

# Developing a Sustainable Educational Portal for the D-Grid Community

Viktor Achter, Sebastian Breuers, Marc Seifert, and Ulrich Lang, Joachim Götze, Bernd Reuther, and Paul Müller

**Abstract**—Within the last years, several technologies have been developed to help building e-learning portals. Most of them follow approaches that deliver a vast amount of functionalities, suitable for class-like learning. The SuGI project, as part of the D-Grid (funded by the BMBF), targets on delivering a highly scalable and sustainable learning solution to provide materials (e.g. learning modules, training systems, webcasts, tutorials, etc.) containing knowledge about Grid computing to the D-Grid community. In this article, the process of the development of an e-learning portal focused on the requirements of this special user group is described. Furthermore, it deals with the conceptual and technical design of an e-learning portal, addressing the special needs of heterogeneous target groups. The main focus lies on the quality management of the software development process, Web templates for uploading new contents, the rich search and filter functionalities which will be described from a conceptual as well as a technical point of view. Specifically, it points out best practices as well as concepts to provide a sustainable solution to a relatively unknown and highly heterogeneous community.

**Keywords**—D-Grid, e-learning, e-science, Grid computing, SuGI.

## I. INTRODUCTION

**S**UGI (Sustainable Grid Infrastructures) is a project of the German Grid Initiative (D-Grid)<sup>1</sup> [1], which is a joint initiative of research and industry partners started in September 2005. Its goal is the development of a distributed, integrated resource platform for high-performance computing and related services to enable the processing of large amounts of scientific data. The major task of the SuGI project is to disseminate the knowledge of Grid technology [2], [3] and to enhance its use. Therefore, SuGI addresses all academic computing centers as well as enterprises, which still have not adopted Grid technologies. They will be supported in providing Grid resources and services. During the project, research results and technological experiences gained in the D-Grid projects will be made available to the intended audience ranging from experts of Grid computing over organizers of Grid workshops to users of Grid technology.

SuGI uses two approaches to introduce new users to Grid computing: a portal<sup>2</sup> that gives theoretical background, and

training systems that provide practical experience with real Grid middleware. Thus, SuGI offers training courses, makes video and audio recordings of external courses available, and provides training systems to allow administrators and users to try out basic configuration steps within a Grid middleware. All this is made available to the Grid community via a scaling training infrastructure. This article deals with the conceptual and technical design of an e-learning portal for Grid computing and Grid technologies, addressing the special needs of heterogeneous target groups<sup>3</sup>. The focus of this paper is directed to the quality management<sup>4</sup> of the software development process, Web templates for uploading new contents and the implemented search and filter functionalities. The following section will give a short survey at the framework of the SuGI Project. The conceptual design of the e-learning portal is described emphasizing the process of quality management and its implementation in particular. Further, important technical aspects will be mentioned. Section III. and IV. are dedicated to a more in-depth description of two important features of the portal: the Web template for uploading new contents and the search and filter functionalities to access existing contents. The paper will be concluded by a short survey and outlook

## II. DEVELOPMENT OF AN E-LEARNING PORTAL FOR GRID TECHNOLOGIES

The construction of a sustainable and scalable e-learning platform for the D-Grid poses several challenges to the conceptual phase. Within the Grid community, many heterogeneous groups are combined with varying amounts of employees and differing roles assigned to them. Many aspects concerning the overall effort of usage have to be taken into account. First of all, the process of deploying contents has to be as easy as possible because especially small and medium sized computing centers have very limited resources. Therefore, the overall cost of producing and deploying

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<sup>3</sup> Cf. <http://portal.sugi.uni-koeln.de/en/about-sugi/zielgruppen.html>

<sup>4</sup> Within this paper, the term 'quality assurance' refers to processes directed to ensure a stable quality level, while the term 'quality management' – often also referred to as 'quality enhancement' – refers to processes directed to improve the level of quality.

