SUSTAINABLE LIVING – A MULTIPLAYER EDUCATIONAL GAME BASED ON ECODESIGN

Peter JUDMAIER[1], Maria HUBER[1], Margit POHL[2], Markus RESTER[2] and Daniela LEOPOLD[3]

[1]Institute for Engineering Design and Logistics Engineering, Vienna University of Technology, Austria

[2]Institute of Design and Assessment of Technology, Vienna University of Technology, Austria

[3]Department of Education and Human Development, University of Vienna, Austria

ABSTRACT
The educational Ecodesign game *SuLi* (Sustainable Living) aims at transferring basic knowledge about sustainability to young people onwards in a playful way. When playing the game, the impacts of producing and consuming goods are displayed. The importance of design and production decisions is transferred and the players are confronted with the consequences of their activities in an enjoyable but reasonable manner. This knowledge about the impacts of production and consumption along a products´ life cycle will help preferring environmentally sound products that were produced under fair conditions. The integration of the target group of the game takes place at an early stage of development so that their needs and wishes can be addressed and taken into account. During the testing phase the practical use of the game is also tested and evaluated on this high school.
The project is co-funded by the Austrian Ministry of Transport, Innovation and Technology and the Austrian Ministry of Science and Research.

Keywords: Ecodesign, Life Cycle Thinking, Design Education

1 INTRODUCTION

The raising resource depletion and the resulting development of resource prices of e.g. petrol, gold, copper in the last years show that the heavy dependency of global industry on non renewable fuels and resources leads to an economic situation critical both in economical, ecological and social terms [1]. The correlation between rising CO_2 concentration in the atmosphere and rising temperature is evident and there is no denying that global warming has anthropogenic causes [2]. The global dimension of production processes and consumption leads to a complexity hardly conceivable for end customers. The sales price, design, functionality and image of a product are usually the most important decision parameters when a product is bought. The e.g. environmental performance of a product is rarely considered as an important quality criterion. Impacts referring from the used materials, the production processes, the use phase of products etc. are usually not taken into account because of lack of information or knowledge.

In this respect, young people are an important target group for sustainable consumption issues. Adolescents have their own financial means and present an important consumer group. Besides, they are the decision makers of the future, knowledge about environmental impacts of production and consumption activities can be integrated in their daily working life, provided that the adequate information is available.
Sustainable product development integrates environmental, economic and social aspects into product design and draws the linkage between the ecological, economical and social aspects of production and consumption.
The aim of the educational Ecodesign game *SuLi* (Sustainable Living) is to transfer basic knowledge about sustainable products to young people in a playful way in order to promote sustainable consumption and decisions towards sustainability.

2 LIFE CYCLE THINKING

Sustainable product design/Ecodesign aims at considering and reducing the impacts of a product along its entire life cycle. This includes the extraction of the raw materials, the manufacturing of the product, its distribution, the use and finally, the disposal of the product. Design in this respect compiles the engineering design of a product as well as its form and functionality. Sustainability comprises the three dimensions: economy, ecology and social conditions.
The goal of Life Cycle Thinking (LCT) is to identify phases and processes within the whole product life cycle (raw material, manufacturing, distribution, use, end of life) which have or could have significant influence on the environmental impacts. Ecodesign should concentrate on these phases with the highest improvement potential. Ecodesign has to fulfil the customers needs with causing a minimum of environmental impact, merely the amount of raw material used, the energy needed along product life. An Ecodesign product serves its purpose with only a minimum of environmental impact. The question is how to design such products.
The life phases of a product are tightly linked to each other. Interdependencies have to be considered and the effects of the planned measures have to be analyzed beforehand. The positive effects in one phase e.g. less material should not be compensated by the negative effects in another phase like a higher effort for dismantling a product. This is a central aspect of Life Cycle Thinking. [3][4]

