Foreword

I must admit that I have often looked at the economic possibilities in Industry with some envy during my years as university professor, and Industry has for a long time been a potential source of financial support for academic research projects. Increasingly, there has been a growing hope that Industry could (or even should) contribute also to the University infrastructure for basic education. This all changed in the past year in the most unexpected and dramatic way, when the economic growth we have all become so used to turned into recession, and the market collapsed into free fall. What actually happened remains for historians to explain to us one day. However, what I believe is already clear is that we must rethink the relation between Industry and University. Paraphrasing John F Kennedy - Ask not what Industry can do for your University, but ask what your University can do for Industry.

So what can we do, and what are we doing? Obviously, our main importance to Industry - and Society at large – is, and will remain to be, that we educate engineers and provide research training for graduate students. This is what we are used to doing and – I dare say - we do this very well! Normally, however, we seldom see our graduated students, or doctors, again once they have left us. Phrased differently, we provide very little education for the working engineers. There is probably right now (due to the recession) a time window, which could be used for updating knowledge of many employees and not least engineers. In 2008, the Foundation for Strategic Research decided to fund PIC-LU (Process Industrial Centre at Lund University), which involves this department together with the Department of Automatic Control. One of the core activities of PIC-LU is in fact a competence development program for Industry. We are very excited about this timely new possibility.

In addition to the funding obtained for this new Centre, we were happy to see also several other application granted in the past year. The Swedish Energy Agency granted a continued base funding of the Ethanol Process Development Unit, as well as new projects on lignocellulosic ethanol development, and a new EU project on this subject went into final contract negotiations. Furthermore, a large national project called “Mistra Pharma” with the aim of studying the removal of highly potent biologically active substances in waste water was also granted. This is a new challenge which will call for a deeper multidisciplinary interaction between civil and chemical engineers and biotechnologists. Overall, the department seems to find its way into more and more national and international research collaborations. We will work hard to keep this positive trend also in the coming years!

Lund, March 2009

Gunnar Lidén, Head of Department Chemical Engineering
1. Undergraduate education

The department is deeply involved in the engineering programs for Chemical Engineering, Biotechnology, and Environmental Engineering (abbreviated K, B and W, respectively). The department gives seven compulsory courses at the basic level for these programs. With the incorporation of Water and Environmental engineering into the department there is a growing involvement in the Civil Engineering program (V), both at the basic level and at the advanced level.

The department is responsible for twelve optional advanced courses in five engineering programs (apart from the four program already mentioned, students from also the Applied Mathematics program (π) the Nano Science program (N) and the Risk Management program (RH) choose courses at the department). The majority of the advanced courses are part of the Process Design specialization for the Chemical Engineering and Environmental Engineering programs.

An important part in the training of engineers is the Master thesis work (“examensarbete”). By tradition the department has always been very active in arranging and supervising thesis work, primarily due to good contacts with industry. The number of finished Master theses was 44, which is an increase compared to the two previous years.

Courses on basic level

Table 1.1: List of courses at the basic level offered by the department during 2008.

<table>
<thead>
<tr>
<th>code</th>
<th>Title (Swe/Eng)</th>
<th>Program</th>
<th>ECTS points</th>
<th>Registered students</th>
</tr>
</thead>
<tbody>
<tr>
<td>KETA01</td>
<td>Kemiteknik/Chemical engineering</td>
<td>K</td>
<td>21</td>
<td>54</td>
</tr>
<tr>
<td>KETF01</td>
<td>Transportprocesser/Transport Phenomena</td>
<td>B, K</td>
<td>7.5</td>
<td>90</td>
</tr>
<tr>
<td>KTE023</td>
<td>Kemisk process- och reaktionsteknik/Chemical Process and Reaction Engineering</td>
<td>K</td>
<td>15</td>
<td>38</td>
</tr>
<tr>
<td>KET045</td>
<td>Kemisk reaktionsteknik/Chemical Reaction Engineering</td>
<td>B</td>
<td>7.5</td>
<td>45</td>
</tr>
<tr>
<td>KTE170</td>
<td>Masstransport i tekniska och naturliga system/Mass Transfer Processes in Environmental Engineering</td>
<td>W</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>KET030</td>
<td>Energiteknik/Heat Engineering</td>
<td>K</td>
<td>7.5</td>
<td>32</td>
</tr>
<tr>
<td>KAT031</td>
<td>Separationsprocesser/Separation Processes, Basic Course</td>
<td>B, K</td>
<td>7.5</td>
<td>90</td>
</tr>
</tbody>
</table>
Courses on advanced level