<sup>1</sup> The German Grid Initiative (D-Grid) is funded by the German Federal Ministry of Education and Research (BMBF)

<sup>2</sup> <http://sugi.d-grid.de>

learning contents must not be higher than the cost of organizing in-class workshops and trainings. Secondly, most D-Grid users are employed and engaged in several projects and activities and, therefore, do not have the time to attend to a lot of in-class trainings. This includes, that the obstacles of accessing the learning contents must be as small as possible. Although, there are several e-learning platforms on the market, most of them provide vast amounts of functionality<sup>5</sup>, that is not needed in this case and thus, complicate the procedure to access the contents, the users intend to use the system for. Thirdly, the solution must not produce high maintenance costs. Solutions, demanding operators to monitor and actively work on the portal to assure the trouble-free operation are likely to fail within this environment. Fourthly, while common learning management systems aiming at a high level of interaction between tutors and learners, the SuGI portal tends to avoid this kind of activity or at least, reduce it to a minimum. And last but not least, the solution must be integrated easily into the existing D-Grid infrastructure. The SuGI project has taken all these as well as further aspects into account and developed a lean e-learning portal. The complex process of conceptual design as well as implementation will be described in the following sections.

#### A. *Conceptional Design of the Portal*

Since the beginning of software development, processes related to software development and especially their implementations turn out to be an extraordinary challenge. This is documented e.g. in the Chaos Report [4], surveyed and published biennially by the Standish Group. According to this report, at least a quarter of all IT projects do not achieve their goals. In contrast to many projects of other branches, software development processes usually build innovative projects [5], marked by a high risk level. This is furthermore determined by future events or developments. Usually, there are only few experiences to deviate proven procedure recommendations. The development of an e-learning portal is not an exception to this difficulty. In contrast, multiple dependencies of external influences come along, which are hard to control and thus, bear high risks. Additionally, requirements are not defined by well-known procedures or distinct groups of users. This makes a cogent review of requirements very difficult.

As a result, development processes of a portal need to coincide with a regularly adapted and verified project control. Thus, a thorough analysis of external and internal factors is necessary at the beginning. Within this context, restrictions of resources, geographically distributed project partners as well as related communicative restrictions and target groups need to be mentioned. The target group of a portal usually consists of at least one large community composed of different individuals with diverse taste, level of education, and experiences. As shown in the following sections, this makes the conceptual design of a portal a difficult challenge. In case of the SuGI portal not only one but several differing target

groups are addressed which highly complicates the process of orientation towards the requirements of the specific target groups.

An important aspect to increase quality and consequently also sustainability of e-learning portals consists of tasks in the field of quality assurance and quality management. According to BIAS ET AL. [6], comprehension cumulatively prevails, that a consistent implementation of quality management will measurably improve the quality, reduce long-term costs and achieve innovations by higher motivation of employees. In the field of information processing, methods of quality management have been used for many years. During recent times, such a necessity has also been recognized for the fields of education as well as formal and informal advanced training. Among others, this has led to sustainable changes in schools and universities in the EU (e.g. evaluation, accreditation, and certification of degree programs, faculties or departments as well as extracurricular further education programs).

This has various consequences for the portal developed by SuGI to enable e-learning as a component of a sustainable infrastructure for e-science and e-business in the field of Grid technologies. Besides strategic and conceptual design as well as implementation, the evaluation to assess wishes and satisfaction of our target groups enabling a continuous improvement of all offered services play an important role in the development process (cf. [7], [8], [6], [9]). According to the above mentioned aspects, this does not only include work results like the portal itself, but also makes all structures and processes of conceptual design, implementation, and evaluation as explicit and transparent as possible.

Theoretical aspects of quality assurance and quality management play a superior role in the development of the SuGI portal and shall be explained here in more detail. According to GAISER AND WERNER [10, p.24], it is not possible to construct a fully developed product in the field of educational portals. Because of the constantly changing contents as well as rising demand for more functionality, the use of cyclic process models is indispensable. Furthermore, this approach enables the development starting from an initial version, and resulting in a complex portal by taking prerequisites, requirements, and wishes of users into account. Additionally, it is possible to react on new technical and functional requirements arising during the development process.

