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GROWTH THROUGH NEW PRODUCT DEVELOPMENT:
THIRD DOWN AND MANY YARDS TO GO

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GROWTH THROUGH NEW PRODUCT DEVELOPMENT: Third Down And Many Yards To Go

ABSTRACT

The need for economic growth with stability is recognized today in Michigan, as is the fact that more effective use of science and technology in industry can contribute to this growth. In addressing itself to these related problems, the Industrial Development Research Program of The University of Michigan's Institute of Science and Technology has developed a research plan, which the author describes. Basing his discussion on the IDRP's findings to date, the author reviews criteria for closing the technological gap, and suggests (1) attacking the problem initially in Michigan's machinery sector, and (2) extending university diagnostic capabilities to firms, especially those which are small to medium-sized.

The need for increased economic growth and stability in Michigan is well recognized in the state today. The critical importance of technological innovation in generating economic growth is also well recognized. The fact that the Midwest, including Michigan, has not kept pace in this time of rapid technological advance should be evident by now. It is also becoming generally recognized that the creation of new firms and the growth of existing firms through development of new products using new technological advances would produce the kind of economic growth and stability we need in Michigan. This improved economic status, in turn, should enhance our ability to attract other research-based industry to the state, thereby providing further growth. The sixty-four dollar question, of course, is, "How do we get there from here?"

In examining this question it might help to recall a somewhat analogous situation which was faced by many football teams fifty years ago. It was in the fall of 1913 that a little-known team from a small town in Indiana, with an end named Knute Rockne, toured the East challenging such established gridiron giants as Penn State and Army. A number of rule changes in the 1908-1912 period permitted for the first time an open passing game, much as it is played today. Notre Dame, with Dorais passing and Rockne catching, exploited the new rules in crushing Army and Pennsylvania, as well as every other team it played that year.

The analogy is obvious. The Army juggernaut was one of the dominant teams of the era, just as Michigan's production juggernaut has been one of the world's dominant industrial mights in recent years. But suddenly the rules have changed; and just as that mighty Army team was eclipsed by Notre Dame's new forward-pass attack, so has Michigan industry been eclipsed by developments linked to research and technological advance in places like Texas, Massachusetts, and California.

Considering that the rule changes were there to stay, what should football teams in the 1913-1920 period have done? Learned to play the new type of game, of course. But resistance to change is characteristic of human nature. By 1921, fifteen years after the first introduction of the forward pass to the game and eight years after Notre Dame's great success with it, Elmer Berry, the former Head Coach of Football and Baseball at Y.M.C.A. College, Springfield, Massachusetts, noted that most of the entrenched juggernauts had refused to change with the rules, relying instead solely on the time-tested, bone-crunching type of ground game. Said Berry:

> Apparently many regard the forward pass simply as a valuable threat, something for occasional use, something to take a chance with, something the possibility of which makes the real game still workable . . . . In general they have frowned on the forward pass; opposed it, sneered at it, called it basketball and done what they could to retard its adoption. It has taken away from them the advantage of numbers, weight and power, made the game one of brains, speed and strategy—even if you please like baseball, luck,—rendered the outcome of their practice games with smaller colleges uncertain. Why should they have hastened its development? Rather it has been the smaller colleges that have found in the forward pass their opportunity, which have developed its possibilities until now the larger ones as well are turning to it as the final means of winning their big game. [1]

Since the era of rapid technological advances began during World War II, R & D is now, relatively, in about the same phase as the forward pass was at the time of Coach Berry's writing. If you substitute the words "R & D" for the words "forward pass" and the words "established firms" for "large colleges" and the words "new firms" for "small colleges," you have a fairly accurate description of the R & D climate in the Midwest and Michigan in recent years.

But football is a game, and as such does not for the most part affect our well being. The economic game, on the other hand, is crucial to all our lives. Fifty years from the beginning of this technological era—by the year 2000—it will be completely clear that we in Michigan should have learned to play the R & D game sooner than we did. But it should not be difficult to see why we didn't. It was more consistent with human nature to resist the change until we were forced by economic necessity to accept it.

One important objective of our research concerning the product development capabilities of Michigan firms has been to acquire a degree of understanding of the problem; to see it from the viewpoint of the firm which must face this changing technological environment. We recognize that only through such an understanding can we devise workable plans whereby The University of Michigan, and the Institute of Science and Technology in particular, can be of maximum assistance to Michigan industry at this critical time.

