AALBORG UNIVERSITY

Integrating Sustainability in Engineering Identity

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A System Shift in (Higher) Education

(Sterling 2004)

“Paradigm:

Instead of higher education reflecting a paradigm founded in a mechanistic root metaphor and embracing reductionism, positivist, and objectivist, it begins to reflect a paradigm founded on living systems or ecological metaphor and critical subjectivity...

Purpose:

Instead of higher education being mostly or only as preparation for economic life, it becomes: a broader education for sustainable society/communities; sustainable economy; sustainable ecology…

Practice:

Instead of higher education being largely confined to instruction and transmission, it becomes: much more a participative, dynamic, active learning process based more on generating knowledge and meaning in context, and on real-world/situated problem solving.”

Different Levels of Engagement

(Adapted from Sterling 2002)

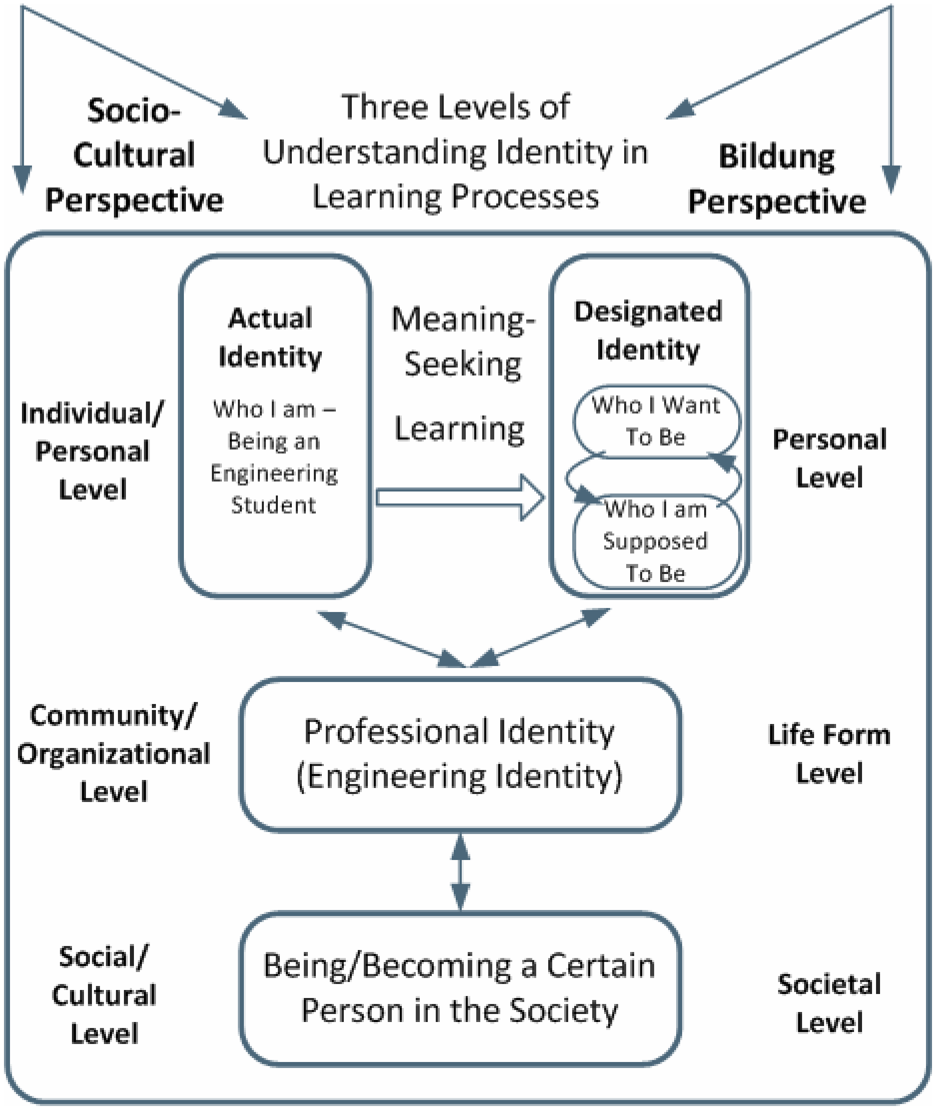
Education about sustainability — an "add-on" strategy → Awareness

Education for sustainability — a "built in" strategy → Critical reflection on and in action

Education as sustainability — a "re-build"-strategy → Questing, contextualising and negotiating the concept of sustainability

Toward a Sustainable Education Paradigm?

