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manpower

and other industrial resources

contents

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THE STATION

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Governor Griffin and a large delegation from Georgia will go to Cleveland on October 24 to invite manufacturers of that area to consider establishing plants in Georgia. Similar meetings were held earlier this year in New York and Chicago.

Georgia Tech is one of the state's most powerful magnets the governor might use to attract many highly specialized industries to Georgia. Georgia Tech is a nationally recognized source of four industrial necessities:

1. Scientific and engineering manpower. Georgia Tech is the largest engineering college in the South and the third largest in the United States. Its graduates are second to none.

2. Skilled, trained employees on the technical level. Affiliated with Georgia Tech, and located at Chamblee, near Atlanta, is the Southern Technical Institute, graduating technicians with two years' practical training and experience. Industry calls them its "non-commissioned officers."

3. Co-op students. Many firms utilize the services of some of our best-qualified undergraduates by arranging to employ them for periods of work, alternating with quarters of campus instruction. By employing two such co-ops, it is possible to keep a single job filled at all times with a high-caliber man.

4. Research and development services. The Georgia Tech Engineering Experiment Station, with a budget of about $1.8 million a year, is the South's largest industrial and engineering research organization. Its excellent laboratory facilities are available to industry on a standard contract basis.

Georgia Tech, for many reasons, is vitally interested in the state's aggressive efforts to attract new industry.

RESEARCH in Industrial Development

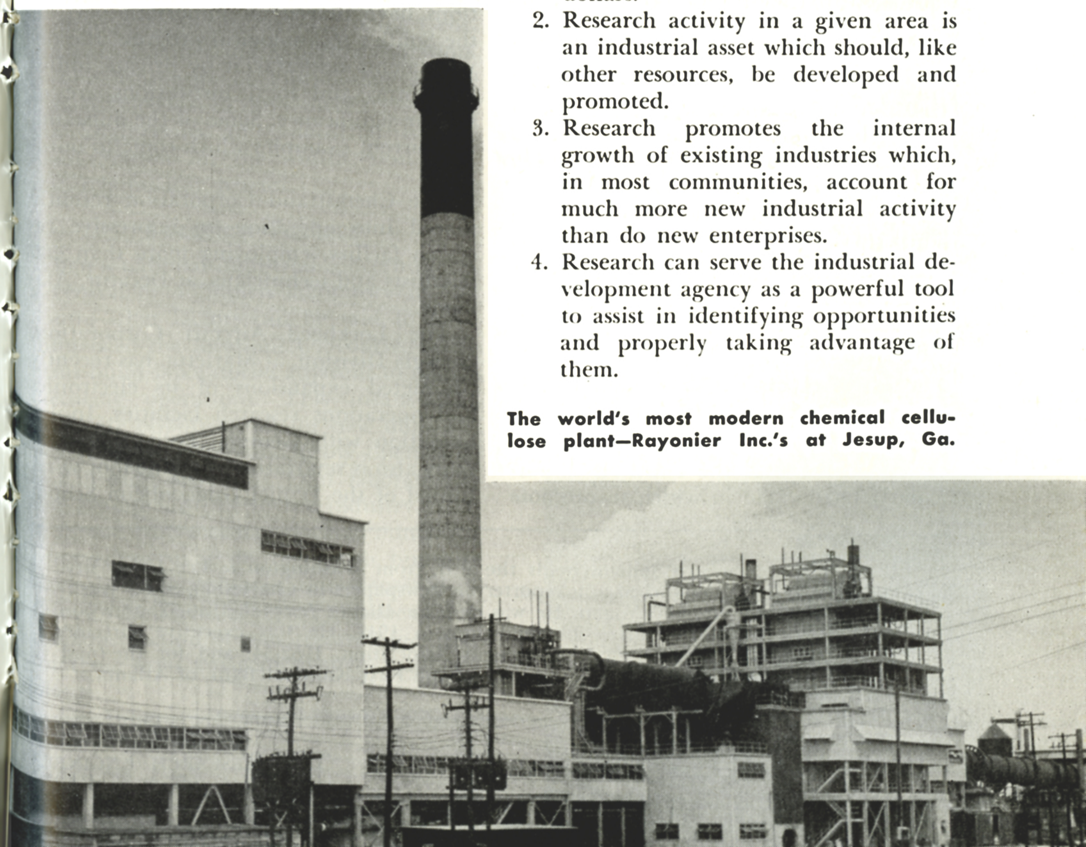
Research is an industrial asset. Like any other resource, it needs to be developed and promoted, to be of greatest service to the industrial South

GEORGE GOODWIN, vice president, Southern Association of Science and Industry.

Why should industrial development officials be interested in scientific research? What does a chamber of commerce executive, for example, have in common with a chemist working in a laboratory? How can the industrial developer and the research scientist combine their talents to achieve the fastest and soundest possible economic progress for a specific area?

There are a number of answers to these questions, all of which are important to those who are particularly interested in the Southern states. Perhaps the four most important factors are:

1. Scientific research today is a big, fast-growing industry employing hundreds of thousands of persons and requiring the investment of billions of dollars.
2. Research activity in a given area is an industrial asset which should, like other resources, be developed and promoted.
3. Research promotes the internal growth of existing industries which, in most communities, account for much more new industrial activity than do new enterprises.
4. Research can serve the industrial development agency as a powerful tool to assist in identifying opportunities and properly taking advantage of them.



The world's most modern chemical cellulose plant—Rayonier Inc.'s at Jesup, Ga.

THE COVER PHOTOGRAPH, which shows employees leaving the Lockheed-Georgia aircraft plant, at Marietta, symbolizes skilled manpower — one of the most important ingredients in industrial development. Manpower, along with research, industrial psychology, and technological information, is the subject of this issue of THE RESEARCH ENGINEER. — Photo by Lockheed Aircraft Corporation, Georgia Division.

Let's look at each of these factors from the viewpoint of the industrial development technician:

Total expenditures in the U. S. this year for organized scientific research will exceed $4 billion, as compared with a total expenditure of about $1.5 billion in 1946. This means that not only is research a big business, but also that it is a business that is growing at a very rapid pace. All forecasts predict that this growth will continue, and that additional billions will be spent for research facilities in the years immediately ahead. Hundreds of new laboratories are going to be built, and Southerners are interested in having as many as possible built in the South.

We should be interested in research, then, if for no other reason than that it is a fast-growing industry which we want to induce to locate in our area. Of course, this means that we must become familiar with research activities to some extent so that we can appraise the needs of the industry and the advantages the South may offer.

Recent Expansion

Our recent experience gives us good reason to believe that the South is a particularly fertile field in which to promote the establishment of new research facilities. Industrial, college, and non-profit laboratories are expanding rapidly. In recent weeks Congress has approved the construction of a $12.5 million headquarters and laboratory setup for the Communicable Disease Center, U. S. Public Health Service at Emory University, Ga. Since World War II, moreover, the Federal Government has located more than a dozen other extremely important national scientific centers in the South.

Why has the South been selected as the site for these numerous Federal installations? One factor is relative security against enemy attack. Bombers traveling over the North Pole have to fly farther to reach Southern targets, and there is a better opportunity for interception. Of course, suitable land sites, power, and water are important. A fact that is often overlooked is that it is relatively easy to recruit a staff for a new scientific facility in the South.

Industrial Research

While these important Federal installations have played an important part in the South's technological progress, the developments undertaken by private industrial firms and local institutions are of similar significance. Some of the outstanding current examples which come to mind are:

The Chemstrand Corporation recently placed into operation an impressive research facility, employing more than 400 scientists and technicians, at Decatur, Alabama.

The Lockheed Aircraft Corporation, Georgia Division, at Marietta, has recently completed expansions of its electronics and operations research facilities. In cooperation with Georgia Tech, this company also is renovating the nine-foot wind tunnel of the Daniel Guggenheim School of Aeronautics, to enable it to undertake an extensive program of aerodynamics research.

George Goodwin holds the A.B. from Washington & Lee University. He has worked as a reporter on newspapers in Charleston, S. C., Washington, and Miami. He was on *The Atlanta Journal*, 1946-52, and won a Pulitzer Prize for reporting, in 1948. He was executive director, Central Atlanta Improvement Association, 1952-54, and for the past year has been vice president of the First National Bank of Atlanta.

Eli Whitney's cotton gin, 1792, suggested by a group of South Georgia planters.

Even a leading department store, Rich's, Incorporated, of Atlanta, is actively supporting research. Rich's sparked the development at Georgia Tech of a $750,000 electronic computer laboratory, soon to be dedicated and named the Rich Electronic Computer Center, a division of the Georgia Tech Engineering Experiment Station.

The legislature of Florida has appropriated $500,000 to the University of Florida Engineering and Industrial Experiment Station for the construction of a research nuclear reactor.

