of scarce resources for defense industrial planning and information gathering.

Third, a defense industrial planning process would provide large amounts of *useful information for a minimum expenditure* of DoD's scarce resources. There are limited resources available for all defense needs and competing demands (procurement, manpower, etc.) for those resources; industrial planning resources not devoted to data gathering could be used to correct any deficiencies found. One way to promote this objective would be to use publicly available data as much as possible, thus minimizing the need for costly information-gathering efforts solely for the DoD.¹⁵

Fourth (and related to the desirable characteristic of low cost) is the need for the process to contain *incentives for firms to participate* and to supply accurate, complete information in cases where DoD must do its own data collection. Creating the proper incentives while keeping costs down is not an easy task. For example, one possible way of motivating firms to supply better information is to pay them for their efforts directly rather than relying on overhead reimbursement where that is available.¹⁶ This might be desirable if the defense industrial planning process had the first two characteristics discussed above, enabling planners to better determine what the most critical problem areas are and to concentrate on these areas. For IPP as practiced in recent years, however, it would merely constitute paying for incomplete and possibly misleading information and would not be desirable.

¹⁵See Sec. IV for more discussion.

¹⁶Brief studies of special topics related to preparedness are commissioned from time to time, and more use of direct payment is currently being contemplated for IPP.

As part of the proper incentive structure, ways must be found to *minimize the incentives* for firms to provide information that is self-serving to the firm but counterproductive to DoD's goal of obtaining adequate supplies of products at a reasonable price. This problem is illustrated by a case cited in the GAO study of IPP. A contractor provided IPP data that, unknown to service planners, was based on an assumption that the contractor would produce in-house certain parts that had typically been subcontracted. Forecasts based on this assumption showed a shortfall in capability that effectively required the service to pay a prime contractor to develop a new manufacturing capability already available from subcontractors. As is often the case, however, there was no money available to pay for the IPMs.¹⁷

Fifth, a defense industrial planning process should be constrained by as *few arbitrary assumptions* as possible. This is true with regard to both the availability of inputs to the production process and recognition of the possibility for substitution of products or processes in a crisis. The system should be structured so that those with the most intimate knowledge of the manufacturing process--the producers--provide information on the most efficient (in terms of time and cost) way of increasing production, the constraints they are likely to encounter as they attempt these increases, and the means and costs of overcoming constraints.

Establishing the proper incentives is not easy. However, several comments can be made here. First, we have suggested that the industrial planning process be founded on (1) a fairly precise estimate (or estimates) of surge demand and (2) the use of a methodology that provides a view of how industrial activity all through the tiers would have to be increased in response to surge demand for final products. A process with these two characteristics would provide a realistic framework for pinpointing potential problem industries and focusing analytical efforts on them. Second, to the extent that a defense industrial planning

¹⁷ *Restructuring Needed*, p. 6. Had funding been available, it could most effectively have been used in expanding the existing capability, rather than funding the development of another source. See also Baumbusch and Harman (1977), pp. 47-49 and 53-56; and Appendix B (p. 90), this volume.

process emphasizes the lower tiers, there would be less potential for abuses of the type described in the GAO study. Industry representatives should then have more confidence in the ability of DoD planners to distinguish the reasonable from the frivolous or deceptive, and their behavior as suppliers of information should be affected accordingly.

The sixth characteristic of a defense industrial planning system is that it should take account of *effects of the regulatory and administrative process* that surrounds defense procurement. It would certainly be desirable if, for example, the system helped to assess the effects of compliance with environmental regulations on producers' ability to meet surge demand. Similarly, it would be extremely helpful to know to what extent various substantive requirements, government inspection, quality control procedures, etc. contribute to the length of the production process so that they could be modified in time of crisis. And it would be useful to know whether systems of assigning priorities for access to supplies of raw materials authorized by the Defense Production Act are having their desired effect and could be altered quickly to accommodate to surge needs.¹⁸

Finally, the defense industrial planning process should provide some insight into the *total capability of industry* (not just current defense producers) to respond to increased DoD demands.

The preceding characteristics can be combined into a methodology that has three basic steps: (1) analysis of circumstances in which industrial surge would be required (refinement of demand), (2) analysis of lower-tier industrial activity necessary to manufacture defense products, and (3) collection and analysis of data on the ability of potentially critical industries to respond to surge demand.

In the next three sections we will discuss, step by step, our test of such a methodology.

¹⁸For more discussion, see Sec. V.

III. DEFINING SURGE DEMAND

THE CONCERN

The discussion of the nature of recent international conflicts in Sec. I suggests the importance of gearing industrial planning to up-to-date assessments of what the nature of surge demand is likely to be. However, as this research was conducted the issues involved in trying to define the nature and extent of surge demand were still under discussion in DoD. In the absence of some fairly precise official estimate of the likely composition of surge demand, we devised a crude proxy for the nature of demand likely to be levied on industry by identifying a set of five *crisis characteristics* that we could evaluate in possible combinations for purposes of assessing what types of military equipment would be needed.

CRISIS CHARACTERISTICS

Warning time is the period either before the actual outbreak of hostilities or perhaps before their serious escalation or U.S. direct involvement. During this time some additional defense production might actually be undertaken. However, in many possible situations this period is likely to be very short or its effective use is likely to be precluded by political constraints.

Political constraints that would prevent military planners from taking actions to increase purchase of defense products range from outright legislative prohibition to informal restrictions. The situations in which political constraints are likely to be minimal (a NATO war, for example) are also those for which the warning time that could be used in the absence of these constraints is likely to be short. Conversely, where warning time is likely to be longer, the political constraints that preclude effective use of it for increasing defense production are likely to be more severe. Some Vietnam type of conflict in Asia or Africa would be an example.

Intensity of conflict has to do with the expected rates of consumption of material and the consequent requirements to restock from

inventory, new production, etc. We have considered only nonnuclear levels of conflict in the conduct of this research. The limitation was made to narrow the range of topics to be covered in the analysis, because the use of nuclear weapons introduces a multitude of special considerations in any analysis.

The intensity and the *duration of the conflict* will determine how much equipment is consumed and what total extra production will therefore be required from industry.

U.S. military recovery time is particularly important from the standpoint of the defense industrial base. This is the time, *after* the conflict ends, that it would take the U.S. military to replenish its stocks to the pre-crisis (or some other desired) level. Such replenishment might be a consequence of either U.S. consumption of equipment through direct participation in a conflict or consumption of our equipment by some ally. There are obviously a number of variables that would determine the length of this recovery time, among them the amount of reserve industrial capacity available for defense production. The tank hull and turret casting case described above demonstrates what happened when the recovery period after the Yom Kippur War (plus compensation for drawdown for other foreign military sales) required the U.S. Army to replenish its stock of tanks in a situation where industrial capacity for producing these castings had declined severely from what had been available under "normal" conditions.

Another obviously important variable influencing the length of the recovery period is the amount of resources the government is willing and able to commit to the effort. The important thing about U.S. military recovery time, whatever its length, is that the United States would be vulnerable during this time if another crisis should occur; and even if industrial production has little effect on the crisis itself (e.g., because of its duration), it will be the principal influence on the extent of the recovery time.

DISCUSSION

Having defined this set of conflict characteristics, we now consider some of their possible and perhaps likely combinations in an

attempt to determine what kind of requirements might be levied on industry. For purposes of our discussion, we label these combinations Type A and Type B. Equipment that would be required in both types of conflicts can be divided into three categories: (1) Whole Systems; (2) Spares, Replacements, and Support Systems; and (3) Munitions.

Type A Conflict	{	Short Warning Modest Political Constraints High Intensity Short Duration Recovery Time (length?)	Type B Conflict	{	Moderate Warning Severe Political Constraints Moderate Intensity Long Duration Recovery Time (length?)
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In the Type A conflict, although the "Whole System" category of equipment would certainly be consumed during the conflict, DoD would have to rely on existing stocks for immediate warfighting capability because the conflict would be of short duration--weeks or at most a few months. And although equipment falling into the latter two categories (Spares, Replacements, and Support Systems; Munitions) would be consumed at an even higher rate, industry might be able to increase production of certain types during the actual conflict. For some high consumption items with short production process times (certain munitions, for example), industry's ability to increase production might even be critical to the outcome of the conflict. Industry's ability to increase production of all three types of equipment (including Whole Systems) would be important to determining the length of the recovery period and how large a commitment of defense resources would have to be made to make sure that it is not dangerously long.

For the Type B conflict, all three types of equipment would also be required, although their rates of consumption (the intensity) are likely to be less than in Type A. However, as we begin to approach the one-year maximum period that we have defined as surge, it might be feasible for industry to increase production of all three types of equipment and its ability to do so might be important to the outcome of the conflict. In any case, just as in the Type A situation, its

ability to increase production would be important in determining the length of U.S. military recovery time.

Both types of scenarios would place heavy demands on munitions production. The Type A situation would require greater emphasis on Spares, etc.; the Type B situation would rely more heavily on Whole Systems production even during the crisis. But all three kinds of production would be needed for full recovery, and the magnitude of the demands for total industrial production would depend on the duration and intensity of the conflict.

This approach to defining surge suggests that we should give careful attention to the capabilities of the industries that support the production of spares, replacements, and support systems, and munitions, because these are likely to be required in large quantities in any conflict situation and critical additional production might be feasible even in Type A circumstances. However, we should not ignore whole systems either, because of the potential importance of additional production to the outcome of some longer conflict and the need to restock them after any conflict--their important role in the determination of the length of U.S. military recovery time. To provide the precise estimates of demand that we believe are necessary for an intelligent assessment of lower-tier surge capability, DoD should expand on the analysis just described. The results of such an effort might suggest, for example, that in all probability *conflict duration* is likely to be so short for most contingencies that it would be a misuse of scarce resources to do defense industrial planning for new production of whole systems for use during the conflict.

We have used this rudimentary framework for evaluating the types of equipment required, and we ask the question: How does the economy function to produce products that fit into the categories of Whole Weapon Systems, Spares, Replacements, and Support Systems, and Munitions? Section IV outlines the methodology used to address that question.

IV. UNDERSTANDING LOWER-TIER INDUSTRIAL ACTIVITY

THE TIERS AND THE PRODUCTION PROCESS

The production chain that supports this final delivery of products to DoD can be extremely complex. Each sector in the chain must secure the necessary inputs from its suppliers and use its own productive capabilities to meet the input demands of sectors higher in the chain. For obvious reasons, the higher the sector in the production chain, the less the firms in it are likely to be aware of the contributions, limitations, etc. of these "suppliers of suppliers" in the lower tiers. As we described in Sec. II, the IPP's method of gathering information is deficient because it relies on firms fairly high in the production chain to provide information about the capabilities of those lower down. Of course, DoD uses such a method because of the prohibitive costs of identifying and directly gathering information from all suppliers of the producers of 6000 or so end products. Furthermore, information gathered on individual products would be unreliable because, for example, it would not account for the effects on the electronics sectors of simultaneous increases in demand for missiles *and* radios. What we need is a methodology to provide this overview of industrial activity.

INPUT-OUTPUT ANALYSIS¹

Input-output analysis enables us to determine for every dollar of delivery to final demand for a particular product what inputs (also measured in dollars) are required from the industries that make up the links in the production chain.

The first stage of such an analysis (at the national level) involves the determination of the product flows that connect various sectors of the economy. These flows are measured in annual dollar sales of one

¹A more detailed presentation of the material in this section can be found in M. D. Miller, *Measuring Industrial Adequacy for a Surge in Military Demand: An Input-Output Approach*, R-2281-AF, September 1978.

sector to another, and they reflect interindustry operations at the direct dependence level. From these direct dependence figures, a set of mathematical steps can be performed to transform this "flow matrix" into one that measures the more important concept of *total dependence* (both direct and indirect).

Input-output analyses of the U.S. economy are performed at varying intervals by the Bureau of Economic Analysis (BEA) of the Department of Commerce, as well as by some private concerns. BEA analyses are readily available and allow calculations of intersector dependence with existing publicly available data. The disadvantages are, first of all, that full-scale analyses of the economy are conducted only about every five years and the compilation of the results usually takes several years after the data gathering; therefore, it is necessary to assume that relationships between inputs and outputs remain fairly stable over time.² Second, two basic assumptions underlying the methodology itself cause some experts to disagree over its utility. These are the notions of (1) constant returns to scale and (2) nonsubstitutability among inputs. According to the first, it is assumed that inputs are directly proportional to outputs; that is, for a sector to double its output, it must double all its inputs.³ According to the second, only the particular set of processes, input materials, etc. actually in use can accomplish a particular type of production of a given output. Although there is considerable disagreement among the experts about how much these assumptions and the question of stability over time affect the usefulness of input-output analysis, there is general agreement that the methodology is helpful for a problem that requires a broad overview of the industrial relationships involved in defense production.⁴

²There is some evidence that this is not a bad assumption. For more discussion, see *ibid.*, p. 5.

³But a rapid increase that required the recruitment of less skilled labor, for example, might yield less than proportional increases in output. However, a clearly perceived international crisis might engender significant improvements in productivity even from the existing production base.

⁴For more discussions of the theoretical framework of input-output analysis, its assumptions and limitations etc., see Miller (1978), pp. 5-8.

USING INPUT-OUTPUT ANALYSIS TO UNDERSTAND DEFENSE PRODUCTION

For this analysis we used the 1967 BEA input-output tables, the most recent available.⁵ Under BEA's industrial classification system the economy is divided into 367 sectors that roughly correspond to the Standard Industrial Classification system used by the Bureau of the Census. From these 367, it was necessary to identify the industrial sectors that are the producers of the three categories of equipment--Whole Systems; Spares, Replacements, and Support Systems; and Munitions--that would be needed in a crisis. Both on the basis of type of equipment produced as indicated by sector name and the total dollar value of DoD purchases from the sector,⁶ we identified 13 sectors as being the producers of critical defense equipment included in the three categories of warfighting equipment suggested by our surge demand refinement in Sec. III. These are enumerated in Table 1.

To support its own production, each of the 13 defense sectors must rely to varying degrees on output from each of the 367 sectors of the economy (which include, of course, the 13 defense sectors themselves). In some cases, this dependence is direct and obvious (as in the Aircraft Engines and Parts sector supplying the Aircraft sector); in other cases, it is indirect and perhaps less obvious. For example, the Aircraft sector requires a total output of 3.7 cents from the Basic Steel Products sector for every dollar it delivers to final demand, yet less than 0.3 cents of this output is delivered directly. Most of the output must therefore make its way through several tiers of industry before finding ultimate end use by the Aircraft sector.

An acceleration in DoD demand on any or all of the 13 defense sectors would necessitate varying degrees of response from each of the 367 sectors. Many of the sectors clearly do not have much to do with defense production (Artificial Flowers; and Pickles, Relishes, and Sauces, for example). To make our computation tasks more manageable, we tried to isolate which of the remaining 354 sectors are the most important suppliers of the 13 critical defense sectors and settled on

⁵Tables for data gathered in 1972 were not available at the time of this research.

⁶We used 1975 defense purchases data, the most recent available.

Table 1
1975 SALES TO DoD OF 13 CRITICAL
DEFENSE-RELATED SECTORS
(\$ millions)

Sector	1975 Sales
<u>Whole Systems</u>	
Complete Guided Missiles	3427
Tanks and Tank Components	350
Aircraft	5463
Shipbuilding and Repairing	2086
<u>Spares and Replacements</u>	
Sighting and Fire Control Equipment	100
Radio/TV Communication Equipment	3595
Aircraft Engines and Parts	2111
Aircraft Propellers and Parts	35
Misc. Aircraft Equipment	960
<u>Munitions</u>	
Non-Small Arms Ammunition	854
Small Arms	50
Small Arms Ammunition	116
Misc. Ordnance and Accessories	164

a list of 86 important defense-related supplier sectors--the *lower tiers*. Our analysis concentrated on the industrial effects of attempts to increase purchases from the 13 critical defense sectors both on themselves (directly and as suppliers of each other) and on these other 86 lower-tier supplier sectors.⁷

LOWER-TIER POTENTIAL VULNERABILITY TO SURGE

Because each potential conflict differs with regard to the extent and scope of industrial involvement as well as to the timetable by which the necessary industrial response is to be assessed, we were unable--in the absence of some specific guidance from DoD--to define detailed estimates of surge requirements for the three categories of equipment. We therefore adopted a parametric approach and assumed that DoD demand

⁷ See Miller (1978), pp. 10-14, for more discussion of the criteria by which the 13 critical defense sectors and the 86 supplier sectors were selected.

on each of the 13 sectors increased 100 percent over 1975 annual purchases--a doubling of production in a year. This 100 percent figure is a convenient base for our parametric study but may understate or overstate an actual crisis surge demand.⁸ An advantage in using input-output analysis, if the constant returns to scale assumption is correct, is that by modifying this 100 percent figure (or even replacing it by a specific dollar figure), we can readily obtain corresponding results based on any desired degree of surge; for example, the results for a "50 percent surge" can be obtained by dividing the reported results for that sector by 2.

