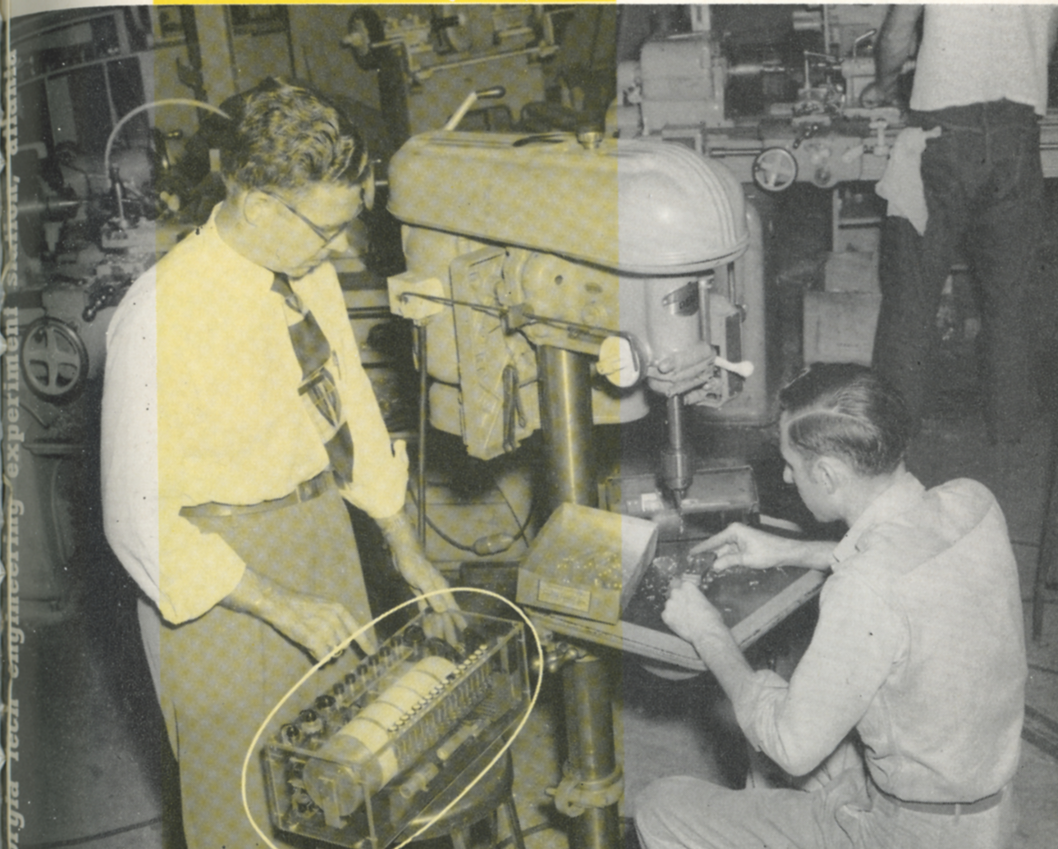
the research engineer

july, 1954



time study machine

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cover

Harrison M. Wadsworth, Jr. uses the Georgia Tech Auto-Graphic Time Study Machine in a survey of drill press operations being performed in the Station's shop by James E. Smith. Photo by Leander (Pappy) Prowse, Photographic and Reproduction Services.

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authors

J. Elmer Rhodes, Jr., Research Physicist, holds the B.S. from Birmingham Southern C., 1942, and the Ph.D. in physics from the Johns Hopkins U., 1947. Since 1946 he has been on the staff of Georgia Tech. His fields of research interest include structure of matter, solid state physics, physical properties of smokes and fogs, acoustics, and instruments. (Also see p. 14, this issue.)

Dale Jones, Assoc. Prof. of I.E. and Res. Assoc. in the Station, holds the B.S. in I.E. from Oklahoma A & M, 1942, the M.S. in I.E., from Georgia Tech, 1949, and the Engr.Sc.D. from NYU, 1952. He is an authority in time and motion studies and has developed several devices for measuring t. and m. in industrial operations. He is now writing a text entitled "Wage Incentive Principles and Practices."

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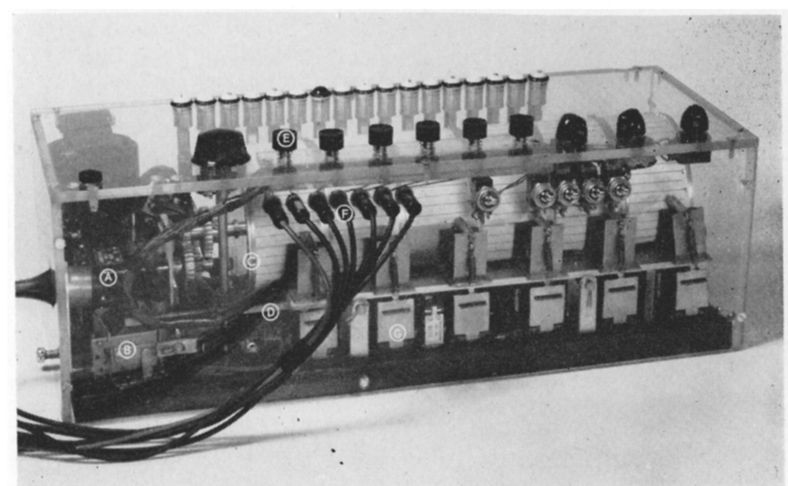
The Georgia Tech Auto-Graphic Time Study Machine

DALE JONES, Associate Professor of Industrial Engineering and Research Associate

An industrial time study is intended primarily to establish, in an optimum manner, the normal times for the divisions of work studied. By normal we mean the time required for the operator to perform work when he is following the standardized motion pattern, working with a natural movement speed. Thus, normal time is the product of observed time and the productive effort rating efficiency inherent in the observed time. The normal time for performing any given job, plus time allowance necessary for fatigue, personal demands, and minor unavoidable delays imposed on the operator, forms the basis of the production standard for that job.

