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Human Problems in Scientific Research

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Obviously a problem in scientific research must appeal to someone—to directors and sponsors as well as to the actual workers, in order to be undertaken at all. In order to make it appeal it must be expressed in language and described as a project. Its good possibilities must be emphasized with skill; its disadvantages must be slurred over. To the worker it must appear to offer prospects for the attainment of prestige, the rapid publication of research papers, and advancement in status and income. To the scientific or institutional director it must be such as to appear important and must offer such prospects of results and subsequent erudite publications as can be depended upon to impress lay sponsors or legislators, as the case may be.

Propaganda is needed all along the line. Hence we find O. A. Stevens writing in *Science* for November 26, 1937 on "Freedom of the Press and the Scientist." Stevens put in a plea for better scientific publications, rather than an increased number of uncertain quality as at present. He said that "the chief restriction on the scientist's publication is the publisher's profit or the bank balance of the technical society." If the editor rejects, the author can still publish at his own expense. The consequent avalanche of publication, very largely propaganda, threatens to confuse and engulf the conscientious and serious research worker.

The multiplication of small scientific journals of overlapping subject matter occurs constantly. Brief notes appear time and again to put certain matters on record and to gain notice, but the promised definitive reports never appear. Mimeographing is cheap and is resorted to for purposes of scientific propagandizing. Research workers appreciate this condition, but each one is reluctant to curtail his own propagandizing. Stevens concluded: "I am quite aware of the need of increased facilities for publication, but I am convinced that we have a still greater need for a wiser use of those now available."

Scientific publication, being a byproduct of research and not a directly remunerative activity for the scientist, has a peculiar status. Essentially the scientific specialists subsidize their own publication outlets (in most cases) by paying very high subscription rates for technical journals. Editorial staffs mostly work unpaid. They are for that reason alone diffi-

dent about refusing publication to papers offered and, besides, members of the editorial board hope to publish papers also and can understand the aspiring scientist's need to get a hearing.

Problems must be so presented to those in control of funds as to impress them, whether they be legislators, boards of trustees, private philanthropists, or committees in charge of dispensing grants. Certain relatively trivial aspects of the problem must often be played up to camouflage some pure research investigation of fundamental importance that cannot readily be explained to nonspecialists. The problem must have a practical application, even if this be somewhat specious.

How a Problem Ramifies

THUS AN INSTITUTION has a laboratory devoted to carbohydrate investigations. A chemist goes to inquire about a research position. The scientific director begins to denounce cane and beet sugar as bad for the health, a dubious contention. He cites the known fact that the body must break these down into dextrose and levulose before it can utilize them—though it has ample physiological means to perform this function without strain. However, it might fatigue the hydrochloric acid in the stomach, or something. It therefore seems wise to make such sugars as levulose on large scale to help human digestion!

The problem elaborates and ramifies as the director talks about it. Quite possibly levulose would have special value for sufferers from diabetes who should be able to assimilate it more easily than they can ordinary sugar. The case is unproved, but it is an idea. The institution had just got wide publicity for its announcement that it was now making a certain so far worthless chemical at $1 a pound which formerly cost $250 a pound to produce. Maybe that chemical too will have some future use in treating some disease—who knows? Yet it is known all the while that the body will not absorb and utilize such a five-carbon substance!

Another laboratory announces widely the production of a very rare difructose anhydride, a sugar worth $50,000 a pound—a perfectly artificial price governed by pure noncommercial considerations, yet it was quoted as of commercial significance in the institution's propaganda. The substance lurked in dandelions and some old lady promptly wrote in explaining she wished to cash in the mortgage on her home by selling dandelion stems. New research problems appear by magic all around.

Honey is mentioned. In aggregate the honey business is small. But one bureau could work on its economic phases, another on its therapeutic

qualities, another on its vitamin content and nutritive properties, another could standardize honey after filtration, and yet another could make a chemical study of its constituents, the means of preventing it from crystallizing, or its possible substitution for invert sugar in the baking industry. Thus research projects abound to a director's fertile mind. Obscure, fundamental aspects of problems regarding hard work are skimmed over; possibilities of failure are ignored.

The problem may be shaped to suit certain interests. The basic nutritive lack of oleomargarine is vitamin A; a bit of color and a few unsaturated fatty acids would help it. Its fats already more nearly approach those of the human body in composition than do those of butter. The small deficiencies can easily be added and a cheap, efficient substitute for butter might appear. But it is customary for experiment stations in dairy states to prove that experimental animals languish on oleomargarine and thrive on butter. They must at least avoid publicizing scientific information that might injure local business, and even be careful how they discover such heresies in the first place.

They must also avoid research lacking in practical aim. Thus many experiment stations were originally interested in animal, not in human nutrition. It was only by a half-surreptitious deflection of aim that they got into the field of the latter. Even today some do human nutrition research half-secretly in animal research departments. This was true at Wisconsin which later became a noted center of research. Its projects had originally to be camouflaged, because basic research for which no immediate practical value can be cited usually goes begging. When the Wisconsin State experimenters first wanted money to buy a colony of rats the legislators could see no sense to that, and they had to buy the animals out of their own pockets.