In satisfying such a 100 percent increase in demand, each defense sector, besides having to increase its own output, must rely on increased output from its lower-tier suppliers. To determine the degree of this reliance and its subsequent effect on the suppliers, we need to take into account the following:

1. The total (annual) output of each of the 99 defense-related supplier sectors.
2. The (annual) DoD purchases from each of the 13 defense sectors.
3. The input-output (I/O) coefficient that measures the required output (in dollars) of each supplier sector necessary to accommodate a delivery of one dollar to the DoD by the given defense sector.

By computing the ratio:

$$\frac{100\% \times (\text{I/O Coefficient}) \times \left(\frac{\text{Total DoD Purchases}}{\text{from Defense Sector}} \right)}{(\text{Total Output of Supplier Sector})}$$

⁸Vietnam experience provides some perspective on the meaning of a 100 percent increase. During that period, the largest annual production increase required of the sectors (as defined by the BEA) was 196 percent from Miscellaneous Ordnance and Accessories. Second was Non-Small Arms Ammunition with 148 percent. The largest increase required from any sector outside the Munitions group was 56 percent from Tanks and Tank Components.

for each defense and supplier sector, we obtain the percent increase in annual total output of each of the 99 defense-related sectors necessary to accommodate a 100 percent increase in DoD demand on a given defense sector.

To illustrate this, suppose that last year the DoD purchased \$100 million in goods from Sector A, and that for every dollar A delivers to the DoD, Sector B must produce 10 cents in output. Moreover, assume that last year's total output of Sector B was \$50 million. If there were a 100 percent surge in annual DoD demand on Sector A, Sector B would have to produce an additional \$10 million of output, which implies that Sector B would have to increase its annual production by 20 percent.

To determine which sectors might possibly be vulnerable in a surge situation, we did an analysis of the effect of a 100 percent increase on each of the 13 critical defense-related sectors individually. The assumption of the 100 percent increase on one sector at a time (see Table 2) gives us a picture of which supplier sectors are most important to each of the individual upper-tier defense sectors. Thus, for example, although the percentage increase required from optical instruments to sustain the 100 percent increase on sighting and fire control is absolutely rather small, it would have to be achievable for sighting and fire control to double its output. The assumption of the 100 percent increase on all the sectors in a particular defense group places more stress on the industrial system and begins to demonstrate (see Table 3) the cumulative effects of increases in demand for more than one product, as discussed in Sec. II. For example, a 100 percent increase in demand on *all* spares and replacements industries requires the nonferrous forgings industry to increase its output by 10.3 percent. The results in Table 3 also indicate the degree to which the 13 critical defense-related industries would have to increase their own output to achieve surge. Looking at just those sectors that would need to increase their output by 10 percent or more, we see that only three of the 86 lower-tier sectors would be involved. Using the more extreme

Table 2

LARGEST REQUIRED PERCENT INCREASES IN SUPPLIER SECTOR OUTPUT
FOR 100 PERCENT DoD SURGE ON A GIVEN DEFENSE SECTOR^a

Defense Sector	Supplier Sector	Increase
<u>WHOLE SYSTEMS</u>		
Guided Missiles	Misc. Aircraft Equipment	9.4
	Aircraft Propellers & Parts	4.3
Tanks and Tank Components	Non-Small Arms Munition	1.7
Aircraft	Misc. Aircraft Equipment	26.5
	Aircraft Propellers & Parts	22.3
	Engineering & Scientific Instruments	10.9
	Nonferrous Forgings	8.5
	Aircraft Engines & Parts	7.3
	Sighting & Fire Control Equipment	5.5
	Steam Engines and Turbines	3.2
Shipbuilding and Repairing		
<u>SPARES AND REPLACEMENTS</u>		
Sighting & Fire Control Equipment	Optical Instruments & Lenses	2.5
Radio/TV Communication Equipment	Misc. Electronics Components	11.1
	Electron Tubes	5.1
	Semiconductors	4.5
Aircraft Engines and Parts	Aircraft Propellers & Parts	17.9
	Nonferrous Forgings	7.4
Aircraft Propellers and Parts	Aircraft Engines & Parts	0.1
Misc. Aircraft Equipment	Aircraft Propellers & Parts	7.3
<u>MUNITIONS</u>		
Non-Small Arms Ammunition	Watches, Clocks, and Parts	2.1
Small Arms	Hardwood Dimensions/Flooring	0.2
Small Arms Ammunition	Copper Rolling and Drawing	0.9
Misc. Ordnance & Accessories	Non-Small Arms Ammunition	1.1

^aUsing 1975 defense purchases and sector output data and 1967 I/O coefficients. This table reports all increases of 4 percent or more in total output of a given supplier sector, or if no sector supplying each of the 13 defense sectors required an increase of at least 4 percent, the largest required percent increase and the sector from which it is required are reported.

Table 3

LARGEST REQUIRED PERCENT INCREASES IN SUPPLIER SECTOR OUTPUT
FOR 100 PERCENT DoD SURGE ON DEFENSE GROUP^a

Defense Group	Supplier Sector	Increase
Whole Systems	Complete Guided Missiles	78.3
	Tanks and Tank Components	67.6
	Aircraft	55.5
	Shipbuilding and Repairing	38.3
	Misc. Aircraft Equipment	36.1
	Aircraft Propellers & Parts	27.1
	Engineering & Scientific Instruments	13.4
	Nonferrous Forgings	11.9
Spares and Replacements	Sighting/Fire Control Equipment	75.4
	Aircraft Propellers & Parts	66.1
	Aircraft Engines & Parts	49.7
	Radio/TV Communications Equipment	36.1
	Misc. Aircraft Equipment	21.6
	Misc. Electronics Components	11.8
	Nonferrous Forgings	10.3
Munitions	Non-Small Arms Ammunition	105.2 ^b
	Misc. Ordnance & Accessories	32.3
	Small Arms Ammunition	26.0
	Small Arms	10.8

^aUsing 1975 defense purchases and sector output data and 1967 I/O coefficients. This table reports all sectors from which at least a 10 percent increase in total output is required.

^bThis figure exceeds 100 percent because about 15 percent of this sector's output is cycled back into its own production process rather than being sold. Thus, to deliver \$1 in goods to the DoD, it must produce well over \$1 in output.

assumption of a 100 percent across-the-board increase (see Table 4), the same is also true.⁹

The industries listed in these tables are those that would require large increases in their total output to sustain the various 100 percent increases. Of course, these quantitative results merely tell us where demand would be greatest in the event of surge. To evaluate whether any of these industries might be a possible bottleneck, we

⁹See Miller (1978), pp. 25-53, for more discussion of these results and their interpretation.

Table 4
LARGEST REQUIRED PERCENT INCREASES IN
SUPPLIER SECTOR OUTPUT FOR 100 PERCENT
ACROSS-THE-BOARD DoD SURGE^a

Supplier Sector	Increase
Non-Small Arms Ammunition	110.6 ^b
Aircraft Propellers & Parts	93.6
Sighting & Fire Control Equipment	81.6
Complete Guided Missiles	81.3
Tanks and Tank Components	68.2
Aircraft Engines & Parts	59.5
Misc. Aircraft Equipment	58.3
Aircraft	58.3
Radio/TV Communication Equipment	40.4
Shipbuilding and Repairing	38.4
Misc. Ordnance & Accessories	37.3
Small Arms Ammunition	26.8
Nonferrous Forgings	23.0
Misc. Electronics Components	17.4
Engineering & Scientific Instruments	14.7
Small Arms	11.9

^aUsing 1975 defense purchases and sector output data and 1967 I/O coefficients. This table reports all sectors from which at least a 10 percent increase in total output is required.

^bSee Table 3, note b.

would need much more information about industrial activity in these potentially critical sectors.

For example, by comparing published sectoral capacity utilization rates with surge demand requirements delineated in the tables, we can crudely evaluate a sector's ability to increase production.¹⁰ For the industries under consideration here, the published data indicate that, almost without exception, there is sufficient excess production capacity in each lower-tier sector to support even a 100 percent across-the-board surge in DoD demand for the products of the 13 critical

¹⁰Data on capacity utilization is collected and published by the Bureau of the Census in "Survey of Plant Capacity, 1975 Supplement," MQ-C1(75)-2, 1977.

defense sectors. For our purposes, however, the comparison of sectoral capacity utilization data with percent increase requirements is not very helpful because it is based on the questionable assumption that *all* excess capacity could be converted to defense-related production, and it tells us nothing about the operation of the sector at the *firm* level. To make a more intelligent assessment of whether any of these industries would actually become bottlenecks in the event of surge, we need to know something about the potential for conversion from civil to military production, and we need to know something about the production processes for individual products, how specialized they are, and whether required skilled labor, equipment, materials, etc. are likely to be available. This type of information becomes dated quickly and is not generally available from published sources, so it must be gathered by direct contact with firms.

TARGET SECTORS FOR A PROTOTYPE INDUSTRIAL SURVEY

Having identified which lower-tier industries would be most affected by surge demand requirements, we then attempted to design an instrument that would be useful for gathering information about the abilities of these industries to increase defense-related production. A copy of this instrument and details concerning its design and use can be found in Apps. A and B. Because time and resource constraints prevented our contacting firms in all industries identified by our input-output analysis as being potentially vulnerable, we selected three sectors for a test of our approach, *Nonferrous Forgings*, *Optical Instruments and Lenses*, and *Semiconductors and Related Devices*.¹¹ Although the empirical evidence just summarized demonstrates the potential vulnerability of each of these sectors, other factors influenced their selection for a test of our data-gathering approach. For example, we believed it would be desirable to have our test set of industries represent a range of product types and manufacturing processes, degrees of technological sophistication, mixes of firm sizes, degrees of total industry

¹¹For more discussion of the evaluation of potentially vulnerable industries, see Miller (1978), pp. 43-53.

involvement in defense business, etc. We also thought it would be desirable to select at least one industry where international trade considerations might have an effect on industrial surge capability.

To get some perspective on the total capability of each industry, we attempted to obtain information from all firms that we could determine were members of each of the three sectors (not just those currently doing some defense-related business). The information we gathered is analyzed in Sec. V.

V. PROSPECTS FOR INDUSTRIAL SURGE IN THREE SECTORS OF INDUSTRY

INTRODUCTION

To evaluate whether potential vulnerabilities within the lower tiers of the defense industrial base are likely to materialize in the event of international crises, a more detailed review was made of three sectors of industry--semiconductors, optical instruments and lenses, and nonferrous forgings. We devised a set of questions and posed them to all firms that could be identified as in one of the three sectors of industry under consideration.¹ Our questions are a *prototype* of an instrument that the DoD could use in conducting its legally mandated responsibility for industrial preparedness. In this sense, the specific results for the three sectors of industry are of secondary importance; our principal conclusion is that the information-gathering process that we have developed works and should be adopted by the DoD.²

To present the results of our data-gathering effort, we will first discuss how we went about identifying and contacting the firms in each of the three industries. Next, we will briefly review information about our response rates and the characteristics of our samples. Finally, we will describe how we used the data gathered to answer critical questions about industrial surge capability in each of the three industries.

METHOD OF DATA COLLECTION

An important characteristic of the design of our information gathering effort is that we contacted *all* firms³ that we could identify as

¹See App. A for a copy of the instrument used for collecting this information.

²Although care was taken in devising the data-gathering instrument reproduced in App. A, in the course of the analysis of the data we learned a great deal that could be used in refining the instrument. Our recommendation for revision is reproduced and discussed in App. B.

³*Firms* as defined here are individual businesses, companies, or partnerships. Some of these firms are composed of more than one *establishment* manufacturing the same or different products.

producers within each of the three industrial sectors--*not* just those firms known to be "defense" producers. In this way, we were able to determine whether firms not currently doing defense business would be interested in and, by their own evaluation at least, capable of participating in additional defense production. This approach allows us to determine whether new entry has occurred or could occur in various sectors of industry, and it yields information about the more commonly analyzed concerns over exit from industries supporting defense needs.

The design of our approach to the acquisition of information from the sectors of industry is described in detail in App. A. Firms were identified as being in one of the three above-mentioned sectors of industry if they were classified in the appropriate Standard Industrial Classification (SIC) category by one of the following sources: Standard & Poor's Register, Dun & Bradstreet Million Dollar Directory, or Dun & Bradstreet Middle Market Directory.⁴ From these sources, we expected to identify all firms in the three sectors whose annual sales exceeded \$500,000. We recognize that some smaller companies are omitted from the study. Still, a large range of firm size has been captured, and the firms omitted would contribute quite minimally to production capability.

These directories identified 61 nonferrous forgings firms, 138 optical instruments firms, and 237 semiconductor firms. The president of each of these firms was contacted by letter (with the data-gathering instrument attached) and was asked for his voluntary cooperation in participating in our data collection effort. After several weeks, if we received no response, we sent a second letter to the same corporate officer as a reminder of our request and an encouragement to participate.⁵

⁴We also consulted the "Buyers Guide" issue for *Aviation Week and Space Technology* in an attempt to ensure that all of the important defense suppliers in the three sectors were included in our survey.

⁵As an additional step, a random sample of 25 firms in each of the three sectors was selected and a phone follow-up was made on each of them. However, the phone follow-up response rate was no different from the mail contacts, so no separate presentation of these results has been reported below.

RESPONSES TO THE DATA-GATHERING EFFORT

A breakdown of the responses to our inquiries is shown in Table 5. About 40 percent of the 446 firms contacted gave us some response, and of these, about 40 percent provided completed data instruments. Thus, somewhat over 15 percent of the firms contacted provided data in the instrument we furnished. However, although some of the other responses are not included in the tabulations, they did provide useful information that has been incorporated as part of our analysis and interpretation of the results.

Table 5
NUMBER OF RESPONSES BY SECTOR

Response	Nonferrous Forgings	Optical Instruments	Semi- conductors	Total
Some response ^a	31	63	82	176
Firm returned completed questionnaire	10	23	36	69
Firm was misclassified and does not manufacture goods under the relevant SIC heading ^b	16	31	31	78
Firm responded by saying that it would not com- plete the questionnaire	5	9	15	29
No response	30	85	155	270
Total	61	148	237	446

^aInstruments were mailed in mid-1977, and all responses were received by the end of the year. All information received relates to the calendar year 1976.

^bThis includes four forgings, two optical, and two semiconductor firms who stated that they were, at one time, involved in such productions but had since left the business.

As Table 5 indicates, the difference between the number of firms responding to our inquiry and those actually providing data is accounted for by the classification procedures used by the directories we consulted. In some cases, firms indicated that they were involved only in

marketing or distribution of products in the given SICs. From the standpoint of industrial surge capability, the firms involved solely in marketing or distribution were not relevant to our study. A more common problem was the misclassification of firms into one of the SICs of interest when, in fact, they produced items in a related SIC. For example, several recipients of our optical instruments questionnaire wrote to tell us they did not manufacture these products, but rather ophthalmic goods--e.g., eye glasses.⁶ The misclassifications that we were able to document suggest that there may be firms that manufacture products in the three sectors but are not so classified by any of the directories. The misclassification problems encountered suggest that it is very difficult to identify *all* firms in a given industry, even those with sales over a certain minimum amount. Appendix A contains a more thorough evaluation of this problem and some ideas for how it might be dealt with if DoD undertook a data-gathering effort such as this in the future.

Still another way of measuring our coverage of each industry is to compare output figures reported by our respondents with data available from the Census Bureau on total sector sales and sales to DoD. Data in Table 6 indicate that the total volume of our respondents' production in the three SICs was \$1.8 billion, of which \$335 million, or about 19 percent, went to defense end use in 1976. We compared these results with Census Bureau data from 1975, the most recent year for which figures are available.

Taking the three industries as a whole, we found that our respondents are responsible for about 38 percent of total production. When we compared our reported defense-related production in optical instruments and semiconductors with Census Bureau data on total SIC sales to DoD, we found that our respondents appear to be responsible for more than 100 percent of the total--semiconductors 180 percent and optical instruments 109 percent. Perhaps some part of this discrepancy can be accounted for by the different years used in the comparison, and by

⁶To avoid any confusion about what individual products are part of a given sector as defined by the SIC, a detailed list was included in the data-gathering instrument. See App. A.

Table 6

1976 DEFENSE-RELATED OUTPUT OF RESPONDING FIRMS^a

	Nonferrous Forgings	Optical Instruments	Semi- conductors
Number of firms returning completed questionnaire	10	23	36
Number of firms with some defense-related SIC production	6	14	26
Total value of respondents' SIC production (\$ million)	117	190	1484
Respondents' SIC production as a percent of total SIC production	23	17	49
Total value of firms' defense-related SIC production (\$ million)	28	122	185
Respondents' defense-related SIC production as a percent of total DoD SIC production	56	109	180

^aThe numerical data presented in this table reflect responses from those firms that actually answered the particular question. Not all respondents answered all questions.

the fact that the Census Bureau data may provide a less comprehensive accounting of indirect sales than our information. Also, the populations from which the Census Bureau takes its probability samples contain not all manufacturers of a particular product but only those reporting that the product is their *primary* product line. Although we cannot fully explain these discrepancies, we have no reason to believe that our respondents misunderstood the relevant questions or misrepresented the facts. Questionnaires for all three industries included a comprehensive list of all products that are categorized as belonging in each of the three SICs.