Table 1.2: List of advanced courses offered by the department during 2008.

<table>
<thead>
<tr>
<th>code</th>
<th>Title</th>
<th>Program</th>
<th>ECTS points</th>
<th>Registered students</th>
</tr>
</thead>
<tbody>
<tr>
<td>KAT051</td>
<td>Separationsprocesser, FK/Separation Processes, Advanced Course</td>
<td>K, W</td>
<td>7.5</td>
<td>21</td>
</tr>
<tr>
<td>KET040</td>
<td>Kemisk processteknologi/Chemical Process Technology</td>
<td>K, RH,W</td>
<td>7.5</td>
<td>14</td>
</tr>
<tr>
<td>KTE071</td>
<td>Biokemisk reaktionsteknik/Biochemical Reaction Engineering</td>
<td>B, K, W</td>
<td>7.5</td>
<td>18</td>
</tr>
<tr>
<td>VVA030</td>
<td>Urbana vatten/Urban Waters</td>
<td>V, W</td>
<td>15</td>
<td>34</td>
</tr>
<tr>
<td>VVA910</td>
<td>Projektkurs i vattenförsörjnings- och avloppsteknik, del I&amp;II/</td>
<td>V, W</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>VVA920</td>
<td>Project course in water and wastewater treatment, part I&amp;II/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KET010</td>
<td>Energi och Miljö/Energy and Environment</td>
<td>K, W</td>
<td>7.5</td>
<td>24</td>
</tr>
<tr>
<td>KTE061</td>
<td>Kemisk reaktionsteknik FK/Chemical Reaction Engineering, Advanced</td>
<td>K, Pi, W</td>
<td>7.5</td>
<td>17</td>
</tr>
<tr>
<td>KET050</td>
<td>Projektering/Feasibility Studies on Industrial Plants</td>
<td>K, W</td>
<td>7.5</td>
<td>24</td>
</tr>
<tr>
<td>KTE131</td>
<td>Processriskanalys/Loss Prevention</td>
<td>K, W</td>
<td>7.5</td>
<td>25</td>
</tr>
<tr>
<td>KETN01</td>
<td>Processsimulering/Process Simulation</td>
<td>B, K, Pi, W</td>
<td>7.5</td>
<td>27</td>
</tr>
<tr>
<td>KAT080</td>
<td>Partikelteknologi/Particle Technology</td>
<td>B, K, N,W</td>
<td>7.5</td>
<td>12</td>
</tr>
<tr>
<td>KTE055</td>
<td>Katalys/Catalysis</td>
<td>K</td>
<td>7.5</td>
<td>11</td>
</tr>
<tr>
<td>KTE190</td>
<td>Biogokemisk modellering/Biogeochemical Modelling</td>
<td>W</td>
<td>7.5</td>
<td>10</td>
</tr>
<tr>
<td>VVAN01</td>
<td>Decentraliserad VA-hantering/Decentralized Water and Wastewater</td>
<td>W</td>
<td>7.5</td>
<td>20</td>
</tr>
</tbody>
</table>

Other courses where the department contribute

Table 1.3: List of other courses where staff from the department was active in during 2008.