But vitamin A was discovered at Wisconsin. Many years later it was shown there (as well as elsewhere about the same time) that ultra-violet-ray irradiation of certain substances imparted to them vitamin D properties. The Wisconsin scientists, unlike Madame Curie, were quick to see the potential monetary value of their discovery and to protect it by patent. They thus made it finance later research investigations in perpetuity. They also prevented it from falling into the hands of the murderous charlatans who have used radium nostrums actually to kill certain unfortunate victims of credulity. In the process they ultimately came afoul the anti-trust law for helping keep the price of vitamins high—but their outlook differed fundamentally from Madame Curie's.

Apology for the Scientist

YET THERE IS A GREAT DEAL to be said for scientists in a profit economy patenting their valuable findings and obtaining control over the income therefrom and the social utilization thereof. Those who supply the income have the whip hand over any research institution. They may often wish to make specific appropriations for very specific purposes. This may be very unwise. The scientists may know they lack equipment, knowledge, trained workers, or basic methods yet to attack the problem intelligently and with reasonable hope of solution.

Perhaps other seemingly useless or irrelevant research should be carried out first to provide a method; perhaps the problem is in a blind alley until science advances all along a related line. But if all this were expained, the scientific staff might come to be regarded as rebellious or inefficient. An insistence that certain related projects first be attacked would be regarded as a confession of weakness. The other projects might seem remote and impractical to the sponsors.

A research institution may also possess a single outstanding individual or laboratory that it must favor. The individual may be a biological or an organic chemist—or a close relative of a wealthy man. If a chemist, he may insist that all problems in the field of medicine are basically chemical, not bacteriological, in nature. He may demand the right to attack problems more properly in fields other than chemistry. He may take his pick of the available grants and projects, leaving the scraps to others.

The scientist who is good at ballyhoo, who is related to the rich, and who understands the use of propaganda techniques, can go far with scanty intellectual equipment. Often he is a near charlatan. Cases are on record where he has been instrumental in causing the death of several innocent victims in his efforts to try out therapeutic guesswork too quickly under clinical conditions. Such men, purely by propaganda, gather together imposing staffs in expensively constructed and lavishly equipped buildings. A worker of this sort may even contrive to change almost overnight the specialty upon which he claims to be expert in order to meet some new monetary grant more than half way.

Such upstarts cannot always be ignored. Men of sound scientific standing and gifts must often cater to them, see that they get a hearing in scientific meetings and space in scientific journals—because they stand close to the big sources of funds and know how to secure sponsors. Other better men hope through them to meet these same sponsors and secure funds. This chap freezes cancer tissue to kill the abnormal cells; that

one heats it to cook them; the other one adds a bacteriological serum to autolyse them.

All of this reaches the general public in the form of mass campaigns to banish cancer. Yet the cancer research situation has long been especially riddled with fakery and scandalous competitive struggles for funds to support any sort of laboratory babbling at all that can be palmed off as research. But a laboratory which starts with the fundamental problem of cell growth and proliferation itself, and seeks to discover the naturally occurring chemicals in the organism which accelerate or inhibit these processes—the only basic approach—finds it difficult indeed to secure funds. For that work cannot be propagandized dramatically.

There is great rivalry between specialists, supported by contradictory propaganda, largely because science has been so extensively compartmentalized. Science is well organized for analysis but synthesis is neglected. Physical chemists distrust organic chemists and both are contemptuous of biochemists. The medical research worker can dismiss a colleague as "only a botanist." The chemists can and do hold that modern research on virus diseases proves that the fundamental nature of disease is chemical, not bacteriological.

Nutrition workers meanwhile aver that the cause of all ill health is faulty nutrition. They deplore the ignorance of physicians about nutrition and can find a diet to remedy everything. Medical men do have vested rights in their theories. They do prefer to be repair rather than maintenance men. They in their turn incline to scorn laboratory workers, clinicians, experiments done on rats, biochemists, and specialists in nutrition and dietetics. Yet laboratory experiments do provide physcians with useful knowledge.

When Goldberger first began to show that pellagra was caused by some dietary deficiency, others were positive that the condition was caused by germ infection. Takaki met the same opposition when he showed that beri beri was a dietary deficiency disease. The physicians were slow to give in. Takaki's results in the Japanese navy were attributed to the improved sanitation that went into effect simultaneously. In spite of Goldberger's proved failure in transmitting pellagra by infective means, many physicians held out for years that it could not be caused by a faulty diet.

Writing on "The Progress and Present Aspects of Medical Science" in the June 9, 1937, *British Medical Journal*, Dr. Robert Hutchinson of London said:

The first impression that any survey of the present aspects of medical science must produce is one of confusion. An immense amount of investigation into the causes and treatment of diseases will be found going on, but too often it is ill-conceived and ill-directed, with a result that much so-called "research" is a mere beating of the air, a form of solemn trifling, wasteful alike of time and money. The confusion is reflected in medical publications, which have become excessive in number, and often so highly specialized that their very terminology is only to be understood by the initiated; full of facts and observations, but poor in ideas, in fertile hypotheses, and in helpful generalizations.

