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RESEARCH REVIEWS

Safer Flying through Research

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COVER PHOTO: This pilot is being assisted into his harness in preparation for a strike mission in North Korea. Battle risks and many other risks of flying are unavoidable. But something can be—and has been—done to prevent or reduce crash injury to pilot and passengers. Lives have already been saved as a result of Cornell University's Crash Injury Research Project. For more about it, see pages 11 to 15.

Research Reviews endeavors to report briefly highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C.

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In This Issue

Temperature-indicating paint is being applied to a pulsejet engine prior to operation. By the changing color of the paints, the outside temperatures of the engine are revealed.

Tell-Tale Paints Reveal Temperature Changes

J. E. Cowling

. . . Head of the Paint Section, Protective Coatings Branch, at the Naval Research Laboratory

Measurements of temperature have long been important to many a process, and through the years a variety of meters, gauges, and ingenious mechanisms have been devised to give readings on the heat of a surface, the temperature of a solution, or the presence of heat under all sorts of circumstances and conditions. Newer and better instruments have been developed to meet growing demands which in recent years have been more insistent in the field of high temperatures. Because the needs of designers and engineers have been urgent in jet, missile, and other high-temperature programs, new efforts have been turned to temperature-measuring devices. Because the Germans had established as far back as 1936 that paint could be used to indicate temperature by a tell-tale change of color, attention has been directed in this country at NRL to the possibilities of paint compositions in furnishing critical information on temperature.

Investigative work on the pigments and resinous vehicles for temperature-indicating paints is going forward at NRL in the Protective Coatings Branch of the Chemistry Division. So far the research has been on a modest scale, and in extension of the rather successful work already accomplished by scientists and the I. G. Farbenindustrie in Germany. For some time "Thermocolor" paint and "Thermochrom" crayons made in Germany have been sold in Europe; more recently they have been introduced commercially into the United States.. As a result, the scientists assigned to the problem at NRL had something fairly tangible to start with, as well as information where additional work needs to be done to fill in gaps and to extend the range of compounds, as yet untried, that might serve as temperature indicators.

An objective of the research at NRL is a familiar one in many fields—the desire to be independent of foreign sources for needed materials. As the work progresses and compounds are identified, more accurate ideas are obtained as to what pigments, resins, and other ingredients for these paints will be required. Such knowledge contributes to stockpiling plans and other programs designed to strengthen the strategic position of the United States.

With investigations still far from complete, NRL scientists have been able to establish a series of compounds that will record temperatures from 50° to 278°C. There are gaps along the line between these limits—it may be possible to fill in and get a better series of temperature points over some of the wider gaps. Work is now concentrated on the lower and medium temperature ranges. Eventually the program will be extended to establish compounds that will indicate temperature in the higher ranges.

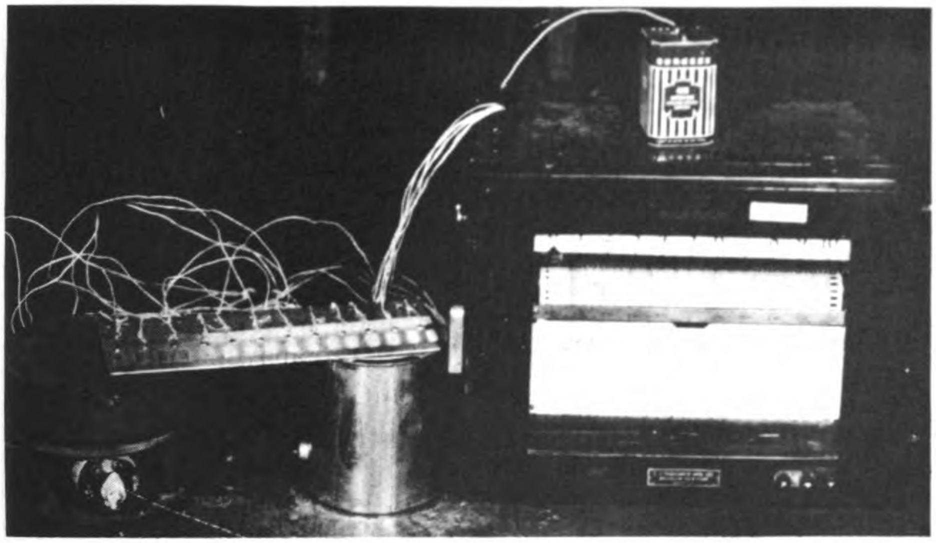
As the scientists at NRL set about the job of making up these temperature-indicating paints, several problems became apparent almost immediately. The first was to find an adequate vehicle to carry the pigment. The oil or other binding agents had to remain stable when subjected to elevated temperatures; any decomposition or other form of instability would rule out the prospective vehicle. Also there could be no tendency on the part of the vehicle to assume distinctive colors of its own that would confuse the color transformation of the pigment.

Some difficult problems were also encountered in the development of the pigments. For instance, some pigments changed in color at a desired temperature after a short period of heating, but they also changed to the same color after prolonged heating at a lower temperature. Some pigments reverted to the original color upon cooling, a characteristic not desired in this particular research. In all cases, the goal was to find a compound that would indicate temperature with an accuracy of ±5°C. As an example, the compound chromium ethylenediamine trichloride turns from yellow to red at about 119°C; the accuracy can be counted upon within the range 117° to 121°C. Other temperature levels and compounds, together with the color change that occurs, are listed in Table 1. Each color change is striking enough—such as from pink to black—to be easily identified and, if need be, compared readily with a color chart as a calibration or check on the temperature recorded.

Table 1

Compound	Color Change	Temperature Range (°C)
(d) (1) $Cr(en)_3Cl_3$	Yellow - Red Red - Black	117 - 121 260 - 278
(e) (2) $Cu(py)_2(CNS)_2$	Green - Brown Brown - Black	117 - 122 232 - 260
(a) (3) $(NH_4)_2VO_3$	White - Pink Pink - Black	128 - 134 160 - 168
(e) (4) $Cr(en)_3(CNS)_3$	Yellow - Red Red - Black	115 - 124 240 - 263
(f) (5) $Co(H_2O)(NH_3)_5Cl_3$	Red - Black	168 - 175

The work at NRL has progressed along lines that sought to provide two series of materials, one to function between 50° and 100°C, and the second to extend from 100° to 275°C. The chemical compounds of metals which may exist in more than one valence state, each of which is characterized by a different color, were obviously possibilities for temperature-indicating pigments. The compounds of cobalt were particularly attractive because in the valence II (cobaltous) state they are relatively unstable and may be changed to the valence III (cobaltic) state by heating. The most characteristic color change in this instance is from pink to blue. Several other metals will yield series of compounds functioning on the same principle. Among those most likely to be of value are the compounds of nickel, chromium, copper, iron, and manganese.



Here a test panel fitted with pyrometers is being heated on a hot plate while the temperature is recorded

With educated guesses such as these as a guide, scores of complexes were prepared and put through a series of tests. A simple procedure for testing was followed. One side of a metal strip was given a coating of paint, or perhaps stripes of different paints would be lined up in parallel. Then one end of the metal panel was placed on a hot plate; very soon temperature gradients would be established. Changes in color followed and if the compound was satisfactory, the color became fixed at a certain temperature, and would not change even though the temperature receded or the heating was prolonged at the critical temperature. Six hours of heating was regarded as a sufficient test in the case of prolonged heating. As an over-all standard for temperature-indicating paints, a 30-minute heating at the index temperature was specified.

Thermocouples or surface pyrometers have been used effectively during the investigations for temperature checks and calibration. The cooling-off period in the tests was observed and noted over a period of time as some pigments reverted to their original color in a matter of a few hours; others required a week or more while those fully meeting the objectives of this research showed no tendency to revert.

Of the scores of compounds that were tested, best results were obtained from coordination complexes of cobaltous salts with ammonia, hydroxylamine, hexamethylenetetramine, pyridine, ethylenediamine, and hydrazine. Many of the complexes of cobalt have not as yet been tested, but are regarded as promising (see Table 2). A few additional useful temperature-sensitive pigments have been yielded by compounds of nickel, chromium, and copper.

This vacuum tube was coated with temperature-indicating paints before heating. The cooler glass at the base was pink, shading into light blue farther up, and dark blue at the shoulder and top, where the glass was hottest.

Table 2

(a)	Cobaltous pyridine arsenate	50°C
(b)	*Nickelous hexamethylenetetramine bromide	62
(c)	Cobaltous hemaxethylenetetramine thiocyanate	74
(d)	Cobaltous acetate	82
(e)	Cobaltous pyridine thiocyanate	93
(f)	Cobaltous silicofluoride	99
(g)	Cobaltous citrate	110
(h)	Cobaltous formate	116

*This change is not permanent. Reading must be made shortly after temperature is lowered.

Properly plasticized methacrylate resins have proven ideal vehicles for low and medium temperatures; most of the successful temperature-indicating paints have been prepared with this resinous material. As research continues toward higher temperatures, more stable vehicles such as silicones will then be used. Experiments already undertaken have turned to such things as adding white pigment to increase hiding strength and to enhance the physical qualities of the paint. In most cases it was expedient to reduce the final product to low viscosity so very thin films could be painted on the metal test strips.

While the investigators at NRL have not been concerned with crayons such as are marketed under the trade name "Thermochrom," these materials enjoy some advantages over paint. Crayon marks change color in a second or two when the temperature index of the particular crayon is reached. It is a simple matter to make a series of marks not only on surfaces, but on a machine part, a fragile object, etc. Under test, the marks change color in sequence as the temperature rises and thus give a close approximation of the temperature gradient.

