

Specific Aspects of Research in Sweden and General Recommendations

Scope of the Evaluation

In the field of chemical engineering, and in the context of 23 researchers' programmes, the international expert panel evaluated the projects funded or previously funded by the former Swedish Research Council for Engineering Sciences, and the Swedish Research Council.

Most areas that internationally are considered chemical engineering were evaluated. For practical reasons, chemical engineering concerning polymers was not evaluated, with the exception of polymer technology associated with fuel cells. Each specific evaluation includes a review of the scientific quality of work accomplished over the past five years, as well as recommendations based on the proposed project. Finally, the expert panel makes some general recommendations also comprising the future development of the actual research.

In the Swedish context, chemical engineering encompasses a broader view than is significantly adopted in some countries – and this view could also be termed technical or industrial chemistry. Even with this broader definition, the expert panel felt that some projects might best have been placed in other discipline areas.

The focus of chemical engineering research is shifting from one based on processes and process improvement to one based on product and product development. This evolution is evident from the projects reviewed by the expert panel. Adequate funding opportunities need to be made available to support both conventional chemical engineering of high quality and emerging opportunities. Efforts should be made to attract young, motivated researchers to this important area.

Chemical Engineering in Sweden

The chemical engineering discipline in Sweden shows a very wide diversity. It encompasses individuals with materials science, fibre and polymer technology, chemistry and biochemistry training, as well as those with more traditional

catalysis/reaction engineering backgrounds. The projects support national industries (i.e., pulp and paper, mineral processing, and pharmaceuticals) and address issues of national and international concern (energy issues and the environment).

The education of chemical engineers in transport phenomena, especially mass transfer, reaction kinetics, applied mathematics and applied chemistry (and, increasingly, biochemistry) is an ideal basis for solving problems, which are outside the traditional chemical process industries. This is seen in the diversity of the issues being worked on, and in the interdisciplinary nature of the existing groups and collaborations. This unique ability will allow the field of chemical engineering to continue to adapt to changes and to meet emerging challenges.

The expert panel was impressed with the level of many of the research projects. In relation to the international arena, a strong emphasis is placed on pulp and paper research; and as such it warrants special mention. The average quality of the research projects in this application area, funded over the past five years, is judged to be from *very good to excellent*. The breadth and quality of the Swedish pulp and paper research places it amongst the best in the world. There are pockets of excellence in other areas of competence. Consideration should be made to enhance these areas through increased funding, by further concentration or consolidation of efforts, and through increased collaborations.

Mathematical modelling and simulation are important tools widely used in chemical engineering. Commercial software packages are available and are used routinely by many chemical engineering researchers. When applied to the appropriate problem, this approach is extremely useful. However, care must be taken not to neglect the fundamental issues underlying the problem.

Level of Research Funding

The expert panel was concerned by the low number of young researchers presenting projects in chemical engineering. Given the demographics of this research population, more opportunities and secure support must be made available to attract young, talented, and innovative researchers to this area. Opportunities must be available for young researchers to develop research independent of their mentor. They should be adequately funded during the early stages of their careers.

Specific Needs and Future Directions

The current demographics within this research community and the expanding role of chemical engineering, particularly in new, scientific research areas, makes the time opportune to examine the contribution that it can make to Sweden's technical and economic growth. A task force should be formed in order to determine the form and direction that chemical engineering research should take in Sweden, to ensure that adequate resources are made available for its mandate, and to reorganise the area and make it more visible and cohesive. In this context, it should be stressed that sufficient funding must be maintained for established projects/programmes of high quality (from the Swedish Research Council or other funding agencies) so that core competency is retained in fields important to Swedish industry. Additional funds should be made available for new initiatives in potential growth areas of strategic importance.

Future Evaluations

The evaluation process was performed at the Swedish Research Council, in Stockholm. The researchers gave ten to fifteen minutes long presentations, followed by thirty minutes of questioning by the expert panel. The panel was very pleased with this format. Preparation for the interview process could be aided by requiring the grant holders to provide their web site addresses, where further information on their backgrounds, research groups, and institutions/departments should be found.