<table>
<thead>
<tr>
<th>code</th>
<th>Title (Swe/Eng)</th>
<th>Program</th>
<th>part</th>
<th>ECTS points</th>
<th>Registered students</th>
</tr>
</thead>
<tbody>
<tr>
<td>KOO090</td>
<td>Vatten- och Atmosfärskemi/Water and Atmosphere Chemistry</td>
<td>W</td>
<td>30%</td>
<td>9</td>
<td>38</td>
</tr>
<tr>
<td>KOK032</td>
<td>Miljökemi/Environmental Chemistry</td>
<td>K, B</td>
<td>50%</td>
<td>7.5</td>
<td>97</td>
</tr>
<tr>
<td>VVB090</td>
<td>Infrastruktursystem/Infra structure systems</td>
<td>V</td>
<td>30%</td>
<td>21</td>
<td>47</td>
</tr>
<tr>
<td>VVB100</td>
<td>Infrastruktursystem – vatten och avlopp/Infra structure systems – water and wastewater</td>
<td>V</td>
<td>100%</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>VTVA01</td>
<td>Infrastrukturteknik/Infra structure engineering</td>
<td>L</td>
<td>30%</td>
<td>12</td>
<td>60</td>
</tr>
</tbody>
</table>
Special courses

Table 1.4: List of special courses offered by the department during 2008.

<table>
<thead>
<tr>
<th>code</th>
<th>Title (Swe/Eng)</th>
<th>Program</th>
<th>ECTS points</th>
<th>Registered students</th>
</tr>
</thead>
<tbody>
<tr>
<td>KKK080</td>
<td>Förståelse och Lärande/Teaching and Learning</td>
<td></td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>TNK115</td>
<td>Industriellt förlagd utbildning/Industrial organised education</td>
<td></td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>KET410</td>
<td>Individuell fördjupningskurs/Individual advanced course</td>
<td></td>
<td>15</td>
<td>2</td>
</tr>
</tbody>
</table>

Master theses

All engineering programs have a compulsory Master thesis requirement on 30 ECTS points. A total of 44 Master theses were published at the department during 2008, which is slightly more than the last two years, see the figure below.

![Figure 1.1: Number of Master theses at the department 2004-2008.](chart)

List of MSc thesis 2008:
3. Edalat Farnaz (2008) Optimization of the denitrification process in a sewer system and the effect at the connected WWTP
5. Görfelt Karin (2008) Optimering av lakvattenrening på SYSAV AB
20. Larsson Peter (2008) Optimering av jäsnings av sura hydrolysat från barrved till bioetanol
25. Markström Hanna (2008) Effects of wood ash addition on base cations and acidity in forest soils
34. Senar Enric (2008) Modeling and simulation of a diesel oxidation catalyst used in a NOx storage and reduction system for HD Trucks
42. Tunå Per (2008) Substitute natural gas from biomass gasification
44. Wendt Annette (2008) Optimization of WSA process
2. PhD education

The PhD program at the department is a four year education, i.e. 240 points, which are divided into a thesis work of 180 point, and 60 points of PhD courses. The department had 24 active PhD students during 2008.

The department organised four PhD courses during 2008. One of these was organised through the CPDC graduate school, a national graduate school financed by SSF, with PhD students from other universities and from industry. All courses attract PhD students from other departments.

<table>
<thead>
<tr>
<th>code</th>
<th>Title</th>
<th>ECTS points</th>
<th>Registered students</th>
</tr>
</thead>
<tbody>
<tr>
<td>---</td>
<td>Integrated process design and control</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>KET035F</td>
<td>Modelling in biotechnology</td>
<td>7.5</td>
<td>6</td>
</tr>
<tr>
<td>KAT002F</td>
<td>Transport phenomena</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>KET045F</td>
<td>Transport Phenomena in Membrane Processes</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>

Three PhD students graduated with a PhD degree during 2008 (see list on the next page). The number of dissertations has been high during the past four years, with eight to nine dissertations per year. The decrease this year was predicted due to the drop in accepted PhD students, which started in 2004 and continued for some years not only at the Dept. of Chemical Engineering. Between 2004 and 2007 the number of active PhD students at the Engineering Faculty at large decreased by as much as 35%, which means that the drop in newly registered PhD students in that period was very large.