Temperature-indicating paints can be used handily in places where it would be most difficult to introduce thermocouples or surface pyrometers. If a heat exchanger should be located in a place where access is limited by machinery or a structural obstacle, it might not be too much of a problem to daub some temperature-indicating paint at critical spots. Another advantage to be gained by the use of paint comes from the ease with which it can be used to cover completely a relatively large area. In service testing, the paint on areas covered might tend to show up spots of heat in odd shapes and sizes that would take painstaking hours to indicate with conventional instruments. This ability of temperature indicating paints to "map" the temperatures of surfaces is particularly advantageous in recording the results of dynamic tests on jet engines and rockets, information which is usually much more vital than the results of static tests. Normally such data cannot be gained by means of the usual temperature-indicating instruments.

As in many cases of NRL research, results on these paints will readily translate into benefits for private industry and for other laboratories. In ranges up to 200°C there are likely uses for the paints in organizations working with paper, textiles, rubber, and synthetics. Chemical and electrical equipment also commonly operate in temperatures up to 200°C; this same range applies to the inspection of motors and some steam boilers.

If we can develop paints effective up to temperatures of 450° C, these would be useful to manufacturers with processes or products involving zinc, aluminum, and glass. Then at higher temperature ranges, where imported paints have already proved to be reliable indicators, there is a long list of potential users including iron and steel fabrication, welding establishments, foundries, and enamelling works.

As a result of their work with these paints and many hundreds of inspections of color changes, the scientists at NRL recommend a standard control or system for correlating the color result to a temperature scale. Degrees of color blindness, needless to say, would considerably alter a translation of observed results to a written or other record of temperatures. A warning is also sounded on the use of photographic color charts as these do not always reproduce exactly the same. But once a reliable color scale or calibration has been determined, there is every reason to expect useful and at times highly valuable information from the tell-tale characteristics of these specialized paints as they put a finger of definitive color on a temperature that is or was present.

Auto Accidents vs Battle Casualties -- 1952

A recent review of BuMed statistics for the past year brings out a thought-provoking fact—the motor vehicle was more deadly to Navy men and Marines in 1952 than North Korean bullets. Tabulating "admissions to the sick list," it was found that battle casualties and motor-vehicle accidents were almost equal; 8,700 for the former and 8,486 for the latter.

But this apparent statistical equality is misleading. Of all the battle casualties, only a little more than half—4,750—were serious enough to remain in the sick list, the remainder being returned to duty after treatment at a dressing station. Also, the amount of time lost per admission was much greater for auto accident than for battle casualties. On an average, 22 men were admitted every day of 1952 for traffic injuries, the average lost time per case was 46 days, and 1 in 12 died. The total noneffective days—greater than from any single cause except upper-respiratory infections—represented a daily absence of 1,070 men, enough to man a full combat infantry battalion of Marines.

Most of the injury-producing accidents involved passenger automobiles colliding with another vehicle or with a stationary object. The score was about 80 percent for autos, with motorcycles ranking a poor second with 12 percent. Of course some of these accidents occurred on duty, but the vast majority—89 percent for Navy men, 79 percent for Marines—happened on liberty or leave. And apparently military drivers are more careful (and drive slower) on duty than on their own, because both the mortality rate and time-loss were considerably lower for duty-status accidents.

As among civilians, most of the accidents occurred during holidays and during the summer months. And in 9 out of 10 traffic accidents the service men were under 30 years of age. (Reported by Medical Statistics Div., BuMed, in "Medical News Letter" for 9 October 1953)

Thinking Abilities

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One of the most critical problems of any organization is how to select an individual whose mental qualifications fit the needs of a specific position. Probably the most-needed people, as well as the most difficult to find, are those who can think effectively. How to identify individuals with potentialities for distinguished thinking, how to develop or improve their talents, and how to use them most effectively, are problems which have faced psychologists for some time. But before we can answer any of these questions, we must know more about the nature of thinking procedures, how they develop, and how they are used in practical situations. In other words, some basic research must be done.

In the past, the psychologist's answer has usually been summed up in one concept of "intelligence." Individuals whose thinking one should expect to be of a high calibre and great effectiveness could be selected by means of intelligence tests. A high IQ was regarded as the answer to the problem of the prediction of genius. The observing layman, however, has had good reason to doubt this simple solution. He has been aware of the fact that the person with high IQ does not necessarily show good judgment or common sense, nor does he necessarily make a good leader or a good inventor or planner. On the other hand, some persons with not particularly high IQ may show superiority in one or more of these directions.

The layman's skepticism of the IQ as the answer to all talent problems is now recognized by many psychologists to be based on good reason. The IQ tests were designed to predict which children will excel, and which ones will not, in school learning, and this means school learning of the bookish type. IQ tests are most heavily loaded with questions testing the ability to know and to understand words. It is rapidly becoming recognized that man has many talents, not just one, and that while IQ tests are very useful as far as they go, we must go well beyond them if we are to assess all the useful talents of individuals.

It was first recognized that there are many non-intellectual abilities that are not touched by IQ tests and yet that are important in many vocations, such as clerical, mechanical, and other relatively non-verbal pursuits. It is just now being realized that even in the area of intellect there are many aspects that have not been given sufficient weight in IQ tests. Intelligence has often been defined as the ability to think, but intelligence tests have not stressed thinking as much as they should. It has been discovered that there are a number of thinking abilities, not just one.

We know that this is true because of certain experimental facts. We know that two individuals of equal age and education, and perhaps of equal IQ, are not equally capable of solving different kinds of problems. One person may find problems of type A very easy and he does them rapidly and accurately, but he finds problems of type B very difficult. Another person finds the relative difficulties with these two types of problems to be in the reverse order. Still a third person may solve them both equally well. If this is true for a population of individuals, the correlation between scores on two tests, one composed of type-A problems and the other of type-B problems, would be close to zero. We conclude that there are two different thinking abilities involved. This illustration can be extended more generally. Some thinking tests have high correlation (persons who score high in one tend to score high in the other), some have intermediate correlation, and some have none whatever.

Factor analysis is a complicated statistical method used to determine from correlations of test scores what the underlying abilities or factors are. Research in the Army Air Force during World War II showed at least 25 distinct abilities in the classification tests they had developed. Only a few of these were intellectual, including verbal comprehension, associative memory, visual memory, visualization, judgment, and the like. Some of the non-intellectual ones were: spatial orientation, perceptual speed, psychomotor coordination, psychomotor precision, and psychomotor speed. Some of the abilities were found to be more important in the training of a pilot and others in the training of a navigator, while others were important in the training of both. These discoveries made possible a more rational approach to the procedures of selection and classification of different kinds of personnel.

In the Air Force results were indications of several possibly important factors in the area of thinking abilities, but the conclusions concerning them were not very decisive. Since the war, there has been undertaken at the University of Southern California some intensive research on thinking abilities, under contract with the Office of Naval Research.[1] This research was begun more than three years ago under the title of "Aptitudes of High-Level Personnel." The "high-level" personnel studied were research scientists, inventors, and supervisory and administrative personnel, both civilian and military. To simplify our approach to the problem, we arbitrarily divided the entire area of thinking abilities into four more manageable sub-areas. These were designated as the domains of reasoning abilities, creative-thinking abilities, evaluative abilities including judgment, and planning abilities. At the time this article was written, two factor analyses had been made in the domain of reasoning abilities, one in the domain of creative abilities, and one in the domain of evaluative abilities. Under way is an analytical study of planning abilities as well as a more comprehensive study cutting across the domains of reasoning, creativity, and evaluation. There have also been some preliminary attempts to relate the factors discovered to the performance of research scientists, engineers, and military officers.

I shall report here only some of the more significant conclusions indicated by the results of the project thus far. In fairness to earlier

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[1] Those chiefly associated with the writer in this research project, in alphabetical order, are: Raymond M. Berger, Paul R. Christensen, Andrew L. Comrey, Russel F. Green, Alfred F. Hertzka, Norman W. Kettner, Gordon Taaffe, and Robert C. Wilson.

investigators, it should be said that not all of these findings are entirely new. It is the first time, however, that the area of thinking abilities has been investigated so extensively and intensively, and many of the findings are definitely new.

One of the important aspects of reasoning has to do with relationships. The individual sees relationships, he uses relationships, and he tests relationships. There seem to be at least three abilities that have to do with grasping or comprehending relations between things or ideas. One ability involves perceiving relationships between things we see and another involves perceiving relationships between ideas. This distinction seems to indicate a difference between good "concrete" thinkers and good "abstract" thinkers. Just how far-reaching this difference may be is still to be determined. The tests that bring out these factors in reasoning involve rather simple relationships. When there is a system of relationships, or a pattern of ideas to be grasped, we find still another ability involved. Thus, the power to have elaborate and intricate conceptions may be a unique ability.[2]

We use relationships in the solution of problems. In a broad sense, problems are of many kinds. Let us restrict ourselves for the moment to the kind commonly known as arithmetic-reasoning problems. These are encountered quite generally in scientific and technical work. There is a unique ability for handling this type of problem, but it has been very difficult to pinpoint the particular aspect of such problem solving that has most to do with the factor involved. In solving such a problem there are many steps. One must first understand the problem. One must think of possible steps needed in its solution. One must be able to select the most promising steps and to reject the others. More specifically, in the strictly arithmetic-reasoning problem (to which the factor is not confined), one must decide what numerical operations are required. The actual computing processes, we know, are dependent upon another factor, the facility with numbers. Our present efforts are directed toward determining more exactly what unique thinking ability the arithmetic-reasoning problem entails.

