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Cover illustration
A special "upside-down" liquid helium refrigerator built at the CRTBT, Grenoble, that provides unmatched ease of use. The device is inserted into a standard ^{4}He storage vessel and samples, protected by radiation shields (not shown), are attached to the plate at the top.

PHYSICS UNDER STRESS

How to Move Forward

Hans Chang, the Director of the Foundation for Fundamental Research on Matter (FOM), the Dutch funding agency, gives his personal views on how to tackle the challenges facing physics.

Physics is in a period of transition. Discussions among individual physicists, however, often remain centred on inadequate funding or "we want more of the same". The situation is not improved by not facing and adjusting to present realities.

Consider some major developments in the environment surrounding the physics system. The news magazine *Time* last year quoted a former Director of the US National Science Foundation as saying: *The American public hears that we are number one in science, and they want to know why that fact is not making our lives better. The one thing that works in this country does not seem to be paying off.* At this year's annual meeting of the German Physical Society, the country's federal Minister for Research stressed the importance of explaining the benefits of basic research to the general public. In the United Kingdom, the Chairman of the Science and Engineering Research Council recently introduced the notion of "wealth-creating science" in defending the interests of his organization; the US Congress speaks of "productive science". In The Netherlands, there is a political consensus about the volume of government funds for research (they are sufficient/more than enough), and almost certainly on the fact that the proportion spent on basic research is too large.

Many national political arenas signal the same message [1]: *The period of generous government funding for national research — which many scientists believe to be the norm but was in fact an anomalous period — is over. The model of that period — input in research will produce by some magical process something useful ("strategy of hope") — is also passé. Science is not going to be funded for its excitement (only) anymore. The science that is funded has to contribute much more clearly to the strength of the nation* (Ed.: the US). *The rationale for research in each industrial country will come under renewed examination.*

Low Priority

Within this overall funding scenario for national policies in science, funds for physics — especially for high-energy and nuclear physics and for space research — are being placed under extra pressure. In some countries, these fields have been declared to be of low or even negative priority.

Academics whose task it is to argue for increased government support on the input side of the physics research system are not helped much by recent developments on the demand side, *i.e.*, in industry. In times of growth, companies boasted about their scientific prowess. In times of survival, the idea that investments in research have been valuable to a company is seriously questioned. The chairman of one of the world's leading electronic companies has even stated that too much emphasis on basic science prevents companies from being competitive. Senior executives of Western multinational companies — who mostly nowadays have a financial rather than a technical background — are often ordering a redesign of their organization's industrial research. For them, scientific knowledge is simply a commodity that can be produced, traded, and/or bought anywhere in the world. To quote A&T's Pensias, the Nobel laureate: *The test is not going to be whether we do good science or not. The test is: is the company going to be healthy or not.* Regardless of the new buzz words in industrial research management (customer-contractor principle, third-generation R&D management, push/pull-management, partnership management) the message is clear, large companies are reducing research staffs and, in parallel, shifting research programmes to more applied topics more relevant to their companies. It is said at AT&T's Bell Laboratories, Bellcore, IBM, Xerox, Philips Research, Exxon, and elsewhere that physics is losing the corporate struggle. The academic community can of course argue that these developments in industry and industrial research provide another reason for governments to take greater responsibility for supporting basic research that involves high risk, exploratory work. But such an obvious argument will only be credible in the political arena if there is explicit support from the demand/market side of the physics system.

Less Interest

Incoming students, another important parameter on the input side of the academic system, also need consideration. In The Netherlands, the number of first-year physics students at the (technical) universities has decreased continuously since it peaked in 1988 with 827 students. The main cause is demographic (the effect of the post-World

High-school children in Amsterdam learn all about the theory of relativity in a Saturday masterclass. Masterclasses given by a university professor turn out to correct the dull image of physics and universities.

War II baby boom) and it seems to hold for all the natural sciences. But the quality of incoming students has perhaps also changed. There is strong evidence that for many years, the best-qualified high-school graduates in The Netherlands used to enroll at university in either theology/philosophy or in physics. Other disciplines now also appeal strongly to the best and brightest, or as a clever student in business administration provocatively explained to me: *I chose this subject* (instead of physics) *so that I can become the boss of the physicists.* The trends with respect to decreasing student numbers in the natural sciences seem to be similar in most west European countries.

Increased Atomisation

The last few years have seen the discovery of new physics phenomena providing new challenges and intellectual excitement (high-T_c superconductivity, Supernova 1987A, bucky-balls, atom cooling and atom optics, superdeformed nuclei, single-electron devices). This list [2], which in no sense exhausts the surprises, shows Nature's abundance. As none of these phenomena appeared in research policy documents trying to forecast the future of physics, the obvious lesson is that scientific discoveries invariably exceed the power of our imagination.

