

Sustainability and innovation in educations under the Faculty of Engineer- ing and Science

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1 Introduction

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The D2D-project, which stands for "Development to Dissemination" and vice versa, builds on the results of the Cradle-to-Cradle Islands project and aims at creating a process that enables developed innovations to be commercialised across the North Sea Region.

As research and educational institution, Aalborg University plays an important role in educating engineers of the future. Knowledge is an important resource for economic growth. Likewise, sustainability and innovation are an important prerequisite for a green future. Therefore, it is important that the engineers graduating from universities have a solid knowledge about sustainability and innovation, no matter their area of specialisation.

In this report, we have analysed the curricula of Aalborg University (Faculty of Engineering and Science). It is analysed to what extent sustainability and innovation are integrated into the curricula taught at the university. In case of Aalborg University, we build upon the PBL-SUS project ("Sustainability at Engineering and Science, Aalborg University – Practice and potential") carried out in 2012. The PBL-SUS project, including the methods used and the results of the project are presented in section 3.

2 Description of AAU as D2D University

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2.1 Aalborg University (AAU)

AAU offers education and research within the fields of natural sciences, social sciences, humanities, technical and health sciences. AAU is a dynamic and innovative research and educational institution oriented towards the surrounding world. It is characterised by combining a keen engagement in local, regional, and national issues with an active commitment to international collaboration (Aalborg University, 2014).

AAU collaborates with regional and national educational institutions as well as with other national and international universities (Aalborg University, 2014). AAU is internationally renowned as a leading educational institution within problem based learning (PBL). Through PBL, AAU wishes to secure flexible interaction between theory and practice in the programmes. One of the principles of the PBL model is the fact that the students work on a problem-oriented basis (Aalborg University, 2014).

2.1.1 Faculty of Engineering and Science

The Faculty offers a comprehensive range of programmes in engineering and science in all types of degree programmes: Bachelor of Engineering, Master of Engineering, Surveying, and Bachelor and Master of Science (Heiberg, 2011). The Faculty of Engineering and Science consists of twelve departments, see also figure 1.

3 Introduction to the PBL–SUS Project

Kirsten Krogh Hansen

The point of departure for the study “Sustainability at Engineering and Science, Aalborg University – Practice and potential” (PBL-SUS) is the fact that Aalborg University (AAU), like many other universities throughout Europe, has signed the COPERNICUS University



Charta on sustainability. This commits the university to adopt and implement the COPERNICUS Guidelines, including but not limited to, integrating sustainability into the curricula taught at the university. Thus, the study set out to investigate to what extent this has already happened at the Faculty of Engineering and Science at AAU and how sustainability could be enhanced in the Faculty curricula.

Overall objectives of the study were:

- 1) To map existing practices and interpretations of sustainability in engineering and science education programmes at the Faculty
- 2) To point at strategies for implementing sustainability adjusted to the specific programmes.

The study has been carried out in two phases and at two different levels:

- 1) Phase 1: Programme and management level
- 2) Phase 2: Course and academic staff level

The first phase of the PBL-SUS project was carried out in the spring of 2012. It covered a document analysis of curricula under the Faculty of Engineering and Science, interviews with the dean of the faculty, vice dean, the heads of the three schools as well as interviews with heads of study boards. For the D2D project, the relevant information will be found in the PBL-SUS document analysis.

3.1 PBL-SUS and D2D

One of the potential outcomes of the D2D is course development. The setting of D2D is also sustainability. As the PBL-SUS has already been carried out and one of the key findings in this project was sustainability in the educational programmes the D2D course sug-



gestions could build on this knowledge, thereby choosing programmes with sustainability and ensuring an innovation aspect also.

This document will summarise the key findings relevant for the D2D project.

4 Document analysis

The main research question for phase 1 was:

What has been achieved so far in terms of integration of the concept of sustainability in the educational programmes of the Faculty?

and the first sub-question was:

How is the concept of sustainability integrated, interpreted and delimited in relation to the different educational programmes and contexts?

The initial step towards finding an answer to these two questions was achieved by carrying out a document analysis of the curricula for all existing programmes at the Faculty to investigate whether aspects of sustainability are included in the programmes and if so, which aspects.