Location Factors

When a national industrial concern places a central or a branch laboratory in the South, what factors can be said to have influenced the location? Of course, many firms build laboratories adjacent to manufacturing operations. This means that there are opportunities for new units adjacent to large manufacturing operations not already served by local laboratories. For example, in the textile industry there are some firms that have located numerous production plants in the South but still have their research operations centered in the North. There are good arguments for the construction of new research facilities for these firms adjacent to their Southern plants.

Also, there are many Southern firms that have expanded rapidly in recent years and are now in position to consider the construction of new laboratory facilities. There are now several hundred industrial laboratories operated in the South by local concerns.

"Satellite" Laboratories

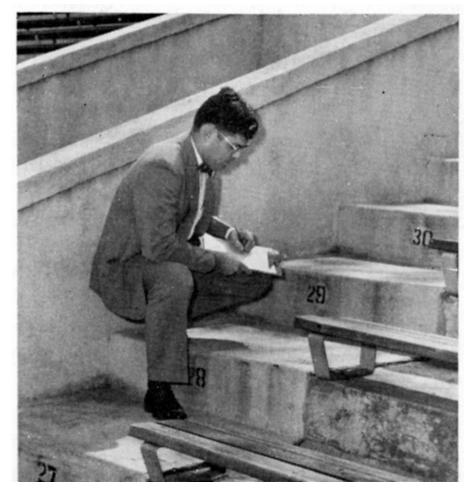
Another recent trend of interest to industrial development personnel is the subcontracting program that is now widespread in the research world. Both Federal agencies and industrial firms "farm out" many small projects, and wherever a large research center exists, small units are likely to develop.

For example, five new electronic development shops, all privately owned, have sprung up in the past five years in the Melbourne, Florida, area, to serve the nearby missile research range. These new industries are considered ideal for the local community. They are clean, wage rates are high, and they are growing rapidly.

"Market" Orientation

In the industrial development field, we hear a lot about "market orientation." It is significant, therefore, that no section of the country has a greater need, or market, for scientific research. Also, the fast growth of research activity has opened a new market for laboratory apparatus and supplies. In the past five years, a score of new sales offices, distributing centers, and manufacturing plants have been established in our area.

A surface coating (left) developed at the Station was used on Grant Field stadium.



So, it is evident that the research "industry" is worthy of our consideration. Now, let's look at another way we can use research to further industrial progress in the South:

An Industrial Asset

The second major reason we should be interested in research is that it is a valuable industrial resource, to be considered along with utility services, water, minerals, and labor supply in appraising our assets. It is no accident that the New England Council has publicized technological services and facilities as the number one advantage of the New England states. We have all seen the advertisements in national business publications citing the research facilities that exist in various localities.

It is particularly important for us in the South to make known the existence of numerous well-equipped and well-staffed industrial laboratories, to offset the "Tobacco Road" treatment we received for so many years in the press. In the business world, the lack of research facilities is the social equivalent of going without shoes. Since we now have shoes in the South, we ought to make this fact known. Certainly no local brochure is complete unless it describes local scientific activities.

It is encouraging to note that several of our electric utility firms have described certain of our research activities recently in their national advertising. It would help improve our business "atmosphere" if more of our industrial development groups would do this.

Consulting Laboratories

While few industrial firms will list the availability of consulting services as a primary location factor, the existence of such services may help convince the firm that a particular area has a good industrial "climate." In this respect, it is important to note that the South has made great progress in recent years.

Ten years ago there was not a single major consulting research institution in the South. There were few routine testing laboratories and the private consultant who made a decent living in the South was regarded as somewhat of a genius. Today, we have some forty well-equipped general consulting laboratories, several dozen commercial testing laboratories, and hundreds of individual consultants covering almost every field of science. It is a fact that a business firm can obtain expert scientific aid in almost any field of technology in the South.

Another measure of the technological "climate" is the volume of employment of technically trained people. There are now thousands of professional chemists, physicists and engineers employed in our area. Membership in technical societies is at an all-time high, with new chapters being formed in many cities. The existence of this activity is important in attracting additional technical activity since opportunity for professional advancement is more important than salary for many scientists.

Promoting Existing Industries

We are all familiar with the fact that in the average city or market area the expansion of existing business activities accounts for a much greater proportion of industrial growth than does the location of new enterprises.

In the average Southern community, the expansion of existing industries will account for at least 80 percent of future industrial growth. Since research is one of the prime accelerators of internal expansion, industrial development groups should have a tremendous interest in furthering the applications of research in their own areas.

Perhaps this local promotion of research is the biggest gap in most industrial development programs. To our knowledge only a handful of local groups in the South have given any attention to the possibilities of intensive local application of available scientific knowledge.

As a start in such a program we would like to propose that the local development agency make a research application survey of its service area. Such a survey would include all manufacturing and processing concerns in the area. It would identify

those firms which are not now receiving expert technical advice. The duty of the industrial development group then would be to attempt to make some arrangement whereby each firm could receive technical assistance in its field of work.

In order to conduct such a program intelligently the industrial development agency must first be familiar with sources of scientific aid. Some of these are:

(a) Laboratories operated by or for specific industries. For example, in the textile field a number of Southern mills have joined together to support the Institute of Textile Technology at Charlottesville, Virginia. Hundreds of technical problems large and small are tackled for member firms each year. We are familiar, too, with the Herty Laboratory, at Savannah, for pulp and paper technology and cellulose chemistry. One advantage of this type of organization is its intimate familiarity with the needs of the industry it serves.

(b) The establishment of a general consulting research laboratory to serve a variety of firms in a given area. For example, business firms in the Birmingham area have taken the initiative in organizing the Southern Research Institute. This type of independent, nonprofit research organization already has proven its value in other sections. There are now eight such organizations, well dispersed throughout the country.

(c) Utilization of the facilities of a university or college. The largest research and development laboratory of this type in the South is the Georgia Tech Engineering Experiment Station. Others are the University of Florida Engineering and Industrial Experiment Station, and the Department of Engineering Research, North Carolina State College. There are more research organizations of this type throughout the country than any other. The college research organization has the advantage of being able to utilize the services, not only of a full-time research staff, but also of research associates from the teaching faculties and of graduate students. The mutually dependent fields of education and research form, in this kind of organization, a potent combination.

What is the role of the industrial development expert in promoting research? The industrial development group is ideally situated to bring together both the industrialist who needs scientific help and the scientist who is able to give it. It would be a wonderful thing for the South if every industrial development group would become a clearing house for information about research assistance. Such groups can be of tremendous help both to the many small business men who are completely unaware of the existence of nearby consulting services, and to research organizations which in many cases lack the promotional instinct necessary to sell their own services.

Two Percent Criteria

While the research needs of a company vary according to the nature of its activity, it is generally agreed that it is necessary for a firm in a competitive field to spend at least 2 percent of its gross income for development of new products and processes. Numerous studies have shown that Southern firms have generally failed to invest in research to this extent and thus have been handicapped in market competition.

Perhaps the most common misconception is that scientific research is only for big business. Of course, a business must be big for 2 percent of its income to cover the expenses of an elaborate research laboratory. Thus, it does not occur to many small business men that it is possible to buy $5,000 worth of research, or even $500 worth.

Actually, it is no more sensible for a small business man to think it is necessary to build a laboratory to solve a particular problem than it is for a person with a bad appendix to think that he has to buy a hospital in order to have an operation performed. The truth is that expert scientific help is fast getting to be as readily available as expert medical or legal advice.

So far as is known to us, not one consulting research organization in the South makes a charge for a preliminary discussion. This means that a business man without obligating himself or spending a dollar can outline his problem and get reliable advice as to whether it would be feasible to set up a research project for further study. There are a number of cases in which problems were solved in these preliminary discussions without any expense to the business man.

Research as a Tool

The fourth reason that industrial development groups should be interested in research is that it offers the group itself a very effective weapon in identifying local resources and opportunities. We all know that it is customary when a new development group is organized to start with a routine industrial survey of its area. Hundreds of such surveys have been made by local communities in the South. We have now reached the point that for a particular community or area to distinguish itself it must offer "something special." As it becomes more necessary in the competitive field of industrial promotion to prepare more comprehensive industrial surveys, the development expert must rely more heavily on research.

If the industrial development group is large and well-financed, it may be practical to employ a full-time research specialist. The Houston Chamber of Commerce has recently added a chemistry Ph.D. to its staff. Others will probably follow, as industry grows more complex and industrial development work becomes more specialized.

For most development agencies, however, it is more practical to "farm out" special research studies to consulting organizations. This relieves the development group of the various responsibilities which must be assumed by the employer; it makes it possible to engage specialized personnel for a specific project, without making any future commitments; and it usually results in the employment of superior personnel. The consulting group can offer a reservoir of experience which the development group can't get by employing an individual.

