

Evaluation of Research in Mechanical and Apparatus Engineering (2.10), Agricultural Engineering (2.11) in Estonia

Institutes evaluated

Tallinn Technical University

**Department of Machinery, Faculty of Mechanical Engineering
Department of Mechatronics, Faculty of Mechanical Engineering**

Estonian Agricultural University

**Institute of Agricultural Engineering, Faculty of Agricultural Engineering
Institute of Mechanics and Machinery Design, Faculty of Agricultural Engineering**

National Institute of Chemical Physics and Biophysics

Laboratory of Chemical Physics

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Expert team

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Part I

General Overview

Introduction

At the request of the Estonian Higher Education Accreditation Centre, Tallinn (EHEAC), an evaluation team (hereafter named the “Evaluators”) visited institutes in Estonia carrying out research activities in mechanical and apparatus engineering (2.10), agricultural engineering (2.11). The evaluating team consisted of Prof. Mauri Airila (Helsinki University of Technology) as the chairman, Prof. Dipl.-Ing.Dr. Adolf Frank (Graz University of Technology), Prof. Jukka Ahokas (University of Helsinki) and Prof. Gunnar Sohlenius (Royal Institute of Technology, Stockholm).

The institutions to be evaluated were:

- 1) Department of Machinery, Faculty of Mechanical Engineering, Tallinn Technical University (*Head: Prof. Rein Küttner*)
- 2) Department of Mechatronics, Faculty of Mechanical Engineering, Tallinn Technical University (*Head: Prof. Maido Ajaots*)
- 3) Institute of Mechanics and Machinery Design, Faculty of Agricultural Engineering, Estonian Agricultural University (*Head: Lecturer Jüri Resev, MSc*)
- 4) Institute of Agricultural Engineering, Faculty of Agricultural Engineering, Estonian Agricultural University (*Head: Assistant Prof. Arvo Leola, PhD*)
- 5) Research Group in Mechanical and Apparatus Engineering, National Institute of chemical Physics and Biophysics (*Head: Ago Samoson, PhD*)

The evaluators were provided in advance with self-assessment reports from each of these eight institutions, prepared by the members of these groups.

After a brief orientation meeting at EHEAC, the evaluators visited the different departments and institutes in Tartu and Tallinn during four days (two days in Tartu and two in Tallinn). At these meetings staff members of the various laboratories presented their work. During these presentations as well as during the subsequent discussions additional information about the research activities was provided. This included additional documents such as copies of published papers.

Approach to the evaluation

The evaluators were asked to:

- 1) Judge the activities of research and development in the units evaluated and the research topics implemented by them to ensure the governmental funding for internationally recognised research and development. The Team was asked to

concentrate on research units (university departments, laboratories) with specific comments to sub-units, groups if necessary.

- 2) Identify deficiencies in the activities of research and development units.
- 3) Give recommendations on the development concerning research and development and research areas to the state of Estonia.

The Team received the following materials: A working schedule, principles and criteria for evaluation of the research units, evaluation guidelines for the ranking of research units, and self-evaluation reports created by the research units themselves.

On a first evaluation point, the *quality of the research activities* was considered. This assessment is largely based on the records of scientific publications.

<i>Excellent</i>	<i>The majority of the submitted works are at a high international level and virtually all others at a good international level.</i>
<i>Excellent to good</i>	<i>At least one third of the submitted works are at a high international level and many others at a good international level, these together comprise a clear majority.</i>
<i>Good</i>	<i>The majority of the submitted works are at least at a good international level and virtually all others at a fair international level</i>
<i>Good to satisfactory</i>	<i>At least one third of the submitted works are at a good international level and many others at a fair international level, these together comprise a clear majority</i>
<i>Satisfactory</i>	<i>The majority of the submitted works are at least at a fair international level</i>
<i>Satisfactory to unsatisfactory</i>	<i>A minority of the submitted works are at a fair international level</i>
<i>Unsatisfactory</i>	<i>None, or virtually none, of the submitted works are at a fair international level</i>

Regarding the grading of the research activities, the evaluation team was instructed by the EHEAC to reserve the term **excellent** for groups, which were found to be among the best 10% of the European groups in the corresponding field. Similarly, the term **excellent to good** should be used if the evaluated group was found to be among the best 25 % of corresponding European groups. The full scale comprised 7 levels, in addition to the highest ones the grades are **good, good to satisfactory, satisfactory, satisfactory to unsatisfactory, and unsatisfactory.**

The *over-all capability* of a research unit was evaluated based on the combined assessment of the following criteria (each graded in three levels):

- The originality/novelty of past and ongoing research activities
- The strategy and perspective of the research
- Multidisciplinarity and relevance for other research areas
- The competence of the research groups and their capacity for development
- National and international co-operation
- Success in applying for grants

As the result of this assessment one of the four grades **excellent, good, satisfactory** or **unsatisfactory** was given for the group.

