MODELS FOR IMPLEMENTING SUSTAINABLE DEVELOPMENT INTO THE UNIVERSITY

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Abstract

Any effort to build up an educational framework needs an adequate structure and a formal basis. This is especially true whenever complex multifaceted issues like Sustainable Development, ethics, or project management have to be integrated in the existing setting of a university and its educational system.

In this paper, we present models for integrating Sustainable Development and Education for Sustainable Development into the university agenda. Based on the experience of the authors gained in Germany and South Africa we derive various representations for the sustainability activities and models for implementing Sustainable Development that can be used for planning, implementation and communication purposes.

Keywords: Sustainable Development; Education for Sustainable Development; Modelling

1.   INTRODUCTION

Sustainability is the central challenge for the 21st Century (UN 1993) and therefore universities all over the world have decided to put a focus on sustainability and integrate Sustainable Development into their strategy for development (see e.g. ulsf.org, emsu.org, guni-rmies.net, iau-aiu.net).

However, sustainability describes a very complex aspect of life and is therefore neither easily understood in its full width, nor is implementing a sustainable strategy a trivial task. To clarify the challenges connected to Sustainable Development, one has to break the subject's intricacy down to workable parts. For solving this problem it is necessary to develop and use models for planning, implementing, and communicating the aspects of Sustainable Development.

Here, models are presented that have been proven to be useful in planning, describing and reporting the sustainability fields of a university with due consideration for including education for Sustainable Development into the curricula. This paper concludes the authors' experience gained while working on this subject at the University of Applied Science Aalen (Germany) and the Central University of Technology, Free State (South Africa).

The results obtained cannot only be used to introduce the subject of Sustainable Development into a university strategy, but can be easily transferred to the integration of other complex topics to virtually any organisational structure.

2. THE NEED FOR STRUCTURES – DEALING WITH COMPLEXITY

Structure is a basic need of the human brain. Therefore we try to understand any complex reality by using models to break it down into elements and to structure it. However, one has to stress that the purpose of models is not a one-to-one mapping of the described object, but to simplify reality by representing the main influences, connections, and dependencies.

Hence, the use of models is an integrated element of planning and communication. There is a wide range of model structures available for this purpose; beginning from very informal models - like analogies or textual descriptions - to formal mathematical methods. In general a model can be descriptive or explanatory (or whichever possible combination) and, while explaining a system from its basic elements is academically preferable, for most practical problems a good description is usually sufficient and generally much easier to obtain. However, the optimal type of model to choose depends on the nature of the modelled system, the people who use it and its intended purpose.

The following shows a range of different situations to be modelled and a typical type of model structure used for each:

Table 1: Usage of models

field of application	example for models	example for model types
Project management	Work breakdown structure	Hierarchical Model
	Project network	Network Graph
Analysis	Status Quo analysis – SWOT	Matrix
	Lifecycle Models	Flow graphs
Planning	Policy	Matrix
	Programme	Indicators
Reporting	Report structure	Matrix

3. SUSTAINABILITY: BASICS, HISTORY AND BASIC MODELS

Before developing models that clarify the task of introducing sustainability with all its aspects to a university, it seems necessary to give a short historical introduction to the contemporary usage of "sustainability". Using some basic models, we also illustrate the wide range of importance and impact that is connected to Sustainable Development in general.

3.1   Brundtland report

The notion of sustainability goes back to the so-called Brundtland report (World Commission on Environment and Development, 1987) named after the commission's chair-woman, Gro Harlem Brundtland, with the following definition:

"Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Summarized and interpreted in a global way, the Brundtland definition means a development that ensures that

- all present people (intragenerational justice) and
- future generations (intergenerational justice) can fulfil their needs.

Based on this definition a first basic model can be developed and used to deduce principles of action:

Table 2: Basic portfolio of Sustainable Development.

	environment	development
Future	Conservation of natural resources	Socioeconomic development
Present	Environmental protection	Intragenerational justice

3.2   Rio Agenda 21

The vision of Sustainable Development was stated in the Rio 1992 declaration of Agenda 21. It was recognized that Sustainable Development has (at least) an economic, ecological and a social component.   The declaration is therefore aiming to improve the social, ecological and economic status of the world and to fight the ongoing deterioration in these areas.