The work on these interesting phenomena leads to an ever-increasing number of scientific publications. Although we are still far away from the roughly 500 publications per day generated in medicine and biomedicine, it is clear that this growth cannot continue; we have to learn how to deal with an "information infarct". A recent workshop [3] sponsored by FOM showed how an individual scientist does not experience the problem because he or she defines a given field as that which can be followed and understood. However, cross-fertilisation between sub-fields of physics is crucial for scientific progress so it is ironic that the "atomisation" of physics now concerns policy makers and research managers.

Some Remedies

How can we as a physicists work towards a more favourable situation? I think the human aspect is critical so research managers in the academic world should focus more attention (and even funds) on physics teachers in high schools. Their quality and enthusiasm strongly influences a young person's choice of study. In order to support physics teachers, specific small-scale initiatives have to be developed on a regional basis that identify topics for which help from physics institutes can be effective.

I believe that a thorough training in physics at university imparts skills based on analytical capabilities, methodology, planning, and international teamwork which can be very useful when one moves to other scientific fields, or to positions outside research. We should be able to convey this message to students and not do them the disservice of making them believe that their best place - if there are places - is on the faculty of a physics department.

Public accountability is essential nowadays. While others are better qualified to write about this aspect, it is clear that the media is interested in describing new physical phenomena to the public. A sense of national pride encourages reporting on scientists whose work has been discussed in eminent journals; we should exploit this situation.

In facing today's realities, it is inevitable that money has to be discussed. The days of plenty for science are over; the pecking order of scientific disciplines has changed; the relative position of physics has diminished. Other fields are also able to grasp the imagination of those who pay for science; curiosity-oriented science is not considered to be significantly more important than orchestras, the ballet, *etc.* In the increased competition with other disciplines, physicists should be in better position to use their long experience in planning and teamwork, and in discussing with their political communities strategic plans that integrate international activities. In this context, it is perhaps useful to note that if the goal of a plan includes generating money for the plan, then:

– projects developed within an identifiable international structure serve as a goal in political circles (*e.g.*, for internationalisation);
– projects formulated under the aegis of national (academia-industry) networks inspire confidence that a transfer of knowledge to the national economy is a likely outcome;
– projects which have next to the cultural component the possibility of another customer (*i.e.*, technical applications in other fields) or which are multidisciplinary in nature are bound to receive broader support in advisory bodies;
– projects giving ample support to physicists who are in international terms (nearly) on the top of a scientific mountain demonstrate the vitality, flexibility and discretionary powers of national decision-making structures in allocating funds.

In tomorrow's Europe, national physics communities have an additional opportunity for consolidating or strengthening the position of the field. Under the adage "united we stand, divided we fall", physics research organizations (including the physics divisions of research councils) should foster international cooperation involving research facilities and projects. If necessary, they should not hesitate in investing funds out of their own (decreasing) budgets in suitable ventures. European Community (EC) funds for research are in the meantime increasing (*e.g.*, the 4th Framework Programme 1994-98). I think there is a reasonable chance that at some moment in the future, part of these funds will be reserved for a kind of EC research council system to stimulate basic research: physics research bodies should aim at having become an accepted player on the European research scene by then *via* bodies such as EUPRO [4].

The feeling of malaise in physics, induced by old-fashioned perceptions of our present environment, does not take our field forward. The challenge for national physics communities is to not only to try to understand and to explain to others "the wonderful things one sees", but also to show that there is an increasing (external) demand for people trained as physicists and for the knowledge, insight and techniques that physics brings. If we convey this message, we shall surely be able to claim the attention of the next generation of young people and to receive support from today's political communities.

[1] Roundtable: Physics in Transition, *Physics Today* (Feb. 1993) 36.
[2] Kleppner D., *Physics Today* (Dec. 1991) 9.
[3] The information inundation in physics (20 March 1993, Utrecht); see *EN* **24** (1993) 86.
[4] EUPRO is the European Union of Physics Research Organizations. The following have signed its charter: NFWO/FNRS (Belgium), CNRS & CEA (France), DFG (Germany), EOLAS (Ireland), CNR (Italy), FOM (The Netherlands), NFR (Sweden), SERC (UK). Organizations from Denmark, Finland and Norway are expected to do so fairly soon. EUPRO has decided to explore nine topics to provide the basis for a collaboration between members or for a submission to the well-established COST programme (concerted research actions "à la carte" coordinated by the European Community). Dr. Chang is the EUPRO Chairman until 1 May 1995. See *Europhys. News* **24** (1992) 23.

9th General Meeting of EPS Ordinary Members

Palazzo dei Congressi, Florence
14 September 1993 at 17.00

AGENDA

1. Report of the President, N. Kroo
2. Report of the Secretary, A. Taroni
3. Report of the Treasurer, H. Beck
4. Activities:
– East-West Coordination Committee (A. Landesman)
– European Mobility Scheme for Physics Students (H. Ferdinande)
– Interdivisional Group on Physics Education (C.M. Ferreira)
– Professional qualifications (D.A. Jefferies)
5. Any other business.

QUANTUM ELECTRONICS AND OPTICS DIVISION

The next QEOD Management Meeting will be at 12.30 on 11 Sept. 1993 at the EQEC conference site, Florence.