Understanding Identity and Learning 3 Levels



(Du 2006)

ESD in a Bildung Perspective

Klafkis Bildung Terminology	Focus	ESD Focus
Formale Bildung	Content/Knowledge –Information in itself implies Bildung	Education About Sustainability
Materiale Bildung	Methodological skills – Transfer of knowledge in itself implies Bildung	Education For Sustainability
Kategoriale Bildung	Exemplarity/Contextualisation/ Competences – Experiences with situational interaction of contents and methods implies Bildung	Education As Sustainability

Education About Sustainability

Introducing sustainability as a course for engineers providing:

- **Key Knowledge**: global citizenship, corporate social responsibility, environmental management, eco-design, environmental movements, business and state economy etc.
- **Key Skills**: training students in impact assessment, cost effective analysis etc. (focus on instrumental skills).
- **Key Competences**: Being able to use the method when changing the task description.

Integrative Education for Sustainable Development (IESD)

"It is desirable to integrate sustainable development in university curricula to train students to deal with issues in a sustainable manner when they become professionals. To introduce separate course on sustainable development in the curriculum is not sufficient to reach this objective. SD should also be integrated in courses not specifically targeted at SD. All teachers will have to grasp and integrate the concept of of SD in their courses…"

(Peet & Mulder, 2004)

"Here, sustainable development is conceptualised as something that occurs at the intersection of quite diverse areas of disciplinary concern and institutional competence."

(Gill Nichols, Freword in Gough& Scott, 2007)

Education For Sustainability

Example : Letting the student work on a project and design the problem and solution balancing economic, social and environmental considerations:

- **Key Knowledge**: As before, but more selective to address the specific field of study.
- **Key Skills**: Problem analysis, holistic product development and technological impact assessment etc. (focus on analytical skills).
- **Key Competences**: Ability to transfer the learned abilities to other projects, team collaboration, project management, reflection on own learning etc.

Education As Sustainability

Letting the students question, contextualise and negotiating the concept of sustainability by interacting with other communities of practise in mega-projects:

- **Knowledge**: Examples showing the complexity and context dependency of sustainability, cultural appropriation, contextualising different systems of innovations etc.
- **Skills**: Citizenship, intercultural communication, argumentation, dialogue, combining knowledge, networking (focus on synthetic skills)
- **Competences**: As before but more interdisciplinary. .

ESD Principles

According to Sterling (2004) an ecological paradigm for education will be characterized by the following:

- Process, development and action-oriented
- Critical and creative inquiry
- Active learning style
- Reflective and iterative learning
- Indicative and open curriculum
- Learning in groups, organisations and communities
- Democratic and participative
- Etc.