Fig. 1. Close-up of the time study machine, showing its seven major components: (A) motor; (B) indexing mechanism; (C) chart-bearing shells; (D) recording mechanism; (E) manually controlled posting circuit switch; (F) automatic posting circuit; and (G) relay-controlled stops.



The time studies in any given plant must be of high quality because they determine the equity of production standards. When production standards are equitable—i.e., when employees earn incentive bonuses in direct proportion to their productive effort in excess of standard—we find maximum incentive response. When, however, there are marked inequalities in incentive bonus earnings versus productive effort among employees, we generally find many grievances and consequent low productive effort. Poor time study practice can cause such inequalities.

Large Work Divisions

The stop watch time study man faces a dilemma: He knows that accurate normal times require accurate rating, yet in order to rate operator productive effort during the time study, he must closely watch the operator during the time study. Accordingly, to devote more attention actually to observing the operator (rather than reading the stop watch and posting the reading), and to minimize timing error inherent in reading the stop watch to the nearest one one-hundredth of a minute, the time study man times the job in large work divisions.

Normal times of large divisions of work are not very useful in determining standard time data needed for synthetically establishing production standards. The compromise made by most stop watch time study men involves timing work divisions ranging in duration from .05 to .20 minutes.

This practice, however, necessitates the longer procedure of making separate time studies for separate jobs and separate product sizes on given jobs. Under such conditions, time study men often are too busy to attend to the all-important matter of job methods improvement before actually setting production time standards.

Greatest Advancement

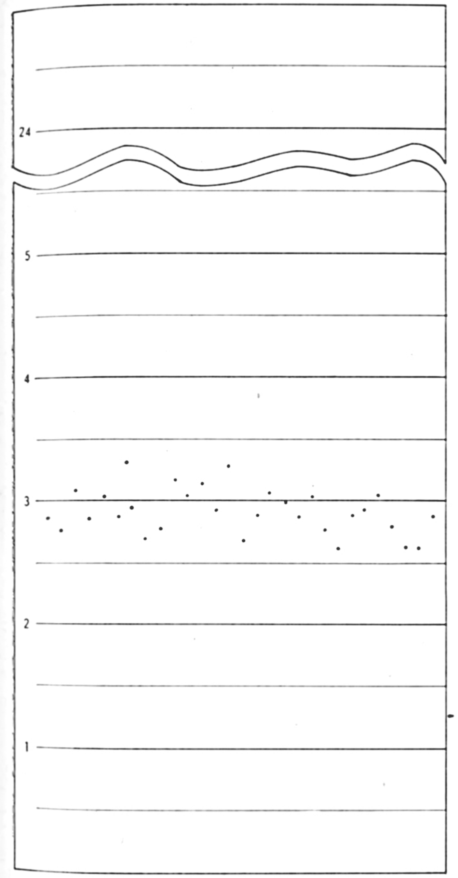
The greatest advancement in time study engineering during the past several decades probably is the development and application of synthetic motion and time study through use of predetermined movement times. The superiority of synthesis over the stop watch in setting precise work time standards for unskilled work has been clearly demonstrated on many occasions. The converse is true of skilled work: We generally find that direct time study of skilled work yields greater precision than does synthetic time study. In a typical plant, more than one-half the movements required in operations are skilled movements which cannot be synthesized with sufficient accuracy by means of the popular predetermined time tables. Instead, these movements should be directly time studied for purposes of building up predetermined skilled movement times necessary for synthesis. These movements, generally less than .010 minute in duration, should be measured to the nearest ten-thousandth of a minute to be within the accuracy limits intended when applying pre-determined movement time data.

Functions of the Machine

As an alternative to the stop watch, the author has developed, in the Rich Laboratory of Industrial Engineering, the Auto-Graphic Time Study Machine. It is expressly designed to perform three functions:

1. It automatically, graphically times individual movements in sequence. The movement times, to the nearest ten-thousandth of a minute, are recorded on separate charts. Specific movement times entailed in any timed movement sequence can be identified.

2. It is used for on-the-job time study rating practice. When so used, plus and minus five per cent normal time error curves on the time charts represent each automatically timed element of the standardized task which is rated. As the task is performed, the rater merely keeps the rating knob set at his estimate of the rating exhibited by the worker. The resultant posted estimated elemental normal times can be analyzed, in reference to the error limit curves, at the end of the study.