The term "reasoning" may suggest to some readers the process of drawing inferences or logical conclusions. Analysis shows that there is a distinct factor or ability connected with logical conclusions drawn from premises. We are not certain which of two aspects of this operation is more important for the interpretation of the factor; whether it is an ability to <u>draw</u> logical conclusions or whether it is an ability to <u>evaluate</u> conclusions from the standpoint of logical necessity after they have been drawn. The evidence on this point is inconclusive, at present, but the factor has been tentatively defined as sensitivity to logical necessity. This emphasizes the second aspect, the ability to evaluate the logical correctness of conclusions.

There is another ability having to do with the drawing of conclusions, but not conclusions strictly of the logical type. The conclusions in this case are drawn to complete an analogy. The good test of this ability presupposes that the relationship involved in an item has been

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[2]Space does not permit describing tests which would give more substance to the names of factors. In a few instances, however, tests will be briefly characterized.

easily grasped. For example, the item might be "Automobile is to highway as aircraft is to ______." An acceptable response might be "air," or "skyway," or "runway." The main task is the fulfillment of a relation.

Still another factor in the domain of reasoning has to do with the use of symbols. Assigning symbols to stand for ideas and then manipulating the symbols to come out with answers seems to offer a unique task. This is the kind of activity required in mathematics and in symbolic logic. It may be that this is an acquired ability dependent upon the study of algebra and other mathematics. Whatever it is, this is an ability in which individuals differ and it is distinct from other abilities.

In the domain of creativity we find some quite different types of abilities. This statement should not be interpreted to mean that none of the reasoning factors mentioned previously play a part in creative work, for many of them undoubtedly do. The circumscription of the domain of creative abilities is an arbitrary one for the purposes of investigation. It will be recognized, however, that an individual may have a high degree of almost any of the abilities mentioned above without becoming a creative thinker, such as a theoretical scientist, inventor, or creative artist or engineer.

It was hypothesized, first of all, that the person who is recognized as creative is likely to be more sensitive than most to the existence of problems. He is the questioning person with unusual readiness to spot the unusual, the defective, and the deficient. Analysis shows that people do differ systematically with respect to seeing that problems exist, either in common gadgets like the telephone and the refrigerator or in social institutions such as education or divorce laws. It may be that this is neither a necessary nor a sufficient condition for making a creative individual, but it is expected that a high degree of this ability will be one predisposing condition.

It was expected that, everything else being equal, the creative person can produce more ideas per unit of time than the non-creative person. Study was therefore made of the differences between individuals with respect to fluency of thought. Two factors that may have relationship to different kinds of creative production were found. One has to do with the facility for calling up words to meet specified requirements of meaning (for example, naming words that mean the same or that mean the opposite). This kind of fluency probably has relationship to creative writing. Another fluency factor concerns the rapid flow of ideas to fulfill a specified need. This can be assessed in individuals by a simple test like asking them to name, in eight minutes, all the uses they can for a common brick. Another simple test of this ability asks individuals to name the consequences of some hypothetical change such as everybody suddenly going blind.

The creative thinker should be a flexible thinker. He should not get into ruts but should readily strike out in new directions. Analysis shows two distinct factors that look like types of flexibility. One kind of flexibility shows up during the solution of problems in a test where the method of solution changes drastically and frequently. The other kind shows up in a test where change in direction is not necessary but the examinee shows such changes anyway. The former we have called "adaptive flexibility" and the latter "spontaneous flexibility." Adaptive flexibility is probably very important for the theoretical scientist, who must be ever alert to the need for new types of solutions and ideas. Spontaneous flexibility should be important for certain kinds of writers and for pun makers. Too much of this trait would probably be a handicap to anyone who must do much goal-directed thinking as in problem solving.

The trait most commonly associated with creativity is that of originality, the ability to have novel ideas. It was hypothesized that this trait exists in graduated amounts in different individuals. Objective signs of it might be found in the tendency of an individual to give uncommon responses to test items. In one type of test, frequency counts were made of every response made to every item in a group of about 400 young men. Every response was then given a weight in proportion to its rarity of occurrence in this population. In another type of test, the examinee must see connections between remotely related ideas. For example, in listing consequences to the event of everyone going blind, some responses are in the form of immediate or obvious effects while others are more remote in time or in sequence of events. The number of the remote type given was taken as a score for originality. A third type of measure attempted was to score responses weighted according to degree of cleverness exhibited. The responses were titles the examinee suggested for short short stories. Factor analysis shows a unitary ability or trait of originality. It also shows that the three methods of testing are about equally effective for measuring it.

The examples given of factors in the domains of reasoning and creative thinking are perhaps sufficient to demonstrate the rich variety that exists among thinking abilities. There are also factors in the domain of evaluation and judgment. It is possible that factors of reasoning, creativity, and evaluation will account for much of the difference between individuals in planning performance, but the investigation of that domain will provide opportunity for the discovery of unique abilities if there are any.

Some of the implications of finding quite a number of thinking factors may be pointed out. It is not certain that these abilities are completely independent or uncorrelated, but they are distinct and in time will be better defined. The question "How well can this person think?" should be asked with respect to each of the factors, for it should be expected that individuals will be uneven in their thinking abilities. It is the rare person, indeed, who excels in all of them. It is even possible to find a few very weak abilities combined with a number of strong ones in the same individual.

The kind of thinking performance we should expect of a person will depend upon the pattern of his strong and weak points. It will also depend upon his motivation and his temperament, which we have intentionally left out of our investigations. Where individuals can work in teams, as in group-research projects, certain strengths in some of them can compensate for weaknesses in others. In terms of team performance, it would be well to see that every necessary trait is covered by strength in at least some of the members.

As to long-range benefits, the first important consequence of discovery of unitary abilities in the general area of thinking is that we are provided with a new set of descriptive concepts. The first need in predicting and controlling events in any field is for workable and dependable concepts. How well the factor names contribute to the understanding of thinking processes remains to be seen. The indications are that some gain has been made in this direction.

Research Proves its Worth in

Reducing Aircraft Crash Injury

A staff-written article on the Crash Injury Research Project directed by Dr. Hugh DeHaven at Cornell University

Cornell University Medical College has been a pioneer in a research effort that systematically explores all possibilities of reducing or preventing aircraft crash injury. The way planes are put together, the position of the cockpit and passenger seats, the strength of structural parts—all have been scrutinized, checked and double-checked by a research team that has been able to "blueprint" improvements widely recognized by plane builders. Other studies on crash injury not essentially engineering in character have also been conducted by the well-qualified Cornell investigators who since 1942 have been employed continuously on a project bearing the name "Crash Injury Research."

During the early years of the research, the National Research Council met the expenses of the project at Cornell University Medical College. The findings and suggestions helped the Navy as well as other segments of the aviation industry, both military and civilian. Beginning in 1948, the Office of Naval Research began making contributions to "Crash Injury Research" and has a continuing interest in the benefits that are accruing from the program.

The ideas of "crashworthiness," so strongly advocated by the Cornell research group, gained wider acceptance year after year until by 1948 some of the key personnel were in demand as consultants. Manufacturers of light planes sought the professional advice of the director, Hugh DeHaven, in 1948 when some of their projected models were still in preliminary design stages. Three planemakers went farther and had assistance from "Crash Injury Research" during the mock-up period. The models on which this service was rendered, and which will be described to illustrate "crashworthiness," were:

1. The AG-1, CAA Texas A&M CROPDUSTER
2. The Beech TWIN BONANZA
3. The HELIOPLANE

It was the express purpose of the CAA Texas A&M light airplane to engage in utility agricultural operations such as dusting, spraying, and seeding. The designers were anxious to provide the best safety for the pilot to go along with such requirements as (1) the ability to land without difficulty on a short field, (2) a payload capacity of 1000 pounds, and (3) a high degree of visibility.

In order to provide crash protection, the pilot was located as far aft as possible (see photograph, top of page 13) with a large amount of energy-absorbing structure ahead of him. Because it was essential that duster pilots have exceptional 360-degree visibility, the cockpit was put near the center of the fuselage in an elevated position. In a position above the rear portion of the wing, the pilot's seat was approximately 13 feet from the nose of the plane. All disposable loads were placed in a hopper in front of the cockpit.

To insure further pilot protection, the seat was specified at 40 g* and as such had the structural strength to hold up under heavy shocks. Standard equipment included a military safety belt and integral two-strap shoulder harness with an inertia lock. A spring-loaded inertia reel kept the harness snugly on the pilot's shoulders but permitted freedom of movement within the large cockpit during normal flight. Automatic locking of the reel under 3-g loads is designed to prevent the pilot from striking the instrument panel, or any forward cockpit structure in a crash at normal operational speeds.

A high, head-rest structure has been placed immediately behind the open cockpit; tubular guard rails which extend from the turnover structure help to deflect wires and branches over the pilot's head. The fuselage structure forming the cockpit area has been designed to remain intact in a head-on collision at normal operation flight speeds of approximately 75 miles per hour. Built-in structural integrity of the 40-g cockpit is such that it can be regarded as a unit by itself, independent of the structure ahead of the cockpit.

In front of the cockpit, the hopper-fuselage area has the same strength as that of the cockpit, and is considerably stronger than the "firewall" built-in forward the hopper. If the firewall holds in a crash, then the strength of the hopper is 40 g. Otherwise the hopper can withstand a shock of only 25 g.