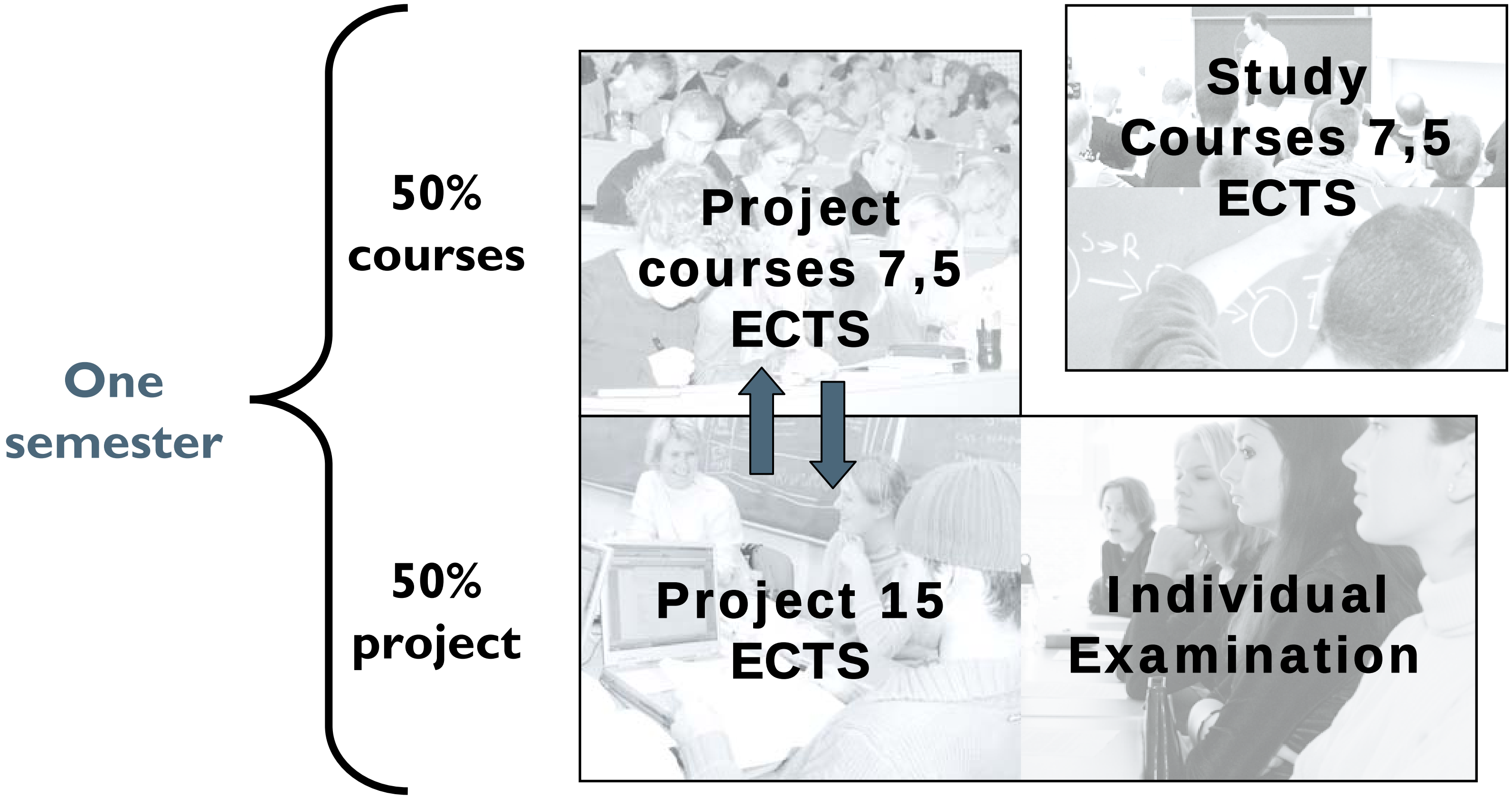
PBL Learning Principles

Learning
Problem Orientation
Project-Based/Organised
Contextual Learning
Activity/Experience-Based Learning

Social
Participant Directed
Team-Based Learning

Content
Theory-Practice Relation
Interdisciplinary Learning
Exemplary Learning

The Ideal Aalborg PBL model



1 ECTS (European Credit Transfer System) = 30 working hours

Model from *The Aalborg PBL model - Progress, Diversity and Challenges*
Anette Kolmos, Flemming K. Fink & Lone Krogh

Key Characteristics

- Self selected groups and projects within themes
- One project each semester
- Each group has a their own group room
- Group size of 6-8 students at first year, 1-3 students the final year
- Each group has at least one supervisor
- Individual examination

Main Objectives of the Basic Year in Engineering, Science & Medicine (ESM)

- To develop students **process** skills - project management, reflective learning and team collaboration
- To introduce students to the **specific discipline** - the first building blocks for creating a professional identity.
- To develop students ability to **contextualise** science and technology

Basic Year in ESM **Engineering** Study Groupings:

Architecture & Design	Global Management & Manufacturing	Urban, Environmental & Energy Planning
Building & Construction	Energy	Nanotechnology
Internet Technologies & Computer Systems	Mechanical & Production Engineering	Computer Engineering (Software)
Electronics and Information Technology	Biotechnology, Chemistry & Environmental Engineering	Health Technology