Educational or e-learning portals like the SuGI portal are particular forms of portals [11, p.326]. Thus, they are electronic customer interfaces in the Internet enabling the customers to access learning contents, information and educational surplus services (e.g. communities and tele-tutoring). They provide a web front-end for content management systems and knowledge databases.

GAISER AND WERNER [10] describe a generic and iterative quality management approach for the development of educational portal solutions, which is geared to superordinated products underlying the developing process [10, p.23]. This perceives the development of a portal as a multi-stage process which can be run through iteratively as well as in several loops (generation). Such a process usually consists of (1) conceptual design, (2) implementation of a prototype, and (3)

<sup>5</sup> Typical features of learning management systems (LMS) are e.g. key memories, calendar and examination management, groupware functionalities etc.

operation of a portal version [10, p.23]. For the development of the SuGI portal, these steps have not only been taken into account, but have also been made transparent and published in a strategy paper (D1.1) [15]. Such a methodological approach, which is clearly different from the development of common software products seemed to be necessary because Web systems – in contrast to traditional software products – are marked by a continuous change of information contents on the one hand and by a steady growth of requirements and desired functionality on the other hand [10, p.15].

A dialogue with the users of an e-learning portal forms an important part of the quality management. To include the users as much as possible into the product design and development has e.g. also been claimed by [12] and [13]. AMBERG ET AL. [14] support a repeatable, comprehensible and documented procedure ensuring a reproducible and quality assured development.

Some central aspects for the development of e-learning portals result out of the above reviewed approaches: development of a portal strategy, formulation of a catalogue of specifications, an educational as well as technical portal concept, implementation (committed by different steps of quality management), introduction and further development (evolution) of the portal, identification of target groups which may be settled beyond institutional borders, and an iterative character of the development process [10, p.16] and [15].

This leads to a development process, designed as an evolutionary phase or generation model and supported by quality assurance and quality management such that the development process is influenced by the evaluation results as proposed by [10]. As a result, the evaluation results are used more efficiently, and permit a scientifically well-founded portal design.

### B. Implementation and Quality Management

The requirements described above and the resulting guidelines for the implementation coincide to a large extent with the strategy for the development of the SuGI portal: the SuGI portal was developed in a multilevel generation model mapping the above described process of quality management in order to enable a scalable training infrastructure, which repeatedly adapts during the funding period and beyond to the requirements of the target groups. Additionally, reactions to changing target groups and requirements are always possible.

To face such challenges, generational or evolutionary development models are suited to a particular extent: they follow a prototypical approach using procedural methods of change management [16]. Fig. 1, as an excerpt of [5], describes a simple model consisting of three steps, which serves as a basis for the iterative process of adaptation of innovative software products. It shows a cycle controlled by feedback, transferring the product from one stable state of development (generation) to another.

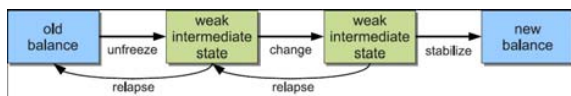


Fig. 1 Three-steps Model of the Dynamics of Change Processes

Accordingly, a *modus operandi* is applied to shift the product in transitional stages (prototypes) in short iterations enabling the users to compare their ideas with the incarnation of the portal to gain an impression whether his conception of a well-designed product has been achieved. In this process, evaluation helps to enter a dialogue with the users and let the users' ideas influence the development process. On the other side, evaluation serves as an incentive for the developers to critically reflect especially about the process of designing and implementing the portal.

Thus, the work for each generation can be roughly divided into the following steps:

- **Specification Analysis:**

Specification analysis works as a base of the proceeding developments. User requirements need to be substantiated to achieve the defined goals. As mentioned above, this process turns out to be very decisive for the portal development because a large amount of users with very heterogeneous interests and qualifications need to be taken into account. Within the SuGI project, internal case studies have been investigated, open as well as closed surveys have been performed, and user feedbacks as well as reviews have been requested.