Before discussing in detail our research on this problem, let me explain briefly the nature and function of The University of Michigan's Institute of Science and Technology.

The Institute's major role, as part of the University, is to conduct research in the physical sciences. The Institute serves as a center for science and technology, and, through state support, conducts a program designed to enhance the state's economic growth through more effective use of science and technology by industry. The Institute's staff includes over 600 people, making up about 8% of the total University staff. Our current annual research expenditures amount to about ten million dollars. About nine million dollars is obtained from cost-reimbursement contracts with governmental units and industry, and about $740,000 from the state. I wish to concentrate today on one part of the state-supported activity—the Industrial Development Research Program.

To return to the sixty-four dollar question I raised before I started talking football—How do firms in Michigan get to the point of developing new products, using new technological advances? This is a complex, multi-dimensional problem. Consequently, we have developed a multi-dimensional research attack on it. Our Industrial Development Research Program is currently composed of the six coordinated projects shown in Table I.

TABLE I. INDUSTRIAL DEVELOPMENT RESEARCH PROGRAM

1. Changes in Michigan Industrial Sectors 1947-1962
2. Product Development Capabilities in Machine Tools and Electronics
3. Michigan's Role in Military and Space Industries
4. Theoretical Framework for Product Development Decisions
5. Liaison with Industry
6. Special Research Topics

The first project is designed to fill in the background of our present problem; our work in this area seeks to delineate the changes taking place in Michigan since World War II, and to point out current strengths and weaknesses in order to help us in choosing future courses.

The second, our primary project during the past year, is intended to help us understand the problem at the firm level—an understanding essential for devising an effective University supporting program.

The third project, on Michigan's changing role in the military and space industries, has been conducted by The Bureau of Business Research, under Institute sponsorship. (This work has been directed by Joseph Crafton of The University of Michigan's Dearborn Center.)

The fourth area represents the theoretical aspect of our research. This effort is designed to provide a more complete and useful framework for making decisions regarding new product development. We need a more complete theoretical structure—a quantitative model—which will enable us to answer such questions as how much of what types of research a given firm should do, and how fast it should attempt to expand its product line to achieve a given measure of success.

Our liaison function, the fifth area, has to date been accomplished mainly through our field research contacts and subsequent follow-up of requests for assistance. More will be said about this later.

The special research topics, listed as the sixth area, include: (1) the 1961 research study of "Location Decisions and Industrial Mobility in Michigan," by Mueller, Wilkin, and Wood [2] of the Survey Research Center, co-sponsored by the Institute and the Committee on Michigan's Economic Future; (2) a study near completion on the feasibility of a state tax incentive for research and development conducted by Michigan firms [3]; and (3) in progress, an exploratory investigation on the extent to which financing has been a deterrent to the creation of new firms and the expansion of existing ones.

Although much of our research is yet in progress, we are now far enough along to see an emerging picture. First look at Figure 1, which shows the proportion of total U. S. value added by manufacture (in current dollars of each period) contributed by various Michigan industries from 1947 to 1960. These data are from the first project mentioned and thus concern the post World War II changes in Michigan industry. There are four important things to note in this figure.

First, note how the metal-working industries, particularly transportation equipment, machinery, fabricated metal products, and primary metals, dominate the Michigan industrial scene. Second, note the downward trends in the first three of these industries relative to the U. S. total for all manufacturing. Third, note the stable, slightly increasing trends in the proportions of primary metals, chemicals, and foods, all of which are also of significant total

