

A Web Innovations on Software Process-Center for Diffusing Techniques

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Abstract: There are two facets on the diffusion of technological innovations on software process: companies who want to promote their products to the right target public and individuals or institutions who are searching for the right innovation to solve their problems. This paper proposes a bridge between them: a *process web-center*. It is a web-based system to disseminate integrated, classified and updated information on software process technologies independent of projects, particular research areas or commercial tools.

1. INTRODUCTION

In an effort to boost a strategic place in the highly competitive market, software development organizations are striving to build up, redesign and improve their software development process. Software process technologies are treated by most of the recent software engineering conferences, symposia, magazines and journals. Besides, it is widely accepted that software developed under a process schema will produce better software quality. Lifecycle standards are seen as a means to modernize software development, as instruments for continuous improvement, and as checklists for software assessment. However, information on process technologies and related standards is usually extensive and spread over the internet, dispersed among technical papers and magazines, conferences, scattered in different mailing-lists and forums, process standards, commercial tools, research

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projects, training courses etc. There is not much on-line material that addresses *learning environments* for diffusing software process technologies. The few sites available are restricted to specific areas in process technologies that are being promoted by the institutions owning the site. As a consequence, process modelers not only spend valuable time in understanding the new issues in process technologies, but also seeking suitable, up-to-date information about them.

Despite the fact that some organizations create their own niches to collect information on some of the above mentioned subjects, the information is usually focused on a particular process. It seems that there is no widely known national or international organized body or mechanism supplying such information without being bound to a specific project.

This paper exposes applied research in this direction. It describes the *process web-centre*, entitled GDPA¹ [Purp99a, Purp99b], that is a web-based system to disseminate integrated, structured and up-to-date information on software process technologies independent of projects, particular research areas or commercial tools.

2. DIFFUSION BASIS

Today, after 4 years of continuous development, improvement and service, the process web-centre consists in an interwoven net of more than 8.000 web-pages holding more than 32.000 internal and external links with more than 2.000 accesses to the home-page per month.

One third of the accesses to the process web-center is from German IP-domains, the second third is from ".COM" domains; the remaining accesses are from a variety of countries. More than 70% of the accesses are from commercial companies and ca. 25% are from educational institutions. Around 30% of the accesses are from "frequent users", i.e. users that have periodically accessed the GDPA home-page in the last 4 months. The percentage of frequent users has gradually increased in the last months with a growth of ca. 29% per month.

The key factors of GDPA are:

1) The information is constantly updated

Although GDPA can be completely downloaded at client site, users periodically return to the GDPA home-page to check what is new. The latest news that are shown in the front page are classified in four categories:

¹ GDPA is a tool of the UniForM Workbench [KPOB 99], a project developed by Universität Bremen, Universität Oldenburg, and Elpro LET GmbH, partially sponsored by the German ministry of education and research (BMBF - Bundesministerium für Bildung und Forschung, 1996-1998).

- remind deadlines for conferences, project proposals, etc,
- process community news about products, books, techniques, conferences, etc,
- GDPA news about the functionality of the software,
- V-Model news about the German software development standard.

All previous news can be accessed by subject or by date. The constant update of information is one of the most appreciate aspects in GDPA.

2) All internal and external links are checked weekly

One of the factors that most disincentive the use of a web-site is the obsolescence of the links to external web pages. Once a week, a tool automatically checks all external links of GDPA and produces a report with a list of errors and warnings. In case it is not possible to determine the new address of an invalid link in GDPA, this link is merely not activated until the new address is discovered.

3) The web is the database

In order to allow the installation of GDPA at the client site without requiring extra efforts for setting up and for running on almost all platforms it was necessary to resign from using databases. For this reason, the software was designed so that all pages could be displayed by the typical web browsers.

4) It can be completely downloaded to the client site

GDPA was specially designed to work independently without necessity to remote calls and other on-line requests to operate it. Thus, the user can operate it directly at his workstation or local intranet. This is beneficial for both the user and GDPA. When the user accesses GDPA off-line, he has very low display time per web page. On the other side, the number of accesses to the GDPA server is considerably reduced and hence, the resources are not overloaded.

5) It is free of charge for non-profit use

GDPA is a research project at the Bremen University in Germany for diffusion software process technologies and standards for the IT community. Although GDPA has absolutely no advertisement, the fact of being free of charge has considerably contributed for its dissemination. Another benefit, is the active participation of the users. Monthly, circa 50 e-mails are received to report corrections and provide news for diffusion.