> *"Humanity stands at a defining moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our well-being. However, integration of environment and development concerns and greater attention to them will lead to the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future. No nation can achieve this on its own; but together we can - in a global partnership for Sustainable Development." (UN 1992).*

Section I of Agenda 21 addresses the social and economic dimensions of sustainability with topics such as developing countries, combating poverty and human health conditions. Section II then addresses conservation and management of resources for development with topics such as protection of the atmosphere, managing fragile ecosystems, sustainable agriculture and rural development, biological diversity, management of resources.

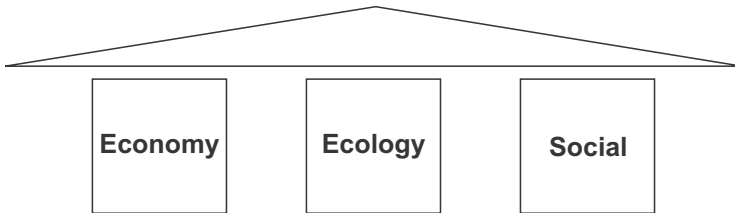In summary, sustainable development in terms of the Agenda 21 is based on three pillars:

Figure 1: The pillars of Sustainable Development.

The second component, "ecology" in this context, is more meant to be interpreted in saving natural resources for future generations, than in the value of an ecological system on its own. However, seeing the interrelatedness of economy (creation of goods) and society (participation and welfare) and the strong relations between these two, one can integrate them into one aspect of socio-economic development.

Analysing the connections between the tree pillars, the following statements can be made:

•   Ecological sustainability is a prerequisite for the survival of a country and even the world as we know it. While an economy can be reconstructed and even rebuilt from total demolition and a political system can be overcome in time, a region can convalesce from ecological damages only – if ever – within timescales that are longer for orders of magnitude.
•   Social stability can only exist on the basis of a liveable ecological system and of disposable natural resources.
•   An economic system and the creation of goods and values that are needed to fulfil people´s needs are only possible in a stable social system which enables the exchange of goods and services.

Hence, a more adequate description is a layered model of the three factors supporting each other:
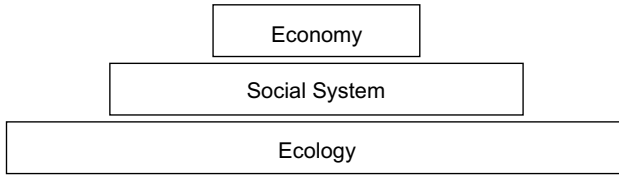

Figure 2: The layers of Sustainable Development

3.3   Rio + 10 World Conference in Johannesburg

The full implementation of Agenda 21, the "Programme for Further Implementation of Agenda 21" and the commitments to the Rio principles, were strongly reaffirmed at the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in 2002 where the following important commitments were made:

> *"(2) We commit ourselves to building a humane, equitable and caring global society, cognizant of the need for human dignity for all.*
> *(5) Accordingly, we assume a collective responsibility to advance and strengthen the interdependent and mutually reinforcing pillars of Sustainable Development — economic development, social development and environmental protection — at the local, national, regional and global levels." (Johannesburg Declaration 2002).*

As a consequence of that notion of "local ... global levels", we can structure the ranges of impact by sorting them from local to global as depicted below:
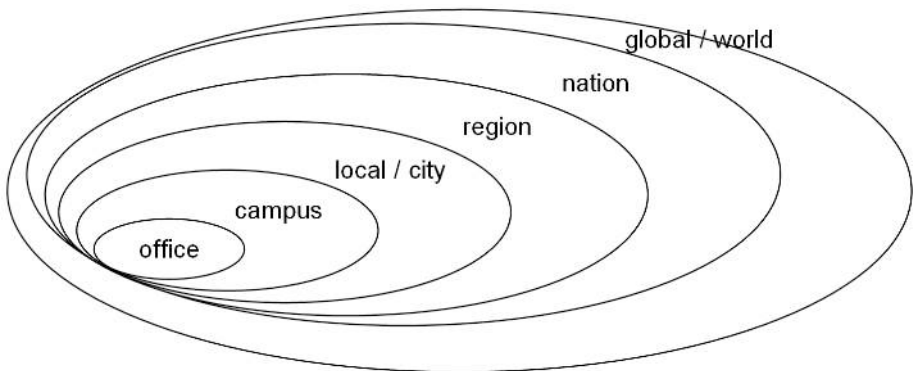