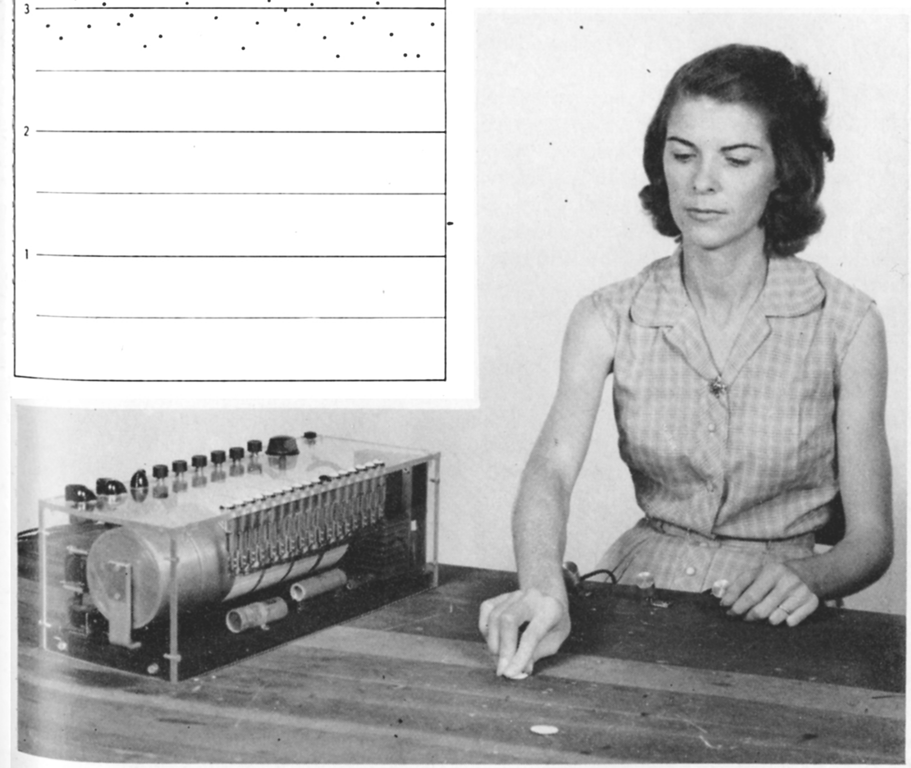


Fig. 2. (a) (left) Replica of a portion of the timing chart showing postings which could be made either manually or automatically. The entire chart is 12½ inches by 1⅞ inches. The time value between successive numbered divisions is .001 minute when the machine runs at 40 revolutions per minute, and .01 minute when the machine runs at 4 r.p.m. (b) (below) Automatic timing is preferred to manual timing when the machine is used for rating practice, and for laboratory timing work divisions of less than .020 minute.

3. It is used to make regular time studies. Estimated normal times may be posted to the normal time curve charts by controlling the rating knob as described above and by tapping the switch knobs at the ends of the separately timed work divisions.

Components of the Machine

The components of the machine (Fig. 1) are as follows:

A. A synchronous motor which, as long as the machine is in operation, revolves a cylinder, at either 4 or 40 revolutions per minute.

B. An indexing mechanism, which consists of a mount with the posting devices attached, and which is moved horizontally.

C. Six mutual, time chart-bearing shells which slip-fit around the cylinder.

D. A recording mechanism, consisting of six relay-actuated posting devices.

E. A manual posting electric circuit.

F. An automatic posting electric circuit, and

G. Six relay-controlled stops which regulate the starting and stopping of the six chart-bearing shells.

A replica of the timing chart is shown in Fig. 2 (a). The chart consists of 25 equal major divisions. Each major division represents .010 minute when the chart moves at 4 revolutions per minute and .0010 minute when the chart moves at 40 r.p.m. Since the distance between the major divisions is one-half inch, it is possible to interpolate between divisions when evaluating posted times to either the nearest one-thousandth or one ten-thousandth of a minute, depending on the speed at which the chart revolves.

When the machine is used to time successive work divisions in successive cycles, the maximum number of work divisions which can be accommodated simultaneously is six, and the minimum is three. If, for example, the cycle is divided into five elements, a switch is turned to Position 5. Then, each time a posting is made to Time Chart No. 5, Time Chart No. 1 starts revolving from the zero time idling position. At that moment, the poster mount automatically indexes horizontally, provided the automatic indexing switch knob has been set in the "on" position.

Although the machine was developed primarily to time short elements and movements, there is no limit to the length of an elemental time which any given chart can time. This is possible because any given relay-controlled stop remains lowered as long as the time chart which it controls is in movement, timing its element. As previously explained, the stop resumes its chart-stopping position at the moment its time chart receives a posting.

Accurate timing with the machine requires that each elemental time chart be idling at its zero time position at the moment the time posting of the preceding element is made (this being the moment the idling chart begins revolving). Thus, when the cylinder speed is set at 4 revolutions per minute, the total cycle time must exceed .25 minute; when the cylinder speed is set at 40 revolutions per minute, such as would be the case when timing very short elements or movements, the total cycle time must exceed .025 minute.

Manual or Automatic Timing

Manual timing, as illustrated in the cover photograph, is recommended for making time studies of standardized, repetitive operations. At the end of each work division being separately timed, the operator of the machine merely taps the corresponding switch knobs on top of the machine, causing electric posting to the time charts within the machine.

Automatic timing, as illustrated in Fig. 2 (b), is preferred to manual timing when the machine is used for rating practice and for laboratory timing work divisions of less than .020 minute. The worker is automatically timed as he activates highly sensitive electric switches integrated with the operation. Closing the switches causes posting and other activity, identical to that resulting from manual operation of the machine. Automatic timing is more accurate than manual timing because it eliminates error due to variation of human reaction time, inherent in tapping the switch knobs.