3 GAME CONCEPT

In the Ecodesign game SuLi players have to consume and produce products of daily use. This takes place in a virtual world that is structured as a multiplayer game. The decisions of the individual players influence all other players taking part in the game. The sample products used in the game refer to different categories: food, clothing, housing, hygiene, communication, media, leisure and sports. The products are designed close-to-reality so that young people can easily establish a connection to their real life. These products are the basis for the simulation of the ecological, economical and social effects players can influence through their own production decisions and consumer behaviour. The data for the sample products are collected along the entire product life cycle according to ecological, economical and social impacts. This permits players to produce products in different manners, which has effects on the price as well as on the ecological and social development (for example contamination level of water and wage level of population) of the game environment.
Players are able to enter SuLi using conventional web-browsers. No additional plug-ins are required. SuLi is a multiplayer game in which the decisions of individual players

influence all other people participating in the game. As in real life, no individual progress can be made without a minimum of cooperation. Each player controls a game character (called an "avatar"). The avatar lives on its own island, each featuring different raw materials, social standards and ecological and economic conditions. As no island is equipped with all raw materials required in the game, it is impossible to play the game entirely self-sufficiently.

The game features a round-based concept. Players must therefore make their decisions regarding production and consumption prior to a predefined time limit, after which their moves are evaluated by the simulation and the next round is toggled. The effects of their decisions are made visible by the modification of the avatar's and the island's properties and illustrated with the help of graphical visualizations. Due to its round-based principle, the game is deployable in synchronous game-based learning (e.g. in the classroom) as well as asynchronous game-based learning (e-learning). This greatly facilitates blended learning scenarios, e.g. in which four or five rounds are played together during class and the pupils then continue to play after class for a week, playing one new round per day. The game is then completed during class, after which the game-play is jointly discussed.

3.1 Production

Players must first design their goods. To this end, they specify the origin of the raw materials used during production, the production conditions, the means of transportation that are to be adopted, the recyclability of the good once it has been used, and, naturally, the price of the good. All of these factors influence the effects of the good in the game world. After a good has been developed, it can be assigned to a factory for production purposes. Players are able to build factories on each of the other islands in SuLi, influencing the local ecological, economic and social standards by virtue of the properties specified during the design of the good. Players are able to gain an income by selling goods and raw materials.

3.2 Consumption

While islands (players' virtual residencies) are primarily altered by the local production of goods, avatars change via consumption. Players must purchase goods in order to optimize their avatar's properties. By consuming goods, the avatar undergoes changes in terms of health, level of education and emotional well-being. Thus, for example, food is necessary for survival and newspapers boost education. Due to the use of non-renewable raw materials such as crude oil or metal, production conditions must sooner or later factor in sustainability and recycling. Otherwise, it is not possible for players to satisfy the demand for goods.

3.3 Simulation

Due to the fact that players are involved in production as well as consumption, they are exposed to game-theoretical conflicts [5]. In order to obtain the highest possible profit, ecological and social effects would have to be ignored during production. Additionally, the purchase of dumping-price products lets the consumer amass a greater amount of goods. However, when players exclusively consume goods produced with minimal consideration of social standards and maximal damage to the environment, this leads to a deterioration of the islands. This fact is made clear to all players from the onset of the game. The question is, to what degree do the other players consider ecological and social conditions when making their purchases?

In many cases it is necessary to use raw materials found on other islands. However, this boosts the wealth of the players residing there. As the transportation of raw materials has a direct bearing on the ecosystem in the game world, players are required to make a choice between personal profit and destruction of the game world.
A simulation calculating a cybernetic micro-world operates in the background of the game [6]. Individual actions have repercussions on the conditions of the game world and thus on all other players. The exploration of control loops and the ways in which they can be influenced constitute an essential part of the game [7][5]. Young people can thus experience the interdependencies of state, economy and ecology and increase their awareness of the scarcity of resources. The objective of the game, i.e. obtaining the best possible ratings for one's island as well as one's avatar, necessitates a certain amount of mutual cooperation. Otherwise, one's habitat is destroyed and nobody wins.
Players must consume and produce in between rounds. Production is an interactive process, during which the simulation immediately evaluates players' design decisions in terms of their ecological, social and economic effects. As in real life, this evaluation is a mere point of reference, as the actual repercussions also depend on the decisions of all other players in the system. The interactive manner in which game goods are designed is targeted at affording young people an insight into life cycle thinking and the parameters of sustainable product development.