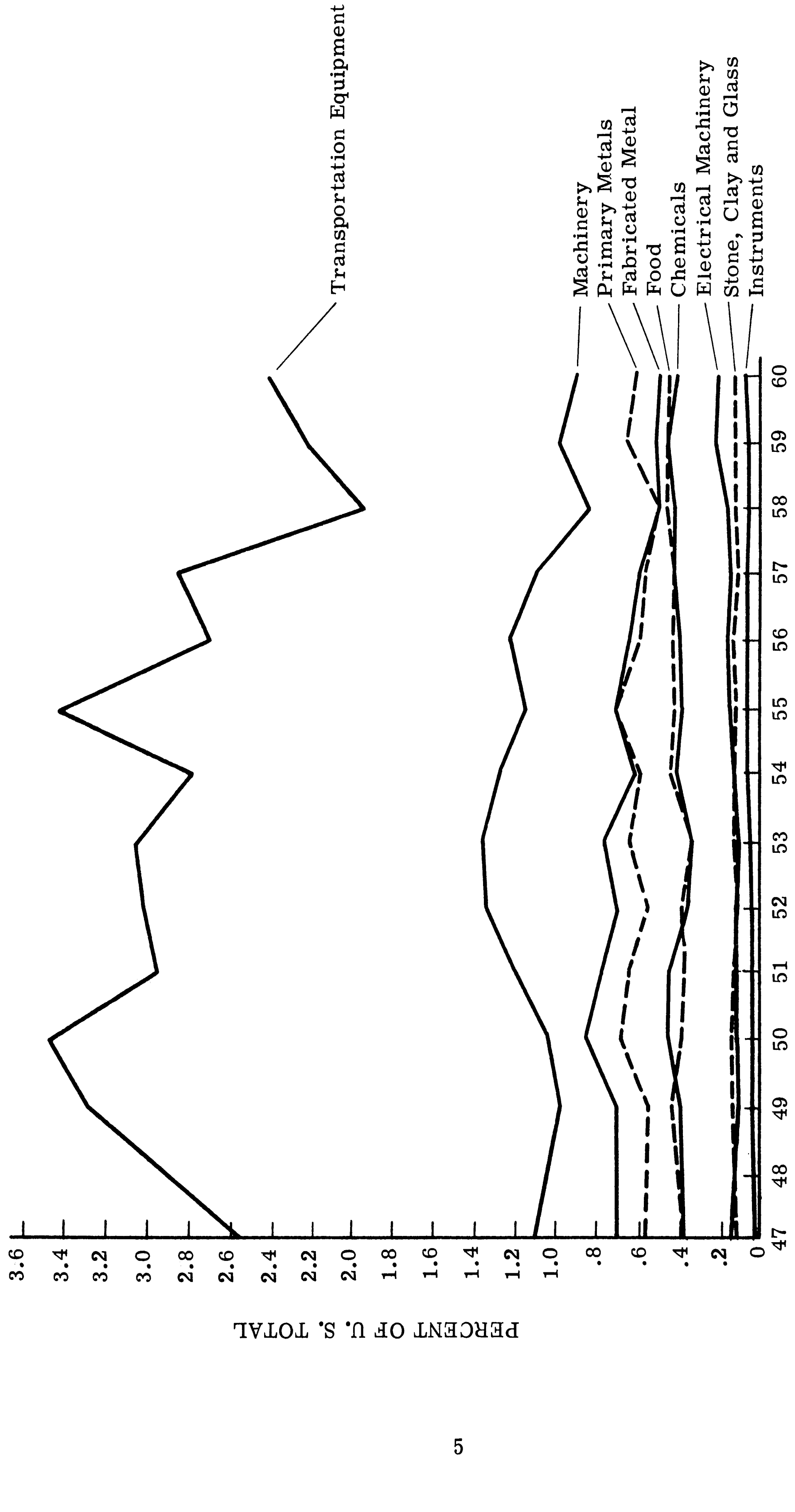

FIGURE 1. PROPORTION OF UNITED STATES VALUE ADDED BY MANUFACTURE IN SELECTED MICHIGAN INDUSTRIES 1947–60.
(Source: Census of Manufactures and Annual Surveys of Manufactures)

magnitude in the state. Then fourth, note that the electrical machinery sector (which includes electronics), the stone, clay and glass sector, and instruments are growing, but are of minor importance in terms of their relative total magnitudes in the state. Other sectors not shown, which are of about the same relative magnitude as these last three, include paper, printing and publishing, furniture, and rubber and plastic products. All of these sectors also show a stable trend relative to the same basis shown in Figure 1.

We need not analyze these trends further at this time except to point out that the well known instability of the auto industry and the effect of its decentralization are clearly shown in the transportation equipment sector. This decentralization, together with the increased in-house capability of the auto industry to produce more of its own components and the shifting pattern of defense procurement, are also no doubt reflected in the relative decline of the fabricated metal products sector.

Regardless, however, of the difficulty of tracing an accurate cause-effect relation, the fact remains that the three largest segments of Michigan's industry have been declining over the past decade in respect to the total of all manufacturing in the U. S.

This picture is now showing improvement, and is expected to continue with the good auto years we are having, but this does not solve our problem. Rather, it gives us, fortunately, a little more breathing room to develop a solution.

It seems to me that the most logical place to confront the problem is in the machinery and fabricated metal products industries. Outside of the auto industry, these are our most significant industries, yet they are declining. We need growth through diversification outside the auto industry. (The auto industry is certainly capable of meeting most of the R & D demands in support of the motor-vehicle industry.)