In order to post estimated normal times with the machine, the automatic horizontal indexing mechanism must be disengaged and the charts of normal time curves attached to the chart shells.

Fig. 3 illustrates a replica of a portion of the chart of normal time curves. As previously mentioned, the ordinate of any chart posting denotes the recorded performance time for the element accommodated by the chart. When the illustrated charts of normal time curves are used, the abscissa of posting represents the time study man's estimate of the productive effort with which the element was performed. Reading from left to right along the abscissa, it can be seen that there are seventeen positions, representing increments of 5 per cent rating, from 70 to 150 per cent, inclusive. Accordingly, since the charted curves represent the product of actual performance time and productive effort ratings, they are normal time curves.

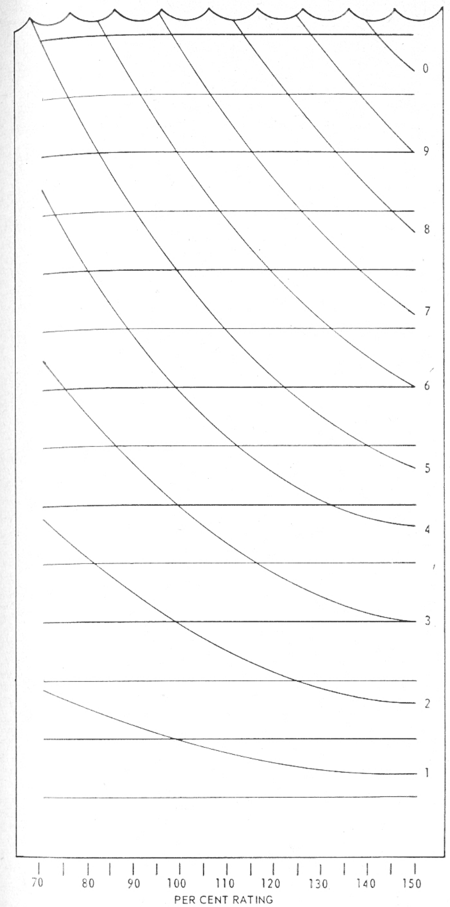


Fig. 3. Replica of a portion of the chart of normal time curves.

When the machine is set up for posting estimated normal times, the horizontal (abscissa) position of the poster-bearing mount is always shown to the operator of the machine via the numbered pilot lamps on the top of the machine. For example, if the posters are at the 110 per cent position, Lamp No. 1 glows. If the posters are in the 85 per cent position, a lamp between Lamp No. 8 and Lamp No. 9 glows. The operator of the machine easily can shift, from left to right, the mount bearing the posters, by revolving the rating knob, which clicks each time the mount moves one position, or five per cent of the scale. Thus, since the pilot lamps always reveal the rating position of all posters in respect to their charted normal time curve abscissas, and since the chart normal time curve ordinates are automatically accommodated by the revolving of the charts, the time study man can post estimated normal times to the charts by:

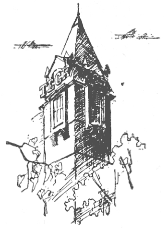
1. Regulating, with the left hand, the rating knob to set his estimate of the operator's productive effort rating, and

2. Tapping, with the forefinger of the right hand, the proper posting switch knobs at the ends of their respective elements.

The machine's predecessor, described in *Advanced Management,* April, 1953, proved in extensive tests to be significantly more precise in establishing estimated normal times of less than .10 minute than the conventional stop watch time study method. The rating mechanism of the machine makes possible this superiority. Because of the refinements inherent in the Auto-Graphic Time Study Machine described in this article, even greater time study precision should be possible.

ACKNOWLEDGEMENT

The author acknowledges the valuable assistance of Mr. Jesse C. James, Research Physicist, Engineering Experiment Station, in the development of the electric posting circuit of the Auto-Graphic Time Study Machine.



the president's page

"This situation of engineering research in engineering schools in the South is crying to high heaven for attention and organized effort," a leading industrial scientist wrote recently.

The author was M. Earl Heard, Vice President and Director of Research of West Point Manufacturing Co. His remarks were published in the July-August *Journal of Southern Research,* the official voice of the Southern Association of Science and Industry, and a section in the magazine *Southern Chemical Industry*.

"Certainly, I have no desire to see anything taken away from research in agriculture," Mr. Heard declared. But he forcefully decried the disproportionately small amount of money all southern states—especially Georgia—appropirate for engineering and industrial research, in comparison to agricultural research.

In 1952, Georgia's farm income (all receipts) amounted to $652,000,000, whereas industrial income (payrolls and profits) amounted to $3,173,000,000, a farm-income to industrial-income ratio of 20.55 per cent.

In 1952-53, the state allocated $1,033,500 to the Georgia Agricultural Experiment Stations, contrasted to only $100,000 to the Georgia Tech Engineering Experiment Station, an engineering-research to agricultural-research ratio of 10.33 per cent.

That fiscal year, state funds for agricultural research amounting to $1,033,500 comprised almost 50 per cent of the budget of $2,146,856. State funds for engineering research amounting to $100,000 comprised only 5.3 per cent of the budget of $1,913,479. Government and industry provided the rest of the income, in each case.