According to the information in Table 6, about 60 to 70 percent of the firms did some defense production. However, defense production as a percent of total output for the firms varies considerably, from a low (on the average for each sector) of just over 10 percent for semiconductor manufacturers to a high of about two-thirds of the production for optical instruments.

Although we cannot prove it conclusively, there is good reason to believe that current defense producers are better represented in our samples than noncurrent defense producers. The discrepancy between total sales to DoD for optical instruments and semiconductors as reported by the Census Bureau and by our respondents may be one indication. Also, defense production as a percent of total production for the firms in each of our samples is higher than industry-wide percentages computed from Census Bureau data. The most extreme difference is in optical instruments, where Census Bureau data indicate that about 10 percent of total industry output goes to defense use. Nearly two-thirds of the output produced by our sample of firms is defense-related.⁷

The information in Table 7 gives us some feel for the range of firms represented in our sample and it also indicates the character of the three sectors. This information complements and, in some areas, augments the various annual surveys of the Department of Commerce (e.g., Survey of Manufactures, Shipments of Defense Oriented Industries from the Current Industrial Reports series, etc.) and potentially could provide a more up-to-date assessment of industrial activity than the comprehensive but infrequent Census of Manufactures. These questions could be useful to defense industrial planners as a monitor of conditions in industry and as an early warning of problems that might otherwise go unnoticed until a crisis occurred.

Nonferrous forgings firms have generally been in business for a long time--none of those responding to our study indicated that they were not in business in 1967--whereas about 20 percent of the optical firms and 40 percent of the semiconductor firms are less than ten years old. The nonferrous forgings firms generally have more shifts per day than do firms in the other two sectors, but they have a lower percentage of equipment in use. Their equipment is, on average, older than that in either of the other two industries. About 20 percent of the firms reported that they used some government-owned equipment in production, reflecting that these sectors are within the lower tiers, for which

⁷For more discussion of the composition of our samples, see App. B.

Table 7

PROFILE OF FIRM OPERATING CONDITIONS^a

	Nonferrous Forgings	Optical Instruments	Semi- conductors
Number of firms returning completed questionnaire	10	23	36
"Large" firms (1976 sales over \$10 million, percent)	56	36	43
Firms entering business since 1967 (percent)	0	19	39
Average number of shifts per day	2.2	1.3	1.8
Average percent of equipment in use ^b	61	86	85
Average age of equipment (years)	23	10	5
Firms possessing government equipment (percent)	20	26	14
Average age of government equipment (years)	21	12	4
Capacity utilization rate ^b (percent)	69	70	75
Specialization of labor ^c	Moderate to high	Moderate to high	Moderate
Specialization of raw materials ^c	Moderate	Moderate	Moderate to high
Specialization of semi- finished goods ^c	Moderate	Moderate to high	High
Specialization of capital equipment ^c	Moderate to high	Moderate	Moderate to high
Finished goods inventory as a percent of annual output ^b	5	1	6

^aSee Table 6, note a.

^bThese sector-wide percentage figures are determined on the basis of a scheme that assigns weights to the reported figures of individual firms according to the dollar value of the firm's 1976 output in the given SIC. See note 12, p. 39, for details of related weighting calculations.

^cThe indications for these items are based on the mean response to a choice of "unspecialized," "moderately specialized," or "highly specialized."

government equipment is not as readily available as for prime contractors. The average age of this equipment is about the same as for all equipment used by the firm; when we use age as a crude proxy for quality, there appears to be no significant difference in the quality of government and privately owned equipment.⁸

Because of the importance of capacity utilization as a measure of a firm's surge capability, we were well aware of the need for a precise formulation of the assumptions under which we wanted firms to respond to this question. In fact, our final choice of wording for a definition of capacity utilization is exactly that used by the Bureau of the Census in their annual survey of industrial capacity.⁹ Of the three sectors studied, the highest reported average utilization rate was 75 percent in the semiconductor industry. If we assume this rate applies equally well to defense production within the sector, then, within the limits of existing plant and equipment capacity, defense output could be increased by one-third if necessary labor and materials are available. The relevance of the amount of excess capacity to the determination of degree of surge capability makes it particularly important for the DoD to maintain up-to-date information on utilization rates for those sectors of industry deemed most crucial to defense production.

We can obtain additional insight into the structure of the three sectors by looking at a breakdown of large (i.e., 1976 sales over \$10 million) and small firms and the type of business they do (see Table 8). Although more large than small firms are involved in defense business in each of the three industries, the *percentage* of defense-related output varies considerably with both the size and nature of the firm. Small nonferrous forgings and large semiconductor firms report that a rather small percentage of their business (5 and 12 percent, respectively) is defense-oriented, whereas large optical instruments firms indicate that 70 percent of their output goes to defense end use. An important thing to note about the information in Table 8 is the extent to which DoD depends on the large firms for its products. Small

⁸ However, the incentives for performing proper maintenance are very different. See also Baumbusch et al. (1977), p. 57.

⁹ See question B.6 on the data-gathering instrument in App. A.

Table 8
1976 DEFENSE-RELATED OUTPUT OF RESPONDING FIRMS^a
(By size)

	Nonferrous Forgings		Optical Instruments		Semi- conductors	
	Large	Small	Large	Small	Large	Small
Number of firms returning completed questionnaires	5	4	8	14	15	20
Number of firms with some defense-related SIC production	4	2	7	7	13	12
Total value of firms' SIC production (\$ millions)	96	21	164	27	1399	84
Total value of firms' defense-related SIC production (\$ millions)	27	1	115	7	163	22

^aThe numerical data presented in this table reflect responses from those firms that actually answered the particular question. Not all respondents answered all questions. In particular, one firm in each of the three sectors did not provide data on 1976 sales and hence could not be classified as large (1976 sales of \$10 million or more) or small (1976 sales of less than \$10 million).

nonferrous forgers produce only 4 percent of the total defense-related output, small optical firms produce 6 percent, and small semiconductor firms produce 13 percent.

With this background of knowledge about the three industries as represented by the respondents to our inquiry, we can use the information we gathered to answer three critical questions. First, what is the extent of industrial surge that could be achieved in each of the industries? Second, what means would firms use to increase their production rapidly? And third, what are the major obstacles to rapidly increasing industrial production for defense end use?

SURGE CAPABILITY OF CURRENT DEFENSE PRODUCERS

After we solicited the general information described above, we posed the question about industrial surge directly:

Now, suppose there was an international crisis leading to a surge in demand for defense-related output, but *no national emergency had been declared*. Using your total 1976 defense-related production of [industrial category named] as a base, please estimate how fast and to what extent your firm could respond to such a surge in demand, in the time intervals indicated in the chart on the following pages.¹⁰

This question was difficult to pose, and several firms did misinterpret it. However, almost all of the misunderstandings were resolved by means of a follow-up telephone call.¹¹

The results of this assessment of surge capability for each of the three sectors are reported in Fig. 1.¹² Also included in the figure is a bar representing the percent of annual output that would be achieved under normal (nonsurge) conditions for each of the four time periods. As we would expect, only very small surge increases above the normal rate of production were estimated for the 30-day period, with the largest such increase reported from the nonferrous

¹⁰ Emphasis was placed on the lack of a declaration of national emergency or war to help make it clear to the firms that we wanted their best estimates of what they could produce without the imposition of government control--or *before* such control could really take effect. In other words, we wanted to get a *conservative* estimate of surge potential.

¹¹ See App. A for the full text of the surge capability question. See App. B for a more detailed discussion of how the question was misinterpreted and how we have attempted to clarify the question in a revised data-gathering instrument.

¹² These sector-wide surge percentage figures are determined on the basis of a scheme that assigns weights to the reported surge figures of individual firms according to the dollar value of that firm's 1976 output (within the specific SIC category) that goes to defense end use. More specifically, if d_i denotes this output (in dollars) for firm i , and s_i denotes the firm's surge potential for one of the four time intervals (in percent, as reported in question C.2A of the data-gathering instrument), then the sector-wide surge potential for this time interval is calculated as

$$\frac{\sum d_i s_i}{\sum d_i},$$

where each sum runs over all firms that provided values for both defense-related output (d) and surge percentage (s).

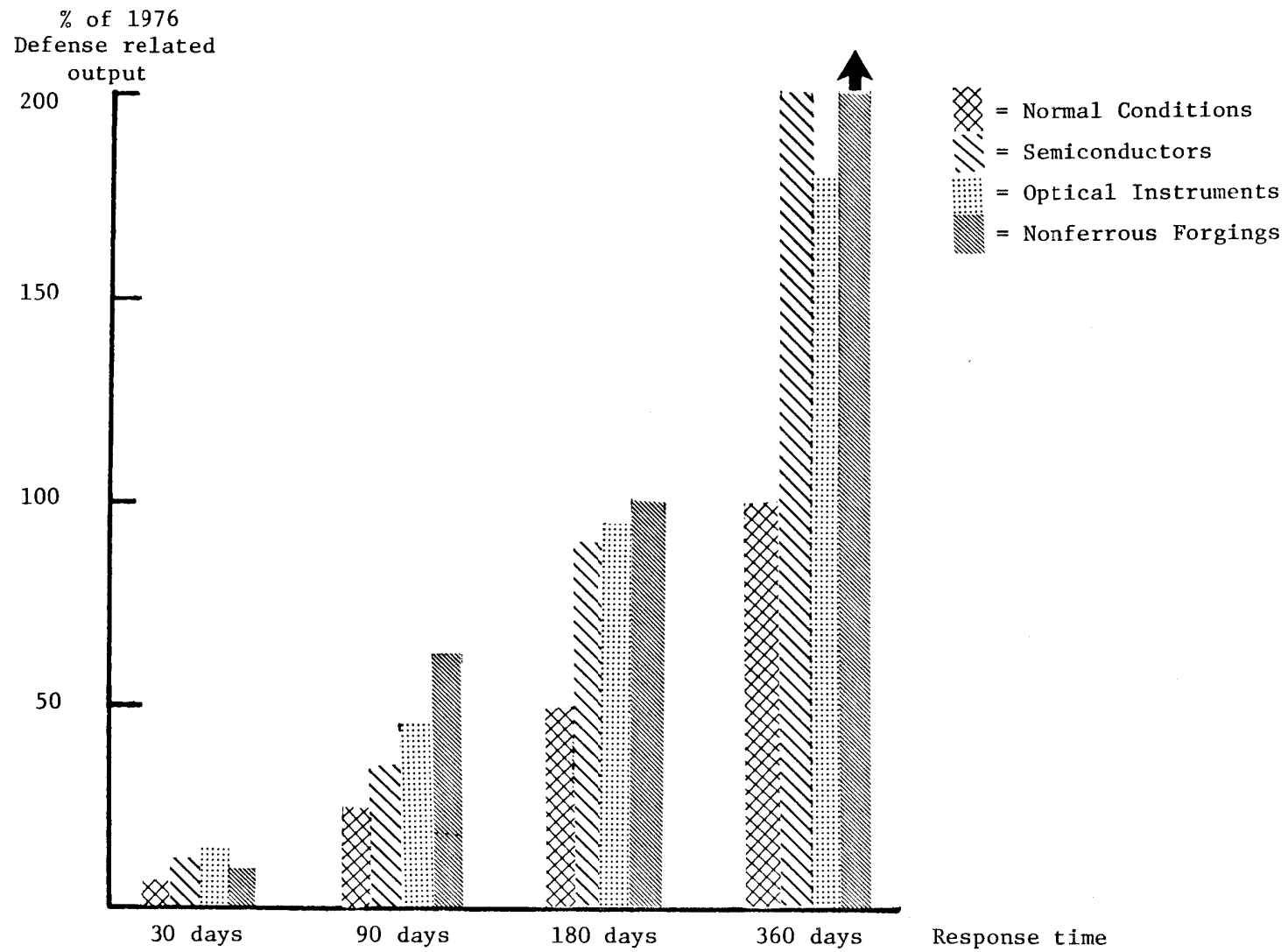


Fig. 1--Surge potential of current defense producers

forgings manufacturers.¹³ By the 180-day period, all three sectors could almost double their normal production for this period.

The numerical values on which this figure is based are reported in Table 9. After about three months the increase in production can

Table 9

SURGE POTENTIAL OF FIRMS CURRENTLY DOING DEFENSE BUSINESS

Percent of 1976 Defense- Related Output Firm Could Achieve in:	Normal Conditions	Semi- conductors	Optical Instruments	Nonferrous Forgings
30 days	8	12	15	10
90 days	25	36	45	62
180 days	50	90	94	100
360 days	100	199	180	398 ^a

^aBased on a sample of only two firms, this figure is not likely to be a very reliable indicator of overall industry capability.

approach or exceed 150 percent of the normal quarterly production; after six months, the production rate is about double that of the peacetime conditions; and that doubled rate of production continues through a full year.¹⁴

We can use these estimates to predict how long it would take current defense producers to achieve levels of production necessary to sustain the hypothetical 100 percent increase in DoD purchases from all 13 critical defense sectors (as discussed in Sec. IV). Forgers could reach this production level after about eight months; semiconductors,

¹³This appears to be plausible from the information in Table 7, as these firms have the largest percentage of idle equipment and considerable unutilized capacity.

¹⁴For nonferrous forgings, the results look even better, but they are based on an extremely small sample for the one-year period--only two respondents, both of which are small firms that produce little of the total defense forging output. However, we received other information about this industry--independently of our data-gathering instrument--that corroborates the conclusion that forgers could substantially increase their defense-related output.

shortly after the end of one year of surge production; and optical instruments, in about 14 months.

MEANS BY WHICH SURGE PRODUCTION COULD BE ACHIEVED

In an attempt to understand the basis for and probable cost of their estimates of achievable increases in defense production, we also asked each respondent to indicate which of ten enumerated types of inputs would be involved in these output increases. These categories are:

Capital

- o Draw down inventories
- o Better use of equipment
- o Use idle equipment
- o Convert some equipment to defense work
- o Buy new equipment

Labor

- o Add overtime
- o Hire labor and/or add shifts
- o Convert some labor to defense work

Other

- o Increase subcontracts
- o Bring some work in-house
- o Other¹⁵

For each of these categories we asked the firm to indicate whether a given category of input would be involved in its increase in production, and, if so, what the cost of using the particular input would be. With very few exceptions, firms did not provide dollar cost estimates that were useful for a prediction of the costs of surge.¹⁶ Thus, the

¹⁵Because very few of the respondents used this category, we will not report it further in the discussion of our results below.

¹⁶In our discussion of revisions to the instrument for future use by DoD, we have attempted to deal with this difficulty. See App. B.

only data available for analysis are simply the indications by a firm that an input category would be among the means used to achieve the surge result in its response. We have used sales by the responding firms in a weighting scheme to convey some sense of the percentage of total output that would involve the use of each of these ten types of inputs during the surge period.¹⁷

Optical Instruments Industry

The responses of the optical instruments firms to the questions concerning the means by which surge would be achieved are summarized in Fig. 2 for each of the ten categories of inputs mentioned above. The four bars for each category represent the four different time periods involved and the height of the bar indicates the proportion of all firms (weighted by the size of the firm in terms of sales) that would use that type of input as part of their plan to achieve the surge production. For example, the left-most bar of the "Better use of equipment" category indicates that about 95 percent of all firms (weighted by sales) would make better use of their equipment as one means of increasing production within the 30-day period. The left-hand bar in the "Draw down inventory" category indicates that only about 3 percent of all sales during the first 30 days of the surge period would involve the drawing down of inventories. This is consistent with the fact that

¹⁷In particular, let d_i and s_i be defined as the i th firm's "output" and "surge" percentage, respectively. Then, for each of the above ten types of inputs, we define a binary variable ϵ_{ij} , which assumes the value 1 if the particular input (j) would be used by firm i in meeting a surge demand in a given time interval, and ϵ_{ij} assumes the value 0 if the input would not be so used. The degree to which the j th input would be involved in a sector-wide surge effort for this time interval is then calculated as

$$\frac{\sum d_i s_i \epsilon_{ij}}{\sum d_i s_i},$$

where the two sums run over all i (firms) that provided values for each of the variables. For example, a quotient of .65 for the 30-day input "Draw down inventory" would indicate that 65 percent of the sector-wide reported 30-day surge potential would be supported *in part* by drawing down inventory.