Science and Medicine study groupins **not** included: Computer Science, Physics, Geography, Sports, Informatics, IT, Chemistry, Surveying, Mathematics, Medialogy, Product and Design Psychology and Medicine (Industrial Specialization)

Contextual knowledge

Contextual Approaches to Engineering

Methods
- Problem Analysis
- Actor-Network Analysis
- Market Analysis
- Technology Assessment
- Needs Assesment

Key Contextual Factors
- Human and Natural Resources
- Technological Innovation
- Cultural Appropriation
- Environmental Impacts
- Social Responsibility and Ethics
- Policy Implementation
- Public Regulation
- Public Participation

(Adapted from the Study Guidelines)

Facilitation of Contextual Knowledge

- 1,8 ECTS course: Technology, Man and Society (TMS)
- One supervisor with focus on contextualising problem based projects – problem analysis & technological assessment.
- Individual examination of the contextual knowledge integrated at the project exam

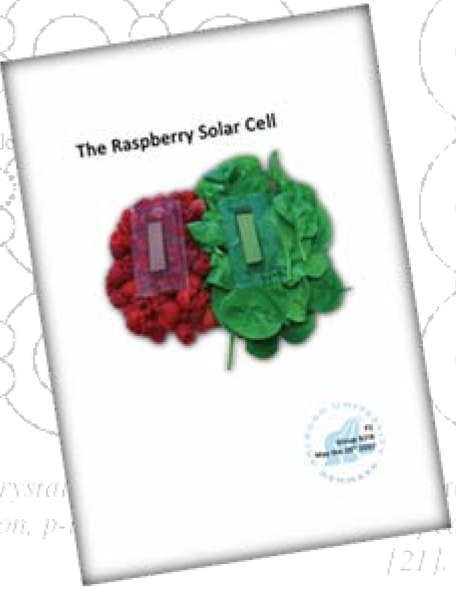
Basic Year in ESM Engineering Study Groupings with TMS (**bold**):

Architecture & Design*	**Global Management & Manufacturing**	**Urban, Environmental & Energy Planning**
Building & Construction	**Energy**	Nanotechnology*
Internet Technologies & Computer Systems	**Mechanical & Production Engineering**	Computer Engineering (Software)*
Electronics and Information Technology	**Biotechnology, Chemistry & Environmental Engineering**	Health Technology*

*Contextual knowledge facilited through other but similar courses:

- For Achitecture & Design: "Space, Man, Context"
- For Nanotechnology: "Nanotechnology, Science & Society"
- For Computer Engineering (Software): "Nature, Man and Society"
- For Health Technology: "Health, Man and Society"

Examples I



"The Raspberry Solar Cell" - Nanotechnology

2nd Semester Project, Spring Semester 2007, 7 Group Members

Technical Content: Solar cell technology and experiments with Dye-Sensitized Solar Cells (DSSCs)

Contextual Content: Climate change and its consequences – the scientific basis, effects, economics , adaptation & mitigation strategies and low carbon technologies

Initiating Problem Statement:

How does the DSSC work, what are the future complications of global warming and how can solar cells help avoid these?

"Electronic Control System for Kite Propulsion"- Electronics

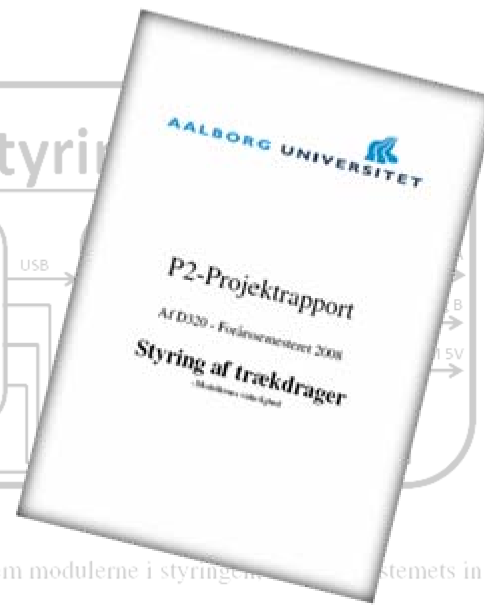
2nd Semester Project in Electronics, Spring Semester 2008, 6 Group Members