Most of the consulting research groups in the South operate on the basis of cost of actual services and materials, plus an overhead factor, usually about 100 percent. Unless a development agency can employ excellent personnel, the consulting arrangement probably will produce more and better information at lower cost.

The fact that most industrial research is, by comparison, strategic or long range in nature should not make it a less important part of the program of the local promotion group.

Coordination Needed

This report would not be complete without a remark concerning the need for coordinating our research and industrial promotion activities at the regional level. Of course, that is the objective of the Southern Association of Science and Industry. We feel that some progress is being made; however, there are still many problems.

A good example is the situation with respect to market research. It is now generally recognized that the increased purchasing power of the South is a prime factor in our current industrial growth. A considerable amount of effort is now being devoted by SASI, by state and local groups, and by business firms, to the study of the size and nature of our market for various industrial products and supplies. These studies will be much more effective if they are properly coordinated.

In the case of large manufacturing plants or distributing facilities, location studies are usually conducted on a regional basis. Rarely is a major addition concerned with a single city or state. New synthetic fiber plants, for example, must consider chemical supplies in Texas, spinning mills in the Carolinas, and perhaps transportation facilities in Alabama. They must perform regional research in order to select a site. Naturally, the South's chances of obtaining large new units is increased if we are able to present regional research data in convenient form.

The practical research investigator believes that no rabbit is ever pulled out of a hat unless placed there in advance. Our problem is to keep our hats well loaded with rabbits.

Manpower Utilization

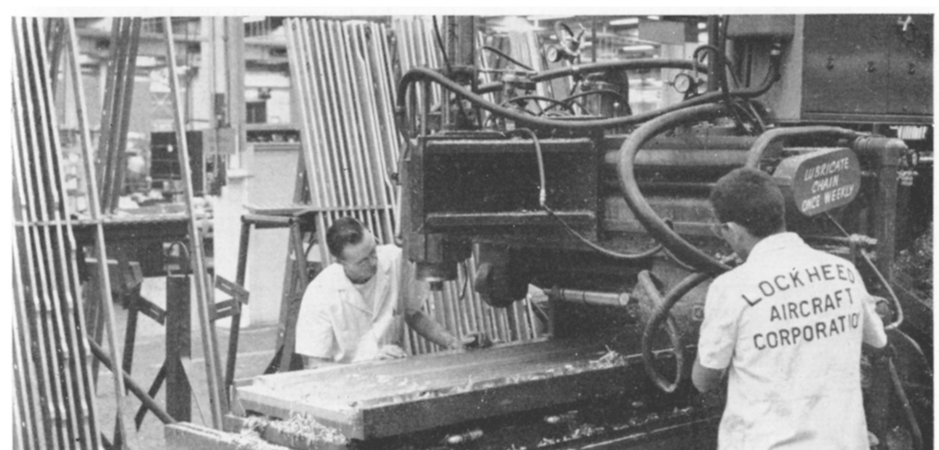
KENNETH C. WAGNER, assistant professor of social sciences and research associate

MANPOWER UTILIZATION is one of the weakest parts of our industrial system and accounts for some of its greatest losses. The problem can be stated quite simply: to use the greatest number of workers in the positions for which they are best qualified, to have those workers spend an optimum amount of time in productive work, and to have them work at an optimum rate of speed. Despite the practical experience accumulated by men in industry and despite the increasing understanding gained through social science research, this problem has never been explored adequately.

In recent years industry has concerned itself increasingly with questions basic to effective manpower utilization: How can absenteeism and turnover be reduced? How can morale and motivation be kept high? Why does informal organization develop? What type of organizational structure is likely to maximize production? What special abilities and skills do supervisors need? The answers to these and related questions are not only important now but will likely be even more important in the age of automation which we are just entering.

Efforts to determine scientifically sound answers to these questions have been hampered by lack of funds. One reason for this lack of support has been a natural tendency for those in industry to feel that their practical experience has taught them more than the social scientist could learn through his research. At the same time there has been a tendency to regard so-called "human relations" problems as comparable to the weather—something that can be understood and even predicted to some degree, but quite beyond effective control. Just as devastating has been the necessary preoccupation with current problems and frustrations, a preoccupation which results in neglect of

Trained manpower is needed to operate this giant spar mill at the Lockheed-Georgia aircraft plant. It "carves" aluminum alloy slabs weighing more than a ton into one-piece wing panels.



knowledge and skills already available.

The belief that human behavior will never be completely predictable and controllable is well-founded. But it tends to mislead and to cloud an important fact: that increased predictability and control are possible. This is not the same as saying that human behavior can ever be completely controlled, or even completely understood. Few people would accept the desirability of such goals even if they thought them attainable. My point is that those who make use of available data and who engage in research can accomplish things that others cannot. There is much which both industrialists and social scientists can learn.

Two Squadrons

My own experiences during two and one-half years as a member of a research team studying Air Force organization provided startling contrasts in the manpower techniques employed and in the results achieved in nearly identical units.

Two flying squadrons which I studied for a year at one base provide an interesting example. In the first squadron the commanding officer left his subordinates completely alone. His instructions were simply to "do your job." He seldom appeared at squadron headquarters or at the flight line. Even more rarely did he bother any of his officers. Each staff member was free to discharge his duties as he saw fit.

My first impression was that here was an excellent example of delegation of authority. But it was quickly apparent that this was an illusion. Virtually all the staff men were new on their jobs. Most of them had recently been recalled from the reserve, and none had an adequate understanding of his responsibilities nor of his place in the overall system. With no interference, support, or instruction of any kind, they tried desperately to do their jobs, became increasingly frustrated, and, finally, merely went through the motions apathetically. Morale and performance dropped steadily throughout the squadron, while "griping" and infractions of discipline increased.

The commanding officer of the other unit I studied kept in relatively close touch with his subordinates. He was a hard-working, driving leader who was always near at hand, pushing both himself and his men to the limit. He assigned work, set deadlines, and expected the assignments to be completed on or before the prescribed day or hour. He appeared to exert extremely firm control over his subordinates.

But his behavior, too, was misleading. Between an assignment and its completion, he left a man completely on his own. Anyone could call on him for assistance and advice if necessary and receive it readily. New men, especially, were urged to do so, but independence was strongly encouraged and quickly rewarded.

The atmosphere within the squadron was a peculiar combination of precision and informality, respect and friendliness, intense effort and relaxation. Respect for superiors was taken for granted; an officer or a noncom incapable of gaining it was quickly replaced or "shipped out." Friendliness was expected also. The squadron had the best recreational facilities on the base. Its lounge and snack bar were the envy of other units, and its parties were famous throughout the area. Esprit de corps was outstanding; crews worked hard to maintain their reputation of having the best performance record in the wing.

Motivation and Morale

Why did men in the top-rated squadron outperform men with comparable experience and training in the other? Because both were military outfits, we can immediately eliminate one possibility: Money was not the answer. The men exerting extra effort were, in effect, increasing their output without receiving overtime pay. The work was just as boring, just as tiring, and as dangerous in one unit as in the other.

Nor were the personalities of the commanding officers a crucial factor. Difference in their behavior undoubtedly did exert some influence, but, as we shall see, other factors were more important. A dramatic example of the relative unimportance of such individual differences occurred when the second in command of the top squadron replaced the commanding officer of the poor unit. The new commanding officer displayed personality traits which resembled those of his unsuccessful predecessor more than they did those of his former "C.O." Yet, within a few weeks the low squadron's rating had jumped from last to within a few points of tying the top squadron. This improvement occurred despite the fact that not a few men complained that the new C.O. was never around and that they scarcely knew him.

What was the explanation? The answer can be found in the successful commanding officers' recognition of the social nature of the organizations they headed. As personalities, they were radically different. However, each employed a "system" which emphasized things important to their subordinates.

The Worker's Point of View

Robert Saltonstall points up some of the important factors involved in making optimum use of available manpower in his summary of the findings of "human relations" research.[1] Much more important to the worker than the size of his paycheck or even the physical surroundings in which he works is the satisfaction of certain personal needs. The worker wants to feel that he is doing something worthwhile, and to feel he is doing his share. He needs recognition; he wants to "count for something." He wants not only a decent living but also a chance to get somewhere. He is interested in a safe future (security) and he wants to know "what's going on." Finally, he is concerned about the social and physical surroundings he finds on the job. Even here he is primarily concerned about working with people he likes and with whom he can feel at ease.

Some of these "needs" conflict directly with beliefs industrialists build up from their experiences. Restriction of output is often cited as an example of the employees' negativism. But of crucial importance to the analysis of such problems is this fact: Research has shown that such phenomena develop primarily because of company failures. They are the workers' attempts to satisfy a need which has not been met by the formal organization. The major cause of attempts to circumvent the prescribed organization and its methods, in other words, are the weaknesses and failures of that system.