It is disturbing to Mr. Heard, and to many others, that whereas Georgia has five times as much industry as agriculture, she spends 10 times as much on research to benefit agricultural Georgia as she does on research for industrial Georgia. Nor is the situation improving; in 1953-54, the state's appropriation for engineering research dropped to $89,000.

Every citizen of Georgia would benefit from greater state support of engineering research, as well as agricultural. In many ways, the two kinds of research complement each other. For example, for the past five years the Georgia Tech Engineering Experiment Station and the Georgia Agricultural Experiment Station have been conducting cooperative peanut studies.

Several other collaborative projects now are bringing together even further the research personnel of the state's engineering and agricultural research stations. That is as it should be, because no one can deny that progress in Georgia depends on a balance between our agricultural and industrial economies. Like Mr. Heard, I have no desire to see anything taken away from agricultural research. It is, however, a fact that industrial Georgia will not prosper to its fullest potential until both industry and the state collaborate to strengthen engineering research.

Blake R. Van Leer

Scientific Research-- A Craft and an Art

J. ELMER RHODES, JR., Research Physicist

SCIENTIFIC RESEARCH is something I like to compare to a proper combination of a fine art and its associated craft. In this broad analogy, pure or fundamental research corresponds to the fine art, and applied research to the craft.

If the arts can be characterized by any one term it is "creative activity". The painter creates (by the exercise of craftsmanship, of course) an image invented in his mind. The source of inspiration may be readily apparent, as with a recognizable landscape or still life, or it may be an image born of a complex of impressions, visual and otherwise.

Another kind of artist, the writer, creates (again, by the exercise of craftsmanship) an image born in his mind and called a work of literature. Into the finished product, again, goes his touch of "creative activity". How much more the writer-artist must do than merely to narrate a possible combination of events drawn from his experiences, peopled with characters also whipped together out of the characteristics of his associates.

The scientist is no less a creator and an artist than the painter or the writer. The creative activity of scientific research is the putting together of past experiences drawn from the present body of science into new and enlightening combinations. These new combinations may turn out to have practical usefulness, or they may not.

What constitutes a masterpiece of scientific research is just as elusive as what constitutes a masterpiece in any of the other arts.

The 1954 Sigma Xi Research Award Lecture, delivered at the annual banquet of the Georgia Tech Chapter, June 4.

One thing every masterpiece must do is to communicate its message lucidly. Another is to make the message both specific and general; it must say something timely, yet it must contain generalities that can be made specific by others, both at the time of creation and later.

We may reasonably doubt that the possibilities of these future interpretations often are realized by the artist himself. Washington's Farewell Address is living political literature today and partly because generations since Washington's have been able to read into it meanings that did not exist when it was written. Any quotable piece of literature lends itself to supplying new meanings in new situations.

During World War II, Beethoven's Fifth Symphony became a victory theme, but we can be positive that Beethoven did not even know the Morse code.

Scientific masterpieces and masterpieces of other arts defy anyone's saying just what makes them preeminent accomplishments: A fortuitous combination of many things, possibly, joined with good craftsmanship and produced in most cases by a professional.

"The Summing Up"

It was while reading Somerset Maugham's autobiographical *The Summing Up* that I first became impressed by the close fit of scientific research into the general mold of an art and its craft. Maugham wrote of the art of the writer but generalized his statements to encompass all the arts.

Of writers he wrote:

> It is true that the amateur may sometimes produce a work of merit. By a lucky chance he may have a natural facility for writing well, he may have had experiences that are in themselves interesting, or he may have a charming or quaint personality that his very inexpertness helps him to get down on the printed page . . . . his next book is pretty sure to be worthless.
>
> For one of the great differences between the amateur and the professional is that the latter has the capacity to progress . . . . The author, like other men, learns by . . . trial and error. His early works are tentative; he tries his hand at various subjects and various methods . . . . By a simultaneous process he discovers himself, which is what he has to give, and learns how to display this discovery to the best advantage . . . . From the standpoint of the reader, very little that the writer produces in the whole course of his life is essential . . . . But I think he can only give this as the result of a long apprenticeship . . . to do it he must make literature his life's work. He must be a professional author.

Who is a Professional?

And elsewhere on "Who is a Professional?" he wrote, "(The author) is lucky if he has sufficient fortune to make him independent of his earnings, but that does not prevent him from being a professional writer. Swift with his deanery, Wordsworth with his sinecure, were just as much professional writers as Balzac and Dickens."

Similarly, Lord Rayleigh with his ancestral holdings, Einstein with his job in the patent office, Lavoisier with his purchased right to collect and keep taxes in his district (which, during the French Revolution cost him his head!), were professional scientists.

The creative activity of the research scientist benefits, first of all, the artist-scientist himself. This is true in all the arts. Maugham wrote:

> The artist produces for the liberation of his soul. It is his nature to create, as it is the nature of water to run downhill. It is not for nothing that artists have called their works the children of their brains and likened the pains of production to the pains of childbirth. It is something like an organic thing that develops, not of course only in their brains, but in their hearts, their nerves and their viscera, something that their creative instinct evolves out of the experiences of their soul and their body, and that at last becomes so oppressive that they must rid themselves of it. When this happens they enjoy a sense of liberation and for one delicious moment rest in peace. But unlike human mothers, they lose interest very soon in the child that is born. It has no longer a part of them. It has given them its satisfaction and now their souls are open to new impregnation.