- **Design / Concept:**

In this step, the different stages of design are traversed. Any executed changes need to be compliant and capable of being integrated to past developments. A future integration of the SuGI portal into the external structure of the portal of the German Grid Initiative (D-Grid) also has to be taken into account. In a further step, design specifications need to be divided into small work packages and – after an effort estimation – distributed to internal developer groups.

- **Implementation:**

Favorably, implementation takes place in small groups (units of organization), which are able to communicate among each other without great efforts. These are usually groups geographically related close to each other. Unit-internal as well as unit-spanning communication / coordination is organized with groupware tools (e.g. Microsoft Sharepoint) as well as versioning tools (SubVersion) and ticket systems (OTRS). For developing new generations, a highly decoupled development system is used. All steps are supported by phases of group internal brainstorming and reflection processes.

- **Release:**

Following an internal quality management process including internal feedback about the scale of achieved goals, the newly developed generation of the portal will be released.

- **Feedback:**

At the end of each development cycle, surveys are organized on the newly released version. These include directed reviews by selected members of the target groups as well as online polls and simple feedback possibilities integrated into the portal. At the same

time, round table discussions are held at events like developer or user (in-class) workshops of different D-Grid communities to identify the participants' experiences using the SuGI portal.

By this course of action, it becomes possible to verify prototypically in short and regular intervals, which of the implemented aspects or functions satisfy the users' demands and which do not. Thus, erroneous trends within the project may be recognized and cleared in an early state which leads to a resource-friendly development. The generation model of the SuGI portal, as it will be sketched below, has been developed out of these premises.

The SuGI portal is planned in three generations<sup>6</sup> (cf. Fig. 3):

*Generation 0* has been created short-termly to provide a foundation for the SuGI portal allowing an early publication of contents and e-learning materials created so far. Contents have been statically integrated into the content management system. An editorial office has been established. Design studies have been undertaken as well as investigations about features favored by users (like RSS feeds). Further, early provisioning ensured the identification and solution of integration problems. The gained knowledge is integrated into the following generations in order to ensure steady improvement. Generation 0 has been released during the first quarter of 2008. To evaluate this generation, round table discussion at in-class trainings have been used as well as detailed reviews by selected test users.

*Generation 1* included the expected functionality to a nearly complete extent and introduced multiple planned measures to enhance the users' experience, e.g. an extended full text search and filter functions. Display of contents has been changed to dynamic database requests. All contents are described with metadata. Features, requested by users, like printing functions, RSS feeds, document libraries etc. have been implemented. Additionally, templates (for the purpose to test) have been created for an easy integration and representation of records and modules. Further, different approaches of constructivist learning theories have been implemented and evaluated contextualization, linking of knowledge, projects etc., standardization). Generation 1 has been released in September 2008. A new design concept has been introduced. A comprehensive evaluation has been made.

*Generation 2* will also be created implying the experience of user feedbacks from previous generations and containing refined structures and functionality. Furthermore, sustainability will play an important role, such that functionality will be introduced enabling provisioning of new contents by specially selected user groups. Additionally, a core community will be established. Generation 2 is scheduled for the third quarter of 2009.

Fig. 2 shows a graphical illustration of the iterative and evolutionary development approach of the SuGI e-learning portal.

<sup>6</sup> Intermediate generations have temporarily been inserted to react more flexible and temporarily closer to the evaluation results and the users' demands.

