

DISCOVERY AND INVENTION IN WAR-TIME

A PART altogether from limitations of resources and materials imposed by national needs and the diversion of scientific workers from creative or fundamental work to emergency problems of defence and the like, the impact of war is rarely favourable to scientific advance. War necessities may, and often do, stimulate invention, but they rarely favour, and indeed commonly retard, scientific discovery and the advance of knowledge. Even in such special branches as aviation, the War of 1914-18 actually retarded technical progress, and as has been pointed out in these columns from time to time, warped the development of civil aviation.

Under conditions of war, the conservation of resources, and above all of creative and fundamental thought and work, becomes a matter of prime importance, and we may well return with increased interest to the symposium on invention presented some years ago before the Institution of Mechanical Engineers, as well as to the highly suggestive study of C. Nicolle, "Biologie de l'Invention" (Paris: Librairie Felix Alcan), published in 1932. Although the symposium on invention was concerned primarily with the evolution of invention and the development and exploitation of invention relative to patent law and economic recovery, the broader questions of the place of invention in industry and its relation to scientific discovery received passing notice.

Even in regard to invention, we may not assume too readily that all is, and will be, well under war-time conditions. The needs of a time of emergency are apt to stimulate invention to solve day-to-day or urgent problems rather than the long-range problems, and particularly those involved in the reconstruction and re-integration of social and economic life after the war. If the latter needs and problems are entirely neglected, there are likely to be many gaps in our knowledge and many unsolved problems which will hinder us reaping the full benefit of our war-time effort. Nor should it be forgotten that it is not only from *ad hoc* research or investigation that the solution or clues to the solution of even the most urgent problems have always come. Fundamental research has a stimulating and fertilizing value which should make us chary of starving it even in the direst necessity.

M. Nicolle's little book, however, made a more serious attempt to probe the theory or mechanism of scientific discovery, to which some attention was given in the symposium. In spite of frequent discussions, we are little nearer to the understanding of this question than in the time of Bacon. Fundamental creative ability may indeed defy analysis, but a knowledge of the conditions which encourage or stimulate it is worth while, all the more when the need to conserve resources is most imperative.

It is recognized that discovery precedes invention possibly by long spans of time, and invention itself presupposes knowledge based on experiment and observation. Broadly speaking, as Mr. H. W. Dickenson pointed out in the symposium in question, a discovery is the apprehension of the order of Nature, while invention is the guidance of the known forces of Nature into new channels for the benefit of man. What we are primarily concerned with here, however, is the ability to evolve new schemes or contrivances, commonly called inventiveness, and the factors which are favourable or unfavourable to the exercise or development of this faculty.

Many factors have similar influences on both invention and the more creative act known as discovery. The initial effort required either in creative thought or inventiveness can be repressed or prolonged by excessive knowledge. The deadening effect of the abundance of technical and scientific literature to-day has frequently been the subject of comment, whether from the point of view of encouraging excessive specialization and pre-occupation with the details of a narrow field or from the mental indigestion it may cause.

This position, however, arises in part from the chaotic condition of scientific and technical literature, and the failure of scientific workers to organize a really adequate and effective abstracting service, with the advantages which the expert handling of such literature and the elimination of duplicated effort would afford. The stringency of war-time conditions in regard to paper and printing may yet supply an added stimulus where the rational motive has been insufficient to overcome inertia or prejudice.

Even when allowance is made for such retarding influences, it has to be admitted that fundamental

creative ability defies analysis. Although, at the present time, a wide experience is more necessary than ever, conscious thinking out in science is a process rarely if ever leading to novel results. As Sir J. J. Thomson observes in "Recollections and Reflections": "New ideas come more freely if the mind does not dwell too long on one subject without interruption. It is, I think, a general experience that new ideas about a subject come when one is not thinking about it at the time though one must have thought about it a good deal before. It is remarkable that when ideas come in this way they carry conviction with them and depose without a struggle ideas which previously had seemed not unsatisfactory".

The creative mind concentrates more or less intensely for a less or greater space of time upon a problem for which no solution is known. A new and correct solution comes to it in exactly the same way as a forgotten name or fact often comes to us after we have cudgelled our brains in vain for it. Just how or what determines the incidence of the new idea remains an unexplained mystery. We can only note the predisposing factors which stimulate it or appear to accompany it.

One of these has already been noted—the break in conscious thinking about the subject. Dr. H. S. Hatfield pointed out in the same symposium that in early youth the power of assimilation may afford a criterion. The creative mind frequently has much less power of assimilation, but along some particular line it actually runs ahead of the matter presented to it, re-inventing what is known. Initiative is another characteristic, even if we dissent from the proposition that genius is merely a capacity for taking infinite pains. It is rare, however, to find genius without that capacity, at any rate in directions which serve its ends.

Again, creative work is rarely accomplished by the steady round of daily hours most favourable to routine work. It has mostly been accomplished in violent bursts of overwork at high pressure, alternating with periods of comparative idleness in which the unconscious mind is able to order its content. Problems are not solved more slowly by easier going: rather they are not solved at all unless the attack reaches a certain intensity. The creative act, as M. Nicolle points out, is essentially irrational. We cannot impart merely by training the sense of values and the capacity to discriminate instantaneously between essential and non-essential.

We can only hope to supply the conditions or opportunities in which they flourish and develop and in which they can be most readily stimulated.

Creative genius, again, is something more than intelligence. It is not simply the acquisition of new facts and their systematization. Such powers may be possessed to a high degree by minds incapable of creative originality. It is indeed true that if genius is to accomplish anything effective, it must be accompanied by good sense, and that, even so, collaborators may play an indispensable part by keeping the creative spirit in touch with realities and supplying just that capacity to work out the consequences or practical applications of the discovery with which genius is apt to be too impatient to trouble. Anything that endangers its spontaneity or limits its freedom, however, threatens the creative spirit. True though it may be that genius may triumph over any misfortune or obstacle, it is only those who succeed of whom we hear.

In science, no less than in art, creative work flourishes in an atmosphere of sympathy and enthusiasm, where the mind is quickened and encouraged to expand. We lay constraint or even discipline on the truly original at our peril. Such minds are rare, but it is difficult to distinguish between latent genius and the normal intelligence. It is one of the dilemmas of wartime that we must seek to preserve for the creative few the full freedom of thought and work essential, while the many accept the discipline and constraints demanded in the national interests. More, rather than less, in war than in peace, the price of liberty is eternal vigilance, and no severer task lies upon the shoulders of scientific workers than that of seeing that all the vigour which they bring to national service in its myriad needs, and the readiness with which they accept sacrifice and discipline with their fellow citizens, shall not be allowed to impair for one moment the disinterested search for truth. They who claim to be defending the cause of freedom and truth must see to it that, within their ranks at least, the quest for truth is unimpeded, and that no political considerations are allowed to fetter discovery or exposition of its results when these are prompted by the disinterested desire to enlarge the bounds of knowledge. Ultimately it is in the truths won in many fields of knowledge—physical, economic, social—by creative minds that alone we can build the new social order which will make the present sacrifices worth while.