Technical Content: Mathematic modelling of kite propulsion system, design of system elements for electronic control system

Contextual Content: Fossil fuels, emmissions, global warming, shipping and CO_2-emmissions from the shipping industry, alternative propulsion methods

Initiating Problem Statement:

What environmental and economic consequences are linked with energy use in the shipping industry, and what is the potential for reducing the negative effects by using renewable energy?



Examples II

"**GreenEats**" – Architecture & Design

2nd Semester Project, Spring Semester 2009, 7 Group Members

Technical Content: Design parameters & product development of sustainable food packaging & eating utensil form

Contextual Content: History of food packaging, marketing & marketing analysis, sustainability and the Cradle 2 Cradle concept

Initiating Problem Statement: Create afood packaging design concept which considers future society and its new technologies

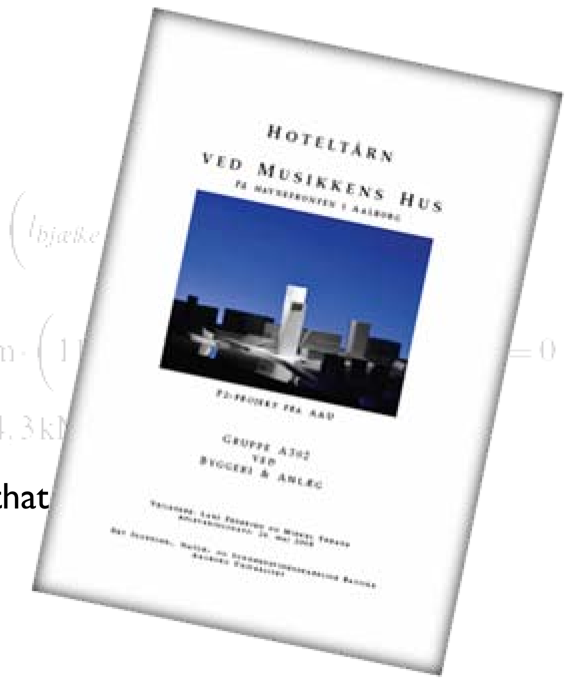
"**Hotel Tower at Aalborg Harbor Front**"
- Building & Construction

2nd Semester Project in Electronics, Spring Semester 2008, 7 Group Members

Technical Content: Dimensioning of static systems, calculation of loads

Contextual Content: Sustainable buildings, stakeholder analysis, active and passive energy saving measures

Initiating Problem Statement: How can an environmentally and economically sustainable skyscraper be planned and constructed at Aalborg harbor in a manner that takes into account as many stakeholders as possible?



Contextual Knowledge not always Knowledge About, For or As Sustainability!

Simple deep-searching on selected key words in a database of 1st year Basic Year projects over a 5-year period (1917 reports) yields the following:

- 'Bæredygtighed': 103 Hits
- 'Bæredygtig': 263 Hits
- Sustainability: 19 Hits
- Sustainable: 50 Hits
- 'Klima' : 353 Hits
- 'Klimaforandringer' : 69 Hits
- Climate: 76 Hits
- Climate Change: 40 Hits

Some Overall Conclusions

A PBL approach means a focus on students' learning process and the competences for learning to learn. It involves a project-organised educational model with a dialectic interaction between the subjects taught in the lecture courses and the problems dealt with in the projects.

The PBL approach address the complex nature of climate change, preventing and solving environmental problems by integrating environmental considerations in professional practise and citizenship. Complex real life problems handled in their socio-cultural and ecological context are the cornerstone of PBL.

Education for sustainability should be integrative – not an 'add-on' course by environmental specialists – PBL can provide a suitable frame for such integration. However, it is important to support ESD by a 'learning as sustainability' approach integrated in student and supervisor identity

Problem based learning methods for climate change can be used on many different levels – in courses, across courses or even across disciplines - depending on the political will.