The Nemesis E-Learning 4-Sectors-Model
A Concept to Enhance the Reusability of E-Learning Products

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***Abstract*—The 4-Sectors-Model has been developed by the TU Berlin and is intended to facilitate providing customized e-learning products to different target learner groups, while keeping the same basic content. This is made possible by the independent development of user interface and content. The different components are assembled at the end to produce the final e-learning product.**

Software development is based on the Generative Learning Objects concept (UCeL).

Further improvements based on results of the ongoing test phase will make the 4-Sectors-Model better adapted to fit user needs. Finally, this project is dedicated to establishing a high standard of didactic quality for the future development of e-learning software at the TU Berlin.

***Index Terms*—Education, Software reusability**

I. Introduction

Founded at Technical University Berlin in 2005 as part of an effort to recycle e-learning material, Project Nemesis has been researching the sustainable use of new media in the classroom. One subproject being worked on currently is the reuse of existing learning designs, or of ones currently under development. In this case, the main concentration of the research is on the development of the 4-Sectors-Model, which will facilitate the partial or full reutilization of existing e-learning products. This will greatly moderate the effort of adapting e-learning products for other target learner groups, provided that certain steps were taken during their development. These conditions will be further described in the course of this article.

The dilemma currently facing the development of e-learning software, is deciding between two different production strategies. On the one hand, in order for didactic material to be reusable, it must be rudimentary and practically context-free. This provides for a relatively efficient recycling process, avoiding the need to start again from scratch. On the other hand, quality e-learning products are renowned for their context-specific learning framework, which boost product acceptance and learner success.

The 4-Sectors-Model offers a possible solution to this dilemma. It provides a four-tier architectural framework for the production of e-learning products: content, user interface, Learning Design and a software framework. The overall project leadership is taken on by an organizational team. Content and user interface are developed in their respective sections, and the software framework section is responsible for conceiving a functional programming architecture that will bring the different sections together in an end product.

II. Related projects

No project comparable to the 4-Sectors-Model could be found in current literature. Nevertheless, a concept developed by UCeL called Generative Learning Objects (GLOs), has had a considerable influence on the direction taken by the 4-Sectors-Model.

GLOs consist of two basic ingredients: learning design and subject specific content. The creation of a Learning Object follows two steps. First, a specific learning design template is developed (without data, specific concepts or examples) and then in a second step, subject specific content is added (including data, concepts and examples).

A Generative Learning Object Template is created in a workshop by a group of experts and students with the help of a facilitator. The facilitator assures that no specific content, terminology or examples end up in the GLO Template.

The addition of subject specific content to the GLO Templates takes place with the help of computer software. The Learning Object Templates are used to generate web-based forms, which facilitate the input of subject specific content by the tutors and students.

A final Learning Object results when subject specific content is added to a Learning Object Template.

The quality control of both steps is assured by a peer review process (Figure 1).

The quality of the content added to the Learning Object Template is assured by a preliminary peer review process. A second review process takes place after completion of the Learning Object to test usability and overall specifications.

The preliminary results and the Learning Object are stored in a database (Figure 2).

The reusability of the Learning Object Template, the subject specific content and the final Learning Objects is assured by separate data-storage of all results. This also gives way to the possibility of easily creating new Learning Objects for different purposes using elements from the individually stored databases.

III. The 4-Sectors-Model

The 4-Sectors-Model is an organizational model for the development of e-learning products.

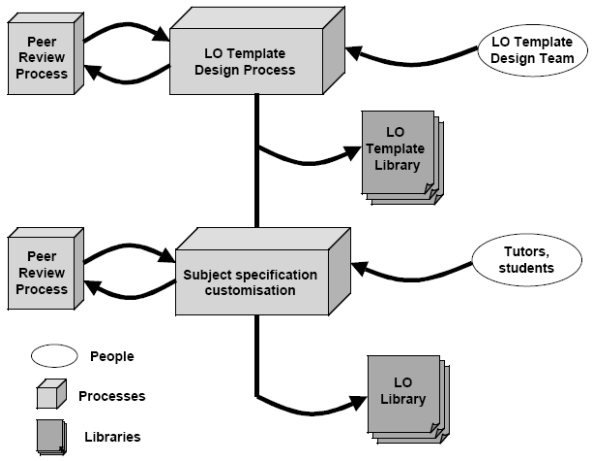

Figure 1. Building of GLOs. This figure shows the people involved in different processes and the libraries created at different stages