The Act of Communicating

This "liberation of soul" requires more than just getting and ruminating an inspiration. It requires the act of communicating it to the appropriate public. This communication uses the techniques of the associated craft. With the writer it means the labor of setting down his inspiration with all the craft he can muster and riding it through publication. A musician must not play just for himself. The scientist must disclose his work by publication or by formal presentation before his audience of fellow scientists.

But, again quoting Maugham, "To the artist the communication he offers is a by-product," and for the scientist we also might add, so are the highly lauded practical results.

In all of the arts, whence comes the inspiration that the subsequent practice of craftsmanship can communicate? You may have heard that it "comes in a flash", and so it may. It comes more often to the working artist, however, than to the one who just waits for the flash to come. The art and the craft lead a sort of symbiotic existence. The very act of working at his craft inspires the artist. That is probably at the heart of the claim that great art is produced by professionals.

Poincare claimed that the act of following through a mathematical theorem provided the stimulation necessary to inspire mathematical inventions.

Inspiration

Of the writer, Maugham wrote, "No professional writer can afford to write when he feels like it. If he waits till he is in the mood, till he has the inspiration—he waits indefinitely and ends by producing little or nothing. The professional writer creates his mood. He has his inspiration, too, but he controls and subdues it to his bidding by setting himself regular hours of work."

The artist who spends his days and nights talking about what art is, instead of working at his craft and his art, will produce no art.

The art and the craft are further entwined in that it is part of the artist's job to get inspiration that can be communicated by the techniques available to him and his craft.

What good would inspirations involving landscapes of great depth have done an ancient Egyptian who did not have the simultaneous inspiration to invent perspective draftsmanship?

Communicating Science

In the scientific field, there are many instances where the communication of inspiration was forced to wait for the development of appropriate craft techniques. It is a modern legend that Einstein carried the inspiration for his general theory of relativity around for months or years until he learned of mathematical devices powerful enough to communicate his inspiration. Newton had to invent calculus before the science of mechanics could reach any degree of perfection, and Newton and his contemporaries could deal with wave motion only by the clumsy device of simultaneous differential equations. The invention of partial differential equations permitted Euler and his contemporaries, a generation later, gracefully to handle an infinity of ordinary differential equations and thereby develop the theory of wave motion in continuous media, the backbone of modern theories of sound, of electromagnetic waves, and of quantum mechanics.

P. W. Bridgman contends that the whole growth of physical science in the past 300 years is indebted to the invention of a new technique, the controlled experiment, and that the development of modern physics in the past 50 years is equally indebted to the analysis of language as a tool for thinking and communicating. This analysis, which Bridgman calls the operational method, applies outside the scientific field held, too, and teaches that abstract concepts like "beauty", "free institutions", "liberty", and "truth", are concepts that can be communicated only by great and patient skill, if they can be communicated at all. So are some of the concepts I use, like "creative activity" and "freeing one's soul of an artistic inspiration". The old dictum "define your terms" is hopeless and irrelevant; operationally. a traditional definition of abstract terms cannot be made. This paper is my own statement of faith that language, imperfect though it is, is still our best medium for communicating abstract ideas.

The Scientific Method

It is appropriate, while considering how the state of a craft limits the communication of its associated art, and how advances in the craft open new fields for the artist, to comment on the possibility of the application of the techniques of science to other fields. The great success of science in the past few decades has suggested that there must be some "scientific method" that should be applied to other fields like sociology and political science.

Bridgman has this to say: "The scientific method, as far as it is a method, is nothing more than doing one's damndest with one's mind, no holds barred." This is hardly a procedure limited to the scientist.

He expresses the view, and I thoroughly agree with him, that scientific success has been the result of the invention of proper tools for the job, like the controlled experiment and the operational method. Yet, the controlled experiment is particularly unadapted for getting the answers to social problems. A controlled experiment is comparatively easy in physics or chemistry, where the number of important variables is small; it is difficult in the biological sciences; in the sense in which the physicist uses the term, a controlled experiment in medicine is never realized. A controlled experiment on a social unit like a community would be ludicrous and probably tragic. The operational method, on the other hand, seems to have much wider applicability.

Commissioned Art and Research

What of research carried out at the request and commission of someone else? Most of us work most of the time on scientific problems which are posed for us by others and which usually are aimed toward some practical end. I have implied that inspiration in scientific research consists partly in recognizing a problem—recognizing a region in the structure of science where the scientist thinks he can apply his craftsmanship and his sub-inspirations to advance understanding. I have implied that these sub-inspirations are everyday occurrences to the practicing professional scientist, and so they are.

When someone else poses the problem, there may indeed be no art, in the sense that the scientist is able to "unburden his soul". But there is little difference in these situations: A scientist at the Georgia Tech Engineering Experiment Station engaged to develop a radar set, a peanut planter, or improved paint or cement, or uses for sawdust; an artist commissioned to paint a portrait of your daughter, or a mural depicting your town's history; or a writer hired to set down a successful businessman's biography.

In any of those cases, all that the sponsor, the commissioner, or the patron could expect would be a piece of competent craftsmanship, studded possibly with a few sub-inspirations.

There is always the chance, however, that the artist, himself, will become inspired by the subject and really will produce art in its fullest sense. Commissioned portraits often have resulted in great art—El Greco, Titian, Rembrandt, among the masters on a long list, readily come to mind.

