The PEARL Initiative:
Producing, Sharing and Managing Blended Online, Mobile and Instructor Led Learning Content within the Oil Industry

by Fabrizio Cardinali
CEO, eXact learning solutions North America, Inc.
Board of Directors, IMS Global Learning Consortium
Chair, European eLearning Industry Group

Introduction

This paper discusses the need to better compete in the contemporary Petroleum Labor provisioning and Skills training sector. It analyzes solutions to better produce, assemble, distribute and share open knowledge resources across open and interoperable networks, while personalizing them for different skill gaps, personal media and location of use.

This paper introduces the need for a commonly referenced Petroleum Engineering Abstract Reference framework for producing, managing, sharing and distributing standard and blended Learning materials (PEARL). It defines present and future learning scenarios and services, starting with the proposal of common standards and protocols (Application Profile). These standards and protocols are intended for the sharing and reuse of standard learning, reference and knowledge materials, within and across the oil industry, together with their best implementation practices and showcase implementations.
New Millennium Labor Market Trends and the Impact on Petroleum Engineering Higher Skills Development

The global labor market is facing clear trends that will dramatically change professional training and development. In turn, this will affect the way we will be using new learning technologies to better cope with such changes in the next decade. Traditional industrial economies, such as those of the United States, Europe and Japan, are shrinking in population, while emerging economies, such as those of India and China, are advancing rapidly in terms of the global labor market.

More than one billion workers from emerging economies have joined the international labor market since the year 2000. When the US Ministry of Labor was forecasting that the top ten jobs of 2010 would not have existed in 2004, the European Commission Statistical offices projected that the rise of the average worker’s age alone will cut Europe’s growth at least 1% annually for the next three decades.

This demographic drift - a clearly recognized pattern in today’s world labor market - hides a less apparent, but, even more relevant challenge: the will of emerging economies to develop highly skilled workforces better and faster, so as to gain higher positions in the production chain. So far, this production chain has been unaffected by the ageing and shrinking population of the traditionally better skilled part of the world.

Being aware that the worldwide production model, set up by western multinationals, will be the first to suffer from economic slowdowns, emerging economies want to rapidly upscale their value chain. They are, therefore, turning their workforces into high-level knowledge workers before the current economy conditions change again.

In 2006, the Chinese Ministry of Research & Development set a goal of reducing China’s dependency on foreign technology from more than 50% to 30%, and to increase its Science and Technology Innovation investments to 60% of its Economic Growth by 2020 (China Daily February 2006 on new Research & Development [R&D] spending boost in China).

Within such a challenging - yet opportunity generating - global labor market scenario, the Oil Industry is facing an even more complex evolution. This is due to the unavoidable constraint of having to deal with the shrinking supply of natural resources.

As presented in Fig. 1 and Fig. 2, the Oil market training demand and supply balance is affected by additional trends, such as:

- Forecast is falling every year - Project slippage and mature oil fields are shrinking (by some 10% annually).
- Drilling today is taking place in complex conditions and environments, while knowledge of subsoil conditions improve, leveraging the current know-how.
- North America, the Middle East and Russia are experiencing the highest skill shortage, while rapidly growing or alternative economies have a skills surplus (for example, Venezuela, Mexico, China, India and Indonesia).
- The highest level of experience in the Oil and Gas industry today is held by personnel ranging from 46 to 49 years of age (see Fig. 3). On average, retirement age is around 55 in this marketplace.
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As a result, the Petroleum Engineering Labor market is entering an even more critical evolutionary stage.

Using the traditional pace and means for building up the necessary industry-standard competence framework to oversee such new, complex oil field activities seems unrealistic. We can estimate that, within the next five to 10 years, the Petroleum Engineering labor marketplace will be witnessing a potential massive Industry Challenge, known as the Big Crew Change (Fig. 3). This challenge implies a rapid shift in knowledge balances (and, perhaps in economic power). Thus, the Oil Industry can expect to face a massive competence and information shake-up as soon as its most valuable experts retire, and the new generation of workers will need to up-skill rapidly.

Recovery of the shrinking oil supply will come from advanced operation and more complex project/oil extraction practices such as deep water drilling. For this to be possible, the future workforce will need to be trained and prepared to change the world of tomorrow’s oil drilling.