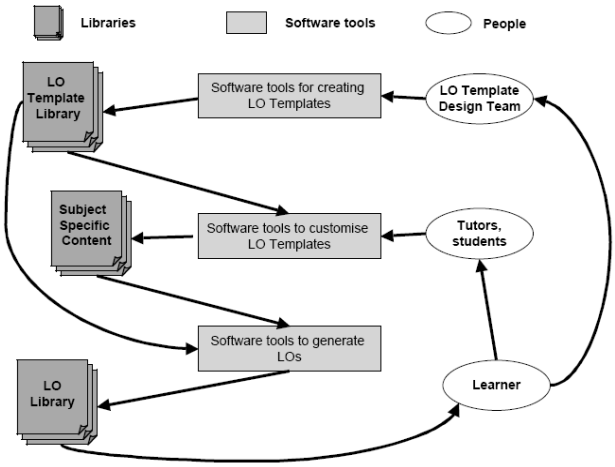

Figure 2. Production of GLOs. This figure shows the people involved, the software tools used and the libraries created at different stages

The concept behind the 4-Sectors-Model is the separation of content and surface instantiation (user interface) of e-learning products. Both aspects are treated separately in the development stages, and then combined in the end phase with specific pedagogical goals in mind.

Figure 3 illustrates the 4-Sectors-Model. The heart of the 4-Sectors-Model is the Learning Design. Defined here, are the guidelines for target learner group adapted e-learning products. Inspired by Generative Learning Objects, the Learning Design is also the coordinating body of the 4-Sectors-Model. In other words, it is the conceptual framework behind an e-learning product. It is separate from the actual substance; subject specific content and user interface are completed individually in their respective sectors.

The Learning Design presents a strictly conceptual guideline, whereas the actual software framework serves several functions. It is comprised of a software core and makes it possible to keep an overview of the various development stages involved in both the content and user interface sectors.

A. Development of an e-learning product

The 4-Sectors-Model provides four pools for the safeguarding of results from each sector. The first encompasses the conceptual data developed in the Learning Design sector. The second pool holds the content, the third holds the user interface and finally the fourth contains the software framework. A separation of the core content and the surface content in different pools permits a more efficient production and maximizes the reusability of e-learning products.

Overall project leadership and quality control proceeds parallel to the production process. Quality control is assured by an objective outside peer-review process.

Five basic steps need to be followed to effectively apply the 4-Sectors-Model to the development of an e-learning product, from its initial conception to its final release. The next section deals with theses steps.

1) Initial project conception

A project begins, when a client comes forward with an

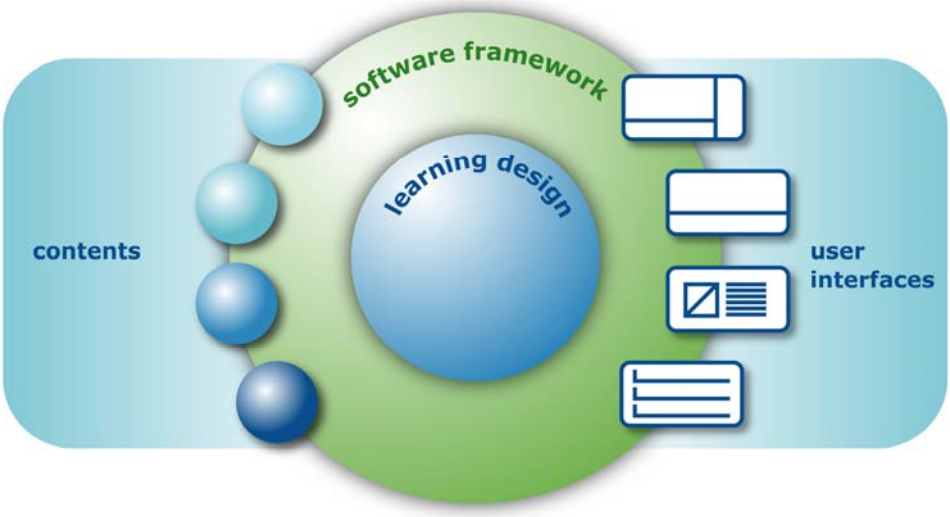

Figure 3. The 4-Sectors-Model

idea that requires and e-learning solution. If necessary the idea will be further developed with the aid of tutors/teachers. This phase takes place in the bounds of the Learning Design Sector. Purely a consulting phase, it is meant to fully explore the client's needs and help translate them into a feasible product concept.

2) Concept development

In the next step, a product concept is developed from the client's original idea. The Product Concept Pool serves as a first resort, in the case that a similar concept already exists. If an appropriate concept is found, it must be established to what extent it can be used to fulfill the current client's wishes. In this case, relevant components are taken on as is and others are modified to suit the project's needs.

If no appropriate concept is found in the Product Concept Pool, it is necessary to create a new Learning Design.