Finally, on a third evaluation point the implementation opportunities for the research results and their importance for the Estonian society was assessed. Here we adopted a three level grading: no comment, good or very good.

The other target of the team was to evaluate the level of the graduate study programs, which are shown in separate reports.

Part II

General Comments

The institutes evaluated and their disciplines were so different that we do not give any general comments but concentrate on recommendations for each institute separately.

Part III

Evaluation of institutes and research groups

1. Department of Machinery, Faculty of Mechanical Engineering, TTU

General comments

It is evident that the main activities are posed on product development rather than on production engineering. So it might be a practice – relevant advice to watch the balance and to strengthen the efforts in production engineering for the next period of budgeting. There is no doubt that the equipment for research (which also means for Ph.D. studies) is not on the level of European institutes. The development of production must be integrated with product development in research as well as industry.

This remark is mainly addressed to persons responsible for teaching and doing research in modern CNC techniques and geometrical metrology. Even though all staff members we met were ambitious and fully motivated, the equipment is not of the state of the art. So the machinery is not adequate to the personal qualifications.

Evaluation of the quality of research

As stated in the self-evaluation report, the purchasing of scientific equipment has gradually increased since 1998. It seems to be important that this track is followed intensively.

At the time software seems to be on a high level, so the next step should be concentrated on machinery and measurement equipment.

It is evident that participation on international conferences is concentrated (with only a few exceptions) at places of former socialist countries. The reason is not obvious but the situation hopefully will change in 2004.

Even though the number of publications is remarkably high, the low variety of themes reflects deficiencies of the existing equipment. To compete with the leading research institutes of production engineering in Europe, an upgrading of the equipment seems to be necessary. It can be stated that the staff is using the existing equipment with remarkable results.

Research topics should be re-oriented with respect to the leading themes of European Research.

With respect to the existing equipment the research activities are rated *good*

Evaluation of the overall capability of the research group

Again the overall capability is restricted by deficiencies of the existing equipment which is not at the state of the art. Additionally, the average age of staff is rather high.

The overall capability is rated *good*

Evaluation of the implementation opportunities of the results

We rate it *good*.

Recommendations

The equipment for research in the field of production engineering has to be updated. This should not be achieved from the ordinary budget. A special funding program should be defined with respect of 2004 – competing Europe.

2. Department of Mechatronics, Faculty of Mechanical Engineering, TTU

General comments

The faculty of mechanical engineering has made a successful action when restructuring their departments to better correspond to the scientific and industrial challenges. The department of mechatronics was established in 2000 by merging 6 chairs. The department is highly relevant and modern in its field and matches well to the structure of the Estonian industry. The department has been organized in two working groups.

The roots of the department are firmly in mechanical engineering and most of the chairs are relevant for mechatronics – integration of mechanical, electronics, control and software in products and systems. It seems, however, that no real transition to mechatronics has yet happened but mechatronics is just an umbrella above the research projects. This is understandable because it takes some time, perhaps years, before grants for new research items can be arranged. The definition of Mechatronics used at TTU seems to be a very wide one, which is not coherent with definitions used abroad. As a result of this definition, many TTU projects will run under “mechanical engineering” abroad.

For our understanding a number of typical objectives of Mechatronics are not being covered at TTU: actuators and sensors, drives and control, linear drives, grippers etc. The problem is also that no expertise other than mechanical engineering based is available in the department. Mechatronics in other universities has good access to other disciplines than mechanical engineering, too.

The number of publications is top. This proves evidence of researchers' engagement and ambition. On the other hand the variety of themes seems to be limited by existing equipment. A large number of research is software.

The age distribution in the department is satisfactory. Many experienced professors and senior researchers will retire within some years. The next generation in the age of 35-45 is well represented in the department and has taken good responsibility. Lack of young researchers requires some attention. Competition from outside is a threat. Talented young engineers are needed also in mechatronics industry.