Figure 3: The ranges of impact

3.4 Education for Sustainable Development

After presenting the historical development and the definition of sustainable development, this paragraph briefly introduces the term "education for sustainable development". Its importance is best described by Nelson Mandela: *"Education is the most powerful weapon you can use to change the world."*

The aim of Education for Sustainable Development is to give every human-being the ability to shape the future and to decide for a better life. To achieve this, education should comprise not only teaching of knowledge and facts but also skills, attitudes and values necessary to shape a sustainable future. Therefore it shall promote competencies like critical thinking, the making of decisions in a collaborative way, or to imagine the consequences of own actions.

3.5 Complexity

From the above definition it is clear, that Sustainable Development is indeed a complex challenge. To efficiently work on the topic, it is therefore essential to use models for simplifying and visualizing. An example for integrating various aspects of sustainability in such a model is the following:

Table 3: Models in sustainablilty

Topic	Description
Long term temporal considerations	The notion of future generation implies a scale of several hundred years
Short term temporal considerations	Development of project plans to realize improved likelihood of sustainability and reduction of the carbon footprint
Flow of resources	Ensuring the optimal flow of energy, value and money to ensure maintenance of the lifestyle of the community and empowerment of disadvantaged segments of the population
Dynamic development of systems	Defining, developing and implementing systems to address short-term needs.
Networks of ecological and socioeconomic systems	Adapting socioeconomic systems so as to ensure sustainable ecological networks

Using this representation, instead of the formal Agenda 21 definition for example, enables people to actually work on the topic of sustainability in a precise way.

4. UNIVERSITY AND SOCIETY

The primary question for the reason or rationale of adopting a new paradigm in an already established scheme can be addressed in a normative sense or in a teleological sense by looking at the outcome of the target organisation and its impact on society. A prerequisite for handling the implementation of (education for) Sustainable Development in a university is therefore a discussion of a university's role in and effect on the world.

4.1 The interaction model

The interaction model is a basis for structuring the (sustainability) impacts of an organisation:

Table 4: The layers of impact.

	general	university examples
Plant (processes)	All activities of the organisation on its premises (plant)	All activities on the campus including their impact via procurement and the supply chain.
Product	The impact of the product or services provided by that organisation and of their use	Training and education, transfer and research activities and their consequences. Moreover, the activities of the alumni in the world of work are important factors.
People	All activities of the staff and workforce of the organisation within and outside their work for the organisation	The activities of the university staff and of the students.

4.2 The stakeholder model and the responsible university

The question whether a university should be active in implementing sustainability and education for Sustainable Development is a normative one that influences university strategy.

A normative question can be answered either on a philosophical level or by looking at the requirements that the stakeholders claim to the object in question.

Considering the main stakeholders of a university, we developed a model for the responsible university that responds to the claims of the various stakeholders and hence takes responsibility for Sustainable Development (Lategan, Holzbaur, 2010).

Table 5: stakeholders

Stakeholders	response
Scientific community	Traditional university: academic / scientific / research
Economy	Entrepreneurial university / developing / training
Shareholders	Commercialised university / economic / competitive
Society	Sustainable university / responsible / transdisciplinary / educating

The integration of the requirements from all stakeholders defines the core of the university. One can therefore visualize the role of the university as a responsible system that fulfills the needs of all relevant stakeholders (represented by the intersection of the requirements):
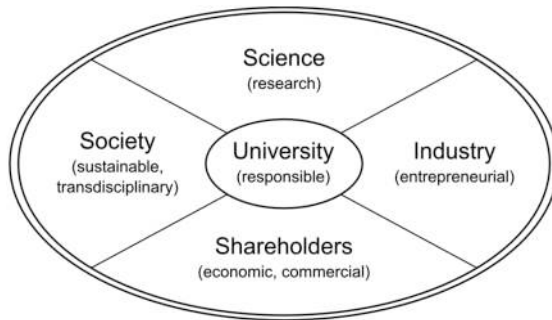