Should the plane have a head-on crash, the initial impact is partially absorbed by the engine and its 15-g mount; the remaining crash energy is transferred to the firewall just ahead of the hopper. After hopper failure—at 25 g—the cockpit area can collapse only if the remaining deceleration is in excess of 40 g. However, by the time the nose section and hopper structure collapse, it can be expected that the remaining energy will not be great and cockpit structures will provide a "40-g island of safety" for the pilot:

The worth of all these design factors was established beyond a shadow of a doubt when the AG-1 agricultural plane crashed shortly after take-off on June 26, 1953. The pilot walked away from the plane with only a sore thumb—he had been pressing hard on the control stick. The plane, however, was considerably demolished when it had the left wing and spring steel gear torn off as it hit a heavy fence post made of

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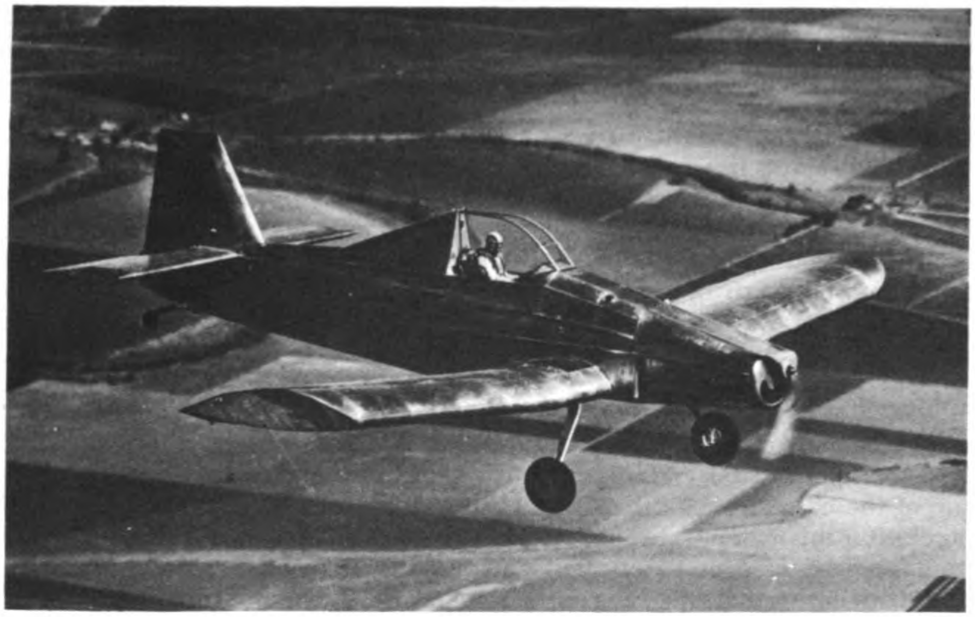
*An engineering consideration of particular importance to aircraft designers is the acceleration of gravity which is denoted with the symbol "g". A classical definition on the acceleration of gravity states that in a vacuum a freely falling body falls toward the earth's center at a velocity of 16.1 feet the first second, and an increased velocity of 32.2 ft per sec per sec thereafter. In the air the rate of acceleration is modified by the force due to air resistance.

In the design of pilot seats and aircraft structures, tests have been established which will give information on how many g equivalent to an acceleration of 32.2 ft per sec per sec the seat or structure will withstand.



This AG-1, CAA Texas A&M CROPDUSTER, incorporating special safety features, crashed shortly after take-off on June 26. Although the plane was a mass of wreckage, the pilot walked off with only a sore thumb—he had pressed too hard on the control stick!

a railroad tie; the cartwheel that followed brought the plane to a stop upside down. The pilot, John Paul Jones of Ft. Worth, paid tribute to the crashworthy design of the cockpit and to other safety features for his good fortune in coming through the crash without serious injury.

Experts from the Cornell project on Crash Injury Research also contributed to early designs of the Beechcraft BONANZA with results that led to further collaboration on the TWIN-BONANZA. The "island of safety" idea was developed still further in this larger plane with 62 percent of the weight below and forward the occupants. Additional

The Beechcraft TWIN-BONANZA

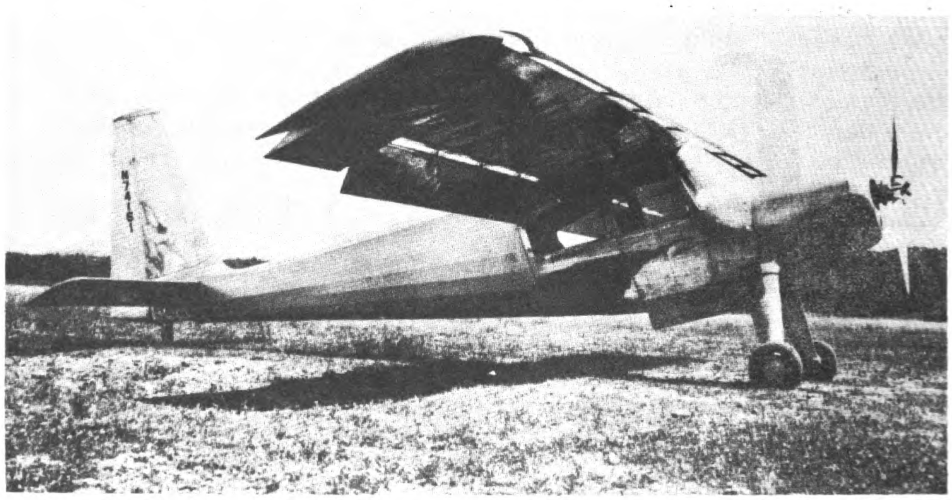
protection was provided by 25-g safety belts and 25-g safety harnesses together with anchors for the safety belt which also were designed for 25 g.

The HELIOPLANE posed a more difficult problem for the engineers interested in crashworthiness as this semi-helicopter was built to accommodate four people including the pilot. Particular attention was given to the design of landing gear. The legs were braced at a point approximately six inches below the longerons, so that—in a crash—the gear would fail by progressive bending below this point. Thereby the energy would be absorbed without tearing open the bottom of the cabin.

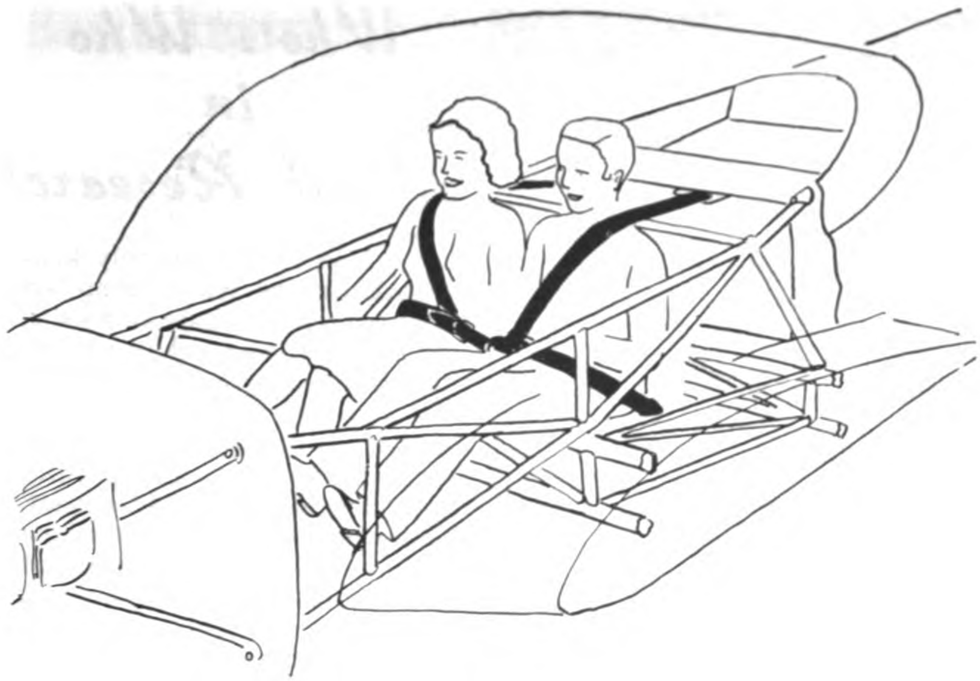
The MEYERS 145 is a light plane that has also made considerable use of crashworthy design as advocated in reports by the Crash Injury Research project. Particularly noteworthy is the structural configuration of the cabin where the design calls for short bays and the use of triangulation throughout. Emphasis also has been placed on a combination "must-be-worn" type safety belt and shoulder harness. This equipment (see drawing opposite) will resist a shock of 4,275 pounds and is both comfortable to wear and easy to put on and take off.

From the beginning in 1942, the work of the research group at Cornell has been coordinated with studies of crash injuries conducted by the National Research Council and the Safety Bureau of the Civil Aeronautics Board. During 1952 a special study was made by the investigators at Cornell of 800 survivors in serious crashes in which the occupants of the planes were wearing safety belts. This supported the strong recommendations made by the Cornell investigators, that safety belts and shoulder harnesses should be provided and trusted.

Although much of the research at Cornell has been in connection with the crashworthiness of light planes, the results have contributed valuable information regarding safety belt installations and safety design in seats for transport aircraft. "Delethalization" of seat-back structures in recent types of civil air transports already has demonstrated that safety design pays big dividends when accidents occur.