4 ELEARNING AND GAME BASED LEARNING

The target group of the SuLi game are secondary school students. The concept of a simulation game was used to address this user group in a specific way. One of the most common arguments for adopting computer games in eLearning is that they can increase motivation considerably [8]. This is especially important in teaching about sustainable product design [3] because raising awareness and changing attitudes is more essential for this topic than learning simple facts. We also assume that simulation games can convey the problems and relationships in an ill-structured and complex domain like sustainable product design in a more effective way than other traditional forms of learning. These arguments might also be relevant for teaching sustainable product design to university students or other groups of adult learners.
Game Based Learning has become increasingly popular in recent years [9]. Nevertheless, many authors point out that there is still too little systematic and conclusive research in this area [7][10]. As mentioned above, one of the positive effects described most often is increasing motivation. Some results also indicate that cognitive abilities might be improved [7]. On the other hand, several difficulties have to be overcome when designing Game Based Learning [11]. Computer games are usually played because they are fun and not to reach any external goal. In contrast to that, learning always has an external goal (to learn some topic defined by a teacher). This contradiction is often difficult to overcome. Game designers often have to decide whether to make the game fun to play, but conveying little information, or highly informative, but boring to play. As far as the SuLi game is concerned, we have discussed several alternative concepts to overcome this problem. An evaluation study will probably indicate which alternative to use.
The SuLi game is based on the concept of exploratory learning [12]. We used Malone's [8] concepts of challenge, fantasy, curiosity, control and self-confidence in the development of the game. In an ongoing evaluation study, it will be tested whether this concept can be used effectively and whether students feel motivated by such a game. We used focus groups, a questionnaire, diaries and content analysis of chat protocols as

methods of investigation. Focus groups, diaries and content analysis are used to get detailed information about students' attitudes and the strategies they use when playing the game. The questionnaire aims at finding out what students learn when using the game. We are still analysing the outcome of this investigation. First results indicate that the game does foster thought processes in the students. They also interact intensively during the game, form coalitions and help each other about how to play the game effectively.

5 DEVELOPING AND TESTING OF A PROTOTYPE

In this project a concept for an educational Ecodesign game for schools and youth organisations is developed and tested. This comprises the analyses of the target group, the development of a methodology for the data generation, the creation of an ecological data matrix for selected products and the implementation of the prototype. The operational structure, the graphical design, the interaction and the technical frame will be designed for the game concept. At the end the evaluation of the concept in form of the prototype will take place at a high school in Vienna.

