Electronic Portfolios for Scientists

Ingo Dahn and Alexander Christmann

University Koblenz-Landau, Knowledge Media Institute,
Universitätsstraße 1, 56072 Koblenz-Metternich
Email: {dahn, achristmann}@uni-koblenz.de
phone: (+49 261) 287-1552

Abstract

Electronic portfolios (ePortfolios) are electronic versions of paper based portfolios. They are increasingly applied in education. Software for building and maintaining ePortfolios is emerging; open specifications for the exchange of ePortfolios exist. They show the potential to serve as a standard tool for documenting achievements in lifelong learning. In this paper we explore the potential of ePortfolios for scientists.

1 Introduction

The use of paper based portfolios is nothing new for scientists. They are used to collect their publications, academic and professional certificates. Increasingly these documents are stored in digital formats. However it is still common practice to print them and to send them by snail mail to wherever they may be required.

Electronic portfolios (ePortfolios) build on these collections of documents and arrange them in a systematic way. In this way they can assist scientists in taking a systematic approach towards their own work. This offers valuable new possibilities, in particular for young scientists, centres of excellence and graduate schools. We are going to explore these, following a description of the main constituents of ePortfolios. Section 4 sketches a framework for an ePortfolio system designed to fit in particular into the working environment of scientists.

2 ePortfolios

Portfolios can be used for many purposes. These have been described in the literature for education ([9]) and career planning ([6]). According to its purpose various types of portfolios are distinguished
([3]):

- Assessment Portfolios
  These Portfolios include elements of the scientist's products, evaluations, qualifications, licenses, certificates and achievements. It is used to prove one's competence.
- Development Portfolios
  Such a Portfolio is designed to plan and keep track of the owner's development. If used in a structured and systematic way, the personal development of a scientist can be planned with such a Portfo-

lio, which is then referred to as a personal development plan. In this case, it includes learning and research goals and information to what extent a goal has been reached, in particular comments and reviews of own work.

- Showcase Portfolios (Presentation)
  When Portfolios display examples of one's best work or positive evaluations of that work, they are usually referred to as showcase portfolios and resemble those compiled by artists and architects.
- Reflective Portfolios
  These Portfolios contain reflections by the scientist. Reflection Portfolios usually focus on specific competences, and are often used in combination with personal development planning.
- Combinations of these portfolio types.

Other sources define Portfolio Types differently, according to context. Marilyn Heath defines special Portfolio Types for assessment, of which the Resume Portfolio and Evaluation Portfolio are especially interesting in the context of this paper ([4]):

- Resume Portfolio
  The purpose of this Portfolio type is to document the knowledge and skills of a scientist, to obtain employment. It resembles a paper resume, but embodies the advantages of an electronic Portfolio.
- Evaluation Portfolio
  This kind of Portfolio is used to portray a scientist's competency to obtain tenure or to meet ongoing evaluation requirements.

Traditionally, portfolios are considered as static collections of documents which are compiled for a certain purpose. According to Lissmann [7] they are carefully planned, well structured and reflected collections of learning results and Danielson & Abrutyn [2] write "A portfolio is more than just a container full of stuff".

All this holds as well for electronic portfolios. However, unlike static paper based portfolios which are once constructed and then sent off to the addressee, electronic portfolios can be easily modified, reconstructed and adapted to a different purpose. This suggests a different viewing angle for ePortfolios which has been expressed in the following definition from the EDUCAUSE National Learning Infrastructure Initiative (s. [1]):

An ePortfolio is „a collection of authentic and diverse evidence, drawn from a larger archive, that represents what a person or organization has learned over time, on which the person or organization as reflected, designed for presentation to one or more audiences for a particular rhetorical purpose."

We note that portfolios for individuals and for organizations are treated uniformly in this definition. The discussion of organizational portfolios is beyond the scope of this paper.

The new component, without which ePortfolios don't exist, is "the larger archive". This definition emphasizes the re-use of the same archived data for the construction of ePortfolios for various different purposes. Consequently, ePortfolio systems must pay attention to support besides the creation of presentations also the reliable long-term collection and archiving of data in appropriate repositories. In this way the repository and the ability to generate presentations of learning achievements become basic tools in support of lifelong learning.

We find remarkable consensus in the discussion of what are the constituents of an electronic portfolio. This consensus is consolidated in the ePortfolio specification developed by IMS Global Learning [5]. This specification describes how learner information according to the IMS LIP specification should be packaged and augmented with reflections by the learner on the learning process.