Finally, either the adapted concept or the newly developed one is added to the Product Concept Pool.

3) Setting goals

Once a general concept for the product has been established, the next step is to define the specific requirements for the content, user interface and software framework sectors. Although this is still part of the Learning Design process, at this point it will be necessary to consult with the other sectors in order to successfully take all design constraints into account. Furthermore, the content, user interface and software framework sectors will take existing modules into consideration for possible reuse.

If a pre-existing concept is to be adopted as the foundation for the development of a new product, requirements for further development will be

- maintained, if the basic concept is unchanged,
- amended, if the basic concept has been modified,
- elaborated anew, if the adopted concept doesn't specify any related requirements.

The result is a complete list of content, user interface and software framework requirements ready to be integrated into the Learning Design and deposited into the Product Concept Pool.

The first three steps are all taken on by staff in the Learning Design sector, but their job does not end there. As project development continues, they are responsible for keeping sight of the project goals set by the client. They are also available for further consultation during the remainder of the development stages.

4) Realizing goals

Now the goals set in the preliminary development are implemented in the content, user interface and software framework sectors.

At this point, if an existing concept is being used, the required product components are brought to the respective Sector Pools and adapted if necessary. If no adequate concept is available, the development of new components is needed. All final components, adapted or new, are added to the respective product pools (content, user interface, software framework) for future reuse.

Although all components are developed parallel, work on the software framework must be speeded up in relation to the project as a whole. It is important that the user interface and content sectors be able to integrate their designs into the interface created by the software framework sector. As they are responsible for the overall coordination and progress of the project, the Learning Design specialists oversee this stage of development closely, and are open to questions and suggestions. Furthermore, they are responsible for the overall coherence and flawless joint functionality of all sectors. Although the interface between the software framework, the user interface and the content should be clearly defined, ambiguities are possible. This could lead to small refinements in the interface being necessary, but changes ought to be kept to a minimum. In the event that changes should be made, they must be announced to all sectors.

There is no predefined development procedure in the 4-Sectors-Model. Each of the sectors responsible for user interface, content and software framework is free to work in the manner they see fit. The 4-Sectors-Model proposes, implements and enhances development strategies for e-learning products.

This leaves the door open for different development strategies, given the specific challenges in each sector.

This makes the collaboration of specialists with little or no experience with the 4-Sectors-Model possible. It can't be expected of them to be familiar with software development techniques. This being said, they must be provided with interface specific tools and formal guidelines in order for them to complete the content design effectively. Or, they must be free to work with familiar word processing programs which enable an easy integration into the exiting software framework. Consequently, this stage of development has to be supported at one point or another by software specialists. They would be required to either aid the content design team or to integrate material prepared on anther platform.

The surface design (user interface) is required to be usability oriented. Therefore, experienced graphic and digital media design specialists already familiar with the 4-Sectors-Model are essential. Because the software engineering will be taken on by a team of experienced programmers, the need for external software specialists is not expected.

All other sectors depend on the efficient development of the software framework. This framework serves as a processing unit, allowing intervention through key interface points integrated into its design. Such a design will be based mainly on classical software development strategies, calling for a permanent staff of software designers and programmers in this sector.

5) Product assembly

Finally, all product components are assembled into the final e-learning product. The required components are called up from the content, user interface and software framework databases and combined in the finished product, which is then stored in the product database.

Figure 4 illustrates the five steps involved in the process described above.

B. Process management

An organizational team oversees the entire development process. If required, they can call for the revision or repetition of any step of the development. This may become necessary, if the external quality control points toward inadequacies in the production process. The