The department has been active in international relations.

Evaluation of the quality of research

Based on the publication record the research activities are judged *good*.

We consider that the department has good chances to be ranked excellent to good within a few years. This requires that also other than mechanical engineering aspects are included in the research projects and that well-known scientific journals are used for publication of results.

Evaluation of the overall capability of the research group

The overall capability is judged *good*.

We see that for a better judgement the department should strengthen its competencies in the fields of electronics, software and control.

Evaluation of the implementation opportunities of the results

The department has analyzed carefully the needs and expectations of the Estonian industry. The conclusion is that there will be increasing demand for mechatronics research, education and consulting. The research results of the department have relevance and value in the society.

Recommendations

The department should put emphasis on building new competence on electronics, control and software aspects. This can be done by collaborating with other faculties, or rearranging chairs when professors retire. Some 6-7 of the professors or associated professors will retire within 5 years. The faculty should consider if some chairs will be merged and new competencies will be built instead.

The publishing activity of the department is excellent with the annual average of some 60 publications. Efforts should be put to enhancing publishing media. It is important to be

active on local and national level but also to try to get into widely spread scientific journals. It is the best way to get ones research results known worldwide and to achieve respect.

Special attention should be put on ensuring the availability of postgraduate students and post-docs.

3. Institute of Mechanics and Machinery Design and Institute of Agricultural Engineering, Faculty of Agricultural Engineering, EAU

General comments

The research projects of EAU were touched briefly during the expert team visit. The projects included 172 published articles, 138 reports, 9 master thesis and 4 doctoral dissertations. The evaluation is done from the abstracts which were included in the self evaluation report and from the presentations and publications which were presented during the visit.

3.1 Working Group of Modelling and Optimization of Tillage Machinery Choosing and Using

Evaluation of the quality of research

The research activities are judged *good to satisfactory*.

Evaluation of the overall capability of the research group

The overall capability is judged *good*.

Evaluation of the implementation opportunities of the results

They are judged *good*.

Recommendations and observations

The group has made a software which can be used in farm advisory purposes. The software needs only some annual updates. It has about 200 users which suggests that it is useful tool in farming plans.

3.2 Working Group of Study and Development of the Manure Disposal Equipment

Evaluation of the quality of research

The research activities are judged *satisfactory*.

Evaluation of the overall capability of the research group

The overall capability is judged *satisfactory*.

Evaluation of the implementation opportunities of the results

We judge it *satisfactory*.

Recommendations and observations

The study has been more of a machine development project than a basic research project. Different companies have started to manufacture the machines. This has more regional influence than scientific influence.

3.3 Working Group of Technologies and Equipment in Animal Husbandry

Evaluation of the quality of research

The research activities are judged *good to satisfactory*.

Evaluation of the overall capability of the research group

The overall capability is judged *good*.

Evaluation of the implementation opportunities of the results

We judge it *good*.

Recommendations and observations

The results are practical and they are used mainly in advisory and planning work.

3.4 Working Group of Research of Machinery Use and Working Environment in Cowsheds

Evaluation of the quality of research

The research activities are judged *good*.

Evaluation of the overall capability of the research group

The overall capability is judged *good*.

Evaluation of the implementation opportunities of the results

We judge it *good*.

Recommendations and observations

The group has a modern research theme which take into account man, machinery, animals and environment. The results have potential to be published in higher scientific journals

3.5 Working Group of the Study of Virtual, Mathematical and Physical Models and working Processes of Agricultural Machine Elements

Evaluation of the quality of research

The research activities are judged *good to satisfactory*.

Evaluation of the overall capability of the research group

The overall capability is judged *satisfactory*.

Evaluation of the implementation opportunities of the results

We judge it *satisfactory*.

Recommendations and observations

The group has concentrated mostly on theoretical research. They may have possibilities to publish the results in higher scientific journals.

4. Laboratory of Chemical Physics, NICPB

General comments

The visit of the NICPB was without doubt one of the highlights on our tour. Even though deep physical knowledge would have been needed to really understand the phenomena, it was evident that this is an institution of outstanding quality.

Two items were astonishing: first the outstanding physical level and second the mechanical precision which is required for the instruments produced.

Evaluation of the quality of research activities

The level of research activities is beyond any discussion. A patent and the international reputation of the leading scientists may prove evidence of this statement.

The rating of research activities is *excellent*.