Obstacles to the Research Worker

TAKE CANCER RESEARCH AGAIN as a specific instance. The problem can be attacked in many ways, some of them much more apt to coax money out of sponsors than others. The approach may be surgical, pathological, by means of the X-ray, or purely statistical. It may deal with the incidence of cancer and the genetic laws of its inheritance. It may consist in microscopical examination of tumor tissues with subsequent histological studies, and an effort to find drugs or bacilli that will destroy cancer cells while leaving normal cells intact.

The problem may be approached as a search for the germ, virus, or injury that induces cancer. Any science from pharmacy to physics may be utilized for the basis of such research. Various agencies from high-power drugs, through dubious sera, to complex rays with which to bombard cancerous tissue may be invoked. Attention may be given to the acidity and alkalinity of the bodily fluids, the acid-base balance. The approach can be nutritional in the effort to show that cancer is of dietetic origin.

The most fundamental approach involves a close study, chemical and physical, of that complex of processes we loosely call growth. The study may have as its immediate concern the activities and reactions to certain chemicals of very simple organisms or plants. An effort is made to discover just what processes constitute growth, and what naturally occurring chemical substances retard or accelerate these processes in living organisms. Ultimately chemicals may be found that will rush cancer cells to maturity and deprive them of power to harm, but that is far off, for this is pure research. The study is complex, it appears impractical, and is most difficult to interpret in terms of propaganda techniques in order to impress laymen and secure funds.

Like other funds, research grants go not necessarily to the most worthy projects. They go to the best propagandists, to those who can so present

their projects as to make them seem most worthy. Obviously the less gifted scientists are likely to be the more gifted propagandists and vice versa. The scientific genius almost invariably puts his worst side to the public and is likely so to present his project as to make it appear negligible.

The necessity to show results is apparent. The easiest way to do this is by means of publications. Ordinarily the individual or the institution that can present the most imposing quantitative exhibition of publications is the one commanding the greatest prestige and most likely to procure funds. Sometimes papers about very unimportant matters will deeply impress laymen if expressed in obscure and baffling terminology. For this reason scientific writing is usually prettified also. Inconsequential papers are decked out with elaborate tables and impressive figures and illustrations largely for propaganda effect.

There is also a tendency to knock corners off a large project, perform a few experiments, and rush hastily to publication. A scientist said not long since: "You ask why don't I get a paper out of this idea? Why waste it? I'll divide it up and get six papers out of it. I need a professorship." Complex mathematical operations, intricate calculations and formulas all have a helpful decorative effect. Language is stilted and severely technical. Even the simplest statement can be made incomprehensible to the average person if that serves propaganda needs of the moment, and obscurity is often a useful propaganda device.

Not long before his death Lafayette B. Mendel listed a group of unanswered questions in the field of nutrition in the *Journal of Home Economics* (September 1935). Despite all the research on the subject the following sample, basic questions still remain unanswered, mainly because they are so difficult:

How many calories and how many grams of protein do adults and children of different habits need daily?
To what extent can the body store vitamins, water, fat, and minerals?
What is "normal" bone ash and how is it related to the mineral intake in quality and quantity?
What are all the truly indispensable amino and fatty acids?
Are all the 11 fatty acids found in milk necessary in the human diet?
What effect has texture on food assimilation?
Is heavy chewing necessary to ensure good tooth structure?
Is the recommendation that a child drink a quart and an adult a pint of milk daily really justified?
Is the propaganda about the use of whole-wheat products in the diet warranted?

Is there any health-promoting virtue in the admonition not to eat starches and proteins together?
What is the true function of roughage in the diet, how much should we take and of what kind?
Are the newer cooking techniques valuable from the standpoint of enabling us the better to assimilate food nutrient elements?
What are the real contributions of meat products to the modern diet?

Yet nutrition journals are replete with articles, though the above-mentioned editorial boards have here as elsewhere power of life and death over publications. Very often such boards act objectively and impartially But, being human, they can also succumb to prejudice, and sometimes deny the channel of publicity to research writers for questionable reasons. They are also suspicious of unconventional and unusual approaches to problems and certain individuals—perhaps geniuses, perhaps near-charlatans—are usually regarded as outside the pale in each specialty. Rejection may hinge on personal reactions and the loyalties of cliques.

The natural reply on the part of a group of too frequently rejected scientific authors is for them to get together and found a journal of their very own, which they do time after time. For scientists must have a mouthpiece. Meanwhile the honest research worker is sore puzzled to sift the wheat from the chaff in this vast bin of scientific propaganda and to assay the true status of problems in his own narrow specialty. The mere effort to assay the "literature"—analyze the bibliography of a subject—is prodigious. In chemistry it has given employment to a new professional group, the so-called "literature chemists."

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