Figure 4: University stakeholders and needs

5.   INTRODUCING SUSTAINABILITY ON A UNIVERSITY LEVEL

We found sustainability being a term that describes a complex setting of demands and requirements that are altogether of crucial importance to the future of our world. Because these terms are valid for wide area of actions, introducing Sustainable Development in a society calls for a broad approach. Universities on the other hand have an extraordinary strong impact. Not only due to their sheer size as a company or their power in influencing the course of science, but especially due to their potential influence on future generations.

It is therefore extremely helpful if not strictly necessary to include sustainability and education for Sustainable Development in the university system whenever Sustainable Development is found to be a desired agenda. However, to fully exploit a university's potential in that matter one has to carefully work on the subject.

5.1 Structuring the fields of activity

The first nontrivial challenge when introducing sustainability in a big structure like a university is nothing less than identifying all possible (and useful) points of action. From the models above, we can draw several aspects of portfolios combining the impact areas with either range or activity. This generates basically a set of projections of the complicated "university space" to a point where specific activities can be developed.

In plain terms the procedure is as follows:

- Find as many aspects of the university structure as needed (the "basis vectors")
- Construct 2D-portfolios out of those.
- For every interaction point (empty field in the corresponding matrix) think about what sustainability would mean in this context and how this can be achieved.
- All the defined actions together form the implementation of Sustainable Development.

Several portfolios that include examples of possible implementation of sustainability will be presented. The aspects given are neither entire nor exclusive. For sake of brevity, we use the term x-y portfolio instead of using the more adequate longish terms "field of x" or "area of y" respectively.

The range impact-portfolio

In a first attempt, one can structure the activities according to the range and the pillars of sustainability (following the structure given by the Johannesburg declaration in fig. 3):

Table 6: Range-impact portfolio

	Holistic governance	Ecology resources	Economy welfare	Social justice
Office	Governance			Inclusion
Campus		Water, Waste		
Community	Citizenship			Engagement
Country			Entrepreneurship	
World		Climate	Globalisation	

The action-impact portfolio

One can also structure the activities according to the main action of a university and the interaction model (see table 4).

Table 7: Action-impact portfolio

	Holistic governance	Ecology resources	Economy welfare	Social justice
Management	Organisational Structure		Procurement	
Operations on campus		Renewable Energy		Gender
Transfer	ISO 26000		Entrepreneurship education	
Education				Globalisation
Research				

Combining the ranges and activities (which are not independent from each other) we get a three-dimensional portfolio, to which other dimensions can be added.

The organisational dimension

Also in an organisation, we have various potential governing principles. An action-organisation portfolio follows (Here, we use the traditional university example):

Table 8: Action-organisation portfolio

	Administration			Academic		
	Students and staff	**Technical infrastructure and buildings**	**...**	**Faculty 1 (Economy)**	**Faculty 2 (Engineer)**	**...**
Management						
Campus		Waste				
Transfer				Responsibility	Energy	
Education	Core Curriculum					
Research						

The dimension of involvement levels

Whenever one compiles a list or statement about sustainability, one has to decide, what actually is education/ research/ transfer for Sustainable Development. Recurring to ethics, one can differentiate between the intention and the action of activities:

(1)   Direct and indirect contribution to SD: the latter is via some of the supporting principles of SD such as resource conservation, energy saving, participation in decisions, integration, democracy, biodiversity, nature preservation, efficiency, sufficiency, education,
(2)   SD as aim or object:

Based on this differentiation, a model for involvement levels can be constructed:

Research SD / SD as a subject

Dedicated research for Sustainable Development
(Sustainable Development is the intention and aim)

Research related to and in support of Sustainable Development
(Research/ education is done to support SD or some of its supporting principles)

Research related to or in support of some aspects of Sustainable Development
(Sustainable Development is an outcome – and one among others)