The HELIOPLANE

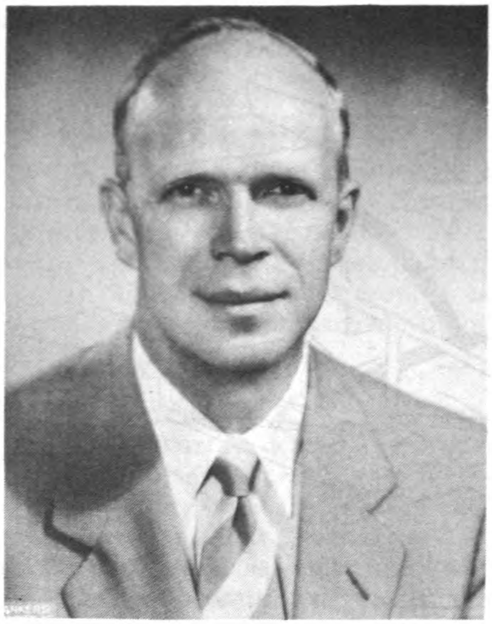


The MEYERS 145 shoulder harness installation

In order to study the effectiveness of crash protective design in larger planes, Cornell medical scientists now cooperate with civil accident investigators in determining crash factors and injury causes in airline accidents. In particular, Crash Injury Research is seeking reliable data from crashes in order to evaluate the safety advantages of rearward versus forward facing seats. At present, there is evidence to support both sides of safety discussions on this subject—with little information to support strong convictions.

With more aircraft going to designs that build-in safety and enhance crashworthiness, the work of the Cornell research group is bringing the kind of results that are gratifying. More pilots and passengers are expected to walk away from crashes uninjured; the survival rate is expected to increase even though hazards mount with higher speeds and the tendency of operators of some planes to fly in all kinds of weather. The accumulative results of these studies have already paid off and promise to pay off more as aircraft designers put additional crashworthiness into planes of the future. (HEP)

Deformed seat backs hit by passengers who jacknifed over their safety belts in an accident



Louis Allen

Who's Who in Naval Research

Louis Allen—widely known throughout the Washington area for his nightly "weather doodles" on D. C.'s oldest educational television program, on WTOP-TV – is the oceanographer for ONR's Military Operations Branch. As such, it is his principal duty to find applied-research answers for the meteorological and oceanographic problems which crop up in fleet operations.

Mr. Allen has the distinction, amounting almost to a rarity among government employees, of being a native Washingtonian. Not only was he born in the District, he graduated from Central High School, received his B.S. (meteorology and mathematics) from Wilson Teacher's College, and his M.S. from the nearby University of Maryland. He taught in the local school system from 1936 to 1942; then he joined Capital Airlines as a meteorologist. Six months later he was called into the Navy.

After attending the air navigation school at the University of Miami, he was ordered to the Naval Air Station at Corpus Christi for duty involving aerial navigation. While there he transferred to aerology (his first love) and pursued meteorological studies at UCLA, and then oceanographic studies at Scripps Institution. He was then assigned to Nimitz's CINCPAC headquarters, first in Hawaii and later in Guam. He made forecasts for fleet operations in the western Pacific, and, as the only oceanographer at Guam, made the sea-and-swell forecasts for the Iwo Jima and Okinawa invasions. When the war ended he was working on similar studies in connection with the invasion of Japan.

When LT Allen was mustered out, he returned to Washington and took a position at the Navy Hydrographic Office. As head of the Program Branch there, from 1946 to 1950, he did research on the application of meteorology and oceanography to the science of navigation. He made special studies of arctic weather and sea ice conditions, and also developed a two-week course in sea-and-swell forecasting for aerological reserve officers. Thus, when he transferred to ONR in 1950 he brought with him a wealth of training, research experience, and operational know-how in meteorology and oceanography.

About Louis Allen's second interest—weather forecasting on television—he says, "This is essentially an avocation. While some people find relaxation in tending roses, I find mine in drawing 'woodles' to illustrate weather forecasts." (ATD)

Basic Instrumentation

—and what it has accomplished

LT Donald E. DeGraaf, USNR

. . . received his M. S. in physics at the University of Michigan. He is now Scientific Officer for the instrumentation program of the Physics Branch, ONR.

Measuring instruments are equally indispensable to the progress of experimental science and the conduct of modern naval operations. Physicist and navigator, biologist and aviator depend on instruments to detect, measure, and record information. In the past, it was necessary for the experimental scientist to expend considerable time and effort in the design and construction of his own measuring equipment; the production of operational instruments for naval use likewise required extensive programs of research and development. This resulted from the difficulty of obtaining information on pertinent advances in instrumentation in other scientific fields, and an insufficient awareness of the features shared by different instrument systems.

More recently, it has been increasingly recognized that all military and scientific instruments have certain characteristics in common; these may be expressed in terms of accuracy, precision, repeatability of operation, frequency response, ruggedness, range, impedance characteristics, etc. Moreover, all measurement systems perform some or all of the functions of detection, transmission of the measurement signal, amplification, indication, recording, and control through some type of feedback. Appreciation of these universal aspects of instruments and measurement has led to the emergence of instrumentation as a scientific field of endeavor in its own right. It is evident that instrumentation cuts across all branches of science and technology: it learns from and contributes to each of them. Thus a new method of measurement developed in one field may find great usefulness when applied to problems in other fields; witness the exploitation of microwave radar techniques in the study of rotational molecular spectra.

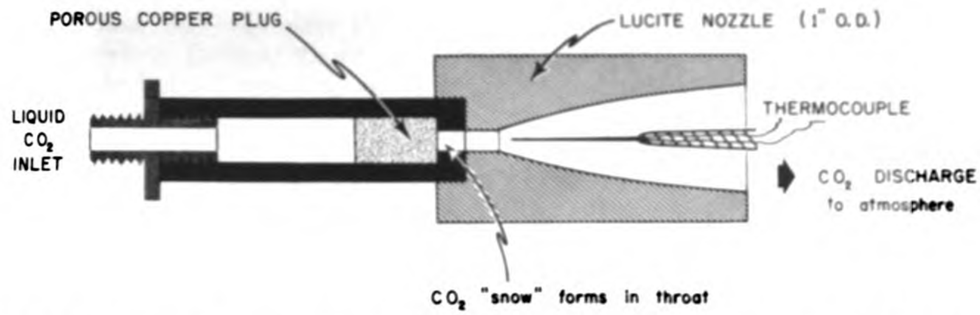
In order to maximize the fruitfulness of this newer viewpoint, an instrumentation center, known as the Office of Basic Instrumentation (OBI), was established in 1950 at the National Bureau of Standards (NBS) under the direction of W. A. Wildhack. NBS is an appropriate location for a facility of this kind, in view of the availability of experienced scientists and precise measuring equipment in every area of the physical sciences. The responsibility of NBS as guardian of the nation's primary standards of measurement, coupled with a progressive research program which keeps pace with the expanding horizons of science, fosters at this laboratory an atmosphere particularly conducive to instrumentation research.

The OBI administers instrumentation research projects in many of the scientific divisions of NBS. These projects are of several types including applications of physical principles to general and specific problems of measurement and control, critical surveys of available methods of measurement in selected areas, and efforts toward the establishment of a consultation and reference center broadly covering the field of instrumentation. Financial support for the Office of Basic Instrumentation is provided by the Atomic Energy Commission, the Office of Naval Research, and the Office of Scientific Research of the Air Research and Development Command.

A few of the instrumentation research activities under the OBI will be described to provide examples of the fruits to be derived from this effort. The carbon dioxide hypsometer (see drawing opposite), developed to measure pressure (and hence altitude), has been successfully tested at pressures corresponding to altitudes up to 105,000 feet. The sublimation temperature of CO_2 depends on the pressure, decreasing as pressure is reduced, for example at increasing altitude. In this device, a thermocouple is used to measure the temperature of the solid CO_2 (in equilibrium with its vapor at ambient pressure) which is formed by the expansion of liquid CO_2 through a porous plug. The chief advantage of an instrument which operates on this principle stems from the fact that both altitude and sublimation temperature vary approximately with the logarithm of the pressure, thus providing a rather uniform sensitivity throughout the altitude range.

An accurate measurement of the clearance between a rotating turbine blade and its housing would be rather difficult to make using conventional micrometers. A mutual-inductance micrometer has been developed for this and similar measurements. This device consists of two coils, a primary to which an a-c voltage is applied, and a secondary in which a voltage is induced. The induced voltage depends on the coupling or mutual inductance of the coils; this coupling changes as metal is brought into the vicinity of the coils. If the coils are mounted on a turbine housing, for example, the induced voltage will vary in a periodic manner as each turbine blade sweeps by. Quantitative voltage measurements provide an indication of blade clearance. The simple electrical connections involved and the possibility of making measurements on running machinery extend the usefulness of this micrometer to other difficult measurement problems. The effects of a number of factors, such as coil size, frequency, and geometry of the configuration, are being studied as a guide to the design of micrometers for specific applications.

Barium titanate is a material whose electrical properties are currently the subject of widespread study. It is a piezoelectric substance; that is, a $BaTiO_3$ crystal develops a voltage when it is squeezed. This property, which is also observed in a $BaTiO_3$ ceramic, makes this material suitable for use in an accelerometer. If a $BaTiO_3$ ceramic plate is loaded with a small mass, the disc will be compressed when it is accelerated in the sensitive direction and will produce an output voltage proportional to the acceleration. These accelerometers combine small size and mass, ranges up to 50,000 g (g = acceleration of gravity) and in some cases have a frequency response flat up to 100,000 cycles per second. They are thus useful for the measurement of high-frequency vibration and shock. Recent work in this field under the OBI has included extension of the acceleration and frequency ranges, and development of improved techniques for obtaining high-g calibration and for the determination of transverse sensitivity to acceleration.