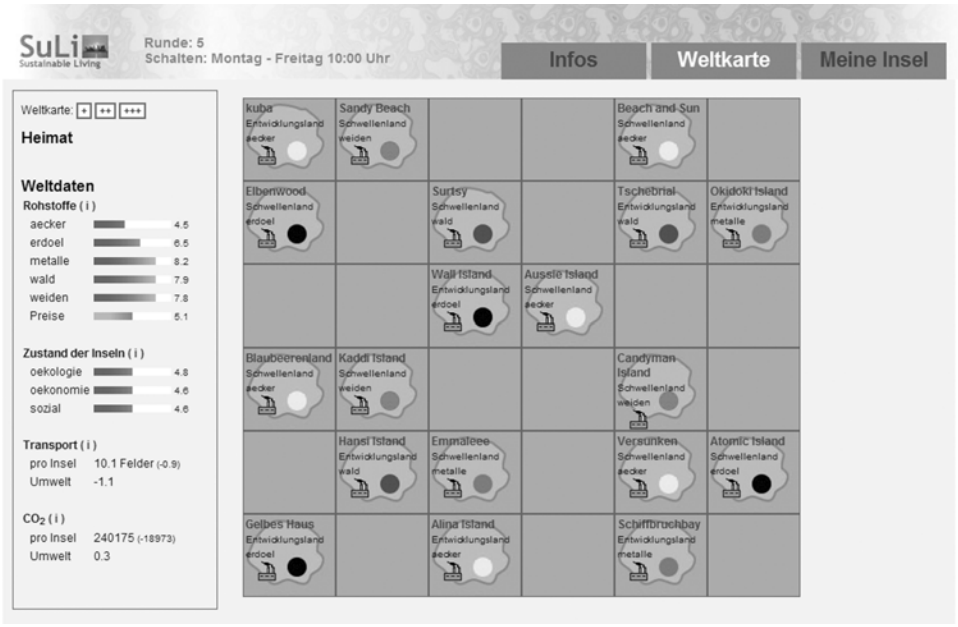

Figure 1 Screenshot of the World Map in the Prototype

We developed a functional prototype of SuLi (see Figure 1), which covers the core functionality, algorithm and circuits of the game. It is realized as web based game and the players only need a web browser to take part. We selected six products for production and consumption in the prototype. These products cover the change of all attributes of the avatar and also all materials existing in the game. For the final version more than twenty products are planned which can be extended easily. For testing, the game is run for six to twelve days with switching once a day. The screenshots show the game world of a test with a class of 18 pupils at the age of 16 years.

6 CONCLUSION

Trial runs have yielded very promising results thus far. It seems that it is indeed possible to playfully convey the relations between sustainability, product development and consumption. On the one hand, the game concept itself succeeds well and ensures a high degree of entertainment. On the other hand, the complexity of the underlying simulation invites players to immerse themselves in the subject matter. In order to achieve optimal results, it is strongly recommended that teachers supervise game play, as this supports the crucial transfer of the interactions experienced in the game into the real world. Thus, there is hope that young people will consume goods with greater awareness on the one hand, and, on the other hand, introduce sustainability into the design decisions arising in their later everyday work life.

REFERENCES

[1] Meadows, Donella, Meadows, Dennis, Randers J, *Grenzen des Wachstums - Das 30-Jahre-Update. Signal zum Kurswechsel*, Hirzel Verlag, Stuttgart, 2006

[2] Stern, N, *Stern Review: Stern Review on the Economics of Climate Change*, for the British Government, 2006

[3] Wimmer, Wolfgang; Züst, Rainer, *ECODESIGN PILOT, Product-Investigation, Learning- and Optimization-Tool for sustainable product development, with CD-ROM*. Dordrecht, The Netherlands: Kluwer Academic Publishers, 2002

[4] Wimmer, Wolfgang; Züst, Rainer; Lee, Kun-Mo, *ECODESIGN Implementation: A Systematic Guidance on Integrating Environmental Considerations into Product Development*, Springer Verlag, Dordrecht, 2006

[5] Salen, Katie; Zimmerman, Eric, *Rules of Play*, MIT-Press, 2003

[6] Wiener, Norbert, *Cybernetics: Or Control and Communication in the Animal and the Machine*, MIT Press, Massachusetts, 1961

[7] Akilli, G.K.: Games and Simulations: A New Approach in Education, in D. Gibson, C. Aldrich, M. Prensky (eds.) *Games and Simulations in Online Learning*. Hershey, London, Melbourne: Information Science Publishing, 2007, 1–20.

[8] Malone, T.W., *What Makes Things Fun to Learn: Heuristics for Designing Instructional Computer Games.* Palo Alto Research Center, Palo Alto, 1980.

[9] Prensky, M., *Digital Game-Based Learning.* St. Paul, Minnesota: Paragon House.

[10] Tennyson, R.D., Jorczak, R.L.: A Conceptual Framework for the Empirical Study of Instructional Games. H.F. O'Neill, R.S. Perez (eds.) *Computer Games and Team and Individual Learning*, Amsterdam, Boston, Heidelberg: Elsevier, 2008, 3–20.

[11] Kickmeier-Rust, M.D., Schwarz, D., Albert, D., Verpoorten, D., Castaigne, J.-L, Bopp, M.: The Elektra Project: Towards a New Learning Experience. *M3 – Interdisciplinary Aspects on Digital Media & Education*. Austrian Computer Society, 2006, 19–48.

[12] Bruner, J., The Act of Discovery Learning. *Harvard Educational Review*, 31, 1961, 21–32.

DI Dr Peter JUDMAIER
Institute for Engineering Design and
Logistics Engineering
Getreidemarkt 9
1060 Vienna
Austria
judmaier@ecodesign.at
+43 01 58801 30750