

## GENERAL COMMENTS AND RECOMMENDATIONS

As an admirable step during the process of re-independence, the Estonian Science Fund Council and the Estonian Science Council have asked the Swedish scientific community to evaluate the status of science in Estonia. In taking on this task it was agreed that such an evaluation should not take into account past difficulties, but be carried out according to the same principles and standards as if it had concerned Swedish science. This means that vital quality indicators are, whether or not the evaluated projects are close to the international research front and whether the results are readily accessible and relevant to the international scientific community. We are well aware that this approach may seem unduly harsh, when used on a scientific community which, like the Estonian, has suffered so many years under an oppressive political system, where international (Western) contacts have been discouraged or barely tolerated and where the publication policy has been directed inwards (i.e. writing in Russian or Estonian) rather than outwards (writing in English). There is no doubt that many talented people have never had the chance to show what they could have done given proper opportunities - and that even the really good projects and the most internationalized researchers (and there are indeed a good number of both categories) have suffered from partial suffocation. Estonian science will now have to function within the competitive and increasingly integrated modern scientific world, with its many international programmes, where influence is mostly related to the relevance and quality of one's own input. We therefore believe that the only proper way to fulfil our evaluation task is to identify the - from an international viewpoint - healthy and productive parts of Estonian science - and to indicate where isolation and the resulting lack of international feedback has led to substandard research traditions and suboptimal organization.

Although many of our recommendations may seem utopic in the rather chaotic present day Estonian situation, we believe that even in the short perspective many of them will be relevant, and we hope that in the long run most of them will turn out to be useful.

Finally, it should be pointed out that our evaluations basically had to rely on the material sent to us, and on the answers, impressions and additional material that we received during the site visits. As so much of the literature is written in Russian and Estonian, which only few of us can comprehend (almost the entire production of some scientists is written in these languages) - and as a short visit to institutes with large numbers of scientists (whom most of us had never met) may give too brief a picture of what is actually going on - it is not unlikely that some misunderstandings may occur here and there. Should this be the case, we do sincerely apologize.

## The structure of Estonian research

(1) *Research vs education*: - A basic principle in Western countries is a strong integration of research and education. The need for that has a complex background, such as to assure students and through them give society, industry, etc. (most students do not remain at universities to become researchers) access to the most modern ways of thinking - and simultaneously give research efforts access to the brightest students. Even though many separate research facilities are found also in the West, most Western basic research takes place at the universities, where thus also the integration between research and education takes

place. Such an integration has not been common in the Soviet-type system, where most basic research is carried out by the academies, while higher education is given at the universities.

The relative isolation of the research in the academies has, in our opinion, several drawbacks. The young generation does not come into contact with the actively working scientists in their role as teachers, and the researchers do not get stimulus from contacts with the students. Also, a scientific career based on tenure track directly after recruitment to graduate study does not create an optimal situation for academic competition, and the interaction of researchers with society becomes rather weak.

Our impression is that the teaching staff at the universities have much too high a teaching load, while at the academy institutes it is much too low. The creation of a good scientific "atmosphere" at a university, requires the involvement in teaching also by the leading scientists.

A gradual integration of the Estonian Academy institutes and the University is recommended. How this integration should take place, and especially the geographical location of the integrated units, is difficult to generalize. It is clear, from the different subject-related comments, that prolific institutions may be found either in Tartu or in Tallinn. In general we believe that this positive factor should determine the geographical localization of the integrated units.

(2) *Demography and decision-making:* - The Estonian research system is generally, although not without exceptions, characterized by a relatively high age of its components - machines as well as manpower. The relatively high age of much of the technical equipment is of course due to economic reasons, whereas the rather top-heavy demographic structure of the research community also is, as we believe, an effect of a general lack of dynamics in the system. Partly this may be because the academy structure, especially if not in an expanding phase, tends to be conservative. Another reason may be that the lack of firm integration with a university system (with, in the ideal case, a profusion of talented graduate students, post-graduates and PhD students) makes rejuvenation more difficult and a not so natural process. An urgent need for Estonia is to "normalize" the age structure, so that students of various kinds, and younger researchers, make up the bulk of people "visible" at any given institute.

From the above follows a need to re-structure the policies for decision-making, moving as much decision-making power as possible downwards through the system - and let the economic responsibilities for different projects follow as far as feasible. Self-reliance is one of many keys to success!

The number of PhD students as a whole appears remarkably low. One reason appears to be the previous requirement that they be guaranteed a position in the same field following the completion of their degree, already at the time of being accepted for study. In our opinion, this policy should not be continued; For those persons that perhaps 20 years from now will be responsible for some enterprise in state, industry, university or academy, it is probable of utter importance what their precise topics of current work are. Important is, however, that they are exposed to challenging problems and learn methods for attacking difficult questions on an international level. This should be utilized to offer possibilities for PhD studies to many more students than now is the case. The migration of scientifically trained persons into all branches of

society should be greatly beneficial, not least for the development of a national industry, based on highly qualified science and technology.