6) It is completely web-based, without complex html frames

This feature is being explored by many companies which are integrating GDPA in their own web-site. Basically, they access each web-page directly without concerning about the split of information among different frames.

3. PROCESS WEB-CENTER

The architecture of GDPA underwent a long and gradual evolution from simple html pages to the actual web-center. The Process Web-Center is an information service on the internet that:

- provides integrated information on software process technologies,
- has a specific "Learning Technology System Architecture" (LTSA),
- whose links are processed at a meta-level,
- stores the standards of software processes into meta-process, and
- applies an ontology library.

3.1 Integrated Information on Software Process Technologies

The following tables present the main data provided in the process web-center GDPA:

a) Software Process Standards

It is widely believed that the use of a predictable and organized software process is strongly correlated with the production of high-quality software. Process standards provide a representation of ideal processes bestowing competitive advantage. This leads to a growing interest of the industry in applying renowned standards to gain certification, and hence acceptance, in the international market-place.

In the process web-center GDPA, emphasis is given to process standards [Purp99d]. However, GDPA is a public domain site and as a consequence, might only contain the text of the standards on software process, available free of charge. Meanwhile, GDPA contains all the 3 books of the standards GD250 also known as the "V-Model" [GD250], GD251 [GD251] and GD252 [GD252] in English and German (ca. 2000 printed pages) [Purp00a]. An outstanding feature of GDPA that differs from conventional approaches is the distribution of the 3 standards in a web-based format built upon the concept of *open-source standards*. Because of the open-source availability, a vast number of requests to incorporate other international standards have been received. This may suggest that there is an increasing demand for changing the static modality in which standards are currently being distributed to the software community.

Table 1. Software Process Standards

GD250	German Standard - V-Model
GD251	Methods Allocation
GD252	Functional Tool Requirements

b) V-Model Learning Environment

Mähönen [Mähö 00] argues that standards are hard to assimilate partly because of the difficulty in understanding the text rather than in implementing the technological aspects. However, one might argue that standards are regulations and are not intended to be auto-didactic instruments. But one is also tempted to say that this argumentation leads to an impasse in the diffusion of process standards. These positions reinforce the idea that a learning environment should be provided externally. Different means such as frequently asked questions (FAQ), mailing-lists and tutorials might be employed for this purpose. When the learning environment for the V-Model standard [Purp00a] was integrated in GDPA, it had an increase of 12% of its accesses.

Table 2. V-Model Learning Environment

FAQ	V-Model Frequently Asked Questions (in German)
Mailing-List	V-Model Mailing-List (in German)
Introduction	Introduction to the V-Model (in English)

c) Software Process Terminology

More than 800 original definitions in English and German are included in the glossary of GDPA. One entry in the glossary might have more than one definition. For example the word "*process*" has 8 definitions from different sources. It seems that the glossary in GDPA is mostly appreciated by authors who need definitions for writing papers. Normal users could be satisfied with just one definition for each word. Nevertheless, a few users pointed out that the variety of definitions is useful to understand the flexibility in the terminology.

We use the ontology approach for a comparative evaluation of process terminology and taxonomy [Free00].

Table 3. Software Process Terminology

Acronyms	Acronyms ordered alphabetically
Glossary	Glossary ordered alphabetically

d) Software Process Publications

The priority in GDPA is for publications presented in congresses, conferences, workshops and symposia such as the International Process Technology Workshop (IPTW), International Software Process Workshop (ISPW), International Conference on Software Process (ICSP), European Workshop on Software Process Technology (EWSPT), etc. Around 1600 publications are catalogued in GDPA, accessible by different indexes: ordered by author, book, congress or subject.

Despite the fact that the majority of the users of GDPA who are from industry do not have so much time to read research papers, they do find it extremely useful to know when the first research publications on the topics appeared that are currently being presented as a novelty to industry.

To conclude with the issue about publications, let us look at the construction of the index by subject. It took almost 3 months to define and refine a consensual and practical index. It was a complex endeavor and required an excellent knowledge of the subject.

Table 4. Software Process Publications

Author	Publications ordered alphabetically by author
Book	Publications ordered chronologically by book
Congress	Publications ordered chronologically by congress, conference, workshop
Subject	Publications ordered by subject

e) Software Process Directories

The directories add a "personal touch" to GDPA. Although the 1500 entries in the directories do not help in understanding nor diffusing the innovations of software process technologies, they are highly demanded by the users. More than 70% of the e-mails received by GDPA are addressing suggestions and corrections w.r.t. the directories.

