

# **INNOVATION IN CONSTRUCTION ENGINEERING EDUCATION – SOME EXPERIENCES AND A PLANNED FOLLOW-UP.**

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## **ABSTRACT**

This paper describes an attempt to include a course, “Innovation”, in an educational programme for construction engineers. This course has been divided into two parts; part 1 which is entirely theoretical, and part 2 which mainly consists of a project. The course has been given during six academic years and the response from the construction engineering student has been mainly positive. Some of the projects have resulted in feasible new products. The intention is to execute some research within the field “Innovation in Construction” with this course as a starting point.

Keywords: construction, innovation, education, product-development

## **I. Background and aim**

The Swedish construction sector is today impaired with different problems that are connected to production technology; e.g. problems concerning quality, productivity and working environment.

The elimination of these problems demand among other things development work within the individual construction company. Such development work is, to a varying extent, executed today within various construction companies. In this work, which can be more or less innovative, different employees are participating (construction workers, foremen, persons responsible for development work etc.) in a planned or spontaneous way, Larsson /1992/

If these persons had better knowledge about the innovation process as regards problems, possibilities and methods the possibility to utilise the development potential which exists within the construction companies and the construction sites probably would increase considerably. Today a great part the development of construction companies with regard to production technology is executed at the building site, Bröchner et al /1990/.

The introduction of the subject “Innovation” into the Construction Engineering Programme at Halmstad University was made in 1993. It was made against the background described above with the general aim of educating more “innovative” construction engineers, i.e. engineers who can see and evaluate the need of and the possibility of improvement and development within construction. The introduction of this subject was also to great extent influenced by the experiences from the “Innovation Engineering Programme” at Halmstad University. This programme, in which the subject “innovation” has been and still is central and important, has been very success-full as regards commercialisation of products developed within the programme by students.

This introduction of the subject “Innovation” into a Construction Engineering Programme is of particular interest as it is the first time in Sweden that this subject has been included, to a greater extent, in the education for construction engineers; see also Larsson /1996/.

The aim of this paper is to describe this introduction by describing the course “Innovation” and its implementation. Furthermore, the aim is to describe some of the experiences obtained during the implementation and to give some thoughts about future research within the field innovation in construction.

## II. The course “Innovation”

### *Aim*

The aim of the course has been described above in more general terms. This aim has been formulated in a formalistic way as follows in the “Student guide for the engineering education programmes” at the Department of Science and Technology, Halmstad University “..To give a good understanding and knowledge about the foundation of the innovation process: the product idea, the entrepreneur, the environment and the capital and give insight as regards the integrated approach which is needed in order to successfully transfer a product idea to a commercial product. Furthermore the course shall give knowledge of and insight into the conditions of the construction sector as regards development and improvements of production technology and products.”

### *Organisation*

From the academic year 1993/1994 up to the academic year 1997/1998 the course comprised 7 credits and consisted of two parts as follows:

- Part 1 Innovation - introduction, 3 credits
- Part 2 Innovation within the construction process, 4 credits.

From the academic year 1998/1999 the course has been reduced to comprise 4 credits only. This course consists only of part 2 mentioned above.

The course is given during the last year. The placement of the present course in the study programme syllabus is illustrated by Figure 1 which shows the last three terms of the program. In Figure 1 it is shown that the course is placed after most of the basic construction courses and just before the final project.

Term 4		Term 5		Term 6	
Construction Management I 3 cr	Construction Management II 3 cr	Working environment 3 cr	Leadership 3 cr	Building Services 6 cr	
Construction Equipment and Methods 3 cr	Computeraided Construction Management 4 cr	Quality- and environmental assurance 6 cr		Construction Law 4 cr	Final Project
Timber Construction 4 cr	Concrete Technology 4 cr	Steel Construction 4 cr	Innovation 4 cr	Final project 10 cr	

Figure 1. Placement of the course “Innovation” in the study programme syllabus – the last three terms.

### *Contents of the course*

Part 1 was a basic, general course. The education was given in a traditional way and this part was concluded by a written exam. The contents was very general with virtually no relation to construction and construction processes.

The present course (and formerly Part 2) is divided into two subparts:

- A theoretical part comprising 1 credit which deals with innovation within the construction process. The education is given in a traditional way, and the literature used, Hjort /1995/, is based mainly on Björklöf /1986/ and Larsson /1992/. The content of this part is mainly as follows:
  1. Basic theory, definitions and concepts.
  2. The construction sector from an innovation point of view – historical aspects.
  3. The construction sector from an innovation point of view - the role of different actors
- A project comprising 3 credits. This project is executed by small groups of students; 2 - 4 students in each group, with instructions from a lecturer. The aim is that a production method, a production process or a building system, which is considered to possess a potential for development and improvement, shall be analysed regarding quality, economy and working environment. The students get a high degree of freedom as regards the work within this project, and very much is depending on their initiative and creativity. Creativity sessions, interviews, and in some cases, construction of models or prototypes, are important parts. The aim is of course that the group shall present tangible proposals as regards improvement and/or products to be developed. The aim is further that the students, if possible, shall develop and study these proposals in their final project, i. e. final thesis.