3 ePortfolio Parts

According to the aforementioned specifications an ePortfolio can have 16 parts. We confine ourselves here to the discussion of those parts which are in particular relevant for the development of scientists. For the following it is important to keep in mind that ePortfolios are not necessarily created for public access. Of equal importance are ePortfolios which are created for applications for a professional position, for discussion of research with senior scientists and peers or for the purpose of self-assessment. Taking this into account we identify the following ePortfolio parts to be of particular relevance.

1. **Data identifying the owner of the portfolio**. Data for electronic contact and public keys for confidential communication should be of particular value.
2. **Qualifications, Certificates, Licenses**. This part of the electronic portfolio holds formal certificates for learning achievements awarded to the portfolio owner. Diploma, PhD degrees, language competency certificates are examples. For each certificate information on the awarding institution must be added. This additional information may be often obtained from the server of the respective institution.
3. **Transcripts**. These describe skills acquired. Some of these can be obtained from the formal descriptions of courses taken.
4. **Activities**. This part contains descriptions of the professional activities of the owner. In particular these can be descriptions of courses taken, descriptions of ongoing or completed research projects, conferences, in which the portfolio owner has been involved. In order to assess the value of an activity it is important to add respective information, for example whether participation in a conference was passive, with an accepted paper of as organizer. Supporting evidence is collected in the following two parts. Activities are important parts of any CV. They usually have a start date and eventually an end date.
5. **Products**. This part contains completed material produced by the portfolio owner. In particular completed papers, PhD thesis and delivered project reports are to be placed here.

6. **Assertions**. This part collects documents which illustrate academic activities, except for formal certificates and documents produced by the portfolio owner. Concept papers and documents of ongoing discussions are well-placed here. Reviews of papers are also valuable information for assessing the status of an academic career as well as concept papers which can be matched against the progress of research projects. It will be useful if the underlying repository keeps track of document history and supports versioning. The documents are linked to the respective academic activities through relations which are defined in another portfolio part.
7. **Competencies**. This part contains descriptions of the competencies acquired by the portfolio owner. Information on special knowledge on particular subjects goes in here as well. Of increasing importance are descriptions of soft skills. Proven competencies in mastering of foreign languages, competencies to write project proposals, to lead research projects, to design applications of research results or to teach are examples of soft skills which are of great interest. Skills should be graded where possible. The potential use of these competency descriptions is greatly increased if competency descriptions can be taken from controlled vocabularies. Such vocabularies should be developed under the auspices of the organizations which represent communities of scientists.
8. **Goals**. Goals and objectives are important to state if the portfolio is to be used for career planning or for monitoring ongoing research or learning projects. Where goals are connected with concrete dates planned for their achievement they may be used to trigger a process of reflection on reasons for success or failure.
9. **Reflexions**. This is the most personal part of the portfolio as it contains the learner’s thoughts on her performance, on achievements, successes and failures. Such information can be made available in selected parts to close peers or to supervisors in order to discuss various issues of activity planning. Templates may help the owner to structure her thoughts. Such information may be also collected in electronic diaries or blogs from where it can be imported into the electronic portfolio.
10. **Participations**. This portfolio part describes the professional network of the portfolio owner. It refers in particular to other scientists she has collaborated with. It will be necessary to augment this with information on the kinds of relationship which have been established. Electronic portfolio systems should offer possibilities to exchange data from this part with social networking software.
11. **Relations**. This part relates the various data in the portfolio with each other. A restricted set of relation types will be used. For example a relation will link a published paper with a project activity under which it was written.

4 Application Scenarios of ePortfolios in Science

Electronic portfolios can, of course, play the roles which are currently taken by paper based portfolios.

4.1 Portfolio to Apply for a Job

Application for a job requires a presentation portfolio. It will contain besides the demographic data required certificates. Competency descriptions may be exemplified by products. The complete list of publications will be given, structured in a standard way into publication categories. Transcripts will be contained if the respective courses have not been taken too long ago. A selection of activities and affiliations most relevant for the position wanted will be added as well. A thorough presentation of the available data and efficient presentation of relations between these data in form of hyperlinks will be crucial. Such well readable presentations may be given in addition to providing the portfolio in a machine readable form.

The portfolio should allow matching the competencies and achievements of the portfolio owner against the requirements of the job offered. Unlike paper based portfolios, electronic portfolios from many applicants, structured in a standard way, can be easily aggregated into a synopsis to support comparing the candidates for the job.