(3) *Age distribution of graduate students:* - We noted that the period of PhD studies is preceded by extensive undergraduate studies - as we understand, normally 6 years. While this may, in some sense, mean a broad education for the future scientists, it also constitutes a problem, since the new doctors become relatively old before graduating (most often above 30). As commented on above, it should be beneficial to science and society alike to have a much increased flow of graduate students. However, since one intention with such a program is to have more persons with a scientific education in different positions in society, these persons must have a chance to begin their career outside the academic world before they are too old. Then a more suitable age for the completion of a doctorate should be around 25/27 years. Thus a shortening of the undergraduate and postgraduate periods should be aimed at; It is better to have a larger number of graduate students completing their exams in a shorter time, than a smaller number continuing for a longer time.

In this context it is also important to modernize the system by which positions are then given to researchers, i.e. the promotion system regulating the career of the scientist. Scientific and pedagogic merits should decide the issue. A vital component in the appointment process is to let all important positions be filled only after the candidate's merits have been scrutinized by a special committee. Such committees, consisting of 1-3 persons, depending on the level of the position under consideration, should preferably be made up of non-Estonian specialists - as the Estonian scientific community (just as the Swedish, where this system is practised) in most cases is too small to ensure a non-biased treatment of the applicants.

### Structural considerations

The simpler an organization is, the more flexible it usually becomes, and the better it generally works!

Some of the research structures we encountered in Estonia seem unnecessarily complicated. Some subjects demonstrated a multitude of departments and working groups and the research projects were carried out by several, not overly integrated groups with their home at different institutes. All this has its history, and quite rational decisions may originally have led to this gradual fractionalization. But seen in a perspective where the overall size of Estonian research will swiftly have to adapt towards the carrying capacity of Estonia itself, it is clear that much is to gain, economically as well as professionally, by streamlining the system. We strongly recommend that measures are taken to simplify organizational structures as far as possible, disregarding "territorial" and other aspects, which in some cases may have led to the fractionalization of the system, and to carefully look into the problem of avoiding duplicate work, or work in units of suboptimal size.

Important is also to define what studies are in reality applied research, which should preferably be financed by for example environmental protection agencies, the polluting industries and cities themselves, etc. - and what is basic research in a more strict sense, which mostly has to be paid through state-financed research funds. What is defined as basic research should then, as strictly as

possible, be concentrated into projects of strong international relevance and of as much frontline character as possible.

The flanks, however, must not be forgotten. Even if funding is concentrated on fewer projects than today, it is still important to keep small-scale activities going on over a larger spectrum of science, to be able to recognize and react on new and promising research trends. It should also be born in mind that the problems of several disciplines may in part be explained by the fact that investments have earlier been concentrated to a few areas that have been considered "modern" or politically important. Therefore, it may be necessary to compensate certain "classical" disciplines for this politically induced, economical imbalance, by allowing them relatively better possibilities until they have caught up with the disciplines, which to a higher degree had the ears of the former politicians.

### Internationalization

As noted several times above and under the different subjects, one main factor in a modernization programme for Estonian science must be a strong push for instant internationalization of the research - using international co-operative projects as the main motor. Many departments and projects are already well (or reasonably well) integrated with Western science and have a net of contacts, which can quickly be utilized when travelling possibilities now open up. For others it clearly has to be a start of something new.

Some points in such a crash program for internationalization are:

(1) *Changing the publication policy:* - In the future no real research papers should be published in Estonian or Russian. Everything except technical reports for local use and works on similar levels should be written in English. This will ensure their readability by the entire world of science and pave the way for publication of the more important results in high quality, properly refereed international journals. Also, learning to routinely write and give lectures in English is one of the basic components in scientific training.

A notable fraction of papers cited in publications by Estonian scientists appears to be relatively old - not seldom published some ten or more years ago. While one should of course respect and use also older results, this appears to constitute a systematic difference in comparison with the citation patterns typical for major journals in the West, where it is not uncommon that the work is based largely on preprints and articles published during the last few years. The reasons behind this pattern are not obvious, a fact that need not be negative in itself (e.g. if the work is oriented towards long-lasting problems). However, the different working approaches may make it more difficult for Estonian scientists to find common interests with international groups, where there may be more interest in the latest problems discussed, in for example recent reprints. This underscores the importance of rapid access to the international scientific community, for example via computer networks.

It also seems advisable to move away from the present policy of publishing large monographs on different subjects, publications where - even if they were written in English - it is difficult to sort out new, regionally or internationally important results from the background and from material of local

interest only. The trend should be towards more compact papers, with much of the information presented in well designed figures and tables.

(2) *Strengthening the scientific libraries:* - Without proper access to the international literature, scientific progress can only be slow. This is of course a matter of money, and probably also a matter of an efficient central library organization, but whatever way it is done the contents of the Estonian science libraries clearly have to be extended and upgraded. An initial phase of that upgrading might be financed through external aid-programmes, but in the long run the system will of course have to be self-reliant. To switch the language in national publications over to English will, besides all other positive effects, make them more attractive on the international exchange market and thereby also promote the library acquisition programmes.