This document analysis was carried out during spring 2012 and is therefore a snapshot of the situation at the time of investigation, not an overview of development over time. Thus, only programmes with curricula approved by the faculty and in operation in spring 2012 were analysed.

This resulted in a total of 111 programmes to be analysed, divided as follows between the three schools of the faculty: School of Engineering and Science - 68 programmes; School of Information and Communication Technology - 29 programmes; School of Architecture, Design and Planning - 14 programmes (see figure 1).





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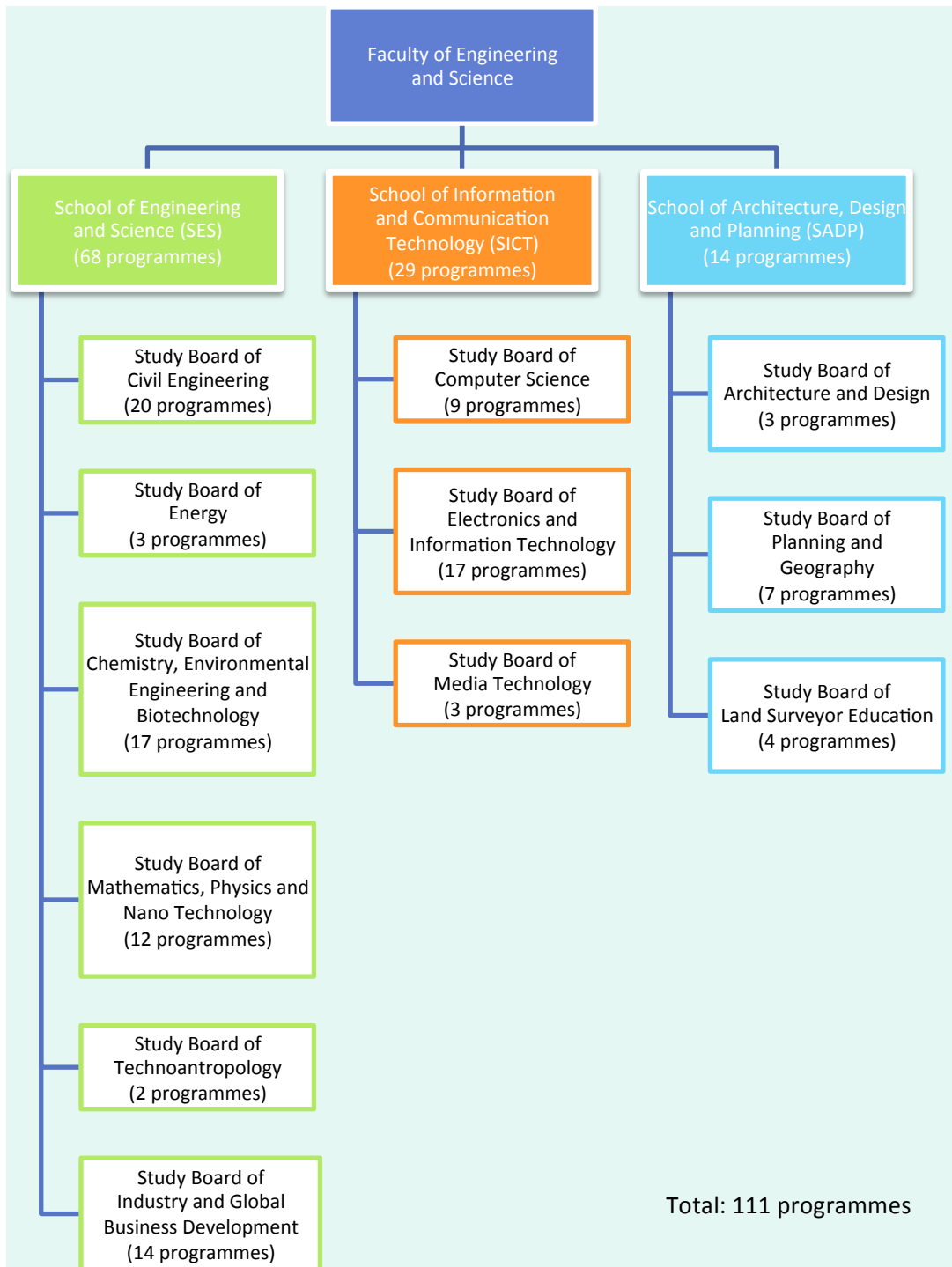