Resistance to Change

Let's look for a moment at a specific example of restriction of output in the textile industry.[2] The company in which the experiment was conducted found it necessary to change work methods frequently because of the competitive situation in the industry. The drop in productivity which resulted while new methods were being learned was evidenced in the fact that new trainees learned the revised methods more quickly than did workers who previously had met the standard on another job. Also, experienced workers expressed their dissatisfaction by the fact that they had more grievances and a higher turnover.

The experiment consisted in letting one group of workers participate in a projected change. The economic factors which made it necessary to adopt a new method were explained, and the employees in the group were given a chance to discuss the problems involved. They were encouraged to make suggestions. In addition, they selected members from their group to experiment with the new

Kenneth C. Wagner holds three degrees, A.B., Augustana College, 1944, M.A., University of Wisconsin, 1949, and Ph.D., University of North Carolina, 1953. He served three years, 1943-46, in the U.S. Navy as a communications officer. For a year afterward he was in the printing business. For two years, while taking graduate studies, he was a research supervisor in the Institute for Research in the Social Sciences, at the University of North Carolina.

methods. These "trial runs" became the basis for time studies which established new piece rates.

The new methods were introduced into the control group in the traditional manner. The production department modified the job and set a new piece rate. Then the workers were called in, and the new rate and method were explained. Finally, workers were given the reasons for the change.

The results were clear: The "participation" group learned faster, reached a higher final production level, and had fewer grievances and lower turnover. Their acceptance and satisfaction can be simply explained: the new method was "theirs"; they had participated from the start in its development and innovation. For the first time they were involved personally, and as a group, in something which had formerly been imposed from outside.

Similar studies have reached the same conclusion. When the worker finds his needs satisfied, he identifies himself with his work, and he no longer feels compelled to rebel and resist.

Job Enlargement

A related manpower problem not often recognized is illustrated by the experiment in "job enlargement" employed by International Business Machines Corporation.[3] The questions raised by IBM are basic to effective manpower utilization — how highly specialized should a worker be? How minutely should jobs be broken down?

Industrial engineers had made great contributions in this area, and IBM profited from their research. The (then) president of the company suspected that specialization had been carried too far. Theoretically, the simpler a job, the more the worker's speed and proficiency should increase. This mechanistic view failed, however, to consider the "human factor" to which industrial engineers are now devoting increasing attention.

IBM assumed that oversimplified jobs create boredom and that bored workers do not turn out a high-quality product. The company experimented by giving machine operators additional responsibilities, specifically letting them set up and inspect their own work. This recognition of the importance of the workers' needs directly contradicted established doctrines and was strongly opposed by many of the company's executives.

The results have been widely publicized. A higher quality product resulted. Idle time was reduced sharply, and there was a 95 per cent decrease in costs of setting up and inspection. IBM's management was convinced that job enlargement "enriched the job for the worker," increased worker satisfaction, reduced turnover, and cut training costs. Through it workers gained prestige and status. Plant organization became simpler, more informal, and better integrated. Foreman-worker relations improved, with an accompanying increase in employees' personal satisfaction with their jobs.

The success which IBM has had in extending this system to all its plants does not mean that job enlargement is a panacea for all the manpower problems that may be associated with industrialization, any more than is job simplification. Both are applicable only to certain types of work and to certain organizations. Each has its uses and its limitations. This experiment, however, refutes again the still popular belief that the worker always tries to avoid responsibility and work. In combination with other research findings, it supports this challenging hypothesis: Shirking work, avoidance of responsibility, and restriction of output may be direct results of poor manpower practices.

James C. Worthy's summary of the findings of studies made by Sears, Roebuck and Company, covering a 12-year experience with more than 100,000 employees, provides further pertinent conclusions.[4] One unexpected finding was that rates of pay ranked fourteenth on employees' lists of factors affecting morale, but pay in comparison with other jobs in the same unit ranked eighth! Hours of work was listed twenty-first. Again, Worthy emphasizes the need for recognizing the importance of the concept of the factory or plant as a *human* organization.

"Tall" vs. "Flat"

Sears' vast experience has produced a wealth of data concerning the effects of a company's organizational structure on performance. Picture a typical company's table of organization. In his summary Worthy points out the advantages of the "flat" over the "tall" structure. The shorter chain of command and the more direct relationships indicated by a flat structure aid greatly in creating the type of social organization that produces efficient workers. Employees can understand better where they fit in and see the importance of their jobs.

Communications problems were simplified by increased personal contact, the Sears research showed, and contact also facilitated understanding of other employees' problems and points of view. Interpersonal and interdepartmental conflicts also were reduced. Those conflicts which did arise often were settled more quickly because fewer people were involved and because these individuals knew each other better.

Such decentralization runs directly counter to the concept of "span of control." In a flat structure an executive often has so many individuals reporting to him that he cannot keep a close check on all of them. The result is that administrators are forced to delegate authority and responsibility. In general, the approach tends to discourage overspecialization and departmentalization. By reducing the amount of close supervision the change adds breadth and meaning to jobs, gives employees greater responsibility and stimulates initiative.

Communications

We have been describing problems and topics which involve communications. It is indeed difficult to find an aspect of industrial activity, or any other human interaction, which does not concern communications. It is the formal channels which convey most of the information vital to the activities of any plant, and it is the weaknesses of that formal system which produce the "grapevine." One of the most interesting recent developments in communications research is the deliberate, contrived use by management of the grapevine.[5]

Unsolved communications problems pose challenging questions for research. Are communications difficulties in large or complex organizations due, at least in part, to the lack of specialized communications networks? Since such organizations obviously have many varied communications needs, why not create distinct "subsystems," each designed to serve a special purpose? Why not have a separate channel for transmitting information horizontally — from foreman to foreman, for example? Such communications develop informally, in any event. Why not make use of available data on informal communications to revise obviously inadequate formal structures?

Employee Needs

An important point to recall here is the nature of the employee's work needs. It is a failure to provide information which the worker feels is important that produces frustrations and helps breed conflict. Harriet Ronken's emphasis on the importance of learning the employee's "frame of reference" deserves mention.[6] She emphasizes the need for familiarity with the worker's perspective on the subject under discussion. Too often, as illustrated by her research and by Sears' surprise that their employees ranked wages fourteenth on their "morale scale," we assume incorrectly that we know what the other person thinks. A great deal of research is needed to explore this and other facets of communications.

In an expanding economy, a question which underlies all these problems is that of the availability of qualified labor. As long as there is an ample labor supply, as there historically has been in the South, there is no pressing need for refined measures of the labor force. As industry continues to move into the South, however, it will become increasingly important to have techniques capable of determining more exactly the numbers and types of employable individuals in a community or area. More detailed breakdowns of the available and potential labor supply will be necessary. This will require more detailed analysis of population trends, as well.

Although many gaps remain in our knowledge about Southern labor, certain myths have been effectively debunked. Summarizing recent studies, Robock and Anderson[7] point out that Southern labor remains plentiful, and that there should be an adequate reserve for future needs. Moreover, Southern workers have proved themselves to be easily trained and to be capable of doing highly skilled work. Low rates of absenteeism and low turnover demonstrate employees' interest in their jobs, and these consistently low rates have been important factors in keeping labor costs in the South low. Nor can the productivity of Southern employees be seriously questioned. One study reported that the executives of 50 companies which had located 88 plants in the South agreed that the Southern worker was at least as productive as the Northern worker.

An important part of the South's labor reserve is its Negro population. Since World War II, increasing numbers of Negroes have moved from unskilled to semi-skilled and even to skilled jobs. As industrialization continues to upgrade the South's total work force, this relatively untapped human resource, the body of educated, intelligent Negroes, is certain to prove increasingly important.

No one knows exactly how productive the Southern worker is, nor precisely what the labor reserve may be in any particular area. Companies still gamble, to a certain extent, on the availability or trainability of the manpower they need to operate new plants. Basic research requiring the knowledge of industrial engineers, economists, phychologists, and sociologists is needed to explore the whole broad problem of the measurement of productivity.

Conclusion

Manpower utilization is a complex problem area which requires the knowledge and varied approaches of several disciplines. The large number of variables bearing on specific problems has produced increasing recognition of the fruitfulness of interdisciplinary research in areas where single disciplines have worked before. The tremendous economic loss resulting from failure to solve the various manpower problems we have discussed, in addition to many others we have not included, can scarcely be estimated. Continued and increased research efforts are needed to explore this vast field.

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Three schools of Georgia Tech have new directors, recently appointed by the Board of Regents: Chemical Engineering, Dr. William M. Newton, succeeding Dr. Paul Weber, promoted to dean of faculties; Chemistry, Dr. William Monroe Spicer, succeeding Dr. B. B. Wroth, retired; and Industrial Management, Prof. Maurice R. Brewster, succeeding Prof. Hubert E. Dennison, also retired.