(3) *Changing patterns of scientific collaboration:* - The political changes in recent years have removed the previous artificial barriers against contacts with Western countries. Such collaborations have been unnaturally limited by political causes since World War II, and during several of the meetings with Estonian scientists we noted an eagerness to (re)establish such contacts. While this is also happening on a grand scale, we nevertheless feel that we must caution against too great an optimism, as to how broadly such contacts can be developed in the near term. Institutes in the Western countries have only a finite capacity to accept new collaborative partners.

Even though we advocate an orientation towards contacts with Western science and a change of the academic system, we want to emphasize that, in our opinion, it is very important for Estonian scientists to keep their previous good contacts with leading scientists and institutes in e.g. Russia, Ukraine, and other parts of the previous Soviet Union. Several of these scientists are among the world leaders in their fields. With its geographical location between East and West, Estonia has good prospects for collaboration in both directions, and it is most important that the links to institutes in the East remain active.

(4) *Foreign exchange programmes:* - A system has to be constructed and financed, under which young scientists - both during their PhD studies and later as post-docs - can travel abroad. This is vital for the future of Estonian science. The programme must be started at once (in fact it has already started to some extent), and in the beginning it obviously has to be financed largely through foreign exchange grants. Such a travel programme would be most efficient at the present time, provided the stays abroad mainly were of rather limited duration, of the order of a few weeks or months.

However, notwithstanding all the benefits of such an exchange system, it does bring about a danger of enhancing brain-drain. This risk is especially large during the present period of economic re-construction. Thus such exchange systems, especially the post-doc exchange system, should include some measures (financial means) to ensure that most of the exchange students find it worthwhile to return home afterwards.

It appears that the situation on a general level being difficult in economic terms, has forced some good people to leave Estonia for longer periods. This is on a short-term basis a real threat to Estonian science, lest these people can be offered permanent positions to come back to as soon as the situation

becomes economically more stable. Appropriate measures to minimize this brain-drain should immediately be taken.

(5) *Nordification*: - From many points of view - historical, ethnographical and general cultural - Estonia belongs to the Nordic sphere having especially close links with Finland and Sweden. For example, a rather large number of Swedish citizens, including many decision makers, are of Estonian origin. These circumstances - and also the simple fact that the regional Baltic context, *sensu largo*, is and will be a main international sphere for Estonian research - make it advisable to further increase the already good contacts with Nordic science.

One way to achieve this is to take part in Nordic co-operative projects, partly using specific Estonian conditions (in ecology, geology, etc.) as base and carrot for this co-operation.

One way to enhance this co-operation could be just to offer Estonian facilities - and Estonian environments of special interest - to different categories of scientists, for the organization of conferences and inter-Nordic PhD courses. This is, undoubtedly, rather a cheap way to expose larger numbers of Estonian researchers and students to their Nordic counterparts, and vice versa. With low prices in Estonia and access to environments impossible to visit until recently, this possibility should be attractive to the other Nordic countries.

(6) *Updating the communication systems*: - Although very clearly a matter of available financial means, the updating of the Estonian scientific communication systems, with faxes and tele-mail, must be addressed as soon as possible. Estonian researchers should gradually be given opportunities for day-to-day contacts equal to those of their Western colleagues.

The (continued) development of electronic computer networks seems to us the most important improvement of infrastructure, which is possible in the short term. The computer links currently being established between the Nordic and the Baltic countries, promise to give capacity for remote login, file transfer, etc., to and from computers located almost anywhere in the world. The use of networking to run programmes on computers located elsewhere, appears to be the by far, most efficient method to improve computing capacity to world standards, especially compared to the prospect of locally purchasing and maintaining the equivalent equipment. This applies in particular to smaller research groups outside the main institutes.

The possibility of remote login also opens exciting possibilities to join software developments, together with groups elsewhere. The possibility of computer file transfer enables the easy acquisition of many computer programmes from institutes around the world, and (at least in some branches of science) may also partly solve some problems with the deficit of hard currency for the purchase of scientific journals. In several disciplines, data bases are maintained at some institutes, where the text of most scientific articles recently published (or accepted for publication) in international journals is stored. On request by a computer user, copies of selected articles can be received via the computer network. Several of these data bases do not carry any charge for their use.

Analogous to the situation in Western Europe, the costs for operating such computer networks should be substantially less than the use of traditional means of communication, such as postal mail, telephone etc.

(7) *Contract research for Western currency*: - In some cases it may be worth looking into the possibility of using the low-cost situation in Estonia for signing concrete research contracts with Western counterparts, or making different types of analyses etc. The latter is already practised to some extent.

### Some final words

Although the very present conditions in Estonia seem chaotic, and the economy of the country is temporarily destabilized, we should look into the future. It is our firm belief that, if proper measures are taken - some of which we have suggested here - Estonian science has both the intellectual and technical potential to be reformed and modernized within not too many years. But it is also clear that in order to speed up this process it must be helped by rather large scale foreign aid. Here the Nordic countries have a special responsibility.