Subliming carbon dioxide hypsometer. The altitude is indicated by the thermocouple which measures temperature of subliming carbon dioxide.

An interesting study now in progress is an exploration of the application of electronic automatic control (feedback) to image-scanning systems. A spot of light is generated which systematically crisscrosses or scans an area on the surface of a cathode-ray oscilloscope (television tube), and this spot is focused in the plane of an image transparency (diagram below). The light transmitted by the image is focused on a photocell, producing an electrical signal which may be fed back into the scanning scope or a "slave" oscilloscope connected so as to display the same picture as the scanning oscilloscope. If the feedback is negative, the system tends to produce a constant light intensity at the phototube from each point of the image, so that the picture appearing on the face of either oscilloscope will be a "negative" of the image. Using a suitable scanning method, the feedback signal may be operated on electronically to produce a mathematically transformed (e.g. differentiated) signal, yielding a picture with increased contrast or having other desired modifications. Promising applications of this new technique include: increasing the recognizability of objects on aerial photographs, pattern

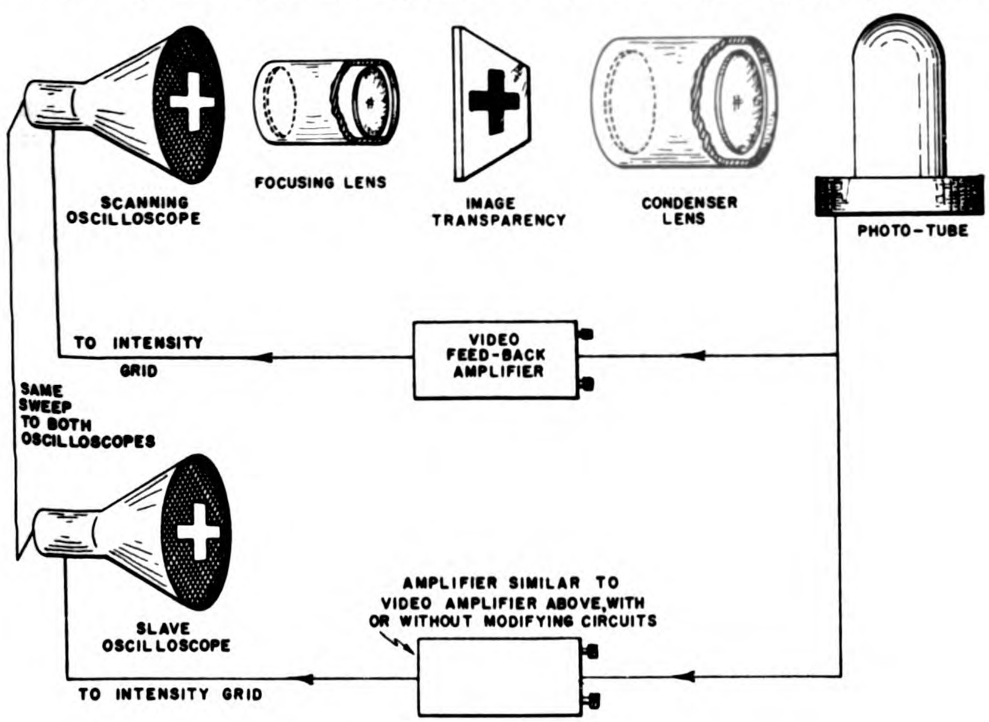


Image feedback system.

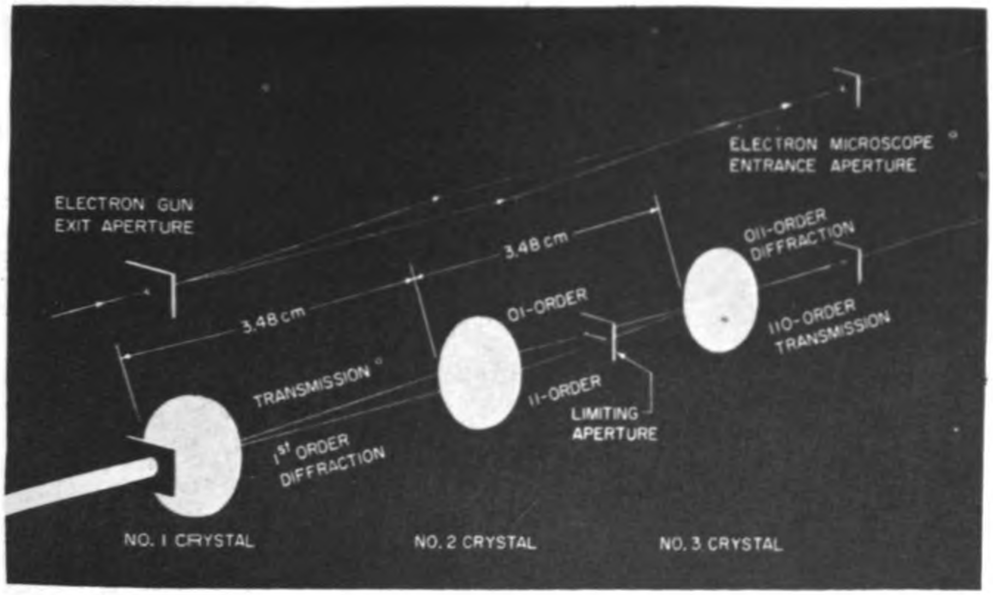
recognition such as automatic comparison of fingerprints, automatic reading of printed matter, solution of non-linear partial differential equations, and studies of visual recognition by humans, including evaluation of radar and sonar displays.

The microwave refractometer is being adapted to the measurement of absolute humidity in another OBI project currently in progress. In this instrument the index of refraction of the air under study is compared with the index of refraction of dry air. The two air samples are contained in microwave cavity resonators at equal pressures. The index of refraction is a function of dielectric constant, which in turn provides a direct measure of the amount of moisture present in the air. The apparatus is capable of high precision, and can make continuous measurements of absolute humidity at temperatures as low as -60° C.

Fundamental contributions to science are expected to result from construction of an electron-beam interferometer (inside back cover), which is now in progress. In analogy to an optical interferometer, an electron beam which is split and subsequently realigned should exhibit interference fringes if the path lengths of the two beams are properly related. Tiny copper crystals (less than one millionth of an inch thick) are used as electron beam splitters (diagram opposite), one crystal producing two divergent beams by diffraction, and the second rediffracting the beams so that they converge in the plane of a third crystal. The instrument, which employs an electron microscope injection system, requires adjustments of the utmost refinement in order to detect the interference pattern. Fringes have been successfully photographed, and at present the apparatus is being modified in order to achieve greater convenience and precision in the observations.

The instrument developments described above represent but a few of the completed and current OBI projects. Additional examples include an electrical "noise" thermometer, which measures absolute temperature as indicated by the random noise voltage generated in a resistor, an electronic gage for non-destructive measurement of the thickness of a conducting metallic coating on a conducting metallic backing, an acoustic viscometer for gases, and a microwave interferometer which will offer high precision in the measurement of wavelengths and short distances. Increasing attention to problems of nuclear instrumentation is exemplified by a project for the development of a fast memory-tube-type pulse-height analyzer, and a survey of existing and proposed neutron spectrometers. Surveys in progress are concerned with millimicrosecond oscillography, autographic stress-strain recorders, instruments for the measurement of fluctuating fluid pressures, analog-to-digital converters, and equipment sensitive to voltages at levels of a few microvolts.

A valuable by-product of research conducted under the OBI is the low-noise electrical cable recently developed. When ordinary electrical conducting wire is jerked, stepped on, or subjected to other forms of mechanical shock and vibration, false "noise" signals are generated which may be large enough to mask the true voltages present in sensitive equipment. This cable noise may result in serious interference with the operation of such devices as microphones, hearing aids, phonograph pickups, accelerometers, pressure-sensitive elements, amplifiers, and other instruments in which signals are present at low voltage levels. It was found that noise of this type has its origin in the collection



Schematic representation of electron beams in the electron interferometer. The incident beam is split by the first crystal, and two portions are selected for successive diffraction and recombination to yield an interference pattern.

of frictional or contact electric charges, which are induced on the surfaces of the conductor and dielectric when they are intermittently brought into contact. Subsequently, a method was found to coat the inner and outer surfaces of the dielectric with a conducting adhesive coating, which prevents the accumulation of the static charges responsible for the noise. The resulting cable is nearly noise-free even under very adverse conditions.

The reference center at the Office of Basic Instrumentation provides consultation service on instrumentation problems for a large number of contractors and research activities of the sponsoring agencies, as well as for industrial and educational scientific laboratories. Service laboratories confronted with instrumentation problems are invited to refer their problems to the OBI. A very useful publication entitled "Instrumentation Literature and its Use," containing a source list of instrumentation literature and a guide to its most effective utilization, has been prepared by the Technical Information Division of the Library of Congress for the OBI, and is available upon request from the Office of Basic Instrumentation.

