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ABSTRACT

The Engineering College at Hogskolen i Telemark has since 1982 practiced cooperative learning as the model of promoting student learning. It has earlier been shown that the Telemark Model does enhance many important aspects of learning and human growth. However, new demands on higher education in Norway asks for new roles of universities and colleges to make the country competitive also in the future. One of these demands is making revenuers. Revenue-making through traditional research activities is well known. The question has been raised, if even the project model can be used to add to the college incomes. In this connection the integrating effects of the Telemark Model might represent a powerful tool even in generating a cashflow into the system. The study shows that there are differences between the departments, and that project work does integrate knowledge and practice. But even if a large portion of the projects are carried out in cooperation with external partners, the economic impact on the College must be labeled "insignificant" so far. A possible conclusion is that the Telemark Model may represent large and so far almost unused resources for income generation. This can be changed by reducing the ambition of having Main Projects at the traditional "high academic level" and instead, take advantage of the integrating effects of the Model. It is then thinkable that a redefinition or extension of what "high academic level" really means will be necessary to stimulate the revenues to pour into the School. Maybe the ability to integrate many elements into a project report and presentation within a specified time may represent one solution to that problem? (Author)

Project Work as an Integrating and Revenue-Making Tool

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1. Abstract *- The Engineering College at Hogskolen i Telemark has since 1982 practised cooperative learning as the model of promoting student learning. It has earlier been shown that the Telemark Model do enhance many important aspects of learning and human growth.*

However, new demands on higher education in Norway asks for new rôles of universities and colleges to make the country competitive also in the future. One of these demands is making revenues. Revenue-making through traditional research activities is well known. The question has been raised, if even the project model can be used to add to the college incomes. In this connection the integrating effects of the Telemark Model might represent a powerful tool even in generating a cashflow into the system.

The study shows that there are differences between the departments, and that project work does integrate knowledge with practice. But, even if a large portion of the projects are carried out in cooperation with external partners, the economic impact on the College must be labeled "insignificant" so far.

A possible conclusion is that the Telemark Model may represent large and so far almost unused resources for income generation. This can be changed by reducing the ambition of having Main Projects at the traditional "high academic level" and in stead, take advantage of the integrating effects of the Model. It is then thinkable that a redefinition or extension of what "high academic level" really means will be necessary to stimulate the revenues to pour into the School. Maybe the ability to integrate many elements into a project report and presentation within a specified time may represent one solution to that problem?

2. Introduction

Spurred by pressure from the industry's organizations, the School of Engineering at Hogskolen i Telemark (Telemark State University), has since 1976 practised cooperative learning, arranged as student project work in groups. The program was started within the Electrical Engineering Department but spread, and from 1982 project work in groups was adapted as *The Model* and Hallmark for engineering education at Hogskolen i Telemark.

It has been documented [1], [2], [3], [4] that this Telemark Model works with respect to student motivation, personal growth, academic diversity/flexibility and even as a solid basis for further studies at a higher academic level.

However, Norway is now said to have entered the "post-industrial era", resulting in demands for changes in the academic structure and way of operation. As the pedagogic goals remain mostly unchanged while the technical course objectives and content may vary, it will also be necessary to check the impact of the learning process on the College itself. New goals have been set for Telemark and the other recently established regional universities in Norway. Among the most important, regional cooperation with local business, research and revenue requirement represent the biggest challenges in comparison to former practice.

Since the project work plays such an important rôle at Telemark, it may be wise to check if this way of organizing an effective *environment for learning* may even provide a platform for "activity integration" and generation of revenues.

After a brief description of the Telemark Model, the paper will compare 81 student Main Project Reports from the School's departments for Civil, Chemical, Electrical, and Mechanical Engineering from the years 1995, 1996 and 1997.

3. The Telemark Model

Dependent on department, the students will spend 30 to 35 % of their scheduled time on project work; the remaining time is spent on traditional learning forms as lectures, laboratory work, simulations, etc.

It is assumed that the Main Project (ca 40 % of the final semester) shall represent integration of knowledge in various fields, presented in a written report of high standards. In addition, the group is required to present the work orally to an audience within 45 to 50 minutes.

Since project work represents a mean of "helping people grow" in addition to the aquirement of useful knowledge, the project reports are not graded. The exception is the Main Project Report, summing up the entire learning process through three years at the college. The grades are based on the report, the oral presentations, and to a certain extent: The group process leading to the documented results.

For further description and documentation of the Telemark Model, it is referred to the URL addresses given at the end of this paper.

4. The Research

All project reports from 1982 are filed in the college library. In order to get a sufficiently accurate picture of the status of the 6th semester project reports, the last three years's period was chosen. The material is presented in Table 1 (ChE = Civil, ChE = Chemical, EEP = Electrical Power and E&C = Electronics and Control, ME = Mechanical Engineering):

Table 1: Distribution of students and projects

	ChE	CE	EEP	E&C	ME	Sum
Number of stud's	70	29	90	76	40	305
Number of proj's	15	10	25	19	12	81
Stud's per group	4.7	2.9	3.6	4.0	3.3	3.8

As seen from Table 1, 305 graduating students were shared by 81 groups, averaging 3.8 students/group. Since the numbers are accumulated through three years, the table also indicates a crisis in technical education, since the capacity is 2-3 times higher than the factual enrolment.