FIGURE 1 ORGANISATION OF THE FACULTY OF ENGINEERING AND SCIENCE AT AALBORG UNIVERSITY (AS OF SPRING 2012)

Curricula at the faculty are prepared in accordance with a standard template. Included in this template are, among others, the following two elements that were of major interest for this study:

- A qualification profile of the programme, containing the learning outcomes of the programme, categorised into three classes of qualifications: Knowledge, skills and competences.
- A tabular overview of the programme, containing all study modules contained in the programme, including the type of module (project or course), the title of the module, number of ECTS (European Credit Transfer System), type of assessment (Pass/non-pass or 7-step scale) and the type of examination (internal or external examiner).

For the purposes of this study the aspects of sustainability found in the sustainability reporting guidelines produced by the Global Reporting Initiative (GRI) were used as the search filter. GRI is a non-profit organisation, founded in 1997 in Boston, USA. It is collaborating closely with the United Nations Environment Program (UNEP) and the UN Global Compact to promote environmental, economic and social sustainability and to supply a framework for sustainability reporting for participants in the UN Global Compact (GRI, 2013). The first set of GRI guidelines was launched in 2000. The version applied in this study is version 3.1.

The performance indicators are divided into 6 categories, each category being further divided into a varying number of aspects and for each aspect are listed a number of key indicators. Below are the 6 main categories from within the three spheres of sustainability, with the number of aspects and the total number of key indicators listed in parenthesis:

Environmental sphere:



- Environmental (9 aspects, 30 indicators)

Social sphere:

- Labour Practices and Decent Work (6 aspects, 15 indicators)
- Human Rights (9 aspects, 11 indicators)
- Society (5 aspects, 10 indicators)

Economic sphere:

- Economic (3 aspects, 9 indicators)
- Product Responsibility (5 aspects, 9 indicators)

To give an impression of how the indicators are formulated two examples are given here, one from Environment and one from Labour Practices and Decent Work. Under the aspect Water indicator EN8 reads:

- *“Total water withdrawal by source” (GRI, 2011, s. 28)*

Under the aspect Occupational Health and Safety indicator LA7 reads:

- *“Rates of injury, occupational diseases, lost days, and absenteeism, and number of work related fatalities by region and by gender” (GRI, 2011, s. 31)*

The 37 aspects (not the indicators) included in the GRI Sustainability Reporting Guidelines were used as key words in the search for sustainability in the programme curricula and they were also used in connection with the interviews.

The document analysis of each written curriculum was carried out in two steps. The first step consisted of a qualitative reading the qualification profile and the tabular overview of the programme. If anything remotely connected to sustainability, defined by the 37 key words, the word ‘sustainability’ itself or even more loosely defined, was found here, the



curriculum was passed to phase two; a further search for sustainability, using the key words, was carried out.

If any of the study modules in the tabular overview of the programme contained any reference to sustainability, the particular module description, with special focus on learning outcomes for the module, was read through and any occurrence of any of the key words was noted.

The 37 key words used in the search might make up the search filter in this study, but they can only be used as such if they are found in a sustainability context. This first level of analysis of the programmes was done to ensure that key words found were actually appearing in a sustainability context.

After a programme had been found to contain elements of sustainability, a more detailed content analysis was carried out. This was done by a search for key words and their context, using the template for the document analysis in Appendix 1.

Each programme was searched for key words and their connection was noted. This was again done as a way of ensuring that the word was actually identified in a sustainability context. As well as searching for the 37 key words the documents were searched for the term “sustainability”, and if the concept itself was found this was noted (along with how many occurrences) in the summary for the programme.

5 PBL–SUS document analysis findings – relevant for D2D

The full description of all findings of the PBL-SUS project can be found in the reporting of the project. This chapter will focus on the findings relevant for the D2D project.



The PBL-SUS project analysed 111 programmes. In the tables below are the programmes with all three spheres of sustainability present, listed. The findings are listed according to school and study board affiliation. Not all study boards are represented here, as not all study boards have programmes with all three spheres of sustainability represented.