4.2 Portfolio for Career Planning

Especially young scientists may want to present their tasks, achievements and reflexions to their senior supervisors. This can be done at regular intervals with the differences highlighted which have been achieved in the mean time. The goals ePortfolio part plays a major part in this scenario. Goals should be discussed and agreed between the young scientist and her supervisor. Between the meetings the portfolio owner should reflect on new experiences. The electronic portfolio can help relating incoming information, like referee reports on papers and projects, or new scientific publications and discussions, with the goals set. Based on these relations, consultations with the supervisor can be prepared better by aggregating the available information into a critical survey of achievements during a particular period. Joint discussion of this survey will form a convenient basis to establish further goals.

4.3 Maintaining Databases for Science Management

Efficient use of human resources is crucial for successful scientific work. It is a frequent task to find an expert in a specific field for consultation, for forming a team to work on a new project or for refereeing proposals or reviewing publications. This task occurs intra-organizational as well as inter-organizational. A variety of databases exist to aid these activities – “who is who” registries of scientists, registries of projects, collections of publications and, with the raise of social networking using Web 2.0, registries of social relations.

A major problem for all these databases is their maintenance. Scientists show little motivation to update their information in the various places. ePortfolio systems may alter this situation radically by allowing to automate this maintenance work. Such a system may know the relevant registries and suggest updating them automatically whenever registered information changes in the ePortfolio.

4.4 Entering Postgraduate Schools

This Scenario is based on P. Rees-Jones: ePortfolio for Development: Implementations by Regional Partnershps; unpublished manuscript. A scientist may have completed his masters degree at a university. After some work in an industry research laboratory, including work on projects in collaboration with universities, she analyzes her experiences and achievements using her ePortfolio. She has been co-author of a few academic papers but much of her work is classified on the server of her employer.

Matching the competencies part of the portfolio with the competency requirements of her employer and exploring the relation with the goals part, she compiles an evidence report from the ePortfolio with the conclusion that entering a postgraduate school would be in her interest as well as within the interest of her employer. Jointly they identify the competencies to be achieved and match them with the competency profiles of available postgraduate schools. The certificates part of the profile helps to evaluate whether she has the formal qualification to apply for these programs. Information on language competencies is essential to decide whether foreign postgraduate schools are an option.

Having selected a particular postgraduate school she compiles a portfolio for her application, leaving out all classified information but adding a testimony from her employer about her successful work for the company. She sends her application to the university hosting the postgraduate school. She expects to get accepted or, if not, to receive detailed feedback on which parts of her ePortfolio need further elaboration.

5 An ePortfolio System Framework

5.1 General Considerations:

Electronic Portfolios have specific advantages and disadvantages. According to Marilyn Heath ([Heath 2004]), the significances are as follows:

Benefits:

- Much of what scientists create is already in electronic format Organizing these artefacts electronically makes it easier to maintain, edit and update them. They can also be reused for different purposes easily.

- Much of what scientists do, for example analysis of large dynamic data sets, does not communicate effectively on the printed page
  An electronic Portfolio can employ a variety of media, like text, graphics and audio.
- Electronic Portfolios can support complex organizations for effective documentation
  Scientists can choose a linear organization if that works best, but most often the structure of an electronic Portfolio is hierarchical. Nearly every kind of organization can be implemented electronically. ePortfolios can be even rearranged differently for a different audience.
- Electronic portfolios are much easier to reproduce, distribute and access than their paper counterparts.
- Electronic Portfolios are an effective way to demonstrate technology skills or learn new ones.
- Electronic Portfolios are inexpensive to distribute.

Disadvantages:

- Electronic Portfolio Development takes time
  Portfolios are both: A product and a process. Careful consideration has to be given to the portfolio's purpose, audience, organization, and format.
- Electronic Portfolio development can be expensive
  It is certainly feasible and desirable to create an electronic portfolio with the hardware and software at hand, when no or only little additional expenses are necessary.
- Electronic Portfolio development takes technology skills
  Especially if a scientist plans to have a really fancy portfolio, his or her technology skills have to match the level needed to accomplish this.
- Electronic Portfolio development can be stressful.

If we ponder a little about these significances, we realize that a system needs to be light-weight, easy to use, cheap but powerful enough, to generate the aforementioned benefits without being an annoyance. Now, what are the key factors to success for such a system? They are as follows:

- The system needs to support the Application Scenarios in this paper.
- It needs to fit into an existing infrastructure.
- The system must be easy and cheap to implement.
- Open standards and specifications are crucial for interoperability with other systems.
- It has to be flexible, to adapt to different scenarios and audiences.
- The system needs to minimize the additional work for the portfolio owner, in particular in a scientific environment.
- Since the workload to maintain and use the ePortfolio-System has to be minimal, it is very important to massively draw on existing data.
- The system has to be fully interoperable with the systems of potential audiences.