All innovations with respect to projects and products are mentioned in the home-page of GDPA, which has a link to an internal Projects/Products catalogue web-page. This page contains:

- some brief description of the innovation,
- a classification (to categorize the publications by subject),
- internal links inside GDPA, such as to the institutions directory, to e-mails sent to mailing-lists, internal studies etc.,
- an external link to an address where the user may find more detailed information, and
- in some cases an extended depiction of the industry best-practices.

Table 5. Software Process Directories

Institutions	Institutions ordered alphabetically
Educational	Educational institutions ordered by country
Persons	Persons ordered alphabetically
Projects/Products	Projects/Products ordered by acronym
Standards	Standardization institutions ordered by country
Who's Who	Who's who in process technologies

f) Indexes

The following indexes are indispensable mechanisms for a direct access to the web-pages and are quite simple to construct.

Table 6. Indexes

Calendar	Calendar of events ordered by year
Figures	Index of figures ordered by subject
Graphs	daVinci [FW94] graphs ordered by activity (V-Model)
Magazines/Journals	Magazines/Journals in Computer Science - only by subscription
Magazines Kiosks	Magazines/Journals in Informatics - Kiosks
Memberships	Affiliated Institutions in Computer Science
Publishers	Publishers in Computer Science
Tables	Index of tables ordered by subject
Web-Site	Index of topics in GDPA

3.2 Learning Technology System Architecture (LTSA)

Computational learning environments are essential to facilitate effective comprehension and assimilation of software innovations. In recent years, learning environments are an issue fostered by many governmental agencies, academia and industries throughout Europe, America and Asia. The working group IEEE "1484 Learning Technology Standards Committee (LTSC)" is launching an architecture to become a standard for all learning technology systems [IEEE 1484].

Foreseeing an unproblematic interoperability with external learning environments, we adopted the architecture IEEE LTSA (Learning Technology System Architecture) although it is still a document proposal and not an official standard yet [Purp99c]. However, in order to employ the LTSA in the learning environment of GDPA, it was necessary to make 2 adjustments: we first added the process "Artifact" for the artifacts (hardware, software or documents) that are produced by carrying out a software process; secondly, we expanded the store "Knowledge Library" to support the "Experience Factory" proposed by Basili [Basi 93].

3.3 Meta-Level Links

In order to rapidly incorporate the frequent innovations on process technologies without major reorganizations in the GDPA structure, the links and objects are treated on an abstract level, called meta-level. The management of objects on the meta-level is not new [KP 81], [TS92] and has shown to be useful to support system evolution. Figure 1 is a simplified and illustrative example. For instance, instead of linking a specific tool (T1) with a specific development phase (P1), the process web-centre keeps the information of the link between the meta-model of T1 (MT1) with the meta-model of P1 (MP1). Thus, the link between T1 and P1 is automatically

deducted from the link between MT1 and MP1. This structure makes it possible that any other tool that “matches” MT1 is automatically linked to P1.

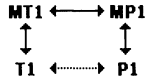


Figure 1. Links on the meta-level

However, not all links in the process web-centre are established on the meta-level. For example, the links between authors and their published papers, institutions and their commercial tools, among others, are assigned directly between the objects and not on the meta-level.

3.4 Meta-Processes for Software Process Standards

To cope with the user's demands for extending the process web-center to other process standards, a substantial restructuring of the database model was necessary. This model should support:

- the diversities among the process models of the standards,
- the formalization of the rules extracted from the standards,
- an experience library based on the experience factory [Basi93].

The GDPA model was built upon the concept of *meta-processes* [Purp00b] and for its construction seven standards were analyzed: GD250 [GD250], ISO 12207 [ISO12207], ISO 9000-3 [ISO9001-3], IEEE 1220 [IEEE1220], IEEE 1074 [IEEE1074], ESA PSS-05 [PSS05] and AQAP-150 [AQAP150]. After many months of refinement, the meta-process resulted in a simple structure, which is organized in 5 layers. Each layer attends to one of the following questions:

- **What is to be done?** The binding set of activities and artifacts which are required and produced during the system development.
- **With what?** All the possible methods, techniques and tools which might be used to perform/execute an activity.
- **Is it done?** Appraisals based on rules, regulations, checklists and assessments lists which can be used either to determine compliance with a standard or to set out the actual state of a process.
- **How is it to be done?** All the practices, recommendations and improvements that can be undertaken based on the results of the previous question.
- **Why is it done?** The explanations and justifications for any of the former questions. These are also known as “rationales”.