![Figure 2.1: Number of PhD theses and Lic. Eng. theses during 2004-2008.](image-url)
Three PhD theses were defended during 2008.


Two Lic. Eng. thesis were defended during 2008.


3. Research

The research activities at the department currently fall into the principal categories: **Energy**, **Environmental Technology, Process and Product Design**, and **Water and Environmental Engineering**. The nature of the work ranges all the way from fundamental studies, e.g. in catalysis, to applied projects in the process industry.

**Energy** is today a very important field, and the department has a strong position in Energy related research. The largest research activity concerns ethanol production from lignocellulosic biomass. This research is financed primarily by the Swedish Energy Agency and the European union. An important asset is the National Process Development Unit (PDU). The PDU consists of two steam pretreatment units, filter presses, state-of-the art membrane filtration and a range of bioreactors between 20 and 100 l working volume. The facility provides the department with a unique capacity of making complete evaluations of feedstock potential – including biomass analysis, pretreatment, hydrolysis, and fermentation and in addition techno-economic evaluations of process concepts. The department also has activities on other – more long term – fuels from renewable resources. Hydrogen production, based on thermal gasification or fermentative processes, is a growing research area. The work is financed by grants from the European Union (on techno-economic analysis of fermentative production of hydrogen) and by the company E.on, through its research foundation, for integrated small scale hydrogen production (utilizing steam reforming, catalytic combustion and water gas shift reaction). The work on various fuels, and not least the competence on pretreatment is very important in the current research development of biorefineries, in which the department will certainly play a role in the coming years.

The research in the **environmental field** concerns both catalytic processes for exhaust gas treatment – primarily reduction of NOx - and biogeochemical modelling for a system analysis approach on sustainability issues in agriculture and forestry. The software models developed at the department – SAFE, ForSAFE and PROFILE – are today used by many academic research groups and there is interest for their application by both forest industry and governmental agencies with an environmental responsibility. A new activity to be mentioned is the “Real Change” initiative, which takes a broad look at sustainability including production methodology, life cycle assessment and policy systems. The consortium is led by Blekinge Institute of Technology, and involves the organization the Natural Step and Chemical Engineering, Lund University.

Research on **process and product design** spans several different branches of industry. Process optimization and process control is the subject of the new Process Industrial Centre at Lund University (PIC-LU) which started in 2008. The center is a collaboration between Automatic Control, Chemical Engineering and the companies Borealis, Novo Nordisk, Perstorp and Pfizer Health and is financed by the Foundation for Strategic research together with the companies. Process flexibility, availability and controllability are key areas in the integrated projects. New oxide catalysts for production of nitriles by ammonoxidation, e.g. production of acrylonitrile by propane ammonoxidation, and production of aldehydes by oxidation of alcohols, primarily formaldehyde production from methanol, are developed and characterized. Novel membrane separation technology is developed with application to the separation of lignin and hemicelluloses in the Forest industry. This will certainly also be of interest in future biorefineries, in which costs of separation will be a key economic factor. Another issue for the Swedish pulp and paper industry is the ability to control paper quality. The drying step is a critical determining factor in
this respect and the department has a long-standing interest and competence in drying. The
department contributes also to the pharmaceutical field, by drug design for controlled release and
model based optimization of pharmaceutical protein purification.

The research in water and environmental engineering covers a broad range of research related
to water use and treatment in the modern societies. Projects are often made together with
Swedish municipalities and companies. Improvement of anaerobic treatment of sludge and other
organic urban waste is since a long time an important research area as is improved housekeeping
and utilisation of organic material in wastewater for extended removal of nitrogen and phosphorus another. The department is furthermore involved in the Eco-city case study Augustenborg run by the city of Malmö, in which we contribute to the development and
evaluation of systems for recycling of household waste. It has gradually been realized that the use
of active pharmaceutical ingredients (API) may give effects in the environment after leaving the
human body. A large national research project, MistraPharma, started in 2008 with the objective
of assessing the size and risk of these compounds to the environment and designing waste water
treatment methods for the most important APIs. The project leader is the Royal Institute of
Technology, and the consortium involves five more Swedish universities (including LU) as well
as DTU. The department will work on the development of new treatment methods in this
project.