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illustrations

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How Personnel and Industrial Psychology Can Serve Industry

JOSEPH E. MOORE, professor and head, department of psychology

Psychology helps management to select, train, and motivate employees—in other words, it serves industry. This article discusses some of the principles, techniques, and the important results

The rapid industrial development of the United States, and particularly the South, has gone forward with a surprising lack of awareness by management of human problems and human variables. In the past the major emphasis has been placed on production first and workers last. Management has taken great pains to see that technically trained men were placed in charge of expensive machines. Yet this same management has all too often promoted or selected as foremen men who had little or no training in how to supervise other men. The nature and make-up of a worker is far more complex than that of the most intricate machine. Nevertheless, these workers all too often have been supervised by foremen who have expert knowledge of machines rather than sound training in the basic principles of human behavior. For the immediate future industry demands both trained workers and trained supervisors.

To select good employees, to train them, to motivate them to do good work, and to keep them happy with their jobs are major activities in which personnel and industrial psychology can render sound and helpful assistance. In this discussion we shall confine our attention primarily to interviewing, job analysis, psychological testing, training, motivation, and consumer and product research. However, we wish to stress that the opportunities to use principles of psychology to improve job satisfaction, labor relations, safety, productivity, conference leadership, customer service, and pride in product are in their infancy. These principles can make valuable contributions to retaining better adjusted workers.

In order to see the value of employee testing, look at a series of typical examples from business and industry.

The Union Bag and Paper Corporation at Savannah, Georgia, made the following statement in its 1954 annual report: "The scientific induction tests which are given to prospective employees are proving particularly valuable in determining the suitability of the job to the capabilities of the applicant."

In the area of office and clerical workers, a two-year follow-up study was made in one plant of another company to see how tests could have prevented certain misfits. The following conclusion was reached: "When the results of a sound psychological testing program are measured in terms of dollars and cents, the potential in cost reduction for the plant reached $40,000 a year."

Some machine shops have found psychological tests of value. One company found that by hiring only those individuals who reached or exceeded a certain test standard, it could save $2,035 annually. It also reported that the testing procedures had been a big factor in dropping the turnover rate more than 74 per cent in five months.

In the hosiery manufacturing field, The Blue Bell, Inc., reported that a visual screening test in conjunction with dexterity tests increased its efficiency in selecting and training workers 18.6 per cent. It added that these tests gave a saving of $80.65 on each of its 198 employees during an entire year. It also added that the turnover rate dropped 5.7 during the same year.

Growing Use of Tests

Recent surveys show that many types of psychological tests are being used more and more by progressive managements to measure and evaluate the abilities, aptitudes, and skills of employees. For example, recently a study was made of the personnel practices of 280 industrial firms[1]. Figure 1 shows the extent to which these companies made use of different kinds of psychological tests.

Training

A progressive business or industrial organization does not leave the training of its employees to chance but provides systematic instructions on many phases of its operations. The objectives and goals of training programs vary greatly. Some are very narrowly conceived, stressing immediate increase in production; others are developed on a broader base, assisting the worker not only in his job performance but in other areas of performance related to his job. In this broad view the worker as well as his work occupies the central position.

Training deals with workers with a variety of backgrounds. Some of these workers have more ability than their fellows, some have better work interests and experience, and some have greater zeal to get ahead and make good. The purposes of training should be not only the improvement of effective work habits and methods of work but also the development of desirable attitudes and motives.

Training employees is likely to become more and more costly. Jobs are becoming more technical; they require longer to master, and they are frequently very narrow and specific in their requirements. More training on a broad front will be necessary to develop a versatile group of employees who can do many technical jobs well in case they must replace others who are out due to sickness, leave, vacation, promotions, and dismissal.

The training director for Johnson and Johnson, a company which has several textile plants in Georgia, recently reported that, "A new employee costs our company about $250 before he becomes a productive worker. Every time a new man is hired and is not properly placed on the job, it costs the company $250. If the man is then transferred to another job and fails again, it will cost the company another $100 to $150."

In fields where college graduates are employed, the companies' training costs are naturally much higher and are still growing. McMurray made a study of 1,167 college trainees chosen by 247 chemical companies over the country.[2] He reported that only 58 per cent of the group were judged suitable after one year. The training cost averaged $2,750 per individual or a grand total of $1,347,500 to all the companies involved.

Kinds of Training

A training program for supervisors proved more valuable for developing a special skill in employees than mere job experience. The time required to change knives on flying shears had shown no improvement over a period of six years in spite of the fact that the individual workers had been given extensive training. However, after a training course for the workers' supervisors, the time was reduced

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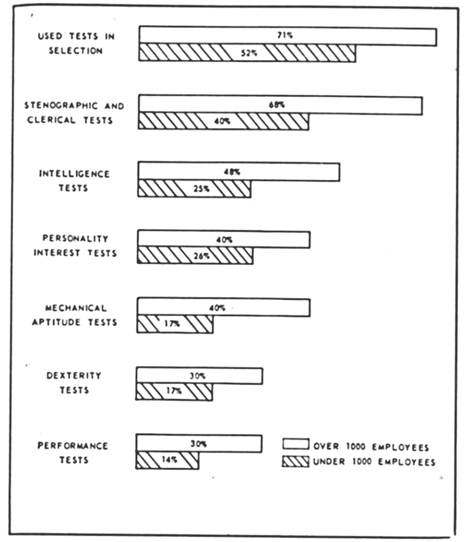

Figure 1. This graph shows the psychological tests used by 280 companies.

from an average of 29 minutes to 18 minutes. This reduction in time saved the company $20,880 a year.

Teaching and training employees for jobs is primarily a psychological problem requiring fundamental knowledge of human learning. To set up sound procedures for training employees calls for broad knowledge of learning principles so that each step in the process is relevant and essential to a particular training objective.

Interviewing Workers

Interviewing is probably the most widely used technique in personnel selection. It is not a simple technique to use at the highest level because there are usually three basic variables operating: (1) the person doing the interviewing, (2) the person being interviewed, and (3) the general situation in which the interview is being conducted. Good interviewing methods for selecting employees can be developed and in most cases brought to a high level of proficiency.

Let us review briefly some of the uses of the interview. They are: (1) obtaining certain information from job applicants, (2) giving various kinds of information and instructions to applicants, and (3) influencing and motivating the applicants. Effective use of the interview may depend to a great extent on the kind of application form which has been filled out prior to initiating the interview. Certainly no interview time should be used to gather information which might better be obtained some other way.

The kind of person doing the interviewing may well make the difference between success and failure. Here are a few guides which have proved useful in selecting interviewers: (1) people should be chosen who have genuine interest in and curiosity about people, (2) they should be above average in intelligence, understanding, and sympathy, and (3) they should be adaptable to various kinds of social situations.

Special training is needed for developing top-flight interviewers. To "like people" and to want to "help people" are not sufficient to become a sensitive interviewer. Training of a high level is essential to qualify one to interview well.

Among the methods which make little improvement in interviewing are: (1) using axioms, (2) using slogans, (3) resorting to broad generalities, or (4) making casual or superficial observation. In contrast, real changes in interviewing have been brought about by the use of the following: (1) a sound review of the basic principles and fundamentals of patterned interviews, (2) presenting model interviews, (3) providing for extensive and varied practice under close supervision, (4) recording interviews so that specific needs may be met, and (5) stressing the memorization of key items on the record forms used in connection with interviewing.

There are numerous kinds of interviews. The needs of a particular company can best be met by a specific type of interview. Some meet one need, some another. A brief list of the types of interviews might include:

(1) *Screening:* to see if applicants appear to meet minimum needs.

(2) *Directive:* involving specific questions for which specific answers are expected.

(3) *Nondirective:* giving the applicant a chance to talk freely at his own discretion.

(4) *Panel:* involving two or more people who ask questions and evaluate the answers and the reactions of the applicant.

(5) *Stress situation:* putting the applicant on the spot; for example, by asking him to come in and have a seat after having removed all the chairs, etc.

(6) *Exit interview:* if properly done, may give the company many helpful suggestions about morale, supervisors, working conditions, etc., in the plant.

Job Analysis

Job analysis is a method of obtaining information about a job. The problems of fitting men to jobs require that we know how to analyze abilities, and this is a purely psychological problem. The most practical and useful method of obtaining this information is to have a trained psychologist observe the job. The basic questions to be answered are what, how, and why is it done. The result of the analysis is to provide facts which should lead to better employee placement.

To get sound information from job analysis one first must determine what specific uses are to be made of the occupational information obtained. If the main use is merely to identify and assign appropriate job titles, only a brief analysis is necessary. If the plant intends to use job descriptions and job specifications to develop a program for testing job applicants, then a large number of items must be included in the analysis.