Fundamental advances in scientific knowledge often have come as sub-inspirations out of work that started as progress toward a very practical end. A famous example is Wallace Sabine's work on architectural acoustics. Sabine was asked to make recommendations for improving acoustics in an auditorium. He devined, in the process, certain features which could be used physically to measure, after a fashion, the degree of satisfactoriness of a room's acoustics. The learned papers which Sabine produced over the 20 years following that practical assignment, and as the result of it, laid the foundations of the present science of architectural acoustics.

The Patron's View

The side of scientific research which I have presented is not the one usually described in public. I can see no logical basis for selling the side of research which stresses only its benefit to the scientist rather than to the patron. What I have said, however, is true of all the arts, and by some devices the arts have been patronized in all civilizations, provided only that there was wealth available beyond mere subsistence; that is, if the civilization did not have its back to the wall. A civilization, a community, an institute, or a business in economic or other distress seldom can afford to patronize art, scientific research included.

I am unable to explain why patrons contribute to these activities that primarily benefit the artist. Maybe the patrons have to benefit from the communication that results. That is certainly true of literature, painting, and other art that "sells". Institutes that support scientific research share the glory of acknowledged scientific achievement. The justification of the few industrial organizations that support research not aimed at specifically applicable results seems to be a combination of advertising possibility, public relations, and the desire to have a pool of experts at hand to keep them prepared for rapid advances of their industry into new scientific areas.

I hardly need say that the art side of research is a necessary appendage to the other facets of research that have more sales appeal—that it is this creation of new knowledge upon which the craft of scientific research must feed.

Trial and Error

It is scientific research directed toward some more or less practical end that has usually been presented to the layman, rather than the side which I have been emphasizing. Often it has been the romantic and heroic story of innumerable failures and final success.

In the Sigma Xi Research Award Lecture of 1947, Dr. Paul K. Calaway related the story of Salvarsan, also called "606" because it was the six hundred and sixth compound made and tested by Paul Erlich and his associates before they found an anti-syphilitic drug which worked. Dr. Calaway's point was that the practical results of research are worthwhile even when failures hold the enormous proportion of 605 to one.

During the World War II, the U. S. Public Health Service coordinated a gigantic research effort in which more than 13,000 drugs were tested—on birds and on men—to get only two or three reasonably satisfactory anti-malarials.

Charles F. Kettering, in his public utterances over the past 15 years or more, often has stressed the high proportion of failures in the business of research.

While large numbers of attempts are unsuccessful or only partially successful, it would be over-cautious and unduly defensive to emphasize that aspect of research. What needs emphasizing in these stories now is not the number of things tried, but the number not tried. In the anti-malarial program almost every compound tested, after the first few hundred, showed some efficacy. They were unsatisfactory because they were toxic or because they were not strong enough in anti-malarial properties. Among millions of organic compounds, the 13,000 actually tried do not constitute 13,000 blind tries.

If we had had more fundamental knowledge of the interaction of drugs and patients and diseases, we might have been able to specify a totally satisfactory anti-malarial in the first place, rather than try 13,000 compounds. The more fundamental knowledge we have, the less blind are our gropings toward practical ends. We seldom resort to trial and error until we feel the chances for success are much better than the possible number of blind tries would indicate.

In principle, we can produce art—scientific research included—by blind trial and error, but no one believes that is the way to do it. The absurdity of mechanically produced art was lampooned by Swift when he had Lemuel Gulliver find in the Academy of Lagado a group producing one folio volume after another with a machine that contained the vocabulary of the nation and that contrived to string words of the language into all possible combinations. The director was requesting additional funds so they could read these volumes and select those that were great literature. This country of Lagado had decided to frown on all its established traditions and manage things "scientifically", as their Academy directed, even if it wrecked them. That eighteenth century gentleman's idea of scientific progress is still widely held, unfortunately, in the twentieth!

Their Engineering Experiment Station showed little resemblance, happily, to the one at Georgia Tech, and their methods scarcely corresponded to Bridgmen's statement of the scientific method.

There has been much said publicly about teamwork in scientific research. Teamwork and craftmanship alone, in an area where fundamental knowledge is lacking, will result in lots of activity, but activity that is no more attractive than that in the Academy of Lagado.

Though I have not repeated them here, it is my belief that there is no exaggeration in the claims that have been made by Dr. Calaway, Mr. Kettering and many others who have pled for institutes and industries to develop scientific research programs adapted to their needs. The advantages to the organizations are many, and the public stands to profit, too. But the key feature of a successful program is not unlimited funds or air conditioned buildings filled with instruments. Like worthwhile endeavor in all human activities, the key feature of a successful research program is able and devoted men, thoughtfully and artfully doing their "damndest" with their brains, no holds barred!

The Sigma Xi Research Award

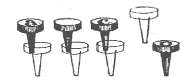
J. Elmer Rhodes, Jr. was honored with the Sigma Xi Research Award, plus a stipend of $300, for his paper, "Microscope Imagery as Carrier Communication," published in the *Journal of the Optical Society of America*, October 1953, and available (Reprint 78) from Publications Services, Engineering Experiment Station. In the course of this research, incidentally, Dr. Rhodes developed a system of phase contrast microscopy which allows interpretation of transparent objects which otherwise are not visible through the microscope without staining. A patent application has been filed on the system.