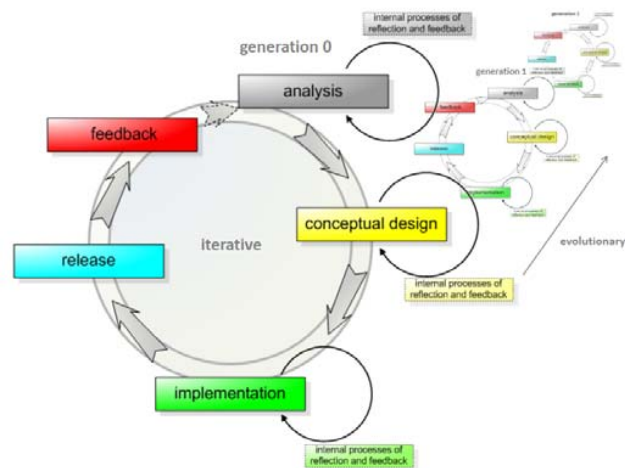


Fig. 2 Graphical Illustration of the Iterative and Evolutionary development Approach of the SuGI Portal

### C. Technical Aspects of the SuGI Portal

From a technical point of view, the SuGI portal is based on a Typo3<sup>7</sup> content management system (CMS) implementing a target group oriented front-end running on a virtualized Apache web server<sup>8</sup>. The CMS follows a plug-in / module approach to extend its functionality to the users' needs. All contents including metadata are organized in a MySQL<sup>9</sup> database which is not part of the Typo3 database and dynamically requested to gain more flexibility during the development process. Multimedia content is stored on a SAN storage solution<sup>10</sup>. Common features like a bilingual frontend, RSS<sup>11</sup> feeds, a news area, and feedback possibilities are implemented by open source Typo3 extensions or common typoscript functions. For displaying the contents layout by cascading style sheets (CSS)<sup>12</sup> as well as to ensure some further functionality, a new extension has been written in PHP<sup>13</sup>. This extension connects the Typo3 CMS with the content database and offers an interface to connect to the indexed search engine. This solution has been chosen in order to allow for migration of the whole system without the need to install and configure many extensions. As far as possible, only standardized open source components have been used which keep the system easy, resource-friendly and license free. Via the web front-end, the target groups are offered not only access to e-learning contents produced internally or externally. The possibility is given to upload e-learning contents and store (and archive) contents of in-house trainings, and to make these contents repeatedly retrievable. All contents can be published open-access and thus, presented to a greater public. Several Grid communities are introduced in a more detailed way supplementing the portal by demonstrative descriptions

<sup>7</sup> <http://typo3.org/>

<sup>8</sup> <http://www.apache.org/>

<sup>9</sup> <http://www.mysql.com/>

<sup>10</sup> [http://en.wikipedia.org/wiki/Storage\\_area\\_network](http://en.wikipedia.org/wiki/Storage_area_network)

<sup>11</sup> <http://en.wikipedia.org/wiki/RSS>

<sup>12</sup> <http://www.w3.org/TR/CSS2/>

<sup>13</sup> <http://www.php.net>

of their workflows as well as providing the user with deeper insights of the use of Grid technologies.



Fig. 3 Screenshot of the current Generation 1.5 of the SuGI Portal

Two features are of such high importance for the SuGI portal, that they shall be described in more detail in the following sections. These are the Web template for uploading new contents on the one hand as well as the search and filter functionalities on the other hand. Both features form direct customer interfaces. Their usability seems to be crucial for the sustainability and thus, for the success of the portal in general. The process of uploading new contents needs to be as easy and resource-friendly as possible to encourage scientists and institutions to contribute as many contents as possible. However, there are several conditions related to the description of a content element by metadata which need to be fulfilled to ensure a high quality and accessibility of the contents as well as to meet e-learning standards like learning object metadata (LOM)<sup>14</sup>. Access to the provided contents is to a large extent related to the typification of a user or to the target group the user belongs to. In contrast to common learning management systems, the SuGI portal does not map full curricula. Further, the provided contents map the full range of thematic fields related to Grid computing, spanning from technical (e.g. installation and configuration of a specific Grid middleware) to safety (e.g. certificates, monitoring etc.) and social (licenses, legal problems, sustainability etc.) aspects. The provided contents cover different levels of difficulty and detailedness on a pedagogical level as well as different types of media (video recordings of talks, instructional films, virtualized training systems, learning modules, text documents etc.) and file formats on a technical level. Therefore, access functionalities like full-text search and

filter need not only to reflect this diversity of the contents but should be able to handle it to enable the user a fast and easy access to the contents of interest.