Evaluation of the overall capability of the research group

The scientists working at NICP are highly specialized on their field. There is a niche which is filled in a professional manner.

The rating is *excellent*.

Evaluation of the implementation opportunities of the results

The evaluation group feels that there should be a stronger connection between NICP and the students at TTU. An institution like NICP should fascinate youth and encourage lots of young students to do a deeper insight into the world of extreme sizes.

Recommendations

All possible support should be given to NICP and its scientists.

The existing machine tool equipment is on a low level and too old. On the other hand it is a good example that ultimate precision does not necessarily depend on new machines, but on the skill of the workers. And this is the main problem at the same time: whenever one of the workers leaves or retires, a bit of experience will disappear. So, even though there are no complaints at the moment, updating the workshop with modern and ultra precise machinery is stated as an important task for the future. Renewal of machine equipment will not improve the scientific level (which is on an extremely high position) but it will make it easier to achieve the mechanical precision.

Part IV

Summary of evaluation

The items discussed are so institution-specific that we do not summarise them here.

Part V

Recommendations

Estonian Agricultural University

Recommendation for the Faculty of Agricultural Engineering is to encourage the researchers to publish more in western academic journals. The resources of research are not up to date, the faculty for instance needs more modern measuring equipments. The faculty has also difficulties in finding young and motivated doctoral students and research workers. The promotion of education would also promote research.

Some of the research programs are very rational with direct use in practice. Their scientific content is not high but their influence on Estonian agriculture is profitable. There is also research work that has scientific value and these themes should be continued (quality of research is good or good to satisfactory).

Tallinn Technical University

Immediate actions should be taken in the department of machinery to guarantee the continuation of academic research when the experienced academic staff will retire within the few years.

We encourage the researchers to take actions for upgrading their scientific arenas for publication. That means access to good peer-reviewed scientific journals and conferences of global reputation in addition and instead of national or locally international conferences. Some kind of ranking or classification of peer-reviewed journals, i.e. in three categories, would be useful when assessment in the future is done.

The following recommendations are focused on production engineering and the relevant equipment at TTU.

Coherency with Estonian industry.

Research should be coherent with the demands of industry. This needs a permanent exchange of information between research groups and enterprises. It was our impression that this point is solved well.

Coherency with EU industry

Research in Estonia should also observe the demands of industry in Europe carefully. When Estonia joins the European Union lots of new chances will be opened for Estonian

industry as supporters e. g. of European automotive industry. Estonian industry should be able to compete with established firms because of lower prices.

Updating the equipment.

This means a severe challenge for both the Estonian politicians as responsible for funding and for researchers at TTU. Modern research is not possible without adequate equipment. This means that there should be set up a **special program** for renewing and updating the equipment at the faculty of mechanical engineering at TTU. This should be declared as an updating program and not be a part of target funding.

The **old equipment** is not adequate to the **high motivation** of the researchers and PhD students.

This remark refers to the field of **production technology** in particular. Modern manufacturing Technology is not possible **without CNC techniques**. This remark is also evident for participation at relevant European research projects. A high level **basic equipment** is required for any application. EU money will never be given to buy a CNC milling machine.

The following recommendation may be given for renewing the machinery equipment and the equipment for geometrical metrology:

- 1 CNC Machining Center (3 axes CNC Milling Machine)
- 1 CAD/CAM station (if not existing)
- 1 CMM (coordinate measuring machine)
- 1 Form Tester (Measurement machine for roundness and cylindricity)
- 1 set of electronic levels
- 1 Laser interferometer (for machine tool measurement and calibration services)

Research topics

Connected with this matter research topics should be updated, which compare with the leading edge of international research activities and which are relevant for Estonian industry as well, such as:

- high speed cutting
- investigations on new cutting tools
- minimum use of coolant
- 5 axes milling
- machine tool error mapping and compensation
- manufacturing system design

Proposal for international contacts

Join **euspen**, the European society for precision engineering and nanotechnology and other organisations like “NC Gesellschaft” in Germany, to get information at its newest.

For our point of view it is essential that the scientific staff get **personal contacts** also to partners in leading European firms. Those **industrial contacts** very often lead to new themes of research.

To achieve this, PhD students and staff should be enabled to visit the leading **industrial exhibitions worldwide**. The costs are worth being invested.

Generally: scientific contacts are started on conferences, industrial contacts on exhibitions.

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Tallinn October 26, 2002

The evaluators' team