Job analysis then is a method of solving employee problems by means of occupational information. Thorough and accurate information concerning jobs enables the psychologist, the personnel worker, and the supervisor to solve plant problems. For example, if it is advisable to develop an aptitude test or selection test battery for certain jobs, then accurate information must be secured on worker production or output. Unless there are available reliable job standards and job performance records, it is not worthwhile to attempt to standardize a set of aptitude tests for selection purposes.

Good, accurate job analysis can help solve many problems other than helping to select workers. The information obtained can often be of great help in planning and executing training programs within the company. The results can also help to give guidance to vocational schools and technical institutes, etc., in curriculum planning.

Job analysis can help place workers where they can do their most effective work. This is especially true when the questions of transfer and promotion arise. Job analysis also is useful in evaluating jobs for pay purposes. The characteristics of a job must be weighed in terms of working conditions, hazards, responsibility, supervision of others, skill demanded, education, training, and so on.

Motivation of Workers

The working man strives for many types of satisfaction. As he does so, he is in turn acquiring new needs, both in and out of the plant. In short, he does not work for mere wages alone. He has many needs. He wants to be accepted by his fellow workers; he wants to understand what he is doing and what purpose and meaning his efforts have. He wants to have supervisors who treat him with respect and try to understand him.

The deeper understanding of what motivates workers calls for many changes in plant philosophy and procedures. The procedure for inducting new employees should not be left to untrained individuals. When employees are transferred to new jobs, they need proper orientation not only to their new work but to the people with whom they work. The worker needs to feel that he belongs to a desirable group of workers in a respected plant.

Most workers have much more potential ability for work than we are presently able to get from them. Sound principles of motivation strive to get the worker to want to do more work, better work, and avoid increased breakage and wastage as he does it. Industrial psychology can give reliable advice and guidance in helping management develop and use sound basic principles of human motivation.

Product Testing

The key approach to customers' buying behavior is to study the way they go about purchasing a particular article. This study must be well planned and systematically carried out. Short cuts and superficial studies of buying behavior generally do not lay a dependable foundation for the building of customer good will and satisfaction.

There are three main ways of studying customers' buying behavior: (1) controlled inquiries, in which interviews and/or questionnaires are used to ask questions about their buying habits and the causes of their motivation to buy; (2) field studies conducted by going where the consumers buy and making specific observation of their behavior as they buy; and (3) experimental studies where the specific conditions can be established and varied as desired.

Accidents

The human factor in accidents is becoming increasingly apparent. Machine guards, safety programs, illustrated posters, and so forth have not reduced the number of accidents appreciably. The greatest reduction of accidents must come through getting the employee to want to be safe.

Safety programs with too great an emphasis on safety may, paradoxically, contribute to having more rather than fewer accidents. A worker who has learned to ignore certain obvious dangers in his work may through posters, etc., become afraid of getting hurt. His newly aroused fear may cause him to be jerky or awkward or slow in an operation which was formerly smooth and well-coordinated; and as a result he gets hurt.

Employees may have work which due to its visual characteristics, its sequence of motion, its noise, its heat or its pressure causes sleepiness which leads to accidents. For example, girl employees who had to reach up, grasp a black bar that was above eye level and pull it down had many serious accidents. The injuries sustained by these employees were due to serious falls where their bodies crashed into machines. An investigation of the causes of accidents revealed that the black bar being pulled down caused the workers' eyes to follow it down, then up and down. The end result was that workers became self-hypnotized and fell in a coma-like trance. The remedy was a white bar on the machine against a white background.

Accidents are to some extent due to faulty attitudes on the part of the employee. He does not care, so we say. It is possible to get employees to care, to want to be safe, to want their department's record for safety kept high and their plant rated tops. It takes time and psychological know-how, but it can be done and done effectively.

Summary

Industrial and personnel psychology can aid management in many ways. We have pointed out that sound employee testing can select workers who learn more easily and quickly; that training employees is becoming more costly; that directors of training need broad knowledge of human learning and how to change human adjustment with speed and dispatch; that sound job information based on job analysis must lay the groundwork for sound employee selection, placement, and training; and that interviewing can be made more consistent, more helpful, and more valuable. We merely glimpsed the future of product testing and consumer services. We pointed out some of the psychological aspects of accidents.

Psychology offers no panacea to business and industry. However, the facts, principles, and techniques of psychology can help management build a sound foundation for a happier, more productive work force.

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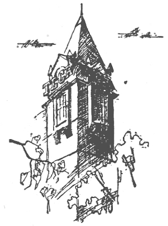


the president's page

Georgia's public relations is being improved throughout the nation by the strenuous efforts of Governor Marvin Griffin. One of the most progressive steps the governor is taking is his series of dinner meetings with top industrialists. He already has met with blue ribbon groups in New York and Chicago, and this month he goes to Cleveland, to describe Georgia's attractions for industry.

Georgia's share of new industry, he said in his most recent talk, has brought about a transformation from virtually an all-agricultural state to a state in which agriculture is becoming balanced by industry.

Governor Griffin is to be commended for presenting to national industry Georgia's many attractions: natural resources, climate, intelligent labor, technical manpower, transportation, favorable building costs, and research facilities.

In today's world situation, however, with the ever-present threat of atomic war, Georgia offers to industry an added inducement, that of the opportunity for industrial decentralization. For reasons of economic and military security, new industry should be located in the uncrowded areas of the country. In short, we must assure national safety by dispersing industry over as much of the vast space of the United States as is feasible.

As early as 1951, the Joint Congressional Committee on the Economic Report said, "Since there is no known defense against the atomic bomb itself except space, dispersion is one of the first considerations for strategic safety of industrial facilities."

Representative Richard Bolling, of Missouri, has introduced into Congress a resolution regarding industrial dispersal. An interesting aspect of his proposal is that he considers defense research just as important as defense manufacture and argues the necessity for dispersal, as well, of both Government and industrial research.

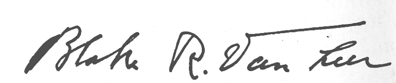
"Along the Charles River in Boston and Cambridge," he writes in a recent magazine article, "there is a terrifying concentration of scientific research, most of it defense-oriented, all of it with defense implications. And it is right at the center of a target area. . . . New contracts have led to an even greater concentration of research talent in the field under study by bringing more specialists to Cambridge."

Representative Bolling advocates the dispersal of Government research to college laboratories throughout the country. Only thus can manpower resources be considered strategically safe.

Industry learned the tragic price of over-concentration of production facilities when fire demolished the huge defense plant at Livonia, Mich., several years ago. That experience encouraged many of the nation's largest producers of defense materiel to accelerate the trend toward decentralization of manufacturing plants.

No civil defense measure is more important as a means of protection in atomic war than national dispersal — not only of production, but of research and development, as well. As more and more progressive industries move part of their production facilities south, Georgia Tech will have an increasing opportunity to be of service.

Already, in the words of Governor Griffin, "decentralization of industry was the best thing that could have happened" for the nation's private enterprise. An accompanying decentralization of research would be equally beneficial to our freedom and national security.



President, Georgia Institute of Technology

Technological Information

ROBERT J. KYLE, head, technical information section

Man's vast store of information is made more accessible to the scientist by a trained group of literature sleuths. Here's how

The solicitation of new industry in a community, superior management planning, the investigation of market potential, and utilization of effective personnel practices are all parts of the total picture of industrial expansion. A still better known part is production, with its modern concepts of wage incentives, inventory control, automation, and a multitude of other innovations.

Most of us appreciate the fact that much of our industrial expansion results from research. Whether the result of the "pure scientists" seeking only understanding or of an applied engineer concentrating on the development of a specific process, research leads to new products and improved methods of making old products.

In his quest for knowledge man has already thought about, even experimented on, a majority of industry's contemporary problems. Fortunately, man has a habit of recording his thoughts — storing them in his writings. This habit stems from many things, varying from a feeling of obligation to share his discoveries with his fellow man to a realization of the commercial advantages of advertising, either as an individual or as a company striving to establish, or to maintain, a reputation.

Staggering Store

The total store of information has already reached staggering proportions, and the increasing rate at which it is being accumulated is astounding. About 400 years ago, when Leonardo da Vinci was applying principles of physics to such "modern" developments as the airplane and the submarine, it was comparatively easy to assimilate the written information which was available. However, today's industrialists, scientists, and engineers, if they are to develop a complete background in their fields, find themselves confronted with the impossible task of reading and understanding thousands of books and tens of thousands of articles. In addition, they must constantly survey new books and technical journals. Obviously, there must be time left for each individual to do his own constructive thinking and experimenting or, except for personal gratification, his efforts would be totally wasted. One Georgia Tech physicist summarized the hopelessness of the situation when he said that people can publish articles faster than he can even read the titles!

In spite of the difficulty of keeping abreast of new developments, few industrialists would dispute the importance of this knowledge. About 50 percent of the products manufactured by du Pont, one of the oldest and best established chemical companies in the world, were not being produced 20 years ago. Many other industries have experienced equal changes. Even when established industries are developing so rapidly, new plans and new ideas must be made and evaluated almost continuously.