### III. A WEB TEMPLATE FOR UPLOADING NEW MULTIMEDIA AND E-LEARNING CONTENTS

One of the main goals of the SuGI portal is to provide a platform for people who want to contribute e-learning contents about Grid technologies and Grid computing to the global Grid community. Thus, the SuGI portal provides an interface between people who are interested in learning more about Grid issues and those who have already acquired the knowledge and can provide information. The upload template addresses the second group, those who can and are willing to provide information. It is intended to facilitate the publishing of contents which means to upload a file or a file collection and enrich this upload with metadata to generate a content element.

Several techniques have been used to generate an attractive solution for providing contents to the users. The provided user interface is based on a plug-in for the CMS. The input form described in this paragraph, guides the user through the process of providing metadata and uploading files or file collections. Every field is wrapped in a 'DIV' element which has a unique identifier. This form can, therefore, be laid out via a suitable CSS.

Some dynamic aspects had to be implemented to support users filling in metadata describing their contents more precisely. These dynamic parts can be separated into two categories: (a) modifications of the user interface according to changes based on user input or interaction and (b) communications with the underlying database to provide information to the user about existing entries in the database or to insert new elements into the database. Category (a) is implemented with JavaScript<sup>15</sup> functions that parse the document provided in the Document Object Model (DOM)<sup>16</sup> of the JavaScript language. Many of these implemented functions are clustered in objects which are supported by the prototype concept of JavaScript. Aspects concerning category (b) are implemented using Asynchronous JavaScript and XML (AJAX)<sup>17, 18</sup>. In Typo3, a plug-in exists which integrates access to AJAX functionality in Typo3<sup>19</sup>.

To facilitate the users' understanding of the interface, a simple description of the input value that they are requested to write into a field is given to them (cf. fig. 4). This mechanism is implemented by using the ONMOUSE\*-event handlers of JavaScript. On moving the cursor into the 'DIV' element of a field ('ONMOUSEOVER') the text of the description text area is set. This is done according to the description that is stored in the title attribute of that 'DIV' element. By moving the mouse away, that text area is cleared ('ONMOUSEOUT').

<sup>15</sup> <https://developer.mozilla.org/en/javascript>

<sup>16</sup> <http://www.w3.org/DOM/>

<sup>17</sup> [http://en.wikipedia.org/wiki/Ajax\\_\(programming\)](http://en.wikipedia.org/wiki/Ajax_(programming))

<sup>18</sup> [http://en.wikipedia.org/wiki/Ajax\\_framework](http://en.wikipedia.org/wiki/Ajax_framework)

<sup>19</sup> <http://typo3.org/extensions/repository/view/xajax/current/>

<sup>14</sup> [http://ltsc.ieee.org/wg12/files/LOM\\_1484\\_12\\_1\\_v1\\_Final\\_Draft.pdf](http://ltsc.ieee.org/wg12/files/LOM_1484_12_1_v1_Final_Draft.pdf)



> Training Contents > Upload

Here you can input a semicolon separated list of authors who contributed to your content.

Author \*:

Title \*:

Subtitle :

Language \*:

Grid project :

SuGI affiliation \*: ☐ yes ☒ no

Fig. 4 Description of Areas of the Upload Form

The information whether a field is mandatory or not, is marked by a color code implemented with CSS. Which metadata is needed for a content element depends on the media type. As a direct consequence, the style of a label marking it as mandatory has to be changed when the type of media is changed in the input mask. This is implemented by using the ONCHANGE handler of the selection box as initializer. To change the label, the style property of its container is overwritten and set to 'optional'.

The user's input is also supported by suggestions which are made according to queries on the already described knowledge database via a dropdown box on text fields. These dropdown boxes are further 'DIV' elements which are filled with text elements. The content of these text elements is provided by an AJAX request which queries the database according to the users' input on every single keypressing event. On selecting one of these elements, the text is filled into the text field.