Figure 5: Levels of involvement in sustainable development

Based on this model other two-dimensional portfolios can be derived e.g. by adding the dimension of sustainability components (ecology, economy, social) or the university actions:

Table 9: Level-action portfolio

	Management	Transfer	Education	Research
Dedicated to sustainability	University for sustainability	Engaged for society		Trans disciplinary Research
Active for sustainability	Implementing SD management	Considering SD in all activities	Education for sustainability	Research for Sustainability Components
Involved in sustainability	Supporting SD activities			
Related to sustainability	e.g. energy saving on campus		Components of SD in some lectures	e.g. electromobility, macro-economics

5.2 Examples for the portfolio models used by the authors

This subchapter will present some specific examples of the above-mentioned aspects

The impact-range portfolio used for Aalen University, CUT and Vaal University of Technology (VUT)

The type of impact-range portfolio was not only used in planning for Aalen University, CUT and VUT, but also to communicate the plans for the implementation at these universities:

	Overall Holostic Intergenerational	Environment Ressources	Economics Management	Social Political Intragenerational
Site Level **Campus**	**Sustainability@CUT**	**Green Campus**	Economic Sustainability	**Blue Campus**
Local/ Regional Community **Development**	**Cooperation programmes**	Climate protection programme	**Entreprenurship** **Sustainable Economy**	**Community Engagement**
Regional/ National **Education** Cooperation	**ESD in curricula**	**Energy Engineering for Sustainability**	Entrepreneurship	**ESD in teachers education**
National/ Global **Research** Cooperation	**Cooperation programmes** SD in Research	**Energy Water**	Corporate Social Responsibility	Research in socioeconomic aspects of sustainability

Figure 6: The portfolio model for CUT as presented 2010

The impact-activity portfolio used for schools in Aalen

A restricted type of impact-activity portfolio was used within the environmental system Green Eel project (www.gruenerAal.de) for schools in Germany. In this system, the activities of a school are structured into educational aspects (teaching, classroom education and outdoor activities) and technical or physical aspects (resource saving, planting trees).

As the Green Eel was originally planned as an environmental management system, main components are in the field of environmental education and resource saving. Depending on the type of school, activities were structured differently. Here we give an updated form. (All physical activities in a school also contribute to education, of course.)

Table 10: Activity-impact portfolio for schools

	Education	**Technical measures / physical activities**
Resources	Desertification, water circle forests and paper production	Water saving, rainfall storage, paper recycling
Energy and climate	Climate change, carbon dioxide renewable energy, entropy	Proper heating and ventilation, mobility behavior
Biodiversity	Biodiversity all over the world, food production	Building habitats at or close to the school, regional food
Environmental protection	iImmission and emission, production and consumption	Proper cleaning methods, practical waste reduction and recycling
Socioeconomic aspects	Poverty and migration, economic principles	Inclusion, integration, learner´s company selling fair trade products

5.3 The Thornbush model for visualizing modes of implementation

The last subchapters describe a model for the implementation of Sustainable Development in education in a university. Implementing education for Sustainable Development always provokes discussion about its implementation into the curriculum and seeing Sustainable Development as a competitor to regular subjects will immediately raise the question of quality of education.

Hence, there is a need for a model for the integration of sustainability (as well as management, ethics and other core subjects) into a regular curriculum. We propose a fractal model that allows the integration of SD subjects on various levels from dedicated modules (e.g. 150 hours) to small inserts in lectures (several minutes). The contents must also link the course subject (e.g. physics) to sustainability and this goes through various levels from:

o *Classical subject oriented terms:* energy, entropy, radiation, photoelectric effect, accumulators and Lorentz force laws, through
o *Applications:* photovoltaic phenomena, electrical motors, metals and rare earth elements, and
o *Sustainability related aspects:* energy distribution and storage, resource depletion, deforestation, to
o *Core aspects of education for Sustainable Development:* consumption patterns, sustainable energy consumption, inclusion, mobility concepts and urbanisation, biodiversity.