5.1 School of Engineering and Science

Table 1 summarises the overall results of the document analysis carried out at the School of Engineering and Science.

TABLE 1 SUMMARY OF OVERALL FINDINGS SES

School of Engineering and Science	Number of programmes
No mention of sustainability	40
All 3 spheres of sustainability	9
Environmental and social sustainability	7
Social and economic sustainability	1
Environmental and economic sustainability	2
Only environmental sustainability	6
Only economic sustainability	2
Only social sustainability	1
Total	68

Of the schools 68 programmes 9 were found to contain elements from all three spheres of sustainability. These nine programmes are listed in table 2, table 3 and table 4.

TABLE 2 FINDINGS FROM STUDY BOARD: CIVIL ENGINEERING

Study board: Civil engineering	Sustainability			Comment
	Environ-	So-	Econo-	



	ment	cial	my	
B.Sc. Civil Engineering	✓	✓	✓	Keywords dep. on specialisation. No hits in Human rights and product responsibility
M.Sc.Tec. Civil Engineering with specialisation in Management in the building industry	✓	✓	✓	No hits in Human rights, one I Product responsibility and 2 in Environment.
M.Sc.Tec. Civil Engineering with specialisation in Buildinginformatics	✓	✓	✓	Key words: Environmental management; occupational health. No hits in Human Rights.
M.Sc. in Engineering Management in the Building Industry	✓	✓	✓	Almost identical to M.Sc. Tec. Civil Engineering Byggeledelse
M.Sc. in Transportation Engineering	✓	✓	✓	One hit in Labour .. and in Product responsibility. No hits in Human rights.
Diplom Civil Engineering	✓	✓	✓	Identical to B.Sc. Civil Engineering

TABLE 3 FINDINGS FROM STUDY BOARD: ENERGY

Study board: Energy	Sustainability			Comment
	Environment	Social	Economy	
B.Sc. Energy Engineering	✓	✓	✓	Key word energy. No hits in Human rights and Labour, one hit in Product responsibility
B. Engineering, Sustainable Energy	✓	✓	✓	Identical to B.Sc. Energy



TABLE 4 FINDINGS FROM STUDY BOARD: INDUSTRY AND GLOBAL BUSINESS DEVELOPMENT

Study board: Industry and Global Business Development	Sustainability			Comment
	Environment	Social	Economy	
(Diplom) Bachelor of Engineering in Industry and export	✓	✓	✓	Focus on economy – not really sustainable mind frame (would benefit from knowledge of SEA, LCA, EIA)

5.2 School of Information and Communication Technology

Table 5 summarises the overall results of the document analysis carried out at the School of Information and Communication Technology.

TABLE 5 SUMMARY OF OVERALL FINDINGS SICT

School of Communication and Technology	Number of programmes
No mention of sustainability	24
All 3 spheres of sustainability	1
Environmental and social sustainability	0
Social and economic sustainability	1
Environmental and economic sustainability	0
Only environmental sustainability	0
Only economic sustainability	0
Only social sustainability	3
Total	29

Of the schools 29 programmes 1 programme was found to contain elements from all three spheres of sustainability. This programme is listed in table 6.



TABLE 6 FINDINGS FROM STUDY BOARD: ELECTRONICS AND INFORMATION TECHNOLOGY

Study board: electronics and Information technology	Sustainability			Comment
	Environment	Social	Economy	
M.Sc. Innovative Communication Technologies and entrepreneurship	✓	✓	✓	Document refers specifically and throughout to concept of sustainability and green ICT.

5.3 School of Architecture, Design and Planning

Table 7 summarises the overall results of the document analysis carried out at the School of Architecture, Design and Planning.

TABLE 7 SUMMARY OF OVERALL FINDINGS FROM SADP

School of Architecture, Design and Planning	Number of programmes
No mention of sustainability	2
All 3 spheres of sustainability	9
Environmental and social sustainability	3
Social and economic sustainability	0
Environmental and economic sustainability	0
Only environmental sustainability	0
Only economic sustainability	0
Only social sustainability	0
Total	14



Of the schools 14 programmes 9 programme was found to contain elements from all three spheres of sustainability. These programmes are listed in table 8, table 9 and table 10.