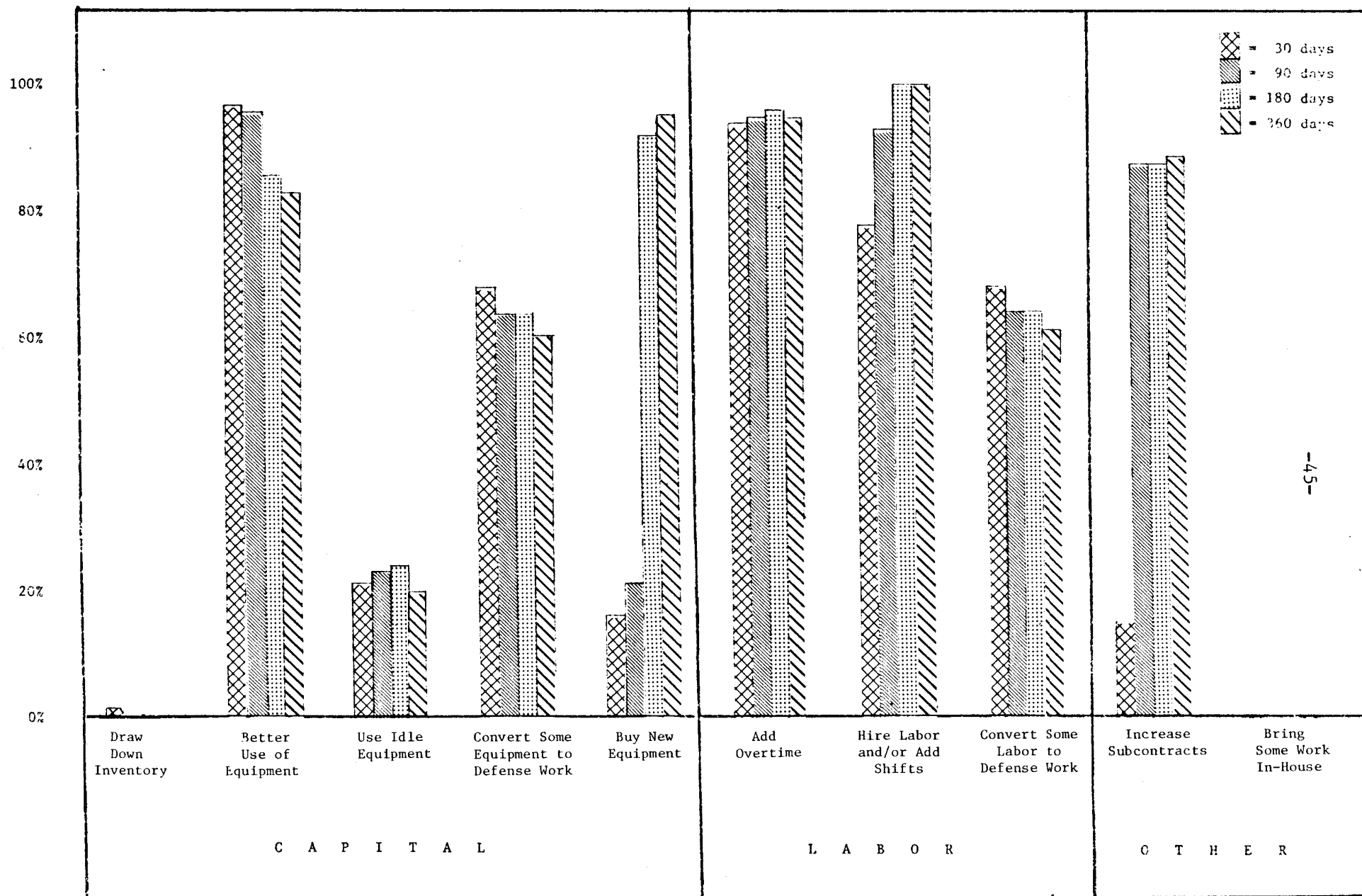


Fig. 2--Means by which optical industry would respond to surge

firms in the optical industry maintain very little finished goods inventory--only about 1 percent of the annual production (see Table 7 above).

The figure reveals that optical industry firms would rely on better use of equipment, converting some equipment to defense work, adding overtime, and hiring new labor or adding shifts, as well as converting labor to defense work as the means of attaining their surge levels of production throughout the four periods of time under consideration. In addition, buying new equipment becomes very important to the optical firms for the half-year period or beyond. This is an important finding, given the way the current IPP process treats the subject of equipment. IPP asks firms to recommend measures to be taken in advance (IPMs) with regard to the provision of equipment for meeting crisis demand requirements. However, as there appears to be no concrete idea of *what* the demand is likely to be (let alone *when* it is likely to occur) IPMs generally are not funded because of skepticism about their usefulness in the event of an actual crisis and the pressures of more immediate competing demands for scarce DoD resources.

In our data-gathering instrument, we did not ask firms to assume that equipment would be purchased far in advance. However, at least for the optical instruments industry, firms indicated that new equipment purchases would contribute to their ability to surge production, even without advance purchases of the type contemplated by IPP. In some cases it may be true that advance purchases would help firms to make a quicker response, but this is not completely certain because of the crucial role that labor plays in industry's ability to increase production. As far as costs are concerned, it is reasonable to assume that some or all of the cost of equipment purchased for surge once it was under way would be passed on to DoD. However, such costs may very well be less than those DoD would incur if it undertook more funding of IPM actions in advance of a crisis. This is true in part because of the impossibility of accurately predicting in advance what investments in equipment should be made. Moreover, the necessity for increased spending would be more apparent in the surge context.

Increases in subcontracting play an important role in the individual firms' plans for the 90-day period and beyond. Some of this subcontracting could involve semifinished goods from outside the optical industry for which optical firms would then complete production. However, other subcontracting might involve firms in the same industry undertaking some steps of the production process that are usually done in-house. To the extent that these other firms are already represented in the data on this industry, this would constitute double counting of the productive capacity that could be relied upon for surge.

Firms in the optical instruments industry expect that they could increase their output in a year of surge to 180 percent of the annual output of 1976. They would do this by a very heavy reliance on additional labor, on reorientation and better use of existing equipment for defense purposes, and by purchasing new equipment for production beyond the first six months. The data from the firms on the means of attaining this level of production are internally consistent in explaining how the optical instruments industry would achieve surge and give some insight into the costs. We cannot say whether this level of surge will be sufficient for defense purposes because the requirements have not been fully defined. However, if we take our 100 percent, across-the-board increase in production as a test of the adequacy for surge, then surge would not be quite completed within a single year's time.

Semiconductor Industry

The semiconductor industry has the largest number of firms of the three included in our analysis, and 36 firms responded to our request with completed data-gathering instruments. The results of these responses on the question of means of achieving surge are presented in Fig. 3. About 50 percent of the surge output for the first 90 days would involve some use of finished goods inventory. However, the firms in the semiconductor industry maintain finished goods inventories of about 6 percent of their annual output, so inventories alone will not sustain much of the surge. For these firms, better use of equipment

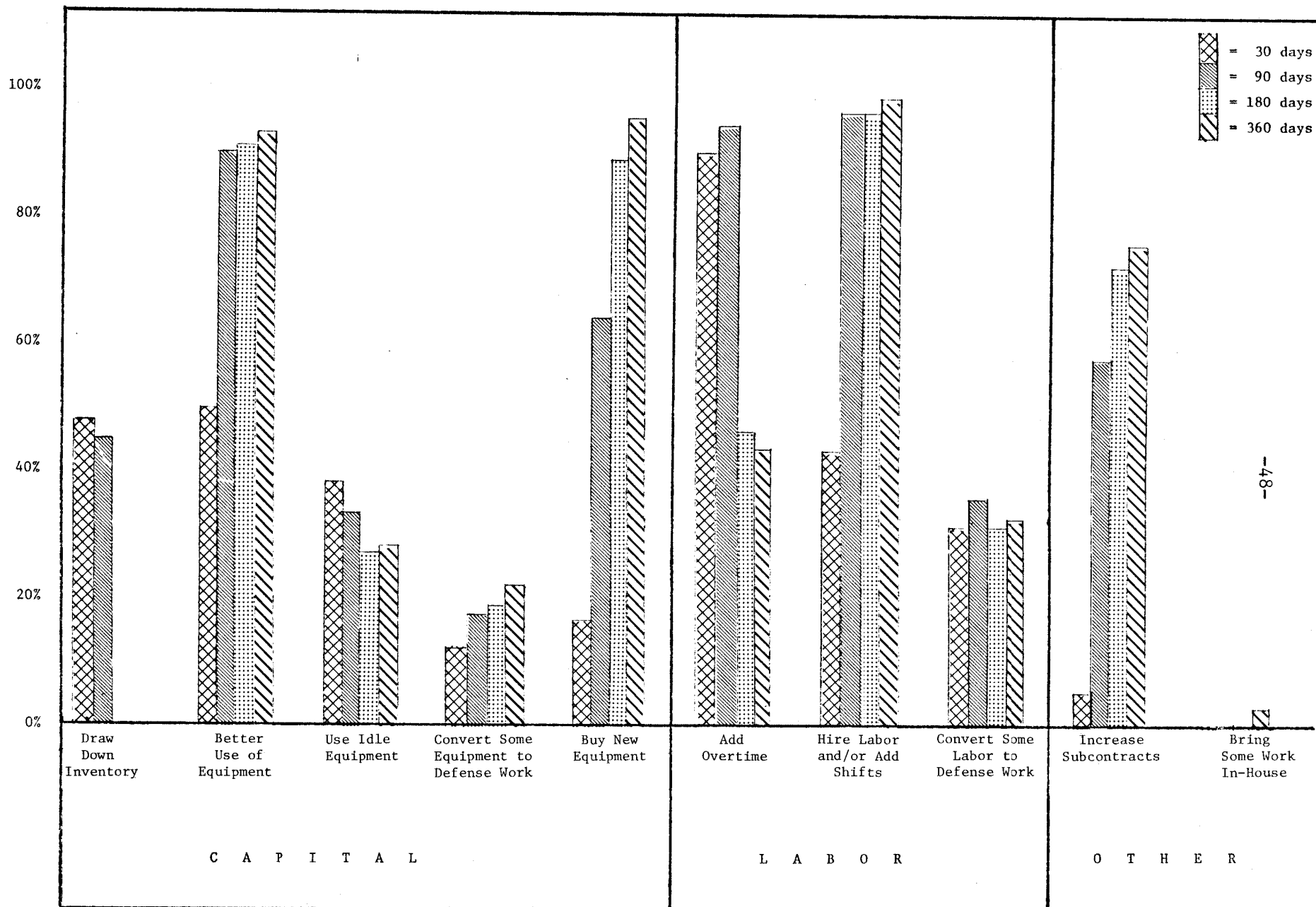


Fig. 3--Means by which semiconductor industry would respond to surge

is considered a very important means of helping to achieve the surge production.

Use of idle equipment has more importance for the semiconductor industry than it has for the optical industry; in other words, between 30 and 40 percent of the surge output involves, to some extent, the use of idle equipment for all four time periods (compared with about 20 percent for firms in the optical industry). This may give a somewhat misleading impression about the *extent* of the reliance on "idle" equipment, because our information indicates that, on average, the two industries have the same percentage of equipment in use (85 percent for semiconductors and 86 percent for the optical firms). The reported capacity utilization rate for the semiconductor industry was 75 percent and for the optical firms 70 percent.

Firms in the semiconductor industry rely less heavily on the conversion of some equipment to defense use than do the optical firms, but they report an earlier and large reliance on the purchase of new equipment for their production. By the time 90 days pass, almost 65 percent of the surge output would involve some reliance on new equipment. This finding is consistent with their reported availability of idle equipment and capacity utilization. And it identifies another potential vulnerability--if new equipment cannot be delivered on the schedule anticipated by semiconductor firms, their projections of output increases will be too large.

Both the addition of overtime and the hiring of labor or adding of shifts are very important means of attaining the surge production. The conversion of labor to defense work is less important for the semiconductor industry than it was reported to be in the optical industry, consistent with the lower reliance on the conversion of capital as well. Also, by the time 90 days have passed, over half of the surge output for the semiconductor firms would involve some reliance on increased subcontracting.

Overall, the semiconductor firms report that, within a year, they could double their 1976 output if DoD sought a surge in their industrial production. Their principal means for doing this include drawing down inventories in the early months and relying on the purchase

of new equipment in later months. They also place a very heavy emphasis on obtaining--by overtime and hiring--additional appropriately skilled labor.

Nonferrous Forgings Industry

The nonferrous forgings industry includes a smaller number of firms than either of the other industries investigated and, although the response *rate* was about the same as for the other sectors, many fewer firms actually responded. Because only six of the ten firms responding were currently doing some defense business at the time of the inquiry, and not all of those filled out the information on means of attaining their surge results, the data are inadequate for a formal presentation of the means of attaining the surge results as we have done previously. However, along with the survey responses, we were able to obtain other qualitative information from various firms and other sources connected with the industry. This information should be a useful supplement to our somewhat less complete quantitative assessment of surge capability in the nonferrous forgings industry.

Both the quantitative and qualitative information we received indicates that nonferrous forgings firms would achieve their surge increases primarily by increasing or changing (converting from civil to defense) utilization of existing equipment. The existence of equipment reserves is partly a consequence of increased capitalization that occurred after the industry experienced capacity problems during the Vietnam war years of the late 1960s. At that time, firms tended to increase their specialization in product lines for which they had particular expertise, thereby further increasing industrial capability by raising productivity. For example, Wyman Gordon, a dominant member of the forgings industry, concentrated its efforts on forgings for aerospace uses.¹⁸

Quantitative data from the completed instruments show the nonferrous forgers to have a fairly low percentage (61 percent) of equipment in use, optical firms had 86 percent, and semiconductor firms had

¹⁸"Component Lead Time Growing," *Aviation Week and Space Technology*, June 19, 1978, p. 17.

85 percent. Thus, unlike the other two, nonferrous forgers did not indicate that they would rely much on the purchase of new equipment (with the possible exception of some additional tooling) to help achieve predicted surge increases.

In addition to relying on existing plant and equipment, nonferrous forgers would also add labor by hiring new employees and converting some labor from civil to defense work. Only one respondent specifically noted use of overtime, which probably indicates the limitations of a formal survey approach for an industry with so few firms. Respondents to our inquiry did not indicate that they would rely on increased subcontracting, so what data we did receive on predicted increases do not have the potential double counting problem.

The nonferrous forgings firms report that they could significantly increase their 1976 output in response to surge demand. Because the quantitative assessments of the size of this increase (particularly for the one-year period) are based on a very small sample, we hesitate to rely on them as much as on the figures from the other two industries. However, a more qualitative evaluation obtained from other industry sources and literature supports the conclusion that it would not be unreasonable to expect the industry to at least double its defense-related output within a year's time. The most important inputs to the achievement of these production increases would be the use of existing plant and equipment capacity and the addition of extra labor.

OBSTACLES TO DEFENSE INDUSTRIAL SURGE

Thus far we have been dealing with the magnitude and timing of increased industrial production in response to an international crisis. In investigating the means by which such a surge in production could be accomplished, we designed an instrument intended to provide insights into some of the costs of that increase. However, data from the firms on this score were extremely sparse, so we must rely on some indirect measures.

One such measure is obtained by indications of the importance of some of the possible deterrents to firms that are considering temporarily

increasing production for defense end use in response to a surge in demand. Several difficulties have been cited as potentially inhibiting to contractors who currently do defense production.¹⁹ Figure 4 lists five such factors, along with the unweighted average of responses from the current defense producers in each sector. One of the strongest inhibiting factors indicated by the firms in all three industries is their perceived inability to attract *skilled labor* on a potentially temporary basis. It is a "significant" problem for optical instruments firms, and a "moderate" deterrent for the other two sectors. The most difficult problem for the nonferrous forgings industry is their perceived uncertainty with respect to the continuing volume of business. And this is also the most severe difficulty, on the average, for semiconductor firms.

These figures do not show the range of responses that were received, merely the averages. For a number of firms, each of these potential deterrents was indicated as "not an obstacle" for some increases in defense production. For example, although a few firms cited *low profitability* as a significant deterrent, twice as many indicated that it would not be an obstacle at all. And, as one would expect from firms currently doing DoD business, only 17 percent believed that the *requirement for production according to military specifications* would be a significant deterrent, while 57 percent believed it would not be a problem. However, nearly half of the respondents thought these specialized production requirements would cause some problems (either significant or moderate) in the achievement of surge increases. The prospects for a successful surge would certainly be improved if some of the specialized procedures could be eliminated or at least identified (in advance of a crisis) for prompt suspension in a surge situation.²⁰

Industry's reactions to this list of deterrents might be thought of as an indirect measure of the *price* that DoD would have to pay for

¹⁹See Gansler (1977).

²⁰For an account of current DoD efforts to reduce or eliminate some of its requirements for excessively specialized or customized products, see Kenneth H. Bacon, "Military Industrial Complex Becoming a Wee Bit Less So," *Wall Street Journal*, September 22, 1978, p. 1.