Because it is only recently that instrumentation has been recognized as a unified scientific discipline, the literature in this field has heretofore been classified and catalogued according to the traditional library classification scheme, making it difficult for searchers to locate desired information on specific phases of instrumentation. In an effort to increase the accessibility of instrumentation information, a new method of classification is being developed at OBI, which is especially adapted to the description of the significant features of instrumentation and measurement literature. With associated developments for the mechanical storage and retrieval of such information, it is anticipated that future research in basic instrumentation and utilization of existing instruments will become considerably more effective.

On The Naval Research Reserve

Successful West Coast Research Reserve Seminar

Pictured above are some of the group of 66 officers who attended the two-week Second Annual West Coast Reserve Research Seminar in August. Captain T. H. Templeton, Commanding Officer, ONR Branch Office, Pasadena, California, planned and executed the Seminar which was made up of leading scientists and technicians from the geographic area west of the Mississippi River. The wide range of scientific fields represented included aeronautics, electronics, geophysics, physics, electrical engineering, chemistry, civil engineering, zoology, geology, oceanography, agriculture, biology, and education.

At the opening session CAPT Templeton extended greetings and introduced RADM G. C. Dyer, Commander, Training Command, Pacific. Representing ONR Washington, D.C., Dr. E. R. Piore, Deputy and Chief Scientist, and CAPT A. B. Cook, Director Military Services Division, also spoke to the group.

The Seminar included tours to the College of Medical Evangelists (where the picture above was taken); Aerojet General Corporation; U.S. Naval Ordnance Test Station; California Institute of Technology; U.S. Naval Fleet Sonar School; Consolidated Vultee Aircraft Corporation; U.S. Navy Electronics Laboratory; Scripps Institution of Oceanography; and the U.S. Naval Amphibious Base. At each activity, talks and demonstrations were given by leading scientific and technical personnel. One of these talks is given on the following pages.

Poisonous Fishes and Fish Poisoning

Bruce W. Halstead, M. D.

. . . Medical Ichthyologist at the College of Medical Evangelists, gave the following paper on 18 August to members of the West Coast Research Reserve Seminar.

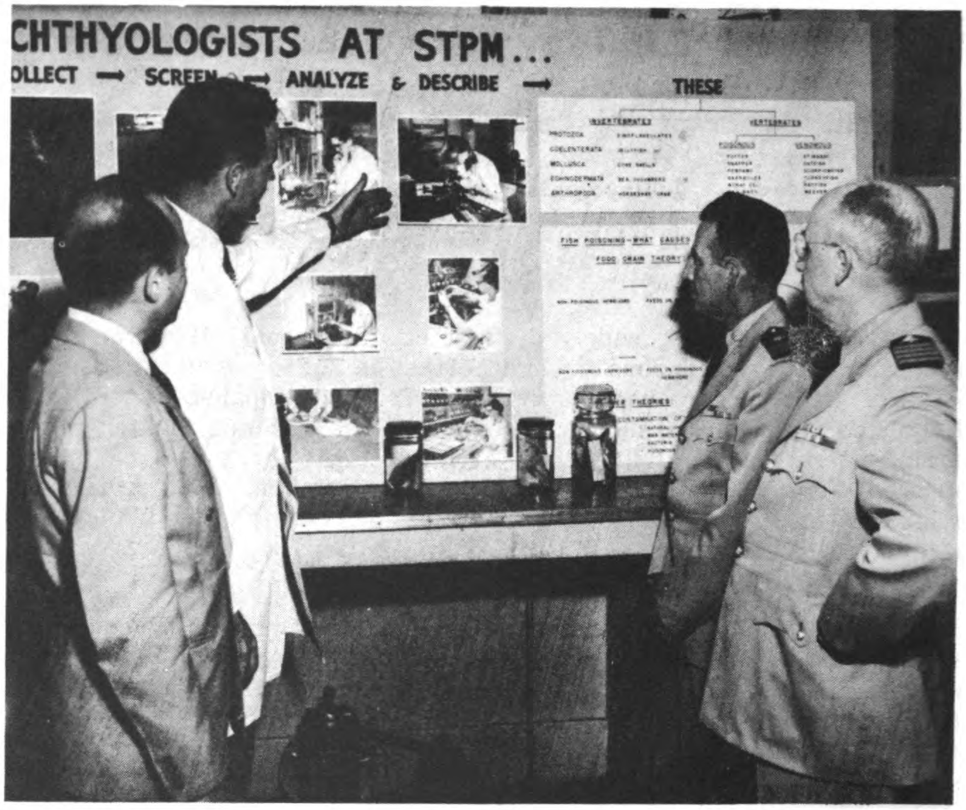
Poisonous fishes, widely distributed throughout all warm seas, are particularly numerous around certain island areas in the tropical Pacific. According to reports received from the Japanese, more than 400 of their military personnel succumbed to fish poisoning in Micronesia during World War II. It has been estimated that there are about 300 species of toxic fishes in the central Pacific Ocean. Among the total poisonous fish population of the world, this number is undoubtedly considerably higher.

Apparently fishes become toxic as a result of their feeding habits. Hence any reef or shore fish is potentially poisonous if captured in an endemic area. Fishes commonly found to be poisonous are such species as: red snapper, pompano, barracuda, surgeonfish, goatfish, moray eels, grouper, seabass, puffers, triggerfish, trunkfish, et cetera. A commercially valuable species in one area may be deadly poisonous in another. Puffers (also known as globefish, swellfish or blowfish) are usually extremely toxic. Ingestion of an ounce of the liver or flesh of some puffers has been known to kill a man within 17 to 20 minutes. In general, the visceral organs—the liver, intestines and roe—of a fish are more likely to be toxic than the musculature and should never be eaten.

The chemical and pharmacological properties of most fish poisons are unknown. Tetraodontoxin or puffer poison has been studied to some extent by the Japanese. Puffer poison, in its purified state, is a white hygroscopic powder, readily soluble in water and insoluble in the ordinary organic solvents. Japanese scientists are of the opinion that tetraodontoxin is neither a protein, an alkaloid, nor a protamine. The exact chemical structure and source of the poison are still unknown. Moreover, it is not known whether the poisons found in such fishes as snapper, grouper, moray eel, etc., are related to puffer poison, or whether they are a different compound.

Most fish poisons (exclusive of puffer poison) appear to have a composite physiological action on humans. Many of the symptoms are similar in nature to those produced by compounds such as aconitine, muscarine and curare. Whether or not ordinary fish toxins are true alkaloids remains to be seen. These fish toxins are water soluble and relatively heat stable. Ordinary cooking procedures do not destroy or appreciably alter the virulence of the poison. Also, the state of freshness of the fish has no bearing on the production or the virulence of the toxin, since putrefaction is not a contributing factor in this disease.

The clinical picture of fish poisoning is bizarre, but the appearance of certain symptoms is quite consistent. One of the first symptoms to develop after the ingestion of poisonous fish flesh is a tingling about the lips and tongue. The tingling soon spreads to the hands and feet, and gradually develops into numbness. These symptoms may appear



Members of the West Coast Research Reserve Seminar visit the College of Medical Evangelists. Left to right are: Dr. Harold N. Mozar, Director, School of Tropical and Preventive Medicine; Dr. Halstead; LCDR Nicolay; and CAPT Rice.

immediately or at any subsequent time within a period of thirty hours. In some cases the sensory disturbance may be preceded by a gastro-intestinal upset. At any rate, gastro-intestinal symptoms are present in about 75 per cent of the cases. The usual symptoms are nausea, vomiting, diarrhea and abdominal pain.

Later, additional neurological symptoms may develop. Ataxia, generalized motor incoordination, muscular weakness, paralysis, irritability, clonic and tonic convulsions are common. Patients frequently complain of a choking sensation, the result of a laryngeal spasm, which in some instances will necessitate an emergency tracheotomy. This distress is aggravated by excessive bronchial mucus production and hypersalivation. Joint aches, malaise, chills, fever, prostration, profuse sweating, metallic taste, intense itching, papular skin eruptions, transient blindness, and painful urination may also be present. One of the most striking symptoms is the generalized paradoxical sensory disturbance in which the temperature sensations of the individual appear to be reversed. Hot objects are described as feeling cold and cold objects as hot. Puffer poisoning is similar to ordinary fish poisoning except that it is much more violent—the neurological symptoms are greatly intensified.

Recovery from severe attacks of fish poisoning is usually very gradual, symptoms of weakness sometimes persisting for weeks or months after specific symptoms have disappeared. An attack of fish poisoning does not impart immunity and there is no known specific antidote at the present time. The treatment is purely symptomatic. Victims suffering from moray eel poisoning appear to be particularly susceptible to violent convulsions and may present difficult nursing problems. Since the convulsions are precipitated by noise, rest, quiet, and sedation are essential. Paraldehyde has been reported to be the drug of choice in controlling the convulsions. Drop ether has also been used with good success. In patients where excessive mucus is a factor, aspiration and constant turning are essential. If laryngeal spasm is present, intubation may be necessary. Nasal oxygen and intravenous fluids supplemented with parenteral vitamins are usually beneficial. Intravenous 10 percent calcium gluconate in many instances has given prompt relief while in others it has been ineffective. Atropine has been found to make the mucus more viscid and difficult to aspirate and is not recommended.

Native peoples have numerous methods by which they attempt to distinguish a poisonous fish from an edible one. Methods involving silver coins, color of fish, condition of the gills, position of the scales--and so on, ad infinitum—are based upon local superstition and not scientific fact. You cannot detect a poisonous fish by its appearance. Moreover, there is no known simple chemical test whereby you can determine the edibility of a fish. The most reliable methods involve the preparation of tissue extracts which are injected intraperitoneally into mice.