Large and small industries face this problem. It is expensive to study a proposed idea, but it costs even more to overlook available information. An obvious solution to this problem is for each individual to study only those writings which pertain exactly to the subject of immediate interest. Of course it is seldom possible to find a ready-made list of required references. Hence, such lists must be laboriously compiled. Then original references must be reviewed, and, if pertinent, they must be studied. The task of collecting and studying a good bibliography is so time-consuming that most investigators are deterred.

In order to prevent the likelihood of superficial preliminary studies and still preclude having laboratory scientists spend unnecessary time in the library, many industrial organizations, some technical libraries, and practically all research organizations have set up individuals or groups to conduct library research. Sometimes this unit is a single librarian with no technical education; other times it is an extensive organization with a number of specialists in the most important fields.

At Georgia Tech, as elsewhere, the information group, called the Technical Information Section of the Engineering Experiment Station, is primarily an auxiliary organization. It must, therefore, direct its efforts to assisting others in their work. Information searches are often carried out as individual projects for industry or for governmental agencies. In other cases, they are a part of larger projects conducted by the Engineering Experiment Station.

Types of Studies

An effective way to collect needed information is to find a single recent article which gives a good perspective of the overall field of investigation. Usually such articles have bibliographies which can be used to secure additional information which is particularly pertinent to the investigator's problem. Another way is to make an extensive study of all of the available published information, including foreign articles, books, and patents. It is frequently necessary to supplement this material by seeking information from unpublished sources. Some studies include correspondence and visitations with industrial companies, associations, or research laboratories. Trade catalogs and similar literature may be collected. Graduate students' theses often give information available from no other source.

Most literature surveys can be classified in one of the following types:

1. Answers to specific questions
2. Abbreviated bibliographies
3. Bibliographies
4. Annotated bibliographies
5. Literature reviews
6. Continuous surveys
7. Patent surveys

Specific Questions

Type 1, the simplest, may be short answers to one or a few short technical questions. Although many such questions can be answered very quickly, their value to the inquirer can be great. If a plant is shut down for want of a technical trick, getting it back into production is, for the moment, the most important thing in the world to management. Sometimes specific questions may seem ludicrous; for example, "How much time elapses between the instant when a battery officer signals 'Fire' and the instant his cannoneer actually pulls the lanyard" or "What is the frequency of the sound impulses made by shrimp." Under the circumstances in which each question was asked, of a technological information group at a research organization, neither was at all funny.

More common types of inquiries submitted to a research institution such as the Georgia Tech Engineering Experiment Station are these: "What is the melting point and molecular weight of vitamin A?", or "What are the differences between the American Society of Testing Materials standards and the Society of Automotive Engineers standards for automobile antifreezes?"

Robert J. Kyle holds two degrees from Georgia Tech, B.Ch.E., 1949, and M.S. in industrial engineering, 1951. He has been employed by the Engineering Experiment Station since 1948, working successively in the micromeritics and coatings laboratories, and, since 1950, in the technical information section. For the past two years, as a research engineer, he has headed this group, which serves many Station projects, as well as conducts more extensive surveys of various kinds.

Bibliographies

Type 2 is abbreviated bibliographies, which are called for when a question has such a complex answer that it is necessary to compile a list of references in order to substantiate the findings. Pertinent references are particularly necessary when individual authorities disagree on some points.

Type 3 is bibliographies, which are generally considered rather comprehensive. Occasionally, they cover a specified number of years. In other cases, they may contain only the information published in certain journals or reviewed in a given abstract journal. In all cases they represent a relatively complete collection of the literature on the given subject. Often they include hundreds of individual references, including books, journal articles, trade literature and catalogs, and patents. The Engineering Experiment Station's bulletin on bamboo, published in 1954 and containing 1,034 references, has been the most popular publication ever issued by the Station.

Type 4 is annotated bibliographies. When a general field is the subject of investigation for a substantial period of time, or the subject of a very thorough investigation, it is desirable to have an extensive collection of all the literature which can be found, together with an indication of the exact material contained in each reference. The Engineering Experiment Station has published book-length annotated bibliographies on such subjects as frozen foods, manganese dioxide for batteries, solvent extraction, and water-sewage analysis. Two such studies are underway at present: a comprehensive annotated bibliography and review of the literature on the simultaneous fluid flow of vapors and liquids, and a more restricted survey on the common defects in enameled steel surfaces. Annotated bibliographies are not necessarily long, for it is often desirable to have abstracts with even the most superficial bibliographies.

Literature Reviews

Type 5, one of the most useful compilations of references, is literature reviews.

Miss Zanier Downs, of the Georgia Tech Library, helps a student locate a needed reference.

In preparing a review, it is customary to collect all the literature which can be made readily available, although the survey can be as extensive or as superficial as fits the individual need. Usually, the original references are consulted in their entirety. They are read and digested, and a summary is drawn of the findings of the various investigators who have written on the subject. Review articles generally refer to the original material from which the material is taken. They may or may not include a critical discussion of the validity of the various articles surveyed.

Type 6, continuous literature surveys, is aptly described by the name. Many companies have their librarians or other persons on their staff perform continuous literature surveys. It is not uncommon for a company or a group of companies to have a continuous review prepared for them by an external organization. For a number of years the Engineering Experiment Station made a monthly summary of literature references of importance in the oil industry for 11 of the nation's leading oil companies. At present a continuous survey is made for the Chemical Sciences Division of the Station, in which references from more than 100 journals are abstracted monthly. The Station has found these abstracts so valuable for its own research staff that it is now considering offering "tailor made" continuous literature surveys to interested companies.

Patent Surveys

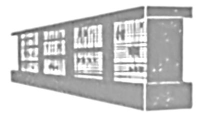
Type 7, patent surveys, vary to an extraordinary degree in their complexity. At the beginning of each patent application, it is customary to have a patent search made. These searches are usually performed by patent attorneys for a nominal fee. They include only the most obvious references related to the patent idea. However, they often serve to show that the idea has already been patented and that the investigator would be wise not to apply. In other cases, patent surveys are made in an effort to determine how a given product is being manufactured. If a process is known to be patented, it is conceivable that a patent survey will lead to the patent which gives a complete description of the process. Obviously, the patentee is still protected by his patent. However, the knowledge of a patented process may lead a competitor to a research investigation which will produce an even better process.

The most extensive common variety of literature surveys are patent searches called "validity searches." When a company holds a particularly important monopoly by virtue of a patent, a competing company may undertake an extremely comprehensive review in the hope that it will be able to discover some early reference to the patented invention. If such reference precedes the date of the patent, it may indicate that the patented idea is not truly an invention but an adaption of earlier thinking. Thus, the competitor can break the patentee's monopoly of the process and the patented subject available to the general public. The patent system is one of our strongest foundation stones in the free-enterprise structure. The technological literature surveyor often is competent to undertake patent surveys.

Conclusion

The resources which modern man possesses hold tremendous opportunities and promises for the future. It is obvious that man must use these resources wisely if he is to profit to the maximum from his heritage and future achievements. The wise appraisal of the things which man has already discovered contributes to the high level of industrial development which we all covet.

We are fortunate in the South, as well as in other parts of the United States, to have the basic ingredients necessary for continued industrial expansion — careful evaluation of future market areas, good management and personnel procedures, proper utilization of our manpower resources, detailed economic studies of each new plan, and experimental research to fill in the gaps in our knowledge. Such reservoirs as the excellent Georgia Tech Library can best be tapped by a group of trained, experienced literature surveyors. Such a group is the Technical Information Section of the Georgia Tech Engineering Experiment Station.



the computer center

THE NEW WING of the Research Building to house the Rich Electronic Computer Center, a division of the Engineering Experiment Station, was completed in early August. The staff immediately began installing the ERA 1101, a large-scale, high-speed electronic computer manufactured by the Engineering Research Associates plant of the Remington Rand Division, Sperry Rand Corp.

Late in August, the CRC 102D, a medium-scale, high-speed electronic computer manufactured by the Electronics Division, National Cash Register Co., was delivered. Both machines were in operation by the first of October.

While awaiting delivery of the two basic computers, the staff of the Rich Electronic Computer Center did some figuring — without, of course, the aid of computing machinery. Using paper and pencil, they arrived at the following interesting statistics:

1. The 10 program and operations specialists now on the staff have an average age of 33.

2. Despite their collective youth, and the fact that the field of electronic computation is only about 10 years old, the 10 staff members have a cumulative total of 45 years' experience with computers.

3. Both of the computers, the ERA 1101 and the CRC 102D, with which the center soon will begin operations, are among the 15 machines on which staff members have had programming or operations experience. The others are ILLIAC, ORACLE, SEAC, MARK II AND III, NORC, IBM CPC, IBM 602A, IBM 604, IBM 650, CRC 102A, ERA 1102, and MADDIDA 44A.