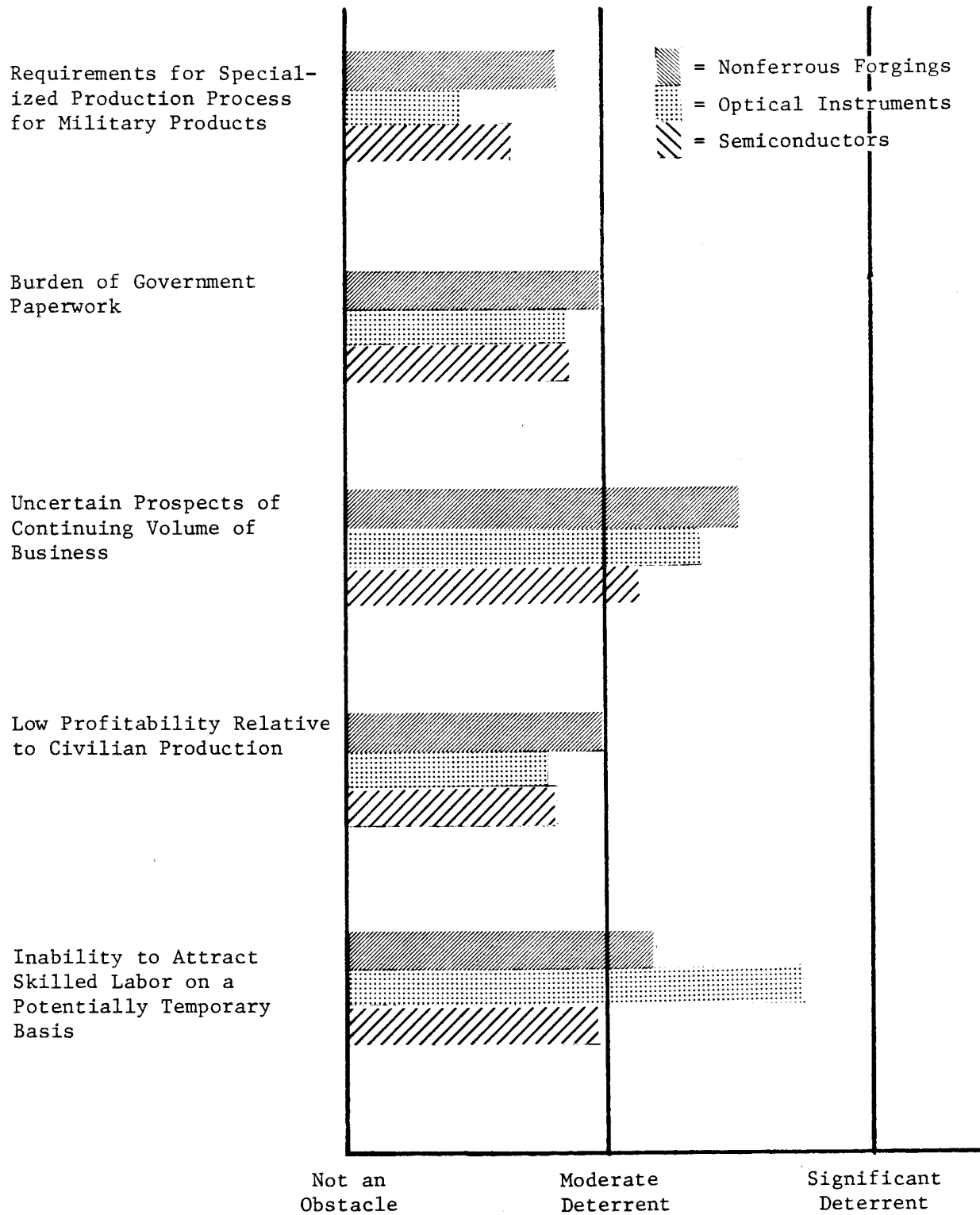


Fig. 4-- Possible deterrents to industry in surge response
(current defense suppliers)

surge production. Industry might be hesitant to risk surge measures without an assurance that increased demand will continue for some minimum time period. The DoD might have to offer special incentives so that industry would be willing to undertake such increased production.

A data-gathering instrument such as our prototype can also provide important signals from supplier firms of current special problems. To this end, we included an open-ended question on the data instrument asking each defense producer to list the three most serious impediments to increasing defense production in response to a surge demand.²¹ The most frequently given responses to this inquiry are included in Table 10. The three most common responses related to hiring and training additional labor, acquiring new equipment, and securing material inputs, with the first appearing more often than the two others combined. This pattern of responses is consistent with the earlier description of the means of attaining surge increases given by the firms. It is also consistent with the responses to the questions on deterrents.

Other significant responses included: increased costs, lack of adequate facilities, availability of testing equipment and lack of the corresponding labor, and commitment to commercial customers. Although DoD sources frequently mention the availability of energy and concerns about recently imposed OSHA and EPA standards as possible constraints to industrial surge, less than 5 percent of the responding firms listed them as impediments.

We also obtained some other insights about possible constraints on firms' ability to achieve increase for surge. These are more a feature of the administrative and procedural framework that surrounds defense contracting than they are related to the manufacturing process itself. For example, some defense producers operate under the Defense Priorities System (DPS), through which priority ratings are assigned to certain products. These "rated orders" are then supposed to be filled ahead of nonrated DoD orders and commercial orders.²²

²¹See question C.4 in App. A.

²²For a more detailed description of the operation of the Defense Priorities System, see U.S. Congress, *1975 Annual Report*, Joint Committee on Defense Production, 94th Cong., 2d Sess., January 19, 1976.

Table 10

MAJOR OBSTACLES TO SURGE FOR CURRENT DEFENSE PRODUCERS^a

(Number giving a particular response)

	Nonferrous Forgings	Optical Instruments	Semi- conductors	Total
Hiring and training labor	5	16	22	43
Securing material inputs	4	4	13	21
Acquiring new equipment and tooling	2	7	11	20
Increased costs of production	0	2	6	8
Testing and quality con- trol procedures and availability of re- lated equipment and labor	0	1	6	7
Inadequate facilities	0	4	2	6
Complexities of doing government business	1	2	3	6
Commitment to commercial customers	1	0	3	4

^a Those obstacles listed (in question C.4 of the data instrument) by at least four different firms.

During the surge in production of tactical aircraft for the Vietnam war, forgings were operating under conditions where forgings for use in the SST and the naval nuclear power program carried a higher priority rating (DX) than those for the tactical aircraft. According to one manufacturer, forgings for use in certain of these naval projects were being completed seven to eight years before they would be incorporated in the equipment. Because of the program's DX priority, these forgings had a place in the manufacturer's queue ahead of those for aircraft with production process times as short as eight months. This problem was eventually resolved through an appeal for an exception--a multi-step process involving the Joint Aeronautical Materials Committee, the DoD, and the Department of Commerce. The problem experienced here

suggests that some political considerations may have as much to do with the DPS as do timely and objective assessments of what programs are really most vital to our national security.²³

It was stated above that several firms had indicated that the availability of test equipment and employees to operate it would be critical to their ability to achieve surge increases. Related to this is the constraint that may be imposed by the actual testing and quality control requirements themselves. In the nonferrous forgings industry, for example, production process times can run to nearly a year. However, a significant amount of this time is devoted to testing and inspection. According to one respondent, new requirements imposed since the Vietnam war have added five to six weeks to the amount of time spent on these procedures. Although some may be necessary, blanket continued application of these requirements would probably constitute an unnecessary constraint on industry's ability to manufacture products more rapidly in a crisis.

As the information summarized in Table 10 indicates, industry views these procedural and administrative constraints as considerably less serious obstacles to surge than the availability of necessary labor and capital. However, these constraints, although less serious, are also more likely to be relieved by DoD action because they were imposed by that action in the first place.

POTENTIAL CONTRIBUTION TO SURGE BY FIRMS NOT CURRENTLY DEFENSE SUPPLIERS

If the DoD is seriously concerned about industry's capability to make a rapid increase in production of crucial material, then it must at least consider the possibility of encouraging firms *not* currently doing defense business to participate in such production. In an

²³ See *ibid.* for more discussion of the use and abuse of the DPS in peacetime. For a discussion of the role DPS played in one product area during the shortage conditions of 1973-74, see *Case Study in the Development of a Material Shortage: Titanium Metal, 1973-74*, in *The Commodity Shortages of 1973-74*, National Commission on Supplies and Shortages, August 1976, pp. V2-V6.

attempt to determine the likelihood that such producers would be willing or able to undertake such activity, we directed a portion of our data-gathering instrument specifically to those firms having no defense-related production in 1976. We posed qualitative questions concerning the rapidity with which such firms could become defense suppliers and the effect that the previously mentioned deterrents might have on their willingness or ability to undertake some defense production.

In Fig. 5, we tabulate the results of questions to these firms relating to their perception of the difficulty involved in becoming a defense supplier during a surge situation.²⁴ As was the case with the defense producers discussed earlier, we were interested in responses for each of four different time periods--30 days, 90 days, 180 days, and 360 days. Our responses indicate that it would be extremely difficult for nonferrous forgers to make any contribution within 30 days, moderately difficult for semiconductor firms, and somewhat less difficult for optical instruments firms. For periods longer than 30 days, semiconductor manufacturers would still have moderate difficulty initiating defense production, and the other two sectors report little or no problem after 180 days. This is a significant finding because it is not routine IPP practice to deal with firms not currently doing defense business. Some recent DoD study teams have focused on *departures* from the defense marketplace, but few if any have been concerned specifically with new *entry*.²⁵

Both overall and specifically as suppliers of defense products, the three sectors of industry we studied have experienced considerable turnover, in terms of both exit and entry. As far as exit is concerned, eight firms responded to our inquiry by saying they had once been but no longer were manufacturers of products in one of these industries. Four of the eight were nonferrous forgers representing about 21 percent of all firms that our inquiry definitely identified as having manufactured nonferrous forgings within the last ten years. Two firms in each

²⁴The total SIC output reported by the noncurrent defense producers in all three industries is about 7 percent of total output of the three industries reported by the Census Bureau in 1975.

²⁵One such study of exit is the Vanishing Manufacturing Sources Study recently done by the Defense Electronics Supply Center.

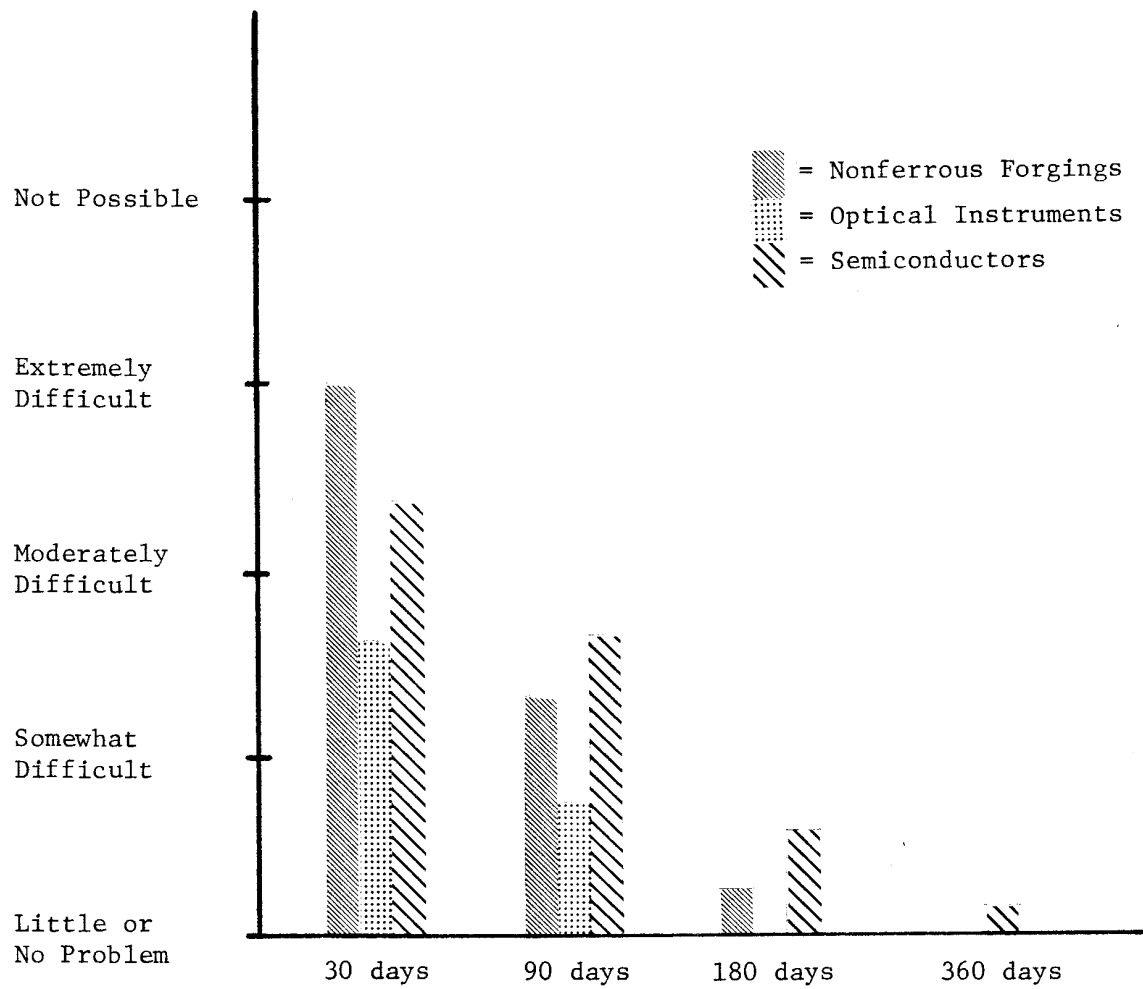


Fig. 5--Surge potential of firms not currently in defense business

of the other industries indicated that they had dropped the relevant product lines within the last ten years. For the semiconductor manufacturers these two firms represent about 4 percent of the total we definitely identified as in the industry; for the optical industry, the figure is about 5 percent. That the forgers appear to have the highest rate of exit is consistent with the well-documented recent trends in the industry. The other two industries have experienced a much lower rate of exit. However, because these percentages are of numbers of firms, they tell us nothing about the amount of manufacturing capacity lost.

As for new entry, in the semiconductor industry 50 percent of the firms reporting some defense-related output in 1976 either were not in business at all in 1967 or had no defense-related business that year. And, although the time period 1967-1976 was generally one of declining defense demand, Table 11 shows that of those firms doing some defense business in 1976, about two-thirds report doing as much as or more than in 1972, and about one-half were doing as much as or more than in 1967.

We asked those firms not currently doing defense business to rate the possible deterrents to surge. The results are tabulated in Fig. 6. The difficulty in obtaining skilled labor on a potentially temporary

Table 11

COMPARISON OF FIRM DEFENSE BUSINESS: 1967, 1972, 1976^a

Percent of Current Defense Producers That Were Doing at Least as Much Defense Business in 1976 as in Previous Years ^b				
Year	Nonferrous Forgings	Optical Instruments	Semi- conductors	Total
1972	50	67	61	62
1967	50	50	50	50

^aTakes into account all defense production by the firms surveyed, not just that in the industry into which the firm has been categorized.

^bThe percentage figures are based on those responses for which data were provided for the year in question. Not all respondents provided complete information.

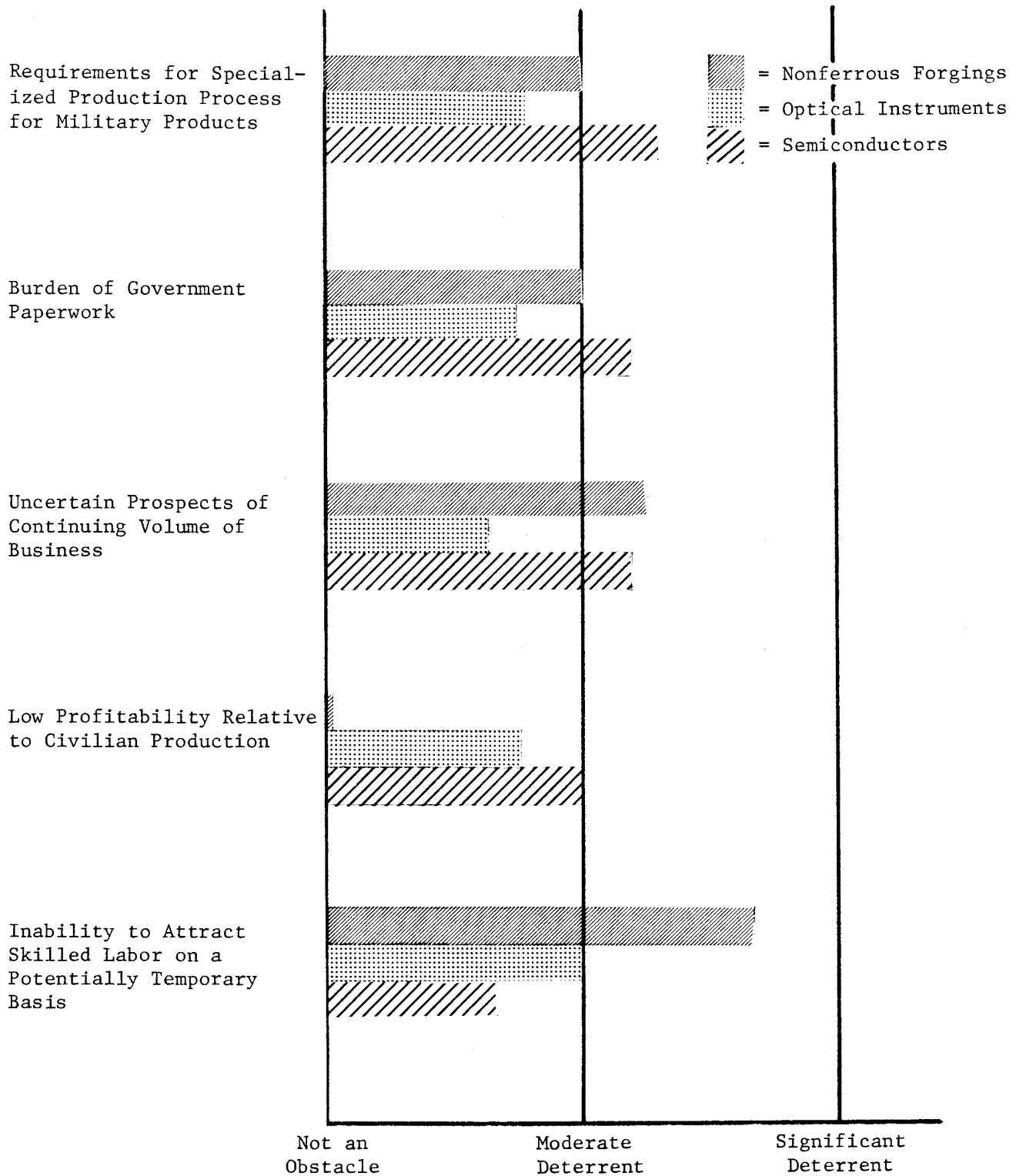


Fig. 6--Possible deterrents to industry in surge response (noncurrent defense suppliers)

basis seems to be a problem for the nonferrous forgers, whereas the concern about low profitability does not. The semiconductor manufacturers indicated that the requirement for specialized production processes, government paperwork, and the uncertain prospect of continuing business were moderate deterrents. The optical instruments firms generally reported less reticence about getting into the defense business than either of the other two sectors, with concern over skilled labor availability being their most serious difficulty.