In reading and interpreting informations collected from the 81 reports, it is necessary to practise judgement to get a fairly visible picture of the situation. In this case the evaluation is done from the EE Power Department, which may represent a possible bias. However, the *main* conclusions will appear so clear that eventual unfair treatment under way hopefully will prove itself insignificant.

5. External Cooperation

In making the palette of 6th semester student projects, the departments may give problems in cooperation with external and/or internal partners. In addition, it is possible to formulate projects dealing with internal research and development work, theoretical studies with/without testing/simulation, library projects and so on. A crude listing of project distribution according to this, is given in Table 2. Due to the uneven number of students at the various departments, the numbers are given in percent.

Table 2: Cooperative partners (figures in %)

	ChE	CE	EEP	E&C	ME	Sum
Public ent.	13	20	56	11	0	25
Private ent.	47	10	24	37	67	36
Other Depts	27	10	0	11	17	11
Intramural	13	60	20	42	16	28

Reading the Sum column, it can be seen that roughly 60 % of all projects are carried out in cooperation with external public and private enterprizes. The distribution between the departments is quite uneven, indicating different departmental perception of what a Main Project should really be looking like. On the other side, sixty percent, or 49 projects, were done in some way of partnership with extramural business. It is evident, then, that there already exists a network linking the Engineering College to the external world.

6. Classification of Projects

The School's catalog describes the Main Projects with a broad pencil, using honorary notations for the description of goals and methods. This opens for personal interpretation and almost infinite variety with respect to themes, organization, types of problems, way of problemsolving, etc. However, after a rough estimation it is possible to group the types of projects according to Table 3:

Table 3: Types of projects (figures in %)

	ChE	CE	EEP	E&C	ME	Sum
Theoretical	40	100	76	37	40	61
Theoretical& simul.	60	0	4	52	60	25
Constr. & test	0	0	12	11	0	10
Researh/constr./ test	0	0	8	0	0	4

"Theoretical" means *curriculum integration* indicating a specialized or a more broadscoped work. Depending on the actual conditions (group process, ease of meeting people, equipment etc.) the final level of the work will vary between the groups. The study reveals a high level of ambition from advisers as well as group members, in its own way confirmed by the prefaces where the groups often say that much learning is a result of the project. About 86 % of the projects are of this type; the simulations can hardly be seen to change the classification of the project. 10 % represent construction and testing, while only two EE groups have included research/verification in their projects.

This tabulation says something about types of projects but very little about the types of conclusions and recommendations. Table 4 will list, call it the practical usefulness of project conclusions:

Table 4: Executable projects (figures in %)

	ChE	CE	EEP	E&C	ME	Total
Executable	27	100	80	37	42	57
Partly executable	13	0	12	26	33	25
Theoretical only	60	0	8	37	25	19

Examples of «executable» and «partly executable» projects are:

- ChE: Freezing of fish, projection of parts of a process plant, including cost estimates
- CE: Highway and parts of building design, including cost estimates
- EE power: Energy conservation including economical analysis projects, modernizing a high voltage laboratory, replacing valve controls with speed control pump systems including economic analysis
- E&C: Instrumentation of a wastewater plant, the control of a sorting machine
- ME: Heating, partial rebuilding machines, projection of heat exchangers

Studies, often at a very high academic level, and often including advanced instrumentation, modeling and simulation techniques are considered non executable. They are often treating a part or parts of sophisticated process industry components, or may be «parallell projecting» of actual electrical power utility projects. The real life scope, complexity and costs of such projects are often of such nature, that even a Main Project will be too small to provide good practical and reliable solutions.

7. Computer Tools

It is a requirement that all reports should be written using some standard word processor. It is *not* required that graphics, drawings and so on should be done electronically. However, this study shows that student groups in all departments often prefer to teach themselves (assisted by the staff) the use of a multitude of advanced computer tools. Of the 81 groups, 65 (80 %) have used one or more tools like Mathlab, Excel, Maple, LabView plus a variety of specialized tools for f.inst. electronics and civil engineering.

For many practical engineering jobs, Computer Aided Drafting (CAD) is a must. 42 projects from all departments were supported by CAD drawings, showing the students' ability to integrate even such modern tools when necessary.

8. Economics

Real-life projects most often include some type of economic analysis. Its simplest form may be the calculation of costs for new projects or constructions. Convincing the customer that it probably will yield a sound profit to replace older systems with new, represent a more challenging problem. Upgrading valve control of flows to a variable speed control system, is an example of this.

The results are listed in Table 5. It may be seen that economic analyses are unevenly distributed within the departments.