### ***Results from projects***

The results from the projects are of course varying; depending on among other things the problem area studied and the ability of the students to be innovative. In order to differentiate the projects as regards the result, they have been classified into three categories:

- Category A: Projects with mainly a general description of the problem.  
Some concrete proposals as regards products/processes may be included but are not studied enough or does not seem realistic for further development.
- Category B: Projects with one or more concrete proposals as regards products/process that are studied fairly well and could probably be developed into a feasible product/process.
- Category C: Projects with concrete proposals which have been followed up within a final project (thesis).

A summary of this classification is given in TABLE 1.

TABLE 1. Projects classified into categories.

ACADEMIC YEAR	NO OF PROJECTS	CATEGORY		
		A	B	C
1993/1994	4	3		1
1994/1995	12	10	1	1
1995/1996	14	13	1	
1996/1997	6	4	2	
1997/1998	3	2		1
1998/1999	2	1	1*	

\*This project might be followed up with a final project

As you see in TABLE 1 above three projects has been classified in category C. These three projects are described in the following.

- The project from the academic year 1993/1994 had the title “New application areas for light-beam steel profiles”. It was followed by a final project which comprised the development and full-scale-testing of a composite slab-element consisting of reinforced concrete and light-beam steel profiles; Andersson and Svensson /1994/. The tests showed clearly that the product in question was technically feasible. Attempt to commercialise the products have not been made.
- “Transportation and assembling of prefabricated concrete carcasses” was the title of the project from the academic year 1994/1995 classified in category C. This project was continued in a final project with the aim to develop and study a new type of device for safety-barriers; Carlsson and Holgersson /1995/. Attempts to commercialise have been made. This process seems anyhow to be halted.
- The project in category C from the academic year 1997/1998 is concerning an ergonomical tool to be used in connection with ceiling-works, Andersson and Mårtensson /1998/. This project has been very success-full and serious attempts to commercialise this product are currently made.

The projects within category B all include concrete proposals as regards products/process that could probably be developed into a feasible product/process. These proposals have not been followed up, mainly due to lack of interest from the students involved.

### ***Observations and conclusions***

The course has been run during six academic years. Some conclusions can be drawn from observations made and experiences obtained.

The attitudes of the students towards the course are presented in TABLE 2, which is a summary of results from course evaluations executed after the completion of each part of the course. At these evaluations each student is given the opportunity to assess different factors with the scale 1 (very poor) to 5 (excellent)

TABLE 2..Results from course evaluations. Mean values.

FACTOR	1994/1995		1995/1996		1996/1997		1997/1998	
	Part 1	Part 2	Part 1	Part 2	Part 1	Part 2	Part 1	Part 2
Lectures	3,5	3,4	4,4	3,2	3,2	3,0	4,0	4,0
Exercises		2,9		2,7	2,5	2,5		4,1
Project work		4,2		3,7		3,3		4,7
Composition of the course	4,0	3,5	3,6	3,2	3,2	3,2	3,2	4,0
Literature	3,7	3,7	3,6	3,3	2,0	2,9	2,5	3,2
Exam	4,0	4,1	2,6	3,7	3,4	3,4	3,0	

From TABLE 2 you can see that the course as a whole has been fairly appreciated by the students. In part 2, specially the project has been appreciated and has been considered interesting and valuable. Anyhow, an observation made during the courses is that the attitudes of the students towards this project varies very much. Some students really appreciate the freedom they have when executing this project, others find it rather frustrating. The latter ones ask for more guidelines and directives from the lecturer. They seem to relate to other, more traditional projects, previously executed by them during the education. Anyhow, the assumption is that most of the students, after the completion of this course, will be more open-minded as regards the need for and the possibility to change and develop different parts of the construction process.

The textbooks used at this courses, Ottosson /1986/, Ottosson /1993/ and Hjort /1995/ have been fairly well accepted by the students. Of these publications only the latter one, which is based mainly on Larsson /1992/ and Björklöf /1986/, is focused on the construction industry; the other two are more general. The construction engineering students have however sometimes requested textbooks more focused on construction. This emphasizes another problem, namely the lack of knowledge within the field “innovation in construction”. The research reported from this field is sparse and much remains to be done.

### III. Future research

The intention is to execute research within the field “Innovation in Construction”. This research will have the above-mentioned course as its starting point and will mainly follow two lines:

1. “Diffusion of innovations in construction.” The intention is to follow and study the commercialisation of some of the innovations emanating from this course.
2. “Innovation in construction engineering education”. The intention is to follow and analyse the course described in this paper in a more systematic way. A part of this work will be a follow-up study comprising students who have participated in this course and who now are working as construction engineers. Their present view-points regarding the course, its content, usefulness and impact will be registered.

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