Finally, it is useful to note the differences in responses between current and noncurrent defense suppliers (cf. Figs. 4 and 6). Both indicate that the ability to attract skilled labor is a serious problem, but those firms not currently defense suppliers indicate greater difficulty with the requirement for specialized production processes and the burden of government paperwork.

Our results suggest a general willingness and capability on the part of firms not currently doing defense business to become involved in a surge of defense-oriented production. Of course, these self-evaluations cannot be accepted without qualification. For example, although some of these firms may never have sought DoD business in the past, a sizable number may also have competed unsuccessfully against firms that currently hold defense contracts. It is therefore in their interest to minimize the problems that might limit their ability to gain a future share of the defense market. If the DoD turns to firms without an established "track record," it might have to bail out a firm that makes a commitment to production without adequate capability to fulfill that commitment.²⁶

Furthermore, without additional detail concerning the nature of the surge defense product(s) and the various requirements for specifications and testing (for which current defense producers may have needed years to gain the necessary experience), the conclusion of "general willingness and capability" offers the DoD a strictly qualitative perception of how readily firms not currently doing defense work could enter the market. If it is determined, as some of our results indicate, that deterrents to doing defense business are greater for

²⁶ DoD occasionally needs to bail out firms even *with* established "track records."

noncurrent defense producers than for those already engaged in defense work, the DoD has an early indicator of the types of requirements it might need to relax to significantly increase the potential volume of surge output. Examples of this include some of the paperwork and specialized testing associated with providing defense products. Planning for waiving these in an emergency situation should increase the opportunity for greater industrial participation.

SUMMARY OF SURGE PROSPECTS

In an international crisis, the DoD must rely primarily on some combination of patriotism on the part of firms in those sectors for which surge is required and the usual business incentives of profits and expanding markets. Current defense producers claim they could achieve significant increases in output within 180 days of first specific indicators of a need for surge. Even within 90 days, production rates in excess of 50 percent above peacetime levels appear feasible. By including an investigation of firms not currently doing defense business, we find that the potential for surge could be even larger, especially if the 180-day period is considered reasonable for meeting the surge needs. Furthermore, as would be expected for both current and noncurrent defense producers, industrial surge capability for periods less than 90 days is minimal; and depending on the exact level of demand, additional production, by itself, would probably not sustain military requirements in such a short period.

The firms in our samples have indicated that a very important basis (for all four time periods) for such increases in production would be the acquisition of additional labor and the better use of existing equipment, and that for periods beyond 180 days, the purchase of new equipment and added subcontracting would become important means of increasing outputs. *Firms repeatedly emphasized that the most severe problems in meeting surge demands would relate to the hiring of appropriately skilled labor and the timely acquisition of additional equipment, with the former receiving the most emphasis from both current and noncurrent defense producers.* These factors combined with uncertainty of continued volume of business as well as some concern about relative

profitability of defense and civilian work are likely to cause significant increases in prices over peacetime levels. However, we have been unable to make a quantitative assessment of the extent of these increases.

VI. IMPLICATIONS

We have explored some of the major deficiencies of the current procedures for carrying out the DoD's mandate for industrial preparedness, and we have suggested an approach that appears to be more effective than the current procedures. This approach involves a review of the entire industrial process by which finished goods are manufactured and delivered to the DoD and selective, in-depth surveys of sectors of industry to determine very current information on capacity utilization and opportunities for devoting productive resources to defense end use. The new approach would account for the possibility of market entry as well as exit and for the potential contribution to defense production of all segments of a particular industry, not just those currently doing defense work. Such an approach should provide useful information relatively cheaply. Our initial test of this approach has suggested ways in which it could be improved. These are discussed in App. B.

In consideration of new policy options, as well as in the evaluation of the current industrial preparedness planning procedures, it is very important to recognize that perhaps the primary goal of defense industrial planning, whether it be for peacetime or crisis, is *risk reduction*. Such planning always involves some government regulation or direction of industrial activity. However, there are many advantages to allowing industrial activity to be unencumbered by regulatory constraints. With an adequate level of competition, such a marketplace yields a broad range of products, produced with little waste of scarce resources, and numerous alternative suppliers for the purchase of any particular product. However, outlays for defense procurement have been declining in real terms over the last decade, so the DoD must now deal in a marketplace where there are few producers for *some* products. For peacetime procurement, the decline in demand for products and consequent reduction in the supply base does not seem to be causing inability to obtain either needed products or alternative suppliers if one supplier should turn out to be unable or unwilling to continue to produce a product line. Nor does it appear to be causing widespread

monopolistic pricing for products.¹ Thus, as DoD risks very little in its efforts to obtain products for peacetime demand, additional intervention into or regulation of the marketplace to reduce these risks would be undesirable. In fact, we have previously suggested that some types of government involvement in industrial activity should be reduced.²

We do not mean to suggest that the current process of peacetime development and procurement of major weapon systems is free of risk and uncertainty. On the contrary, it is fraught with technical, financial, and political risk, but *not* with risks derived from a shortage of industrial suppliers for peacetime defense production.

In time of crisis, it is much less clear that U.S. industry, left to its own independent devices, will be able to sustain requirements for production for defense end use. The question then becomes: What policies will provide reasonable insurance against the *risk* of inadequate supplies and what will be the "premiums" associated with those "insurance policies"? If defense agencies charged with industrial planning recognize that they cannot obtain absolute assurance of the avoidance of all problems in an international crisis, then discussion can concentrate more realistically on which policies promise the most risk reduction for the kinds of shortages that can be anticipated.

In the context of risk reduction, an overview of U.S. industrial activity that uses input/output analysis identifies the critical defense-related industries and their lower-tier suppliers that would be drawn upon for any particular level of final product demands and does it quite cheaply. Identification of problem areas using this approach appears from this study to be a much better first step in industrial planning for surge than is the IPP selection of a number of end items to be "planned."

After potential problem areas are identified, published data from the Department of Commerce may make it possible to obtain greater

¹See Baumbusch and Harman (1977).

²See above, Sec. I, and *ibid.*, Secs. III and V, for discussion of possible additional intervention or regulation and for elaboration of our suggestions for reducing such activities.

insight into the dimensions of such problems. We have already referred to information that can be obtained from the *Survey of Manufactures*, *Current Industrial Reports*, and the *Census of Manufactures*. In addition, other agencies of the federal government conduct analyses of various industries or commodities that could be useful to DoD planners, for example the mineral industry studies of the Bureau of Mines. Still other sources of information might become available to DoD.

In its report on the materials shortages of 1973-1974 the National Commission on Supplies and Shortages recommended the creation, within OMB, of a group of specialists who would undertake analyses to help policymakers understand sectoral and industrial activity. Potentially, such a unit would provide more "objective" analyses and forecasts of industrial activity because of its separation from agencies or departments actually gathering data, and it would also be in a position to identify inconsistent or conflicting policies relating to particular industries or products.³ Should such a capability be created and its activities expanded beyond analysis of raw materials, DoD could draw on its expertise.

If DoD deems it necessary to gather more detailed firm-by-firm information itself, an industrial survey (such as the prototype reported in Sec. V) would be very attractive, both because we have demonstrated the ability to obtain useful information by this device and because the costs of such a survey (both to DoD and to the cooperating firms) are quite modest. And if the critical importance of the industry, as revealed by DoD's assessment of surge requirements, demanded more detailed information than some firms took the time to provide to us, perhaps some funded effort might be desirable. We repeat, however, that we believe that funding of current IPP data-gathering efforts is *not* a useful expenditure of DoD's scarce resources, because the information gathered contributes little to *risk reduction*.⁴

³*Government and the Nation's Resources*, Report of the National Commission on Supplies and Shortages, December 1976, pp. 107-121.

⁴See Sec. II for more discussion.

Another important advantage of the design of our questionnaire is that responding firms were not asked to make many arbitrary assumptions. Our open-ended questions allowed firms to provide their own best estimates of what factors or inputs to their production processes would be most critical in their attempt to achieve surge increases. In their evaluation of potential surge capability, our respondents overwhelmingly indicated that capital goods and skilled labor, not other factors, would be the most serious potential bottlenecks. Had we told firms to assume that adequate supplies of skilled labor would be available, for example, we would have failed to uncover the facts about what a critical constraint both the semiconductor and optical instruments industries believe the availability of labor might be. In the absence of such complete information about inputs to manufacturing processes, evaluation of individual factors is likely to result in policy recommendations (e.g., buying reserve equipment) that, by themselves, will be costly and not contribute much to reducing risks of shortages in a crisis.

It is possible, of course, that if a survey similar to our prototype were used with considerable frequency and fairly comprehensive coverage, it might be useful for predicting such unusual problems as the castings for tank hulls and turrets that became apparent after the 1973 Arab-Israeli War. Or, such a survey could be used for planning thousands of end items and their component parts along the lines of past IPP requirements. But, in both cases, such a procedure would probably be prohibitively expensive.

Ultimately, the decision about how much of DoD's budget should be allocated to defense industrial planning requires political judgment--weighing the potential for an international crisis, the likely characteristics of such a crisis, the ability of defense planners to identify the type of industrial production required and to state in much greater detail than has been attempted heretofore which products would be involved in a surge. Although there is considerable uncertainty associated with each of these factors, it is clear that a better evaluation of surge demand and procedures for a thorough assessment of potential supply problems are prerequisites to an effective defense industrial planning process.

Appendix A
DESCRIPTION OF DATA-GATHERING EFFORT
FOR INVESTIGATION OF THREE LOWER-TIER SECTORS

In this appendix we describe our effort to provide the data for the analysis reported in Sec. V. We include brief discussions of the type of instrument, the strategy pursued in circulating it, and a tabulation of the response rate. A copy of the data-gathering instrument is also reproduced.

Our final choice of industrial data-gathering techniques was dictated by time and resource constraints as well as by the project objectives. Possibilities ranged from in-depth, personal interviews with a few carefully selected firms from each of the three industries to a less detailed mail inquiry of all firms in each industry. Each approach was subject to the problems of response bias, sample bias, and definition of terms, to say nothing of the differences in costs and execution time. Because we were interested in the *overall* surge capability of each of the three sectors, we felt that our effort should reach as large a number of firms as possible. Also, the assessment of such capability requires industry response of both a quantitative and qualitative nature, so the risk of gathering merely anecdotal evidence argued against the in-depth interview approach and led us to choose a widely distributed mail questionnaire as the most efficient means of gathering the needed information. Moreover, we believed that if such an approach could elicit useful information, the data-gathering instrument we developed could be considered a prototype for eventual refinement and use by the DoD in its mandated responsibility for industrial preparedness.

Once we had decided on a mail questionnaire, our next step was to compile a list of those firms that manufacture products under each of the three sector headings. For this, we turned to three sources: Standard and Poor's Register, Dun & Bradstreet Million Dollar Directory, and Dun & Bradstreet Middle Market Directory. We also consulted the "Buyers Guide" issue of *Aviation Week and Space Technology* in an attempt to ensure that all important defense suppliers in the three sectors were

included in our initial mailing. Each of these three sources classifies firms according to the Standard Industrial Classification (SIC), the same scheme used in our input-output analysis. Although these directories account for only a small fraction of all businesses in the nation, they include most of those whose annual sales exceed \$500,000. Many smaller firms may do some defense-related business, but their potential contribution to a sector's overall surge capability is (because of their size) necessarily quite minimal. We therefore decided that the goals of the study would be best served by restricting attention to the "larger" firms in each of the three sectors.

These directories provided a total of 61 Nonferrous Forgings, 138 Optical Instruments, and 237 Semiconductor firms. Many of these firms manufacture products exclusively under the indicated SIC heading, but the majority (especially the larger ones) are more diverse and are classified under several different headings. Moreover, because the three directories give no indication as to the particular type of activity engaged in by a given firm, our final mailing list included not only manufacturers (to which our study is geared in general) but also firms involved solely in marketing, distribution, or research and development.

For delivery of this questionnaire, we chose a mail-out, mail-back procedure, with a letter follow-up and then a phone follow-up if necessary. We decided to use the mails initially to save time and effort where firms were immediately willing to cooperate and to test the use of telephone contacts where some encouragement was needed. We chose as our contact the president of the firm for two reasons. First, he was easily identifiable and letters could be addressed to him directly. Second, it was assumed that his approval would be required before such a form could be returned; so we considered it more efficient to seek his approval directly. With his approval, completion of the form could be handled by the appropriate person identified from the firm president's office. This procedure facilitated our phone follow-up, as the president's secretary in most cases was aware of receipt of the materials and their status within the firm.

Approximately two to three weeks after initial mailing, a follow-up

letter was sent to those firms that had not yet responded. It reminded them of the questionnaire received earlier, encouraged their participation, and suggested that they call if they had any questions. Many firms did call, but for the most part it was to say that they had not received our original package. Second data packages were mailed to the individuals whom the firms designated.

Our objectives in designing the questionnaire included: (1) making questions short and specific, requiring only brief answers; and (2) keeping the length to a minimum, while requesting enough information to make a realistic assessment of surge capability.

To ensure accuracy of response, we designed many questions to serve the dual role of providing needed information on firm operations and checking on the consistency of other responses. For example, question B.2.c concerning finished goods inventory can be compared with question C.3.a. regarding the extent to which a surge demand would be met by drawing down such inventory. Questions A.4 and C.1, which combine to yield the firm's total defense output under the given SIC heading (Nonferrous Forgings, Optical Instruments, or Semiconductors), can be compared with question A.2 concerning the firm's *total* defense output. Many of the responses on completed questionnaires were indeed inconsistent, and in part these cross-checks enabled us to detect the inconsistencies and in many cases to resolve them by means of a follow-up telephone call.

Finally, as a further step to maximize the response rate and assure as complete a data base as possible, we thought it best to formulate many of the questions regarding surge capability as a list of alternatives--requesting that the firm check those in the list that are applicable (see, e.g., questions C.3, C.8, D.1, and D.3). Such questions can in general be answered more quickly and encourage the respondent to concentrate on the points we determined to be most relevant. Of course, our view of surge could very well differ from that of a given firm, and for this reason we encouraged the respondent, in each such question, to add any additional comments that were deemed appropriate. In questions C.4 and D.2, regarding impediments to surge, we asked the respondent to provide his own list.

Questionnaires were initially distributed to a total of 446 firms in the middle of 1977. By the end of the year, 176 (39 percent) of these firms had responded, either by telephone or by mail (see Table 1 in the text). Of these, 69 returned completed questionnaires, and it is based primarily on these that our analysis of surge capability was carried out. Rather surprisingly, a slightly larger number (78) of the firms claimed that they had been misclassified and did not currently produce goods under the SIC heading of interest to our study, even though they had been classified under this heading by at least one of the three firm directories we used. A few said that they had at one time manufactured these goods but had since left the business. (One reported that its facilities had been destroyed.) Upon checking with Standard and Poor's Corporation, we learned that in many cases their staff determines a firm's SIC classification, based on their interpretation and categorization of various reported product lines. Although there is certainly room for some error here, the rather high incidence of misclassification is not immediately explainable.¹

For similar reasons, it is conceivable that a number of firms actually producing products under the relevant SIC headings were not included as part of our survey. In anticipation of this possibility, we included (as a check) a question (C.5) asking each firm to list some of its competitors for production of products under the SIC heading of interest. Although the majority of firms listed had been on our initial mailing list, 26 (or about 33 percent) had not. After further checking, we found that many of these latter firms were not listed at all in the directories, and the remainder were listed under closely related SIC headings. (For instance, many semiconductor firms listed competitors who were classified under Radio/TV Communication Equipment, rather than under Semiconductors.)

As expected, a small number of the 175 respondents indicated that they were not manufacturers but were involved exclusively in marketing,

¹One respondent reported that general firm directories such as those we used were not complete and that a more reliable source would be the lists of firms published by various manufacturing associations within a given industry.

distribution, or research and development; accordingly, they did not complete our survey form. Finally, 29 of the nonresponses came from firms that, for various reasons, were either unable or unwilling to complete the questionnaire. Many replied that they did not have the necessary records. A sizable number misinterpreted the directions and did not respond, they said, because they had little or no defense-related production. Of the completed responses, though, 23 did come from firms who currently are not producing any defense-related output under the relevant SIC heading.