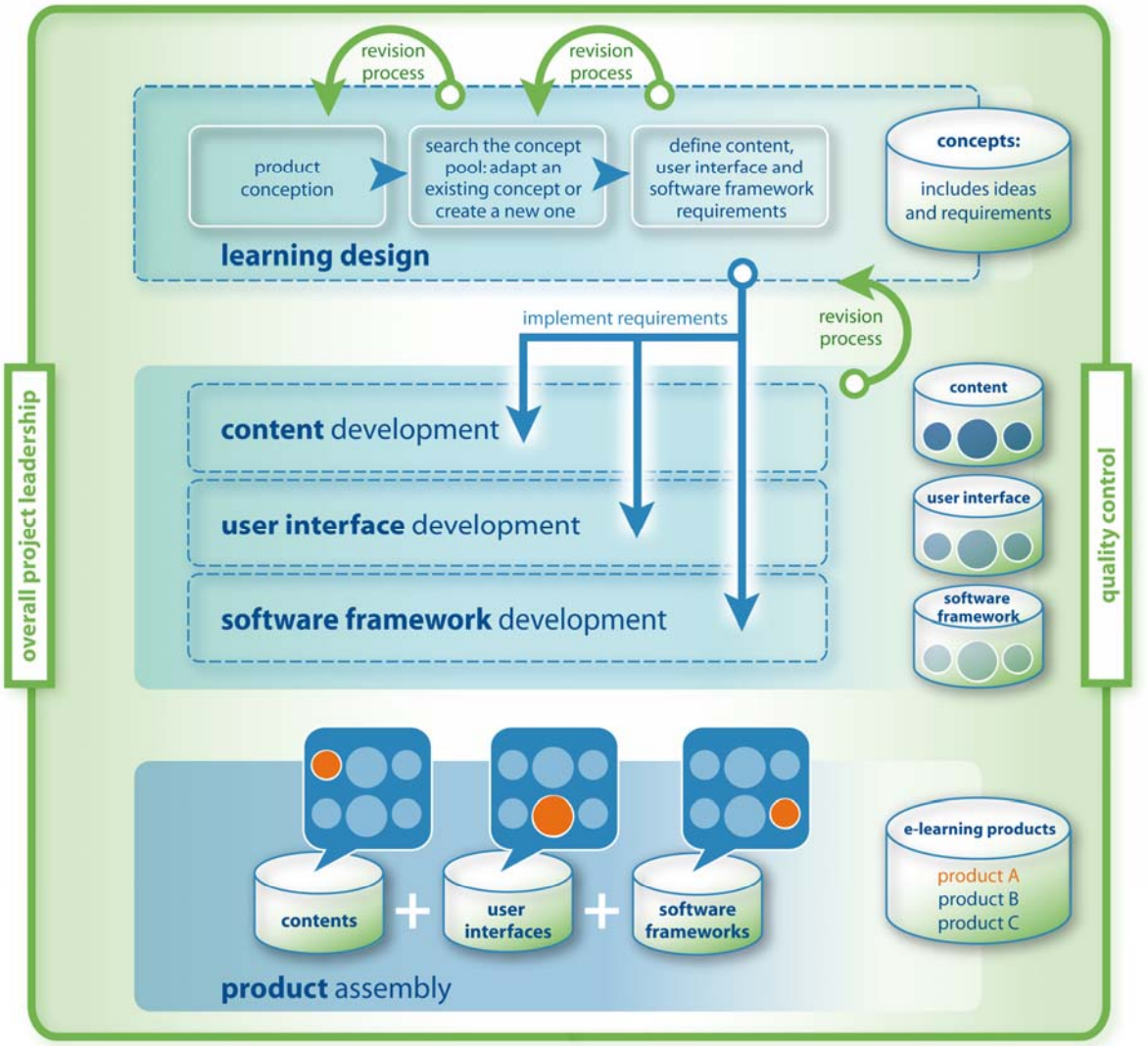

Figure 4. The 4-Sectors-Model development process

organizational team is authorized to call for any modifications to components, at any stage of development, even if it means completely revamping a finished design. If a conflict arises, it may be necessary return to a previous step in the development process. If the product idea is put into question, care must be taken not to lose sight of the client's wishes. In the case that no suitable solution is found, the project may be abandoned.

C. Standards and guidelines

The 4-Sector-Model proposes basic specifications and various standards for the development of e-learning products. These are to ensure that a final product can be easily assembled from the various components developed in each of the sectors.

The following PAS and SCROM [1] standards will be implemented to each of the five steps involved in the development process, as well as to the description of learning scenarios and the use of metadata: PAS 1032-1 [3], PAS 1032-2 [4] as well as IMS-CP [6] and LOM [5]. Tools to assure adherence to the said standards will be required, but it still needs to be determined if existing products can be used to this effect, or if new tools need to be developed.

Main goals are firstly keeping it simple, and secondly not letting technology get in the way of the easiest possible solution. Keeping to these principles will probably prove more difficult than anticipated, unless it is assured by an outside quality control process, which is already being planned.

D. Outlook

Until now, no experience has been gathered in applying the 4-Sectors-Model to an actual e-learning product development, but its application is intended in the course of project Nemesis. Preliminary results will be used to make further improvements to the model.

In relation to the reuse of product components under the 4-Sector-Model, it is to be expected that:

- mostly new product development will be necessary at first, in order to fill the databases with reusable components,
- with the progressive growth of the databases, the reusability rate of individual components (Learning Design, content, software framework and user interface) will increase significantly, requiring only small adjustments to existing material, thus creating new versions,

- eventually, with a varied palette of available e-learning products at our disposal, the reusability of finished products as well as individual components will be increased.

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