

What is CERN for?

Why have the European nations been spending 70 to 90 million Swiss francs every year for an enterprise such as ours in Geneva and, incidentally, another 240 million per year at home on similar work? Why do we support, or why should we support, such basic research?

The usual argument is this: from the point of view of the common man — the taxpayer — basic science should be supported since, so far, every basic discovery has led to important applications later on. I may remind you of the well-known story of Faraday who replied to a sceptical member of the government, when asked what was the use of his strange experiments about the magnetic effects of electric currents: 'I don't know, but I am sure that some day you will be able to collect taxes from its applications'. Faraday was right, though it was a good many decades before the taxes began to roll in and, even then, they came from the 'grandchildren' of Faraday's ideas and not from the ideas themselves.

There are three stages in our scientific attack upon the structure of the atom: first, the study of the structure of the electron shell, second, the study of the atomic nucleus, and — lately — the study of the inner structure of the constituent of the nucleus: the nucleon.

The electron shell is responsible for the behaviour of atoms under ordinary conditions prevailing on earth. This is why the basic science which studies it — the true atomic physics — is such a rich source of rather direct technological applications in optics, electronics, metallurgy, chemistry, and even biology.

The structure of the nucleus comes into play only under conditions of energy exchange which are rarely found on earth; the radioactive phenomena are examples. Only in the interior of stars — so we have reason to believe — are nuclear processes predominant. Nuclear physics would have been a very esoteric science had man not succeeded in creating conditions in nuclear reactors where some nuclear processes such as fission play an important role. But it was by the skin of our teeth; the fusion process seems to resist our attempts to tame it. The reasons are significant: matter cannot be contained under conditions where thermal energy is comparable to nuclear energies unless other very large forces, such as the gravitational field inside a star, or perhaps some sophisticated high magnetic fields, are brought into play.

The phenomena in which the nucleon structure comes into play — the phenomena discovered and observed at CERN, which can be called 'sub-nuclear physics' — involves energies of such order that even the centre of stars is not hot enough to excite them. We observe them in nature only very rarely, namely when cosmic rays impinge on the earth. Perhaps they play an essential role in some of the great cataclysms of star explosions or in the whirl of matter at the centre of galaxies. **It is extremely improbable that the experimental results obtained at CERN will in themselves ever be of practical importance** since they refer to conditions of matter which are far more remote from our own conditions than the nuclear phenomena. Is it, then, justified to ask the governments and the taxpayers for such large sums to support 'sub-nuclear physics'?

There is no doubt that the answer to this question is positive, although one encounters great difficulties in formulating the reasons, simply because they cannot be expressed in terms of an immediate financial or material return. The problems of 'sub-nuclear' physics are today the basic questions of science. They are the perennial questions of 'why' in the structure of matter. Why are the proton, neutron and electron the fundamental constituents of matter? Why are there nuclear and electric forces between them which determine the course of the universe? Ultimately this most fundamental frontier of science will reveal to us the connexions between the phenomena of the infinitely large and the infinitely small; the questions of the origin of the universe and the nature of elementary particles. These questions are of basic significance for all our endeavours, from which not only our technology stems but also our existence as thinking human beings. Physical science today is so advanced that the frontier of fundamental problems has been shifted to regions which are so different from conditions on earth that direct technological applications are most improbable. It would be imprudent, however, to exclude them completely. Nobody expected in 1932, at the start of nuclear physics, that this field had practical applications. **The new ideas themselves may not have any technological consequences, but the 'grandchildren' of these ideas may.**

The reasons for supporting 'sub-nuclear physics' are really based on different grounds from that of direct technical application. The pursuit of fundamental questions was and is the spearhead of science. It attracts the most sophisticated brains and it supplies vitality and vigour to the scientific community which benefits the totality of scientific development. If this spearhead were blunted, physical science as a whole would suffer. Basic science has always attracted and produced the best students, who later on have often gone into more directly practical fields. Scientific activity in any field, practical or impractical, is a search for explanation. If the efforts towards the most fundamental explanations were reduced, the spirit of inquiry would eventually disappear from science. Technology also would suffer from this, since it is the same spirit that creates new ways of exploiting nature here under terrestrial conditions.

Therefore every society that wants to be in the forefront of practical technology must also be vigorously engaged in basic science. It is the very root of the culture and tradition from which our technology grows. To apply again the simile: it is the 'mother' of all scientific ideas and therefore the 'grandmother' of future technological progress.

The value of basic research, then, can be expressed in brief by the following three points:

1. It is an important frontier of knowledge,
2. It is the spearhead of science as a whole,
3. It is the breeding place for new ideas.

Fundamental science clearly plays a dominating role in our culture; its study is the greatest adventure of the human mind.

Adapted from the speech given by Prof. V. F. Weisskopf, Director-general of CERN, at the Annual Luncheon of the Parliamentary and Scientific Committee, in London, on 21 February, 1963.