If an entry according to the users' input could not be found in the database, an input mask appears, which structures the input according to the requirements of the database fields. The visibility property for this new form – again a 'DIV' structure element – is modified according to the users' input. This subform submits its contents via an AJAX request to the Typo3 plug-in. The input is checked according to its integrity and then inserted into the database. This newly generated sub entry will then be available in the dropdown element.

This input form is like a new window that pops up in the browser with the slight difference that this is a real HTML<sup>20</sup> element. It is part of the page and forces the user to take care of it. On appearance, the rest of this input form is faded out by a semi transparent layer as pointed out in Fig. 5. The input layer is enriched with some event handlers, which enable the closing of the layer via pressing 'ESC' and moving around with the mouse to preserve the intuitive interaction with this element as known by the user from the window concept of window managers.

Please create a new author:

Name \*:

Surname \*:

Institution :

Contact :

Close Submit

Fig. 5 Layer for Inserting New Authors

#### IV. SEARCH AND FILTER FUNCTIONALITIES

Enabling comprehensive access to the provided information and knowledge is one of the most important tasks of an e-learning portal. Within the SuGI portal, this is realized by a category based access via the menu, a sitemap, an image map mapping the identified target groups and relevant categories of our e-learning contents as well as handy and rich of features search and filter functionalities. Menu items of the portal represent the categories, the contents are subdivided in, e.g. by clicking on the item 'Events' an overview about all recorded training events (workshops, conferences, summer schools etc.) will be displayed. That kind of access is suited for users possessing clear ideas of the kind of content they are searching for. Search and filter functionalities are more appropriate for users who need recommendations about selected themes or fields of interest.

The menu item 'Training Contents' surveys all e-learning material offered at the SuGI portal. This category invites users to flick through the whole collection of contents provided on the SuGI portal. The filter, integrated on top of the displayed page, enables the filtering of the contents by several criteria like language of the contents, level of difficulty, and media type (video recording, virtualized training system, presentation slides etc.). The filter is realized as JavaScript and may be accessed by using the ONMOUSE\*-event handlers of JavaScript. The filter design and optical representation has been adapted to the portal design by using CSS. Options in the filter are provided in dependency to the existing contents. By combining two or more categories of the filter, a very precise selection of the e-learning contents in adjustment to the user's demands is possible.

A further possibility to access the contents is offered by the implemented full text search function. A full text search window is displayed on every page of the portal, integrated in the vertical menu on the left hand side. To help the user gain a preferable benefit out of the full text search, results are displayed enabling a quick and easy comprise of related contents. Of course, the quality of the results needs to fit to the users' expectation. Search engines often only provide references to web sites or documents. Mostly, results are complemented with a few lines of content or rating / ranking results of the search engine. Such reference lists hardly enable users to estimate the value of the referenced contents. In the SuGI portal, the extensive description of all contents by

<sup>20</sup> <http://www.w3.org/TR/html401/>

metadata is used for displaying the results of the full text search in a more suitable and ascertainable way.

Fig. 6 shows, how a single content element is displayed in a compact way in the SuGI portal. The user can very quickly identify which kind of information is referenced to, the content element's level of difficulty, the document's title, its language, and media type. Additionally, authors, keywords, a related event (if applicable) as well as an abstract are presented. The result of any search is a list of such concise presentations of content descriptions of the encountered information (content elements). This kind of presentation is not only used to display search results but is consequently used for the representation of all content elements on all pages in the SuGI portal. On the right hand side of each content element, a reference to the document or video etc. and to a more detailed description is given. It is possible that several documents are found in case they provide the same or closely related information (e.g. recording of a talk as video and simple slides in addition). Jumping directly into multimedia contents will be included as a searching feature in the future as well. That means not only metadata of videos will be included in the search but also the content of slides etc. Jumping out of the search results' list to the corresponding slide in the video, will then be possible as well.<sup>21</sup>

Several hits referring to the same content element are automatically recognized and summarized. This helps avoiding the user to be confronted with redundant hits as well as unnecessary long reference lists. Ranking of research results is realized depending on the category of metadata in which the searched item is found. Hits within the metadata category 'keywords' are given the highest priority, followed by hits within the category 'title' and other categories or the referenced document itself. At present, the file types DOC, PDF, and PPT as well as external web sites can be searched for.