3.5 Ontology Library

An ontology is an explicit specification of a conceptualization [Grub93]. The ontology approach is an excellent method for comparing innovations on terminology. However, it is costly and is not easy to implement. So far, the ontology library implemented in GDPA is for internal use only.

In GDPA we developed a methodology for systematic comparison of concepts, definitions and taxonomies described in research papers, technical reports and standards. Four properties are defined [Free00]:

- a) *synonymy* among different terms,
- b) *overloading* meanings for the same term,
- c) *inconsistency* in the description of a term, and
- d) *self-reference tautology* when it is not possible to define the meaning of a term.

The first two properties elucidate the distinctions and similarities among terms. The last two properties detect potential errors in the definition of a term which should be meticulously reviewed.

Currently, this approach has been applied to the comparison of circa 400 terms described in 12 publications on process technologies. Unexpectedly, all the 12 publications analyzed in this study presented at least one semantic *inconsistency* or one *tautology*. This result is quite disturbing and it may be a sign that an ontology approach for comparative evaluation of process terminology and taxonomy of should be employed more intensively.

4. USERS PROFILES

Albeit we do not have any official survey about how the users apply the information provided in GDPA, it is possible to identify their profiles by the numerous e-mails with requests that were received. We can identify 4 major groups:

- **Users of the V-Model standards:** They are ca. 60% of the GDPA users. They are primarily concerned on: a) accessing the text of the V-Model standard in the web-based format, b) retrieving the e-mails sent to the V-Model mailing list from the text of the standard, c) use the learning environment for the V.-Model such as V-Model first steps, Frequent Asked Questions, etc.
- **Academic and industry researchers on process technologies:** Most of the e-mails received from this group can be resumed in two sort of requests: a) to update and to correct the information in GDPA about their research, b) to expand the entries in the glossary.

- **Producers of software process technologies:** As GDPA is not bound to a software product or project, producers are quite cautious about demanding changes. However, they do send information about new product releases, new training courses, etc.
- **Users of software process technologies:** Usually they inform about the problem they have for downloading the 13 MB GDPA ZIP file. In most cases this difficulty due to the internal net policies on the clients. Another frequent request is the update of the information about themselves in the GDPA directories.

5. CONCLUSIONS AND FUTURE WORK

This paper outlined the framework of the process web-center entitled GDPA for diffusing software process technologies. The relevant technical aspects and some of user's reactions during and after each technical aspect of its implementation were reported.

GDPA focuses on dissemination of the innovations in software process technologies in general without being bound to a software tool or project. In this sense it covers a wide range of innovations but it does not get into the details of putting the innovation into practice and ensuring that it is introduced in the best way. For this reason, GDPA is complementary to the individual initiatives, with have exhaustive information for the diffusion of a specific software tool, project or method. One could claim that there is a reciprocal dependence between those two modes of dissemination.

In particular, GDPA promotes the dissemination of the standard by enabling a expeditious on-line and off-line access to its target public, available for most of the World-Wide-Web (WWW) browsers. GDPA also supports process modelers to navigate throughout the standard according to their own strategy of learning by supplying a consistent, extensive interwoven hypertext documents, and facilitates the incorporation of the standard increments into the existing process by providing a flexible structure for process elements (elements such as activities, artifacts, agents, etc.)

During the last four years that we have been implementing, maintaining and improving the process web-center for process technologies we had more than 100 informal personal talks with persons who are currently and periodically using GDPA. In general they find it interesting and useful but they also expect many future enhancements.

Aside from the typical maintenance of GDPA and the incorporation of the innovations in process technologies, our next endeavor will be concentrated on the development of a *virtual* web-center where the owners

of the information themselves update the information. In the last months we have been working on the definition of the business processes for input, update, certification and delivery of the information that is going to be managed by the owners. This is not a trivial task and requires a lot of coordination and organization, particularly for the process of certification of the information.

Our second goal is to cover other process standards. This not only requires a huge programming effort but also involves a long course of meetings with the institutions launching the standards to arrive at a final agreement.

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