Assuredly, we would like to follow the lead of California and Massachusetts and develop large electronics industries, but theirs is not the only solution. In terms of my football analogy, we need to learn to play the R & D game, but this does not mean we would be successful in competing with them if we copied their pass plays exactly! The electronics industry is important to Michigan, but we in Michigan need to develop our own solution to our problems, and I believe that one important element in any solution should be the more effective use of the valuable resources now employed in the machinery and fabricated metal products industries. This does not mean that growth in other sectors is not also important; but we should not overlook our present strengths. In 1960 130,032 persons were employed in machinery, 86,012 in fabricated metal products, and 32,644 in electrical machinery, out of a state total of 964,043. (289,563 are in transportation equipment.) [4]

But industries do not solve problems; firms do. Therefore, let us bring the problem a step closer to home. To do this, I should like to cite three examples which developed out of our research on the product development capabilities of firms in the electronics and machine tool industry. Before turning to these examples, however, let me point out what I mean when I speak of product development capabilities, and how we went about making these studies.

I am using the term "product development" broadly. I am referring to all those activities associated with the six basic product development functions shown in Table II. Notice that the R & D activities constitute a small subset of the total. However, they are our primary concern at the Institute of Science and Technology. This table also depicts the scope of this aspect of our research activity. As you can imagine, to implement the concept required a truly interdisciplinary effort. As those of you who participated in the study know, faculty members from electrical engineering, mechanical engineering, industrial engineering, economics, and business administration are helping us with this research.

TABLE II. PRODUCT DEVELOPMENT FUNCTIONS

1. Idea Origination	Engineering and Scientific Research	Research and Development (R & D)
	Marketing and Market Research	
	Other	
2. Engineering Development	Engineering Breadboard Design and Test	
	Engineering Prototype Design and Test	
	Engineering Production Model Design and Test	
3. Production	Development of New Production Machinery	
	Design and Construction of Tools, Dies, and Fixtures	
	Process Engineering, Routing, etc.	
	Pilot Production Operations	
	Full Production Operations	
4. Marketing	Market Research—Market Testing	
	Distribution, Selecting Channels	
	Advertising and Promotion	
	Packaging	
	Sales Force	
5. Finance	Capitalization Structure	
	Source of Funds for Research and Product Development	
	Ease or Difficulty of Obtaining Funds	
6. Management	Organization for Product Development	
	Planning, Controls	
	Growth Objectives	

It was in the course of field work associated with this research that the examples which I want to cite arose. They all illustrate ways in which the University can aid and is aiding Michigan industry. For convenience, all three are taken from the machine tool study.

In one case we found a medium-sized company with a modest engineering staff working on a new metal removal process. The company president thought his staff could benefit greatly in their product design effort by knowing more about the fundamental scientific principles involved in the new process. Unable to sponsor a research program at the University, this company is now completing arrangements to loan the University one of their machines, and to give the University a research scholarship to enable a graduate student to investigate the nature of the process. Results from his work will be made available to the company.

The second example involves another medium-sized firm with an established research program, again investigating a new metal removal process in connection with an existing product. This company has an engineering development capability sufficient for undertaking a government-sponsored development contract, but lacks the capability or facilities for conducting the basic research which most likely will be required to optimize the design of the new equipment development. The University has agreed to support this firm by assisting in developing a suitable work statement for the research, and by expressing to the government sponsor its intent to engage as a subcontractor (on a non-exclusive basis) in the basic research needed to support the firm's engineering development effort.

The third example is that of a firm which, despite its smallness, has been a leader in developing another new machining process. This company has its own research effort, but has encountered a difficult technical problem, requiring further understanding of the basic scientific nature of the process. This company is negotiating a contract directly with one of our engineering department research groups to solve this problem for them, with all proprietary rights being reserved for the sponsor.

Now let us examine these three examples in terms of reasonable criteria for success in achieving the results we need in Michigan. These criteria are shown in Table III.

First, in the three instances cited, it was necessary to bridge the communications gap between the University and business in order that the University might understand the industrial problems to which it might apply itself.

Second, in all three cases the University will engage in fundamental research on the scientific problems involved, and industry will carry out any engineering development work. Since patents are more likely to be involved with the engineering development of new devices, the proprietary interests of individual firms are honored, yet the University research plays a direct supporting role for each individual firm. Thus both the University's interest in learning the "Why" of the scientific problem, and the industry's proprietary interest in the "How" of the development, are harmoniously preserved.