EXHIBIT A-1

-1-

NOTICE: ALL INFORMATION WHICH WOULD PERMIT IDENTIFICATION OF RESPONDENTS OR THEIR FIRMS WILL BE REGARDED AS STRICTLY CONFIDENTIAL, WILL BE USED ONLY FOR THE PURPOSES OF THE STUDY AND WILL NOT BE DISCLOSED OR RELEASED FOR ANY OTHER PURPOSE WITHOUT PRIOR CONSENT, EXCEPT AS REQUIRED BY LAW.

INSTRUCTIONS

The purpose of these questions is to gather data for a study of the capabilities of certain industries to meet increased requirements ("surge" demand) for defense-related products. Unless otherwise stated, the questions contained in this booklet should be answered with regard to the products of your firm that are considered Semiconductors and Related Devices. A detailed list of these products can be found on page 12 of this booklet. As you may know, these products are classified SIC Code 3674 by the Department of Commerce.

Please answer as many questions as you can. Additional comment or detail is welcome where appropriate. If there are questions you are unable to answer for any reason, please omit them and complete the rest.

If you would like further information regarding any questions in this booklet or our study in general, please contact:

Geneese Baumbusch
Project Leader
The Rand Corporation
1700 Main Street
Santa Monica, California 90406

Telephone (call collect): (213) 393-0411, Ext. 7427

A. First we have a few questions about your firm's sales. This information is for use in statistical analysis only.

1. What were your firm's total gross sales in each of the years indicated?

1976: \$ _____

1972: \$ _____

1967: \$ _____

Note: If your company was not in existence in 1972 or 1967, please indicate this on the appropriate line above.

2. Approximately what percent of your firm's total sales went to ultimate end use by each of the following customers in each of the years indicated?

	<u>Dept. of Defense</u>	<u>Other Government</u>	<u>Private Sector</u>
1976:	_____	_____	_____
1972:	_____	_____	_____
1967:	_____	_____	_____

If "none" in any category, indicate by writing "0" on the appropriate line(s).

3. Of your sales that went to ultimate end use by the Department of Defense in 1976, approximately what percent was done under prime contract (direct sales) and what percent under subcontract (indirect sales)?

Of all 1976 sales going to ultimate end use by DoD: _____ % Prime Contract _____ % Subcontract

4. Approximately what percent of your firm's total sales were Semiconductors and Related devices in each of the years indicated?

1976: _____ % of total sales

1972: _____ % of total sales

1967: _____ % of total sales

- B. The next set of questions is about the production process for Semiconductors and Related Devices.

1. What are the normal operating conditions for personnel directly involved in production of these products:

a. How many hours per shift? # _____

b. How many shifts per day? # _____

c. What is the average number of man-hours per month? # _____

d. Any other important operating conditions? Please explain: _____

2. On average, what inventory (in dollars) do you maintain of the following:

a. Raw materials: \$ _____

b. Semifinished goods: \$ _____

c. Finished Semiconductors and Related Devices (ready for delivery) \$ _____

3. Under normal operating conditions, what is your utilization rate for capital equipment?

_____ % in actual production
 _____ % in repair
 _____ % in idle or standby status

4. What is the approximate average age in years of your capital equipment?

_____ years old

5. Is there any government-owned equipment used in production?

☐

YES

☐

NO

- a. What is the average age in years of this equipment?

_____ years old

- b. What is the approximate replacement value of this equipment?

\$ _____

6. Approximately what percent of capacity is your current level of operations?

_____ % of practical capacity

By practical capacity, we mean the greatest level of output your firm could achieve within the framework of a realistic work pattern. Please take into account the following criteria used by the Bureau of the Census when it solicits information about industrial capacity: (1) assume a normal product mix; (2) consider only machinery and equipment in place and ready to operate; (3) assume current availability of labor, materials, utilities, etc.; (4) assume current proportions of subcontracting and use of outside-the-plant facilities; (5) do not consider overtime pay, added cost of materials, or other costs to be limiting factors in computing capacity.

7. How specialized are the inputs to your production process?

	(1) Highly Specialized	(2) Moderately Specialized	(3) Unspecialized
a. Labor:	☐	☐	☐
b. Raw materials:	☐	☐	☐
c. Semifinished/ intermediate goods:	☐	☐	☐
d. Capital equipment:	☐	☐	☐

- C. These questions apply only to companies with 1976 defense-related Semiconductors and Related Devices production. If your firm did not have defense-related production of this type in 1976, check here ☐ and go to Q.1, page 10. All other firms, please complete Q.1 to 9 below.

The next set of questions has to do with your firm's capacity to respond to a sudden increase in demand for defense-related output of Semiconductors and Related Devices (this is sometimes termed "surge" demand). If you are unable to answer any questions, please omit them and complete the rest.

1. 1. First, please indicate the approximate percent of the dollar value of your firm's production of Semiconductors and Related Devices which went to defense end use in 1976

2. Now, suppose there was an international crisis leading to a surge in demand for defense-related output, but no national emergency had been declared. Using your total 1976 defense-related production of Semiconductors and Related Devices as a base, please estimate how fast and to what extent your firm could respond to such a surge in demand, in the time intervals indicated in the chart on the following pages.

For example, assume under normal conditions in 1976, you produced 8% of your total annual defense-related production in 30 days, 25% in 90 days, 50% in 180 days, and 100% in 1 year. If you think your firm, in response to surge in demand, could produce 50% of the 1976 total defense-related production in 90 days, this would indicate you believe you could double your normal production in that period.

Please complete the chart below as accurately as possible.

- 2A. If there were a surge in demand, what percent of your firm's total 1976 defense-related production could you achieve in the following response times?

30 DAYS

3. How would your firm achieve each level of increase indicated above? Please indicate whether it would be feasible or necessary to undertake each of the actions below in the given time interval, and if yes, estimate the cost of each action.

- a. Draw down inventory of finished goods

Yes ☐
Estimated
cost \$ _____

No, not feasible
or necessary to
achieve this level
of increase ☐

- b. Increase production through overtime of
current labor force

Yes ☐
Est. cost
\$ _____

No, not feasible/
necessary ☐

90 DAYS

_____ %

Yes ☐
Est. cost
\$ _____

No, not feasible
or necessary to
achieve this level
of increase ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

180 DAYS

_____ %

Yes ☐
Est. cost
\$ _____

No, not feasible
or necessary to
achieve this level
of increase ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

1 YEAR

_____ %

Yes ☐
Est. cost
\$ _____

No, not feasible
or necessary to
achieve this level
of increase ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

30 DAYS

c. Hire additional labor and/or add shifts

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

d. Increase use of existing capital equipment
currently used in production

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

e. Make use of idle equipment

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

f. Purchase new equipment

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

g. Subcontract some work that is currently
done in-house

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

h. Take in-house some work that is currently
subcontracted

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

i. Convert some labor which is currently used in
non-defense production to use in defense
production

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

j. Convert some equipment used in non-defense
production to use in defense production

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

k. Other

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

90 DAYS

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

180 DAYS

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

1 YEAR

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

Yes ☐
Est. Cost
\$ _____

No, not feasible/
necessary ☐

4. What would be the three (3) most serious impediments to your firm's increasing defense production in response to military "surge" demand?

1. _____

2. _____

3. _____

5. What other firms do you consider to be possible additional sources for the Semiconductors and Related Devices you produce?

6. Does your firm produce any defense-related Semiconductors and Related Devices for which you believe there are no other acceptable sources?

☐

YES

☐

NO



Which ones? _____

7. Does your firm participate in the Defense Department's Industrial Preparedness Planning Program?

| | YES

| | NO

8. In a situation short of a declared national emergency, would any of the conditions listed below limit your firm's willingness or ability to devote larger amounts of productive capacity to military production?

	<u>Significant Deterrent</u>	<u>Moderate Deterrent</u>	<u>Not an Obstacle</u>
a. Requirement for specialized production process for military products	☐	☐	☐
b. Burden of government paperwork	☐	☐	☐
c. Uncertain prospect of continuing volume of business	☐	☐	☐
d. Low profitability relative to civilian production	☐	☐	☐
e. Inability to attract skilled labor on a potentially temporary basis	☐	☐	☐
f. Anything else? Please indicate.	☐	☐	☐
_____	_____	_____	_____
_____	_____	_____	_____

9. Would any of the following enable you to provide more comprehensive information about your firm's ability to respond to a surge in demand. Check those which apply.

☐ additional review of corporate records

☐ discussions with appropriate managers

☐ thorough study requiring _____ man-months of effort

☐ other, please explain: _____

This is the end of the questionnaire for firms which had defense-related production in 1976. Thank you very much for your time and cooperation. We may wish to contact you to clarify some of your responses. Please complete the contact information below.

Name: _____

Title in Firm: _____

Telephone No. _____ - _____ - _____
area
code

D. These questions apply only to companies which had no 1976 defense-related production of Semiconductors and Related Devices.

1. This set of questions has to do with your firm's capacity to respond to a sudden increase in demand for defense-related output of Semiconductor and Related Devices (this is sometimes termed "surge" demand). Suppose there was an international crisis leading to a surge in demand for defense-related output, but no national emergency had been declared. How difficult would it be for your firm to become a supplier of Semiconductors and Related Devices for defense use in the following time intervals.

	(1)	(2)	(3)	(4)	(5)
	Not Possible	Extremely Difficult	Moderately Difficult	Somewhat Difficult	Little or No Problem
a. within 30 calendar days:	☐	☐	☐	☐	☐
b. within 90 calendar days:	☐	☐	☐	☐	☐
c. within 180 calendar days:	☐	☐	☐	☐	☐
d. within 1 year	☐	☐	☐	☐	☐

2. If becoming a defense supplier would be very difficult, please explain why.

3. In a situation short of a declared national emergency, would any of the conditions listed below limit your firm's willingness or ability to devote significant amounts of productive capacity to military production?

	<u>Significant Deterrent</u>	<u>Moderate Deterrent</u>	<u>Not an Obstacle</u>
a. Requirement for specialized production process for military products	☐	☐	☐
b. Burden of government paperwork	☐	☐	☐
c. Uncertain prospect of continuing volume of business	☐	☐	☐
d. Low profitability relative to civilian production	☐	☐	☐
e. Inability to attract skilled labor on a potentially temporary basis	☐	☐	☐
f. Anything else? Please indicate	☐	☐	☐

This is the end of the questionnaire. Thank you very much for your time and cooperation. We may wish to contact you to clarify some of your responses. Please complete the contact information below.

Name: _____

Title in Firm: _____

Telephone No.: _____ - _____ - _____
 area
 code

SECTOR PRODUCT LISTS

Semiconductors and Related Devices

Computer logic modules
Controlled rectifiers, solid state
Diodes, solid state (germanium, silicon, etc.)
Electronic devices, solid state
Fuel cells, solid state
Gunn effect devices
Hall effect devices
Hybrid integrated circuits
Infra-red sensors, solid state
Light emitting diodes
Light sensitive devices, solid state
Magnetic bubble memory device
Magnetohydrodynamic (MHD) devices
Memories, solid state
Metal oxide silicon (MOS) devices
Microcircuits, integrated (semiconductor)
Modules, solid state
Molecular devices, solid state
Monolithic integrated circuits (solid state)
Nuclear detectors, solid state
Parametric diodes
Photoelectric cells, solid state (electronic eye)
Photovoltaic devices, solid state
Rectifiers, solid state
Semiconductor circuit networks (solid state integrated circuits)
Semiconductors (transistors, diodes, etc.)
Solar cells
Solid state electronic devices
Strain gages, solid state
Stud bases or mounts for semiconductor devices
Switches, silicon control
Thermionic devices, solid state
Thermoelectric devices, solid state
Thin film circuits
Transistors
Tunnel diodes
Ultra-violet sensors, solid state
Variable capacitance diodes
Zener diodes

NONFERROUS FORGINGS

Aluminum and aluminum-base alloy forgings
Copper and copper-base alloy forgings
Titanium and titanium-base alloy forgings
Other nonferrous forgings

OPTICAL INSTRUMENTS AND LENSES

Aiming circles (fire control equipment)	Microprobes, electron
Antiaircraft directors, except electronic	Microprojectors
Binoculars	Microscopes, except corneal
Boards: plotting, spotting, and gun fire adjustment	Mirrors, optical
Borescopes	Nepheimeters
Chromatographic equipment (laboratory type)	Nuclear magnetic resonance type apparatus
Chronoscopes	Optical comparators
Cinetheodolites	Optical elements and assemblies, except ophthalmic
Coddington magnifying instruments	Optical measuring instruments
Colorimeters (optical instruments)	Perimeters (optical instruments)
Contour projectors	Periscopes
Correctors: percentage, wind, roll (sighting and fire control equipment)	Ph meters
Coulometric analyzers, except industrial process type	Photometers
Dyna-lens	Photomicrographic apparatus
Electron paramagnetic spin type apparatus	Phototheodolites
Electrophoresis equipment	Polariscopes
Fiber optical devices	Polarizers
Fuse setters (fire control equipment)	Prisms, optical
Glasses, field or opera	Reflectors, optical
Gratings, diffraction	Reflectoscopes
Gun sights, optical	Refractometers, except industrial process type
interferometers	Searchlight mirrors and reflectors
Laboratory analysis instruments, optical	Sighting and fire control equipment, optical
Lens coating	Specific ion measuring instruments
Lens grinding, except ophthalmic	Spectrographs
Lens mounts	Spectrometers and spectroscopes, optical instruments
Lenses, optical: photographic magnifying projection and instrument	Spyglasses
Light sources, standard	Telescopes: elbow, panoramic, sighting, fire control, etc.
Lupes magnifying instruments, optical	Telescopic sights
Magnifying instruments, optical	Titrometers
Metallographs	Triplet magnifying instruments, optical
Meteorological instruments, optical	Turbidometers

Appendix B

LESSONS LEARNED FROM THE DATA COLLECTION PROCESS

PROBLEMS ENCOUNTERED

Section V of this report documents what we learned about surge capability from the industrial responses received. An equally important aspect of this work is what we learned in terms of questionnaire design, selection of firms, and the techniques used to encourage participation. To the extent that this was a prototype effort of a procedure that the DoD might decide to adopt, these lessons should serve as a guide for further users. Because of the time constraints of this study, we did not conduct a formal pilot trial of the questionnaire. Some of the problems we encountered might have been eliminated by use of a pilot instrument and subsequent distribution of a revised questionnaire.

One of the problems encountered in any data-gathering exercise concerns definition of terms. Mail questionnaires are more susceptible to such problems than are interactive interviews. Despite our attempts to keep language simple and unambiguous, it is possible that individual firms gave their own subjective interpretations to some of the questions. For example, when we asked (C.8 and D.3) about impediments to surge response, the alternatives we offered were "significant deterrent," "moderate deterrent," and "not an obstacle." The distinction between a significant deterrent and a moderate deterrent is clearly subjective.

Aside from problems involving subjective interpretation of questions, we encountered many instances of firms that misinterpreted questions and thus provided meaningless or obviously incorrect responses. As many of these occurrences as possible were corrected through a telephone call or a check of public records. For the most part, they involved firms that reported data in units different from those specified on the questionnaire. (Several firms, for example, reported 1976 sales in thousands of dollars rather than dollars, without so indicating.)

A more serious problem concerned responses to question C.2A, dealing with a firm's surge potential. Because this question gets at the very essence of our study, we were especially aware of the importance of minimizing the possibility of misinterpretation. Nevertheless, 30 percent of the respondent firms did apparently misinterpret our instructions and responded to the question as if we were asking for percent *increase* over 1976 production levels rather than percent of *total* 1976 levels achievable. For example, if a firm envisioned absolutely *no* surge capability within a year's time, then the proper response to our question would be 8.5 percent, 25 percent, 50 percent, and 100 percent for the four time periods, indicating that only normal (1976) production rates could be achieved. The misinterpreted response would read 0 percent across the board, suggesting (incorrectly) that no increase in production was possible during any of the time intervals. One of the respondents (typical of many) gave percentage figures of 5 percent, 18 percent, 38 percent, and 80 percent for the time periods. We made a follow-up telephone call and determined that the respondent did not mean to suggest that his firm would produce less than his normal rate in a surge situation, but rather he was reporting the percent *increases* above 1976 levels. Telephone calls cleared up most of the other instances of misinterpretation.

QUALITY OF RESPONSE

In addition to these rather specific problems, we believe a number of other characteristics of our data collection effort probably influenced our response rate, possible biases in our response, and the quality of the information received. These factors ought to be considered if possible future use of a similar effort is considered.

First, it is reasonable to assume that *who* we were and *what* kind of information we were seeking influenced the nature of our response. For example, some recipients had probably never heard of Rand¹ and were therefore not inclined to respond. However, in other cases, Rand's name and reputation for public policy research may have encouraged

¹Indeed, one caller asked if we were graduate students working on a thesis.

others to participate. Such reactions are important to consider in a situation such as this one where participation was strictly *voluntary* and no governmental authority was invoked to encourage firms to cooperate. Had Rand's data-gathering instrument been accompanied by a letter from the Secretary of Defense encouraging firms to participate, or had DoD gathered the data directly, it is possible that the response rate might have been higher.