- Therefore, we consider ePortfolios as dynamic views on distributed data.

5.2 Towards a framework of distributed scientific thin ePortfolio Systems (FODSTEPS)

We make a clear distinction between an ePortfolio as a static product, ready to be distributed to the intended audience, and the ePortfolio framework which consists of a set of systems and services which are used to produce these static ePortfolios on demand from raw data kept in the framework's repositories.

The envisaged architecture is designed to handle sensitive data which are of considerable value for the owner. The architecture needs to provide safe repositories where these data are stored. Quite similar to a bank where financial assets are deposited, repositories for intellectual assets do not only have to keep the data unaltered, but they also have to make them available to others if and only if authorized by the owner. Usually, due to a scientist's work, several repositories of intellectual assets are involved.

This Framework is based on general ideas of JISC's thin ePortfolio Framework ([8]). The following image will show the architecture of the framework which will be explained below:

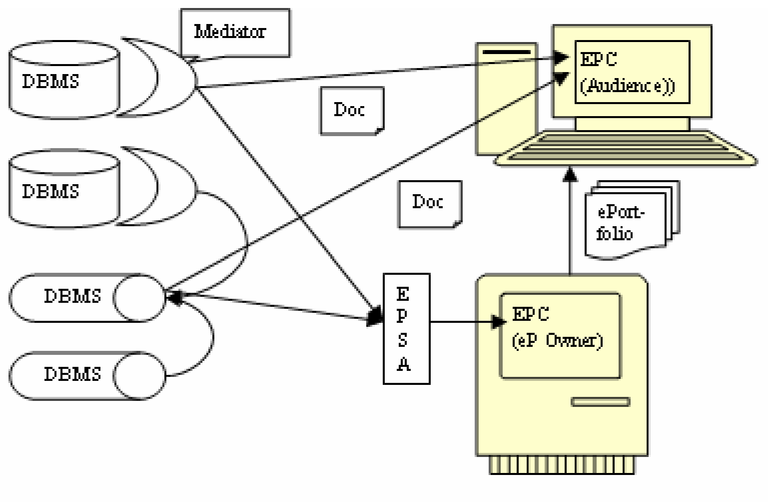

Figure 1: FODSTEPS Framework

In our envisaged architecture, repositories are the main ePortfolio Servers (EPS). Data from various DBMS are integrated into the architecture. Some of them have web-service interfaces, while others are integrated through web service mediators. These mediators will expose web service interfaces. Communication will be based on standardized XML vocabularies like IMS ePortfolio (IMS EP) and IMS Content Packaging (IMS CP).

Users will communicate with the network of EPS through their ePortfolio Clients (EPCs). Conceptually, these clients will act similar to current popular programs for home banking. They will offer the user reports about their intellectual assets as maintained on different EPSs (banks), they give the user the possibility to transfer assets or to provide others with access to selected assets. For the implementation of the EPC it is helpful to note that it must be capable to index and analyse data on the user's computer. This excludes browser based solutions for reasons of access control.

Between the EPC and EPS an ePortfolio Service for Data Search and Aggregation (EPSA) is needed. EPSA

- Takes information about the actual purpose of an ePortfolio to be build
- Sends out search requests to EPSs for data with specific properties to be delivered according to particular specifications
- When needed iterates search to complete document sets for a particular purpose (for example it may request a description of an institution from which a certificate has been obtained previously)
- Aggregates the information about the available data and their properties and forwards it to the EPC.

The user then can inspect the results in the EPC, request the data from the EPS and generate an ePortfolio for her particular purpose. When the EPSA has to consider data on the user's computer too, it (or at least a component of it) should run on the local host. Alternatively, parts of it may be moved to EPSs or even to independent service providers.

All components of the framework communicate through web services. This gives the possibility to integrate with any environment and to adapt in a flexible way to the changing demands in a scientist's life. However it cannot be expected that all systems the scientist may want to send ePortfolios to will expect them in the same format. In particular the academic world and the industrial world currently use different formats.

In order to handle this situation, we envisage that the framework is neutral w.r.t. data specifications. In fact we do not care in which format the repositories store the raw data and metadata. However we expect that the repositories are capable of delivering the data in any ePortfolio format which may be required, possibly through the help of a mediator service.

Thus, in the figure above, the ePortfolio owner's EPC may build an ePortfolio in one format, but forward it to the audience just in a form which describes where to get the data from and the respective authorizations for access. Then the audience's EPC may collect the data from the repositories in its own preferred format.

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