Third, as the second case illustrates, military and space research can be undertaken through joint proposal arrangements between the University research groups and industry.

TABLE III. CRITERIA FOR SUCCESS

1. To bridge the communications gap between universities and industry
2. To utilize university resources effectively in support of industry
   a. Basic research in university
   b. Engineering development in industry
3. To use military and space R & D funds
4. To retain engineers and scientists in Midwest
5. To result in growth through new product development
6. To result in permanent improvement in product development capability in Michigan firms

Fourth, the net result of arrangements such as these is certain to help Michigan retain, our graduating engineers and scientists, and to encourage others to move in. In the cases described, interesting research problems are being explored which offer a challenge to graduates.

In all three examples, members of the University research staff and graduate students will become familiar with new technological fields, and will get to know the sponsoring company's technical and management personnel.

Following such associations in research will come offers of jobs as interesting and challenging as those anywhere in the country; university faculty and research staff will learn of such new job opportunities and recommend them to students; and it is probable that some faculty will take positions in industry and later attract former students, etc. Through this mutual involvement, the capability of industry research staffs will continue to improve. With a constructive attitude on the part of management, such research associations with the universities are sure to trigger these self-generating reaction cycles.

Fifth, this type of research association certainly will directly enhance the ability of new firms to develop new products using new technological advances.

Sixth, these and similar courses of action, followed through time, will build into firms a concrete improvement in research and development capability, a capability which can continue to function independently to give us growth in the future.

Your reaction is probably, "This sounds too good to be true." Or "Why haven't we done this before?" Or "What's different about this?" Let's examine the ingredients. (See Table IV.)

TABLE IV. THE INGREDIENTS

1. University-IST initiative to understand industry's product development problems
2. University-IST technical guidance and follow-through to help firm obtain appropriate form of research assistance
3. Flexibility to use whatever university resources are appropriate
4. Recognition by industry of how university basic research can be of direct benefit
5. Focus on giving effective aid to medium-sized and small firms

First, there is university initiative, acting, in our case, through the Institute of Science and Technology, to gain understanding of the product development problems of industry from the viewpoint of the firms. Second, there is university assistance in diagnosing the nature of these problems, and subsequent follow-through in identifying the appropriate form of assistance. (These important liaison activities are performed through a state-supported program of the Institute.)

Third, there is the necessity of access to the particular university resources best capable of rendering assistance. This requirement is a difficult one for any university which must carry on educational and research programs. We at The University of Michigan are now considering how best to accomplish this, without sacrificing our other objectives.

Then fourth, and most importantly, there is the necessity for the management of these firms to realize that the University actually could help them directly and individually by conducting basic research. Some executives, and this is understandable, seem to think that because a university is primarily interested in basic research, not in engineering development, a university can't be of any practical, down-to-earth assistance to industry. However, the three examples I cited above show how incorrect that conception is.

And fifth, you will note that the firms which benefited in these examples were medium-sized and small firms. In a speech at a conference at The University of Michigan in September 1961, Dr. Harold C. Taylor, Director of the W. E. Upjohn Institute for Employment Research, called attention to "an important and not-yet-solved problem: the problem as to how small and medium-sized companies are going to be able to take advantage of these new developments in product and process technology to a degree that will enable them to compete." [5] To date, The University of Michigan's assistance to industry has for the most been limited to the larger firms, because these firms have the financial resources to sponsor research, they have research staffs, and importantly, they usually come to the University with a fairly well defined problem; it is therefore comparatively easy to match up the problem with the person or group to solve it. On the other hand, the small and medium-sized firms are not in so favorable a position to seek help from a university on their own initiative. Furthermore, the problem presented to a university often requires further definition, which can be accomplished only by understanding much more about what the company is trying to accomplish, the company's resources, uses for its products, etc. It is not surprising, therefore, that some small firms attempting to get assistance from a university feel that they are getting the run-around, or that universities just aren't interested in their problems.

We have found that one way to get at this problem of helping smaller firms is for the University to be willing to extend its diagnostic capability to industry in order to gain the understanding necessary to determine the kind of assistance required by the smaller firms. The availability of state funds makes this possible.

We of the Institute of Science and Technology intend to proceed with this approach, as outlined in Table V.