Table 5: Projects with cost estimation (figures in %)

	ChE	CE	EEP	E&C	ME	Total
Simple calculation	13	80	24	5	17	23
Financial advis-ing	7	0	24	0	0	9
None	80	20	52	95	83	68

Civil's high percentage is mostly due to the many highway projects. The other extreme is represented by the E&C Department. The almost total absence of the economic aspect is due to the theoretical/simulation form of its Main Projects. This absence also indicates that a very large fraction of the Main Projects of this department are internal. This again, indicates that many projects here, and at other departments too, at most represent "curriculum integration".

Looking at the economical aspect, the willingness of the external project partners to cover HiT's costs, has also been checked and listed in Table 6:

Table 6: External coverage of costs (figures in %)

	ChE	CE	EEP	E&C	ME	To-tal
Some material	20	0	28	16	17	19
Revenue+ costs	0	0	4	0	0	1
None	80	100	68	84	83	80

Apparently, the projects have to be external to hope for full or partly coverage of costs. The best reporting come from the EE Power Department with industrial contributions in about 1/3 of the projects. The only one to give the Engineering College even a revenue is a practical engineering project about how to substantially reduce the electrical power costs for a medium-sized local factory. This may lead to the conclusion, that as far as college profitmaking is concerned, most is still undone.

9. Quality of the Report Form

It is a goal, that report form as well as content should represent high quality - measured by any standard applicable to technical and scientific reports. This study shows that great care is taken to fulfil these professional and aesthetic goals.

However, most of the CE reports have a special form, as they tend to look like presentations used by the public Highway Department in stead of meeting the general requirements accepted by the other departments at HiT. Sticking to the rules, paper form grading estimation may be expressed as in Table 7:

Table 7: Quality of Report Form (4 - 1; 4 = maximum)

	ChE	CE	EEP	E&C	ME	Total
Form, average grade	3.80	2.60	3.48	3.26	2.83	3.28

Neglecting the "unusual form" of the CE Main Reports, the academic level of the report form may be rated as "good" and an indication of a satisfactory integration of content and form at the Engineering College of HiT.

10. Discussion

The study of 81 Main Project Reports from the years 1995, 1996 and 1997 reveals mostly high professional ambitions as to content and form. It has also been listed a number of elements integrating knowledge into useful techniques to carry out many practical solutions. Such integrating elements are

- the group process
- the independent group self-pacing of the project
- the groups encountering professional external partners
- necessary interdisciplinarity to cope with problems including f.inst. process and process control systems
- the inclusion of cost/financial analysis in some reports
- the integration of written and oral presentation forms
- curriculum integration to reach a high level of practical engineering proficiency

However, the study shows clearly that even if all valeurs of integration exist, this integration is unevenly distributed within the Engineering College. And further: The projects showing maximum integration are still few. Consequently, the external cash flow pouring into the school due to the project model is still small, and must be labeled insignificant.

A 1996 study among the small and medium sized enterprizes (SMBs) of Telemark [5] has shown that these companies have high expectations for themselves and their relationship with HiT. They expect the engineers to have a practical background, work broadscopedly and accept organizational and human problems as just as important as technical issues. About 70 % of these companies were willing to consider paying the college for useful Main Project Reports. About 75 % of the respondents had not had any contact with HiT so far. There were even indications that the Telemark graduates were flexible and about "ready to use" even at the moment of graduation. Normal practice is "breaking in" fresh engineers, a process which has been reported to take months, and even years. Finally, it should be mentioned that several SMBs - representing *all* departments of the Engineering College, listed many minor problems well suited for Main Project research.

Comparing the results of these two studies, it may be concluded that

1) a latent mutual attraction between the SMBs and HiT's College of Engineering has been registered,
2) the college integration process should be in the best interest of the SMB industry, securing openminded and broadscoped engineers,
3) the projects which received external money were practical engineering design, and
4) departments with Main Projects at extreme high professional level tend to have less practical contact with the many Small and Middle-Sized Enterprizes (SMBs), by many claimed to be the backbone of Norwegian industry.

A main conclusion may be found: *The latent mutual attraction between the SMBs and HiT's College of Engineering must represent a big opportunity for future cooperation and mutual benefit, even economically.*

One of the main obstacles may be the inherited perception/definition of what "high academic level" really means. Up to now, it must mean "penetration", i.e. achieving a research-based high level of understanding and knowledge within a limited number of "sovereign" subjects. The SMBs, however, ask for broadscoped integration. HiT's Telemark Model applies such integration techniques but partly on the cost of "penetration".

Naming successful integration "high academic level" will probably prove to be one powerful tool to strengthen the links between HiT and the mostly non-researching SMBs.

Finally, it is interesting to note the apparently strong relationship between this need and the conclusions of two National Science Foundation publications: The 1992 report on future educational principles [6] and the 1994 report on the needs for re-structure and change [7]. Their common denominator is acceptance of the need for and recognition of the broadscoped educator in future engineering education.

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1) http://www-pors.hit.no/~trondc/fie94.htm
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