In addition to the search function, names of authors as well as keywords, related events and Grid projects are displayed as tags. Users may get a list summarizing all content elements containing the same tag just by clicking on it (e.g. all contents of a particular author or event). Furthermore, all content elements related to particular thematic fields like installation, dCache or a particular Grid middleware which are marked by the lowest level of difficulty are summarized to a document library. Within this document library, a detailed description about the related topic is given. References to the respective document libraries are displayed in the detailed description page of each content element. These document libraries may then be partly accessed from the vertical menu, the sitemap as well as the image map.

## V. CONCLUSION

The main goal of the SuGI project is the support of a sustainable Grid infrastructure in Germany. This will be achieved by reducing obstacles of establishing and using Grid infrastructures. Thus, the method of SuGI is to disseminate knowledge about Grid technology. Therefore, SuGI provides

theoretical background via an e-learning portal and virtualized training systems to gain practical experience easily. The portal offers users several alternative methods of access to find appropriate information, e.g. via a structured menu in combination with sophisticated search and filter functionalities, and tagged metadata-items like names of authors, keywords, etc. Due to the user-friendliness of the portal, new users working on Grid computing may easily find and retrieve information regarding their fields of interest. Content providers will be enabled to describe and structure their provided contents in detail with metadata, e.g. using document libraries to group related documents.

In addition, the SuGI portal itself must be sustainable. This is achieved by enabling portal users to provide new contents on their own. Thus, the portal is designed for:

- easy integration of new contributions, so that up-to-date content is ensured;
- flexible content handling, so that many different types of files and media are supported, ranging from PDF files to structured video presentations;
- a well-structured user interface, allowing new users to find their ways quickly;
- using open source software and standard tools, ensuring stability and simplifying maintenance.

Currently, the portal contains more than 250 contributions. Most of them are video presentations and many contributions consist of more than one file or document. Many more contributions are in preparation. Generation 2 of the portal will be released in the third quarter 2009. Besides improved web templates for uploading new contents, there will be several further features dealing with rating and ranking of contents to support the process of community building. The final evaluation of the portal will start with the release of the second generation. Former evaluations as well as first feedbacks of Grid experts and users have shown that the long-term availability of the contributed contents is highly appreciated. The portals' capability to support communities has forked new co-operations within the Grid community and helped to bring scientists together. These co-operations finally result in new and sophisticated contents for the SuGI portal.

June 15, 2009

<sup>21</sup> This feature is scheduled for the third quarter 2009.

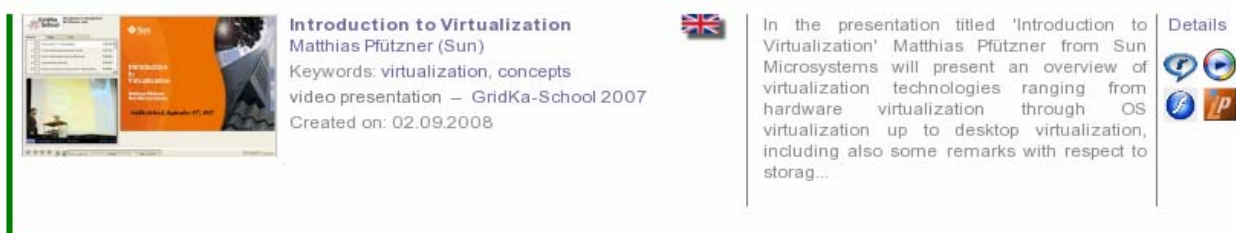


Fig. 6 List View of a Content Element

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