Experience, advanced project capability, superior technology and geology knowledge will drive tomorrow’s market leadership. Those who do not invest in changing their organizational learning practices today might not be leading tomorrow.

Thus, the Oil Industry as a whole needs:

- A strong capability to analyze, target and continue to focus on the most likely future path of the market, including developing the knowledge and skill base of its field workers
- To augment its ability to respond to market challenges and turnarounds in the most efficient and timely manner. This will include a wider uptake of competency based education and new technologies for skills based learning personalization
- To deliver the appropriate information, to the right person, in the right location. This will include wider use of new learning technologies offering mobile and location-based content access
- To enforce strategic (sustainable in the long term), rather than tactical, activities and improvements
Tomorrow’s leaders will be those who conceive and design new services and solutions for the Oil industry which will enable them to rapidly build effective and efficient learning and reference materials. Leading organizations understand that new architectures for wider distribution and wiser sharing of knowledge, are becoming mandatory. Building and sharing common repositories of knowledge, learning, and information assets, which foster the development of more effective and efficient personal skills and critical-business competencies, where and when needed, will be critical to the survival of the Oil Industry. To achieve this, the Industry must act together. And it must act fast.

This paper describes eXact learning solutions’ approach to producing, packaging, distributing, accessing, sharing, and reusing Knowledge, Learning and Information nuggets. Known as PEARL DROPS (Digital Repository Objects for Petroleum Skills), these nuggets could be delivered via multiple media channels and devices and well indexed across the Industry. This would accelerate the Time-to-Competency and Time-to-Knowledge of existing and new workers entering the rapidly evolving world of Petroleum Skills learning and knowledge development.

Innovate to Compete! The Relevance of Next Generation Learning Technologies Solutions For Competency Based Education and Personalization

The development of technology over the last 30 years has been impressive. However, only some innovations have helped to improve education, favoring new pedagogical strategies and models in a radical way. After the leapfrog advancements brought to education by the advent of personal computing in the ‘80s and the Internet in the ‘90s, we are now at the dawn of what many foresee as the next giant leap forward in the use of technology for education. This is based on the converging expansion of broadband, mobile and ubiquitous Internet access, as well as the rapid uptake of Personal, Social and Viral Content Networks and Digital Marketplaces.

Blogs, Social and Virtual Communities, are starting to demonstrate their effectiveness for online education, giving evidence that where workers and students interact among themselves, within social networks, accessing and sharing contents with viral distribution marketplaces, they construct cumulative knowledge far beyond that achieved with self-learning alone. Location based, context aware and “always on” ubiquitous mobile access to working information and performance support is becoming a must for workers on the move who need to stay up-to-speed with a continuously evolving labor and professional marketplace.

As shown in Fig. 4, the convergence of these innovative advancements, together with the Internet’s move toward Service Oriented Architectures and Cloud Computing, will push Online Education towards higher levels of user interactivity and cross community collaboration. This will favor a steady migration towards a constructive pedagogical model of Collaborative and Personalized learning, after the years of Behavioral Computer Based Training (CBT) in the ‘80s and Cognitive Web Based Training (WBT) of the ‘90s.
In the meantime, new trends are rapidly emerging in the contemporary eLearning/learning market. These trends empower more effective and efficient production, management and sharing of adaptive, context aware and multi-channel learning materials, which are able to support the new opportunities and approaches offered by Personal and Collaborative Learning. These include:

- Best of breed components-based architectures separating Digital Content Repositories (DRs) and Learning Content Management Systems (LCMSs) from delivery Learning Management Systems (LMSs). DRs and LCMSs are now the de facto market choice, as opposed to the first generation, turnkey and closed LMS platforms. Today, next generation, open specifications are available for content tagging, packaging and tracking (such as the one defined by NATO’s Advanced Distributed Learning (ADL) initiative for a Shareable Content Objects Reusable Model, SCORM, for Defense training or by the MedBiquitous Initiative for Health Science Education).