To visualise these relations, the branches of a tree that reach out from the stem to the leaves in a fractal way have proven to be useful. As the model was developed in South Africa, we used the umbrella thorn (acacia tortilis) as a prototype and derived the name Thornbush model.
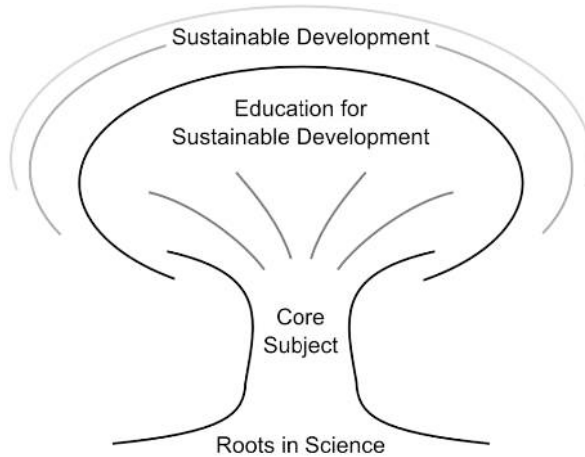

Figure 7: The Thornbush model

The Thornbush model visualizes the way in which education for Sustainable Development is integrated into the curriculum and individual modules or subject descriptions:

- The roots depict the strong basis of our teaching in science and research. General research as well as the blue Sustainable Development-related research is nurturing the tree.
- The stem depicts the core subjects which are the stable basis for all teaching.
- The branches are reaching out and link the core subject to the various applications and to Education for Sustainable Development.
- Green Education for Sustainable Development forms the leaves that reach out in the blue air of Sustainable Development supported by the branches and feeding back to the tree.

5.4   Example for implementing Sustainable Development via projects

In Aalen University education for Sustainable Development is for example implemented through community development projects. In those projects the topic is offered by a non-academic stakeholder. The students can therefore work on "real world"-problems and while advancing their skills and knowledge, give direct outcomes of their projects back to the society:
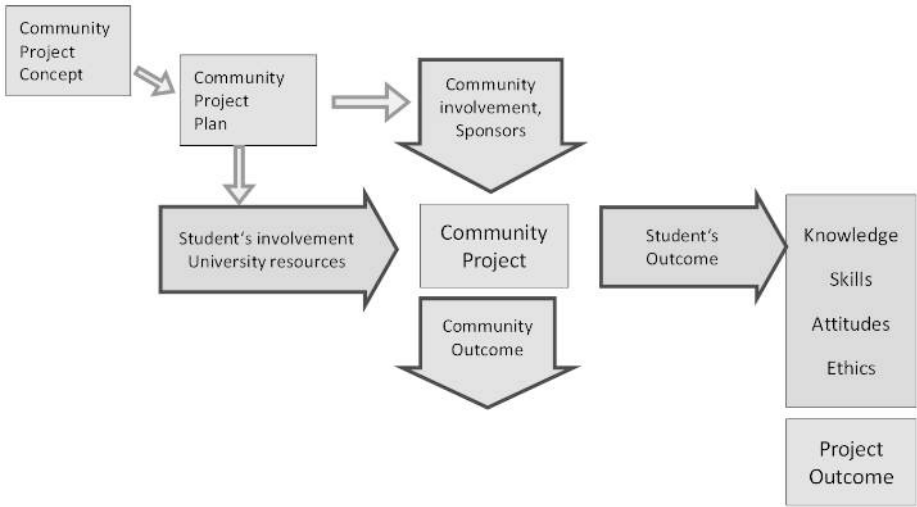
Figure 8: The process model for community engagement

6. SUMMARY

Models serve to reduce complexity by bringing structure into a complex subject. In sustainability management it is important to introduce and use models in order to be able to analyse, plan, communicate and document sustainability issues in an appropriate manner.

Especially portfolio models or matrices are useful to structure that field without the need of sophisticated mathematics. Mathematical modelling competences here lie much more in the way of structuring than in the implementation – modelling for insight not for numbers applies to a large extend.

Based on these models, we will be able to transfer sustainability approaches from one university to others and also compare sustainability activities and reports or statements in a systematic way.

An example of the implementation of these models at Central University of Technology is documented on the sustainability website of CUT under www.cut.ac.za.

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