TABLE V. HOW IST WILL PROCEED

1. Increase substantially the liaison staff. (Use University research and teaching staff.)
2. Use a diagnostic research approach, and follow up all inquiries and requests where firms will cooperate.
3. Cooperate with other universities, and with schools, colleges and research groups at U of M and elsewhere.
4. Initiate supporting research programs if a need is found which existing programs cannot meet.

We recognize that we must substantially increase our liaison capacity. We intend to do this, if possible, with teaching faculty and research staff on release time appointments. We have found that the faculty in general enjoys this work, and both industry and the University receive valuable subsidiary benefits from becoming better acquainted.

We intend to use a diagnostic research approach with firms in other industries similar to that used this summer with the machine tool and electronics industry. We will shift our emphasis, however, toward more active response and will follow through where we find we can be of help. So far we have emphasized the research aspect of the approach—that is, efforts to understand the problem we are facing. The examples I cited were really by-products of our research probing. As soon as we can effect the transition, we are going to make our present by-product our main product and vice-versa. Incidentally, this will not be the first time that a research effort produced a by-product as valuable as the initial product sought.

Furthermore, we do not intend to limit ourselves to assistance which can be found at The University of Michigan. Our objective will be to help firms find assistance from whatever university (e.g., Wayne State or Michigan State) or research organization deemed appropriate.

Finally, the Institute of Science and Technology will be ready to initiate supporting research programs with federal assistance where possible, when sufficient need is found to exist in an industry. It is beginning to appear, for example, that such research assistance might be needed in support of the machine tool industry.

Finally, why will this approach work? There are three basic reasons, as outlined in Table VI.

TABLE VI. WHY OUR PLAN WILL WORK

1. It is operationally feasible and practical.
   a. Program can expand as fast as necessary.
   b. Character of program can evolve as relationships with firms mature.
2. It provides flexibility to meet individual firm needs.
   (Product development decisions must reflect individual firm circumstances and capabilities.)
3. Research encourages firm to seek out information on pertinent technical developments.
   a. This enhances the efficient transfer of technical information from universities to industry.

First, it is practical and operationally feasible. Such a program can expand as the need demands. As research relationships develop, a more formal structure can evolve if needed.

Second, such an approach provides the flexibility to meet the needs of various firms. There are no standard solutions to product development needs. A firm's problems are individual; decisions must be based on the competitive situation facing a particular firm and must reflect its capabilities.

Third, and last, emphasis on helping firms improve their research and other product development capabilities, no matter how small, will increase the efficiency of technical-information flow to them from universities, government, and elsewhere.

By way of summary, and to leave you with some specific suggestions as to what you yourself can do, I offer you the following lists of "Don'ts" and Do's" in Tables VII and VIII.

TABLE VII. DON'TS

1. Don't expect to find a ready-made solution for your new product needs.
2. Don't think you are too small to keep up with the technical frontier in your field.
3. Don't think you couldn't get a military or space development contract.
4. Don't look at research as a gamble; consider it an opportunity to learn about new technical developments.
5. Don't think the University doesn't understand your viewpoint, and isn't willing to help you individually.
6. Don't expect miracles. Universities will have problems in adjusting to increased demand for assistance.
7. Don't wait until you have only six months to find a new product or close shop.

TABLE VIII. DO'S

1. Do - start looking three to five years ahead regarding:
   a. Demand for present products.
   b. Technological developments likely to affect present products.
   c. Identifying areas of potential demand consistent with your basic interests.
   d. Planning needed product developments to meet growth objectives.
2. Do - get at least one top-notch technical man on your staff.
   a. At least as a consultant.
   b. Permanent staff if possible.
3. Do - get to know the university people in your technical field at all universities near you, and especially, learn about the research being done.
4. Do - search out military and space requirements consistent with your basic interests and objectives for the future.
   a. Use your consultant to help with this.
   b. Seek university research assistance, if necessary.
   c. Read current commercial literature, especially the Commerce Business Daily, which is published by the Department of Commerce, and is an excellent information source on R & D contracts and procurement.
5. Do - start now, while good business conditions provide the time to develop new products.

These items are self-explanatory, but I would like to emphasize the importance of the final "Do." In terms of my football analogy, in the Rose Bowl a few days ago, Wisconsin clearly demonstrated that no matter how good your passing (R & D) game is, you may never catch up if you allow a good California team too much of an early lead!

The suggestions of this presentation are not the whole answer to all of Michigan's problems, but we in the Institute of Science and Technology feel that they are important steps to get Michigan back on the road to prosperity.

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