The Rich Electronic Computer Center is under the direction of Dr. Eugene K. Ritter. He previously has headed the Computation Department of the University of Michigan's Engineering Research Institute and the Computation and Ballistics Department at the U.S. Naval Proving Ground.

The purposes of the Rich Electronic Computer Center are three-fold: education, service to industry, and research.

Plans will be announced soon for the dedication ceremonies. All addressees on THE RESEARCH ENGINEER's mailing list will receive an announcement.

The Rich Electronic Computer Center occupies the new north wing of the Research building.

letters

EDITORS: We have read with interest the Sigma Xi Research Award Lecture of last June, "Scientific Research — A Craft and an Art," by J. Elmer Rhodes, Jr., published in RE for July 1954. We like what Dr. Rhodes has to say and would like to condense it and publish it as an article. Do we have your and Dr. Rhodes' permission?

Dwayne Orton
Editor, THINK
International Business Machines, Inc.
New York, N. Y.

After a little THOUGHT, we gladly gave permission, and THINK published the article in the July 1955 issue.

EDITORS: I am enclosing a copy of the speech I made at the annual meeting of the Atlanta League of Women Voters on March 30, in which you will see that I took the liberty of quoting from President Van Leer's excellent article in the October 1954 issue of RE. It seemed to me that it was such a good, brief summary of the trade picture in relation to Georgia that I was very happy to have it . . .

Charles P. Taft
Cincinnati, Ohio

Mr. Taft spoke as president of the Committee for a National Trade Policy, which supported President Eisenhower's policy of easing tariffs by reciprocal treaties, since adopted by Congress. He is a distinguished lawyer and churchman and brother of the late Senator Robert Taft.

EDITORS: I'm enclosing a condensation of the article titled "Underwater High-Speed Photography," which appeared in RE for October 1954. Feeling that this article would interest many of our readers, we would like to publish it in our September-October issue. We would like all of the photographs which originally appeared with it. Also, could you send a few more representative high-speed movie frames . . .

Ben Melnitsky
Editor, *Industrial Photography*
New York, N. Y.

RE is not copyrighted for the specific reason that we hope other publications will reproduce material from our pages. We always appreciate credit, of course.

EDITORS: I was very much interested in the April and July RESEARCH ENGINEERS. The articles by Drs. Edwin J. Scheibner and Edward E. David, Jr., plus the fact that their alma mater chose to publish their work, show very clearly the standing which they have attained at the Bell Telephone Laboratories. I am sending the copies of THE RESEARCH ENGINEER to Dr. Kelly, the president of Bell Laboratories, who I am sure will be pleased over the recognition your publication has accorded these two graduates of Georgia Tech.

Hal S. Dumas
Executive Vice President
American Telephone and Telegraph Co.
New York, N. Y.

Mr. Dumas is a member of the advisory council of the Georgia Tech Research Institute and as such maintains a continuing interest in education and research here. We share his pride in these young alumni and the professional names they are winning for themselves at one of the world's outstanding industrial research institutions.

EDITORS: I want to thank you for your courtesy in sending me a copy of the July issue. I am especially grateful for the extremely kind comments made by President Van Leer on The President's Page. It has been my privilege to devote much of my career to the advancement of education in Georgia and throughout the nation. My contributions have been insignificant compared to those of persons who, as educators, devote their entire careers to the cause of greater public enlightenment. The results have been sufficiently rewarding without the necessity of any compliments such as President Van Leer paid me, even though I do very much appreciate them.

Walter F. George
United States Senate
Washington, D. C.

RE published in July a letter from Philip C. Pendleton, treasurer of the University of Pennsylvania, informing friends of Georgia Tech that Senator George vigorously supported recent legislation designed to benefit educational institutions. President Van Leer commented on the new laws and added his thanks to Senator George.

publications

Walton, Jesse D., Jr., "Apparatus for Automatically Recording Strains Between Enamel and Metal." Reprinted from *The Journal of the American Ceramic Society*, Vol. 38, No. 3, pp. 114-118, March 1955. Reprint 92. Twenty-five cents.

This paper describes the construction and operation of a mechanism for converting the movement of an enameled split ring into a suitable electrical signal to be automatically recorded. It also presents strain curves for a single enamel when applied to several metals. These data were used to determine the relationship between the strains recorded and the properties of the metals to which the enamel was applied. The strain curves obtained when three different metals were enameled with the same ground coat and cover coat agreed with the expected strains.

Goglia, M. J., H. W. S. LaVier, and C. D. Brown, "Air Permeability of Parachute Cloths," Reprinted from *Textile Research Journal*, Vol. XXV, No. 4, pp. 296-313, April 1955. Reprint 93. Twenty-five cents.

The air permeability of 8 standard nylon parachute cloths was determined, using samples 6.05 in. in effective diameter. Fifty-nine experimental nylon cloths manufactured by the Bally Ribbon Mills were subjected to the same test procedure, as were 2 experimental fabrics of Orlon and Dacron, and 4 different samples of wire screen.

Upon assuming that the pressure gradient in the flow through a parachute fabric is proportional to the arithmetic sum of an inertial ($\beta \rho v^2$) and the viscous contribution ($\alpha \mu v$), the existence of a parameter, β/α (whose measure is length), can be inferred. This length can be employed to characterize the geometry of the cloth. Experimental work to date in the case of the 8 standard nylon cloths, the Orlon and Dacron fabrics, 14 of the Bally Ribbon cloths, and the 4 wire screen samples indicates a justification of the assumption.

Employing the characteristic length so determined permits writing a single relation common to all cloths between a "flow-through-drag coefficient," C_f, and a Reynolds number based on the characteristic length, viz., $C_f = 2 + (2/N_{Re})$.

A procedure is suggested for estimating the parameters α and β from physical measurements for plain-weave cloth; thus an indication of the permeability is predicted from construction details of the fabric.

Orr, Clyde, Jr., and H. G. Blocker, "The Viscosity of Suspensions of Spheres." Reprinted from *Journal of Colloid Science*, Vol. 10, No. 1, pp. 24-28, February 1955. Reprint 94. Twenty-five cents.

Particle size distribution, often suggested as a factor influencing the viscosity of suspensions, is considered quantitatively. By an analysis of previously reported data, the viscosity of suspensions of spheres from the lowest to the highest concentration is shown to be described in terms of the viscosity of the pure liquid, the volume fraction of solids, the packed sediment volume of solids, and the geometric standard deviation for the solids.

These and other technical publications may be obtained, and the complete publications list requested, by writing Publications Services, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia.

Three Appointed Regents' Professors

THREE ENGINEERING faculty members with national and international reputations in their fields have been honored by the Board of Regents of the University System of Georgia by being appointed to the distinguished positions of Regents' Professors.

They are Dr. Joseph M. DallaValle, chemical engineering; Dr. Mario J. Goglia, mechanical engineering; and Prof. C. E. Kindsvater, civil engineering.

Only three other faculty members at Georgia Tech previously had been named Regents' Professors.

engineering experiment station

atlanta, ga.

news

georgia institute of technology


Adm. Williams

REAR ADMIRAL RICHARD C. WILLIAMS, USN (Ret.), a member of the Station's staff, has been named an Honorary Commander of the Most Excellent Order of the British Empire. The appointment came from Her Majesty the Queen of England in recognition of "services to the cause of the United Nations during the hostilities in Korea." Sir Roger Makins, the ambassador to Washington, presented the citation and medal at an impressive ceremony June 27. As commanding officer of Minesweeping Task Group Three in 1951, then-Captain Williams was responsible for clearing both coasts of Korea, where he frequently swept in advance of British naval and military activities.

RESEARCH ENGINEERS *Thomas A. Elliott, Robert L. Allen, and Ben W. Carmichael have become the first Station employees to receive royalties for the use of a patented device developed here under Station-sponsored projects. Eighteen months ago they were issued United States Letters Patent No. 2, 674, 374 on their invention, the corrugated slot screen for cleaning peanuts. They assigned the patent to the Georgia Tech Research Institute, which licensed the use of the machine.*


Dr. Bellinger

DR. FREDERICK BELLINGER, chief of the Chemical Sciences Division and an outstanding chemical engineer, in September began a year's leave to undertake a United Nations assignment to Egypt. Under arrangement with the United Nations Educational, Scientific, and Cultural Organization (Unesco), he is advising and assisting the Egyptian government in establishing an industrial research activity. Dr. Wyatt C. Whitley, professor of chemistry and research associate, is serving as acting chief of the Engineering Experiment Station's Chemical Sciences Division during Dr. Bellinger's absence. Dr. Waldemar T. Ziegler, professor of chemical engineering and research associate, is serving as part-time technical advisor to Dr. Whitley.