Publications

The number of publications in scientific journals during 2008 was 36 despite the lower number
of dissertations published in 2008. This is likely due to a certain lag-phase between published
theses and publications, and a drop in number of publication is thus to be expected in 2009.

![Graph showing number of publications from 2004 to 2008]

Figure 3.1: Number of publications in scientific journals the last three years.

The following articles with authors from the department were published in scientific journals
during 2008.

F, Vaccari, A: Pt - Rh/MgAl(O) Catalyst for the Upgrading of Biomass-Generated


4. External contacts and events

The national facility for Process Development of ethanol production processes (PDU) attracts a number of visitors every year. This year visitor came from China, India, Italy, Japan, Netherlands, Norway, Germany, Switzerland and USA. The PDU has also been used for commissioned research for companies in Sweden, Norway, Italy, Netherlands, Japan, Switzerland and USA.

The Center for Chemical Process Design and Control, CPDC, organised a winter school in March 2008 at the Åre ski resort. The main idea was to create networking activities for students from different disciplines and on the same time put together an interdisciplinary short course in the area of integrated process design and control. The theme of 2008 was "Design and control of distillation columns" with an industrial visit at a local distillery. Bernt Nilsson organised the winter school and a number of students from the department participated.

The Department together with the Department of Automatic Control was appointed as one of two national Process Industrial Centres, PIC-LU. These two departments together with process industry start up centre both for research and competence development. Four companies are partners during start up, Borealis, Perstorp, Novo Nordisk and Pfizer Health. The activities in the centre, particularly the competence development program, will attract a lot of external contact and collaboration.

Collaboration with partners in Denmark increase every year, both with academic colleges and industry, and also this year. Our Master students and PhD students often get job proposals for employment on the "other" side of Öresund. Research contacts with industrial partners are also becoming regular. Together with Novo Nordisk A/S the department works in three different research projects. The projects are important in regional perspective to increase mobility and mutual understanding. In December a workshop on "industrial protein chromatography design" was organized with contributions both from the department and Novo Nordisk.

The Department organised a continuing professional development course on Membrane Processes – theory and application in April at the Häckeberga Castle. The course was organized together with the Department of Food Engineering, Lund University.
5. Personnel

Due to both graduation and recruitment of PhD students and temporary guest researchers, the number of employees at the department changed during the year. However, as an average, the number of personnel at the department was about 60 during 2008.

The Faculty consisted of 23 senior staff members, including 11 professors, 3 associate professors, 4 lecturers and 5 researchers. The technical and administrative staff was 8 persons.

The average number of PhD students was 26. Three PhD students graduated and left the department, and six new Ph.D. students were recruited during 2008.

The department had 8 guest researchers and project employees during 2008.

Figure 5.1: Personnel at the Department of Chemical Engineering 2008.
6. Economy

The total expenses for the year 2008 were 48.2 MSEK, and the total income was 48.8 MSEK. Of the income about 50% comes from University funding, the larger share of which is faculty grants for research (see below).

![Figure 6.1. Income of the Department of Chemical Engineering, Lund University, 2008.](image)

With respect to external research grants, the most important funding source is the Swedish Energy Agency, but also the Swedish Research Council and the European Union are very important sources of external funding. The largest grants obtained directly from Industry came from the companies E.on and from Novo Nordisk.

<table>
<thead>
<tr>
<th>Funding institution</th>
<th>Grant paid in 2008 (MSEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swedish Energy Agency</td>
<td>9.1</td>
</tr>
<tr>
<td>Swedish Research Council</td>
<td>4.1</td>
</tr>
<tr>
<td>European Union</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Table 6.1: The major external granting bodies 2008
Contact information:

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Lund University  
Getingevägen 60  
P.O. Box 124  
SE-221 00 Lund, Sweden

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