Naval Reserve Research Company 8-3

Above is a recent picture of Naval Reserve Research Company 8-3, College Station, Texas. In the bottom row, from left, are: LCDR R. E. Schiller; LCDR B. C. Moore, Executive Officer; CDR Norman F. Rode, Commanding Officer; LT M. L. Coffman; LCDR C. F. Lewis; LCDR C. K. Hancock. Middle Row, from left: LT W. D. Fisher; LT C. D. Holland; LT F. J. Benson; LT J. R. Bertrand; O. E. Smith; Chaplain R. L. Darwall; F. S. Wise. Top Row, from left: LT W. L. Tidwell; LT K. L. Dixon; LT J. P. Hollingsworth; LT D. I. Eidemiller; E. A. Bodd; T. O. Fassig; LT J. F. Mills, CAPT W. D. Scoates, USAG; J. F. Hubbs.

Admiral Bolster Addresses Detroit Company

Admiral Bolster, Mr. Handy, Captain Tucker, Lt. Commander Churchill, and Mr. Van House

Admiral Bolster and Mr. Handy

On Monday evening, 28 September, at Rackhum Educational Memorial Hall in Detroit, Michigan, Rear Admiral C. M. Bolster, USN, addressed approximately 125 Naval Reservists at a meeting sponsored by the Detroit Naval Reserve Research Company 9-21. Admiral Bolster spoke on the mission of the Office of Naval Research and the importance of the Research Reservists to the science effort of the Navy. All members of Reserve Research Companies 9-3, Ann Arbor, and 9-16, East Lansing, also attended. LCDR Robert M. Van House, USNR, Commanding Officer of Naval Research Company 9-21, Detroit, served as Chairman of the meeting.

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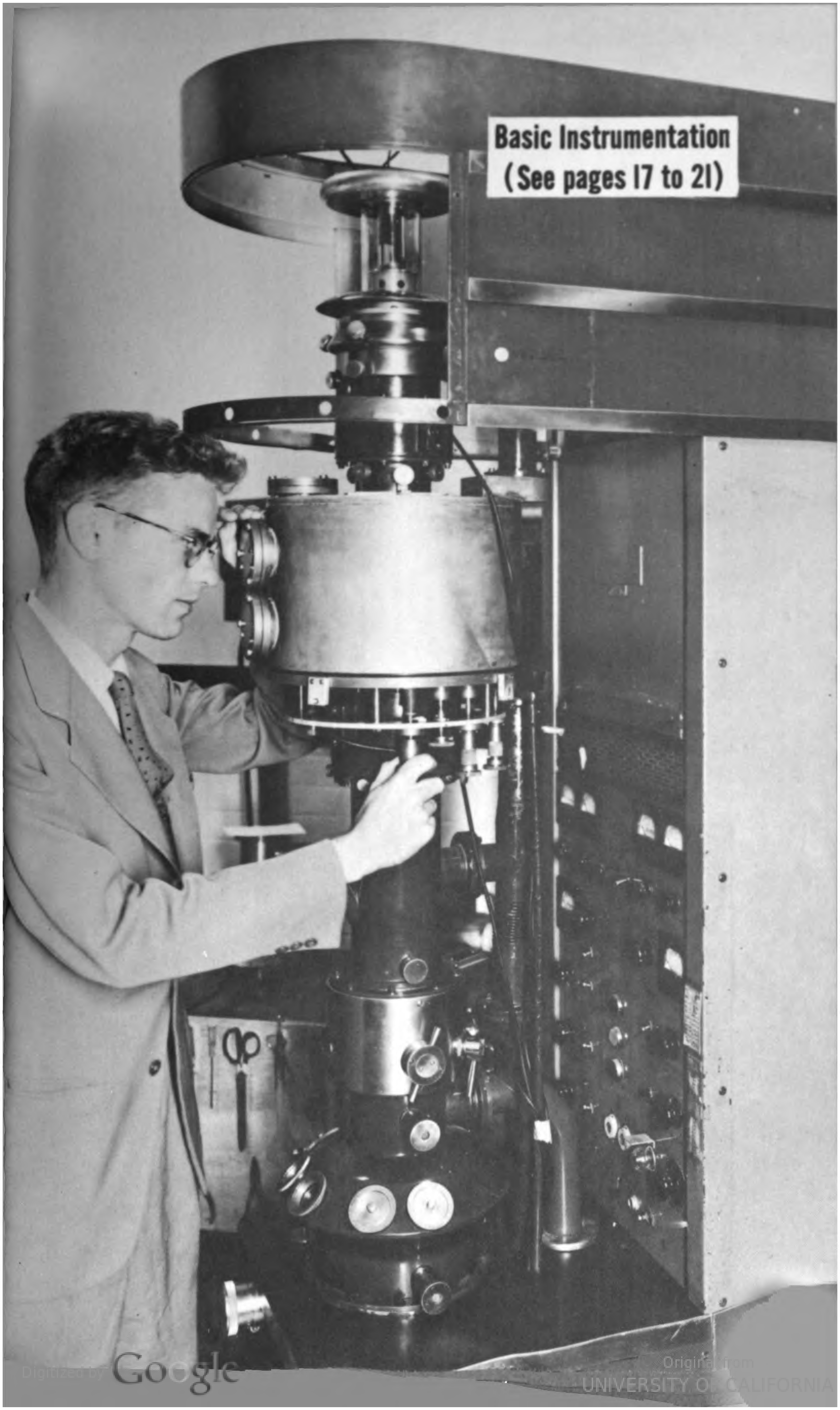
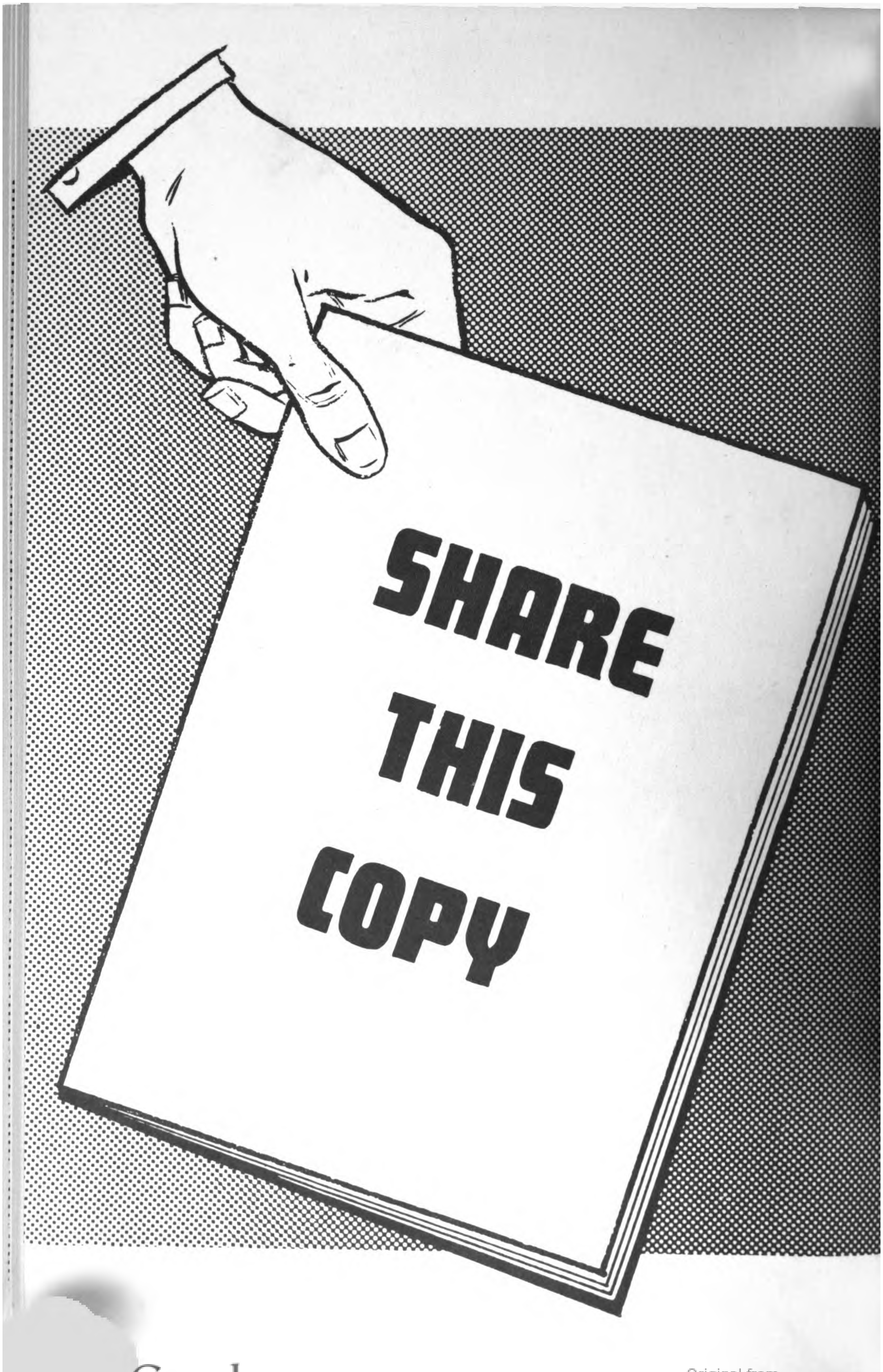


Basic Instrumentation
(See pages 17 to 21)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