TABLE 8 FINDINGS FROM STUDY BOARD: ARCHITECTURE AND DESIGN

Study board: Architecture and design	Sustainability			Comment
	Environment	Social	Economy	
M.Sc. in Engineering (Architecture and Design with specialisation in Industrial Design)	✓	✓	✓	Document includes “designing for sustainability” that focuses on social, environmental and economic aspects and the ability to handle these at different levels of radicalism.

TABLE 9 FINDINGS FROM STUDY BOARD: LAND SURVEYOR EDUCATION

Study board: Land Surveyor Education	Sustainability			Comment
	Environment	Social	Economy	
B.Sc. in Engineering (Surveying, Planning and Land Management)	✓	✓	✓	Even though key words are found I would not determine this degree as sustainable. Focus on legislation, registration and mapping.
(Diplom) Human ecology	✓	✓	✓	Focus on environment in connection to society. Also includes clean technology and tools (including economy) for regulation



TABLE 10 FINDINGS FROM STUDY BOARD: PLANNING AND GEOGRAPHY

Study board: Planning and geography	Sustainability			Comment
	Environment	Social	Economy	
B.Sc. in Geography	✓	✓	✓	Interdisciplinary way of thinking, always considering consequences – nature/society/economy. Could benefit from more legislation and tools like LCA, SEA etc.
M.Sc. in Integrated Geography	✓	✓	✓	Focus on environment, but with an interdisciplinary way of thinking.
B.Sc. in Engineering (Urban, Energy and Environmental Planning)	✓	✓	✓	Covers environment and society extensively, but only touches on economy As an engineering degree it could be a “best practise”.
M.Sc. in Engineering (Urban, Energy and Environmental Planning)	✓	✓	✓	Works with sustainability, but focuses on environment. Possible as best practice.
M.Sc. in Engineering (Urban, Energy and Environmental Planning, with specialisation)	✓	✓	✓	Surprisingly little sustainability considering degree (environmental management). The curriculum encompasses 3 specialisations and there is a chance it’s too generic to determine.
M.Sc.Tec. in Environmental Assessment	✓	✓	✓	Focus on assessment tools, not solutions.



References

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Appendix

Appendix 1: Document analysis – template

Aim of study

The document analysis of curricula from The Faculty of Science and Engineering at Aalborg University aims to discover the existing extent of sustainability in current curricula. The results will form the basis for interviews with heads of schools, study boards and Ph.D. programmes.

The document analysis has three steps.

This analysis is for:

School:

Study board:

Degree:

Step 1: qualitative read through

Read through **Competence profile of the program** and the **Overview of the program**.

Apparent extent of sustainability in curriculum



If sustainability is apparent here (also in a broader sense of the word), continue with the document analysis based on the GRI 3.1 and listed below.



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Step 2: quantitative search for key words and their context
 If further subcategories/connections are needed, feel free to add columns.

Search for GRI 3.1 key words and their context in curriculum

1. *Italics>: words not used specifically in curriculum*
2. **Bold**: more frequent words (>2)

Environmental		
Categories	In connection with...	
Environment		
Materials		
Energy		
Water		
Biodiversity		
Emissions, effluents, and waste		
Products and services		
Compliance		
Transport		

Human Rights		
Categories	In connection with...	
Human rights		
Investment and procurement practices		
Non-discrimination		
Freedom of association and collective bargaining		
Child labour		



Forced and compulsory labour		
Security practices		
Indigenous rights		



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Labour practices and decent work		
Categories	In connection with	
Employment		
Labour/management relations		
Occupational health and safety		
Training and education		
Diversity and equal opportunity		
Equal remuneration for men and women		

Society		
Categories	In connection with...	
Society		
Local community		
Corruption		
Public policy		
Compliance		

Product responsibility		
Categories	In connection with...	
Product responsibility		
Customer health and safety		
Product and service labelling		
Marketing and communication		
Customer privacy		
Compliance		



Economic		
Categories	In connection with...	
Economic performance		
Market presence		
Indirect economic impacts		

Step 3: summary of findings

Summary of findings