The fact that over 50 percent of our respondents were current defense producers may indicate that these firms are more likely to have heard of Rand and its programs of defense-related research. And, although we cannot prove it, it is reasonable to assume that our response rate from current DoD suppliers, whether or not they had heard of Rand, would be better than from noncurrent suppliers because those in the business would perceive it to be more their responsibility and in their interest to respond to an inquiry about defense surge. Also, 39 percent of our current defense supplier respondents participated in some way in IPP. It is reasonable to assume that firms involved extensively enough to provide IPP data may have been more likely to complete the questionnaire. It is probably also true that noncurrent defense producers who *would like* to get some DoD business are more likely to respond than those fully committed to other customers or otherwise not interested.

In addition to these factors affecting response rates and suggesting sources of possible bias in our response, *what* we were asking for was also an important factor. Both the length (total pages) and the amount of detail requested probably caused many firms not to respond. We know this from at least two dozen firms that so notified us, and for every one that indicated the instrument was too long and too detailed, there were probably several that just threw it away. Some firms claimed that they never answer any such inquiries because, according to one respondent, he "gets at least one survey a week." Again, it is possible that a DoD-sponsored inquiry, even one requiring as much effort, might get a better response.

Also related to *what* we were asking for is the issue of

confidentiality.² Although our cover letter contained an assurance of confidentiality and noted Rand's long experience with handling proprietary information and other confidential data, some potential respondents may have been reluctant to participate because of concerns about disclosure. Two or three firms that did communicate with us indicated that they would not provide confidential information. However, 69 firms did provide information, and, by filling in the contact information at the end of the data-gathering instrument, passed up any chance to remain anonymous.

Incentives for disclosing or not disclosing various types of information are important to keep in mind in a consideration of who might sponsor a similar data collection effort in the future. In Sec. II we discussed how the current IPP program gives firms incentives to provide incomplete or inaccurate information. One way of changing these incentives is to have DoD sponsor data collection and analysis by a source external to DoD under rules providing that no attributable information will be communicated to DoD.³ For example, question C.5 asked firms to list possible additional sources for their defense-related output. About 70 percent of the current DoD producers did name some of their competitors, which was useful as a cross-check on our coverage of each industry.⁴ Had these firms been providing information directly to DoD, they might have been more reluctant to provide the names of their competitors.

Similarly, question C.6 asked firms to list their defense-related products for which they believe there are no acceptable alternatives. To the extent that this information is communicated directly to DoD, there are incentives for firms to overstate the numbers of their products for which there are no substitutes. Thus, DoD would want to get separate verification of the accuracy of such information before taking any action in response to it.

²Here we mean information that a firm wishes closely held, not information to which access is restricted for national security reasons.

³This was the arrangement for the Profit 1976 Study conducted for DoD by Coopers and Lybrand, public accountants.

⁴See App. A.

SUGGESTED IMPROVEMENTS

Keeping in mind both the rather narrowly defined problems discussed above as well as the more general issues we believe affected the quality and quantity of response to our prototype effort, we have suggested a revision of the data-gathering instrument. It is incorporated as Exhibit B-1, and the changes are described below.

First, one of the major efforts in the revised instrument is to make clearer the progression of the questions from those first dealing with the firm as a whole, to those concerned with the specific sectors of industry of concern to DoD planners, to those dealing with defense-related production of these sectors. This is the same order as followed in the original questionnaire, but we attempted to make this progression more apparent to the reader by changing a sentence in the instructions and by changing the placement of the section B instructions.

In question A.1, we sought to obtain information on firms' sales and to determine whether a firm was in existence during the years 1967 and 1972.⁵ This latter consideration is important in getting some idea of the rate of entry of firms into various defense-related industries. Although the instructions on the questionnaire were explicit, many respondents left the 1972 and 1967 lines blank, without indicating whether their firm was in business in those years. The revised instrument specifically asks about the firm's existence in these years.

To better ensure that respondents from multi-product firms would reply only on products in the SIC of interest, we have noted SIC in each of the questions of sections B and C (rather than just mentioning it once at the beginning of each section).

In the section on inventory, we eliminated the questions on raw materials and semifinished goods inventories because the answers to them, in the absence of some detailed knowledge of the production process for each industry, did not contribute much to our understanding of surge potential. In addition, information on the extent to

⁵ These years were chosen because they were years for which the Department of Commerce *Census of Manufactures* was carried out, so that published data could be used to confirm the validity of the responses.

which access to supplies of raw materials and semifinished products might be constraints on the firms' ability to surge is elicited later in the instrument.

Another change in section B concerns equipment used in production. We eliminated the question on average age of equipment and asked for what we feel is more useful information on lead-time for delivery of new equipment. Also, we changed the question on government-owned equipment to solicit information about what percent of a firm's total equipment stock is government-owned and what percent of it is currently being used. These changes should provide more insight into the importance of government-owned equipment to a firm's manufacturing process than the information on age and replacement value.

The greatest confusion occurred in question C.2 concerning surge capability. To better account for the possible types of responses, three illustrative examples have been included rather than just one. We further simplified section C by deleting the questions on the cost of various means of achieving surge. Without some specification of assumed availability of inputs, this information was difficult for the respondent to determine. In its place, we have included a revised question C.4, which should be simpler for the respondent to answer and provide the investigator with a better feeling for the overall cost of surge.

Instead of following the question on achievable surge increases with an open-ended question on impediments to achieving those increases, we used the responses we received to the original question (see Table 10 in the text) to structure a new multiple choice question. The vast majority of responding firms had indicated that the availability of inputs to the manufacturing process (labor, capital, etc.) would constitute the most important potential constraints to surging production, so revised question C.5 simply asks respondents to rate the possible obstacles listed most frequently and to provide more detail about the specific way that availability of a particular input would affect their surge potential. Because we had such a good response to the open-ended impediments questions, we might expect that future respondents, in addition to checking the appropriate boxes, would also indicate briefly

the specific nature of some of the problems they would expect to encounter with each of the inputs.

Although the question on participation in IPP was relevant to our study, it would not be relevant if our suggested method of data collection were substituted for IPP, so that question has been eliminated.

The question on deterrents remains essentially the same except that the labor category has been removed because of previous coverage in C.5. The first hypothesized deterrent has been reworded slightly to include the notion of specialized *testing* as well as *production* requirements, and the possible deterrent of obligation to civilian customers has been added. These changes were made partly because of what we learned from open-ended questioning in our prototype effort and partly because of the logic of separately considering constraints imposed by the availability of inputs to the manufacturing process for particular products and those imposed by somewhat more subjective and less product-specific considerations. Finally, in the portion of the questionnaire directed to noncurrent defense producers we added availability of capital goods and raw materials to the potential deterrents list so that respondents could more easily evaluate their effects.

REVISED DATA GATHERING INSTRUMENT FOR
DEFENSE INDUSTRIAL PLANNING

NOTICE: ALL INFORMATION THAT WOULD PERMIT IDENTIFICATION OF RESPONDENTS OR THEIR FIRMS WILL BE REGARDED AS STRICTLY CONFIDENTIAL, WILL BE USED ONLY FOR THE PURPOSES OF THE STUDY, AND WILL NOT BE DISCLOSED OR RELEASED FOR ANY OTHER PURPOSE WITHOUT PRIOR CONSENT, EXCEPT AS REQUIRED BY LAW

INSTRUCTIONS

The purpose of these questions is to gather data for a study of the capabilities of certain industries to meet increased requirements ("surge" demand) for defense-related products. Except for Section A, the questions contained in this booklet should be answered with regard to the products of your firm that are considered [].¹ A detailed list of these products can be found on page 10 of this booklet. As you may know, these products are classified SIC Code [] by the Department of Commerce.

Please respond to as many questions as you can, even if your answers are only informed approximations. Additional comment or detail is welcome where appropriate. If there are any questions you are unable to answer for any reason, please omit them and complete the rest.

If you would like further information regarding any questions in this booklet or our study in general, please contact:

name: _____
address: _____

phone number: _____

- A. First we have a few questions about your firm's sales. This information is for use in statistical analysis only.

¹Industrial sector name.

1. What were your firm's *total* sales in each of the years indicated?

197_{__}:² \$ _____

1972: \$ _____ ☐ Firm not in existence in 1972.

1967: \$ _____ ☐ Firm not in existence in 1967.

2. Approximately what percent of your firm's *total* sales went to *ultimate end use* by each of the following customers in each of the years indicated?

	<u>Dept. of Defense</u>	<u>Other Government</u>	<u>Private Sector</u>
197 _{__} :	_____ %	_____ %	_____ %
1972:	_____ %	_____ %	_____ %
1967:	_____ %	_____ %	_____ %

If "none" in any category, indicate by writing "0" on the appropriate line(s).

3. Of your sales that went to ultimate end use by the Department of Defense in 197_{__}, approximately what percent was done under prime contract (direct sales) and what percent under subcontract (indirect sales)?

_____ % Prime Contract _____ % Subcontract

- B. The next set of questions is about the production process for [].

1. Approximately what percent of your firm's *total* sales were [] in each of the years indicated?

197_{__}: _____ % of total sales

1972: _____ % of total sales

1967: _____ % of total sales

2. What are the normal operating conditions maintained in the production of []?

a. How many shifts per day? # _____

b. How many days per week? # _____

c. Approximately how many employees (full-time equivalents) work directly in the *production* of []?

²Base year of interest.

3. a. On the average, what inventory (in dollars) do you maintain of *finished* [] (ready for delivery)?

\$ _____

4. Under normal operating conditions, what is your utilization rate for capital equipment involved in production of []?

_____ % in actual production

_____ % in repair

_____ % in idle or standby status

5. On the average, what is the current expected lead-time for delivery of such equipment?

_____ months

6. Does your firm currently house any government-owned equipment?

_____ YES _____ NO



What percent (by value) of your total equipment is government-owned? _____ % What percent of this government equipment is currently used in production?

_____ %

7. Approximately what percent of capacity is your current level of [] production?

_____ % of practical capacity

By practical capacity we mean the *greatest level of output* your firm could *achieve within the framework of a realistic work pattern*. Please take into account the following criteria used by the Bureau of the Census when it solicits information about industrial capacity: (1) assume a normal product mix; (2) consider only machinery and equipment in place and ready to operate; (3) assume current availability of labor, materials, utilities, etc.; (4) assume current proportions of subcontracting and use of outside-the-plant facilities; (5) do *not* consider overtime pay, added cost of materials, or other costs to be limiting factors in computing capacity.

8. How specialized are the inputs to your [] production process?

	<u>Highly Specialized</u>	<u>Moderately Specialized</u>	<u>Unspecialized</u>
a. Labor	_____	_____	_____
b. Raw materials	_____	_____	_____
c. Semifinished goods	_____	_____	_____
d. Capital equipment	_____	_____	_____

- C. These questions apply only to companies with 197_ *defense-related* [] production. If your firm did not have defense-related production of this type in 197_, check here ☐ and go to Question D.

The next set of questions has to do with your firm's capacity to respond to a *sudden increase* in demand for defense-related output of [] (this is sometimes called "surge" demand). If you are unable to answer any questions, please omit them and complete the rest.

1. a. First, please indicate the approximate percent of the dollar value of your firm's sales of [] which went to defense end use in 197_.

_____ %

- b. Of this defense-related [] production, approximately what percent was done under prime contract (direct sales) and what percent under subcontract (indirect sales)?

_____ % Prime Contract _____ % Subcontract

2. Now suppose there was an international crisis leading to a surge in demand for defense-related output, but *no national emergency had been declared*. Using your total 197_ defense-related production of [] as a base, please estimate that percent of your firm's *total* 197_ defense-related output that could be achieved in the following response times.

_____ % _____ % _____ % _____ %
30 DAYS 90 DAYS 180 DAYS 360 DAYS

For example, assume under normal conditions in 197_, your firm produced 8% of its total annual defense-related [] output in 30 days, 25% in 90 days, 50% in 180 days, and 100% in 1 year. If you think your firm, in response to a surge in demand, could produce say *twice* as much of this output in each time period as it did in 197_, then a proper response would be:

16 % 50 % 100 % 200 %
30 Days 90 Days 180 Days 360 Days

On the other hand, if your firm could *not* increase its defense production rate in 30 or 90 days, but could *triple* its rate given 180 or 360 days, then a proper response would be:

8 % 25 % 150 % 300 %

Please note that in no case (unless your firm could not even maintain 197_ defense production levels) should your responses be less than the "normal" production level:

8 % 25 % 50 % 100 %

3. How would your firm achieve each level of increase indicated above? Please indicate below whether it would be necessary to undertake each of the actions below in the given time interval.

	30 DAYS	90 DAYS	180 DAYS	360 DAYS
a. Draw down inventory of finished goods.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
b. Increase production through overtime of current labor force.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
c. Hire additional labor and/or add shifts.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
d. Increase use of existing capital equipment currently used in production.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
e. Make use of idle equipment.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
f. Purchase new equipment.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
g. Subcontract some work that is currently done in-house.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
h. Take in-house some work that is currently subcontracted.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
i. Convert some labor which is currently used in non-defense production to use in defense production.	Yes ☐	Yes ☐	Yes ☐	Yes ☐
j. Convert some equipment used in non-defense production to use in defense production.	Yes ☐	Yes ☐	Yes ☐	Yes ☐

4. Approximately what percent increase in the price of your defense-related [] products would be necessary to cover the cost of the output completed within the time period indicated?

<u> </u> %	<u> </u> %	<u> </u> %	<u> </u> %
first 30 DAYS	31-90 DAYS	91-180 DAYS	181-360 DAYS

5. How would each of the following affect your firm's ability to increase defense production in response to military surge demand?

	<u>Not a</u> <u>Problem</u>	<u>Moderate</u> <u>Problem</u>	<u>Significant</u> <u>Problem</u>
a. Availability of skilled labor			
Please explain: _____	☐	☐	☐

b. Availability of equipment and tooling			
Please explain: _____	☐	☐	☐

c. Availability of materials			
Please explain: _____	☐	☐	☐

6. What other firms do you consider to be possible additional sources for the defense-related products you produce in SIC Code [] []?

7. Does your firm produce any defense-related [] for which you believe there are no other acceptable sources?

YES ☐
↓

NO ☐

Which ones? _____

8. In a situation *short* of a declared national emergency, would any of the conditions listed below limit your firm's willingness or ability to devote *larger* amounts of productive capacity to military production?

	<u>Significant Deterrent</u>	<u>Moderate Deterrent</u>	<u>Not a Deterrent</u>
a. Requirement for specialized production processes and testing for military products.	☐	☐	☐
b. Burden of government paperwork.	☐	☐	☐
c. Uncertain prospect of continuing volume of business.	☐	☐	☐
d. Low profitability relative to civilian production.	☐	☐	☐
e. Obligation to civilian customers.	☐	☐	☐
f. Anything else? Please indicate. _____			

This is the end of the questionnaire for firms which had defense-related production in 197_. Thank you very much for your time and cooperation. We may wish to contact you to clarify some of your responses. Please complete the contact information below.

Name: _____

Title in firm: _____

Telephone: _____ - _____ - _____

Area
Code

D. These questions apply only to companies which had no 197_ defense-related production of [].

1. This set of questions has to do with your firm's capacity to respond to a *sudden increase* in demand for defense-related output of [] (this is sometimes termed "surge" demand). Suppose there was an international crisis leading to a surge in demand for defense-related output, but *no national emergency had been declared*. How difficult would it be for your firm to become a supplier of [] for defense use in the following time intervals.

	(1)	(2)	(3)	(4)	(5)
	<u>Not Possible</u>	<u>Extremely Difficult</u>	<u>Moderately Difficult</u>	<u>Somewhat Difficult</u>	<u>Little or No Problem</u>
a. Within 30 calendar days:	☐	☐	☐	☐	☐
b. Within 90 calendar days:	☐	☐	☐	☐	☐
c. Within 180 calendar days:	☐	☐	☐	☐	☐
d. Within 1 year:	☐	☐	☐	☐	☐

2. If becoming a defense supplier would be very difficult, please explain why.

3. In a situation *short* of a declared national emergency, would any of the conditions listed below limit your firm's willingness or ability to devote significant amounts of productive capacity to military production?

	<u>Significant Deterrent</u>	<u>Moderate Deterrent</u>	<u>Not a Deterrent</u>
a. Requirement for specialized production processes and testing for military products.	☐	☐	☐
b. Burden of government paperwork.	☐	☐	☐
c. Uncertain prospects of continuing volume of business.	☐	☐	☐
d. Low profitability relative to civilian production.	☐	☐	☐
e. Inability to attract skilled labor on a potentially temporary basis.	☐	☐	☐
f. Inability to obtain necessary capital goods.	☐	☐	☐
g. Inability to obtain raw materials.	☐	☐	☐
h. Obligation to civilian customers.	☐	☐	☐
i. Anything else. Please indicate.			

This is the end of the questionnaire. Thank you very much for your time and cooperation. We may wish to contact you to clarify some of your responses. Please complete the contact information below.

Name: _____

Title in firm: _____

Telephone: _____ - _____ - _____
Area
Code