The 1954 second prize, plus $100, was awarded to Clyde Orr, Jr. and J. M. DallaValle, of the School of Chemical Engineering and the Engineering Experiment Station, for their paper, "Heat Transfer Properties of Liquid-Solid Suspensions," published in *Chemical Engineering Progress*. The cash prizes were donated by Mr. M. A. Ferst, a Georgia Tech alumnus and prominent Atlanta businessman.

For the record, here is the list of previous faculty recipients of the Sigma Xi Research Award:

1947—Paul K. Calaway
1948—Robert S. Ingols
1949—James L. Taylor
1950—Thomas W. Kethley
1951—M. A. Honnell
1952—William Spicer
1953—W. T. Ziegler

publications



Rhodes, J. Elmer, Jr., Analysis and Synthesis of Optical Images, 1953. Twenty-five cents. Reprint 70.

The formation of an optical image by a lens is often treated so that the image appears as the double Fourier transform of the object, limited by the aperture of the lens and other stops. This publication discusses this treatment and other developments.

Blocker, H. G., Susan L. Craig, and Clyde Orr, Jr., Dynamic Gas Adsorption Methods of Surface Area Determination, 1953. Twenty-five cents. Reprint 71.

Investigations of the phenomenon of gas adsorption, as well as investigations of gas adsorption methods for surface area determinations, have been primarily concerned with equilibrium measurements, and dynamic measurements have received little attention. Two techniques, one approximating equilibrium conditions and one requiring a measure of the rate of adsorption, have been investigated. Both are shown to give surface area results in satisfactory agreement with those of equilibrium measurements.

Wrigley, W. B., "Q"-Section Transformers; Impedance Matching with Single and Double Sections, 1953. Twenty-five cents. Reprint 72.

A quarter-wave section of transmission line has impedance transforming properties which are very convenient and simple to apply to amateur antenna practice. There are, however, certain properties of these transformers, principally selectivity, which are not generally appreciated.

Wrigley, W. B., Folded and Loaded Antennas; Suggestions for Mobile and Restricted-Space Radiators, 1953. Twenty-five cents. Reprint 73.

Using a simplified method of calculation, values are developed for the radiation resistance of various folded and loaded forms of short antennas. Several interesting possibilities for small radiating systems are discussed.

Ziegler, W. T., and R. A. Young, Studies of Compounds for Superconductivity, 1953. Twenty-five cents. Reprint 74.

A number of metal carbides, borides, nitrides, and a hydride, in the form of powders, have been examined for super-conductivity down to 1.8°K, using a magnetic method.

Futral, F. L. and Robert S. Ingols, Copper Catalysis for Manganese Oxidation, 1953. Twenty-five cents. Reprint 75.

Either copper or the cupric ion will increase the rate of oxidation of the manganous ion to the manganic ion by the chlorine or oxygen present in a water. The same catalytic action is also true for Monel metal.

Tooke, W. R., Jr. and John C. Lane, A Resilient Flooring and Surfacing Composition, 1953. Twenty-five cents. Reprint 76.

Full-scale experimental installations of a Georgia Tech-developed flooring and surfacing composition indicate that it has definite commercial potentialities. Applied over concrete, it provides a long wearing surface which is resistant to water, impact, and abrasion. Its flexibility and its ability to bond to metal, glass, plasterboard, wood and all types of masonry permit applications to be made over large areas of various substrates without use of anchoring clips or expansion joints. These properties naturally suggest a number of uses, only a few of which have yet been explored.

To order any of these reprints, or to get a complete list of Georgia Tech Engineering Experiment Station technical publications, write Publications Services, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia.

NEWS

of the engineering experiment station, georgia institute of technology, atlanta, ga.

DR. JACKSON

DR. THOMAS W. JACKSON has been appointed the first full-time Head of the Mechanical Sciences Division. Dr. Jackson holds the B.S. in M.E. from the U. of Illinois, 1941, the M.S. in M.E., from the U. of California, 1946, and the Ph.D. from Purdue, 1951. He joined the Station's staff from a position with the Air Force, working with the Atomic Energy Commission, making analyses of aircraft nuclear propulsion systems.

DR. FREDERICK BELLINGER, Head of the Chemical Sciences Division (and a chemical engineer), has been paid a compliment by his professional associates, the mechanical engineers. He recently was appointed by the ASME to the technical subcommittee of the research committee on properties of steam. The group will develop a research program on steam up to 1,500° F. and 15,000 pounds per square inch.

RESEARCH PROFESSOR DR. ROBERT S. INGOLS has been elected president of the Georgia Tech Chapter, Society of the Sigma Xi. Other new officers: Dr. Joseph P. Vidosic, v.p.; Dr. M. L. Meeks, treas.; Prof. George F. Sowers, secty. Dr. Ingols, incidentally, was one of a select group of leading scientists invited to conduct discussions during the 1954 Gordon Research Conferences. He led the discussion of "Toxicity", part of the Conference on Stream Sanitation, in June.

DR. INGOLS

DR. PAUL WEBER, Director of the School of Chemical Engineering and Associate Editor of *The Research Engineer,* is in Europe on a personal-and-professional trip. He left in mid-July, accompanying the Georgia Tech naval ROTC on their annual training cruise and maneuvers, aboard the cruiser USS Worcester. After leaving the midshipmen, he was to journey to Ireland, Germany, and Sweden.