- XML based templating techniques for the massive design and rapid development of new learning resources, providing much needed granularity and structuring. These are rapidly becoming adopted as today’s content publishing approach (as opposed to the monolithic and large WBT page turning approach of first generation eLearning). Single Source XML templates are also adding the ability to re-render content across different delivery mobile learning media, according to the user’s device, location and context of use (location-based and context-sensitive learning).

- Skill gap analysis, remediation tools and standards are emerging, making adaptation and personalization much more viable, competency based assessment and recovery much more effective, and online learning efficient and attractive; in a word, personal.

- New digital content marketplace architectures and “narrowcasting” distribution models are emerging, which are able to broker learning assets/resources between content providers and consumers, using the profiling capabilities of new technologies and personal media devices.

- The “one size fits all” approach of the mass media marketplace, which has ruled over content distribution over the last 50 years or more, is rapidly giving way to highly customized learning content and services (Narrowcasting, Fig. 5). These highly customized learning content and services are able to continuously profile and cluster communities of interest and practice, and deliver “on demand” relevant content to the end users.

On-demand delivery of customized and personalized learning content was not economically sustainable and technologically achievable in the past due to the heavy production and distribution costs associated with traditional media.

Thanks to the technological innovations and underlying trends discussed, a new blend of innovative architectural and business services for learning content publication and distribution (often called Marchitectures) is now available. These innovative technical and business solutions will offer personalized learning experiences and instructional content to knowledge workers on the move and in the field, taking into consideration their existing skills and competencies, background learning portfolio and profiles, including their abilities and disabilities. Furthermore, they will adapt to available devices, location and user context, repackaging contents on the fly to best satisfy the users’ knowledge access, performance support need and scenario of use.

Personal Media and Social networks have changed the world of content overnight and made it more attractive to end users who are “always on” and continuously “on the move”. These days, the nomadic learner is not unusual.
Fig. 5. Interactive Narrowcasting (delivering content to Ubiquitous, Nomadic and Mobile Personal Communities) is emerging as the main content distribution marketplace of the new Millennium.

Many assume that this is the enhancement for which educational technologists and service providers were waiting. They were waiting to fully support the dramatic turn towards competency and skills based education, with the collaborative and personalization capabilities that this needs at its foundation.

Next generation learning solutions and Marchitectures’ have the underlying power to fill the gap left by traditional curricula and vocational education for rapid and massive personal skills development (Fig. 6).

Those who are the first to invest in these developments may gain market leadership at a pace unparalleled by previous media markets. Those who relax and rely on past solutions might lose their legacy overnight.

On such a basis, many organizations wanting to preserve or gain a leading position in the emerging highly competitive global labor market are considering building such new services. These would encompass the new trends towards open, standard and highly granular, multi-device learning and informative resources (knowledge objects). These resources are semantically tagged to sector agreed metadata and competency descriptors, and are able to interoperate with existing Enterprise HR, Learning and Skills Management systems. Furthermore, they would offer a new degree of personalization and adequateness to meet the learning needs of their target user base, whether these are employees, students or citizens of the New Millennium.

The first organizations able to invest in such innovations, and reach their workforce with updated knowledge-on-demand services that are adapted to the user skills, location, device and context of need, will have a winning edge. They will be better able to face contemporary and future challenges and opportunities in the global competition. They will have a winning edge that any contemporary knowledge organization needs to consider if it wants to compete and win in today’s global market.
The Relevance of Common Standards and Sector Related Application Profiles

Given the rapidly evolving labor marketplace and growing skills shortage, the Oil Industry must be innovative and prepared to embrace new technologies and solutions, which will significantly improve training and development practices for competency, skills and media based learning personalization.

To be economically viable, technologically proven and pedagogically sound, the sector must not attempt to re-invent the wheel. Rather, it must rely on state-of-the-art standards and best practices developed by other sectors in the last five to 10 years. Nevertheless, it must also be prepared to add its own touch, considering the specific needs and the uniqueness of its stakeholders.

As witnessed by several cases including the Oil Industry, clustering stakeholders with high buying power and provisioning volumes to control and rule their own needs for standards not only makes the adoption of these standards more focused and viable, but also provides that industrial sector with significant power to influence and possibly affect the early pioneering specification to a wider market adoption roadmap as it evolves (Fig. 7).

Along with other key industrial sectors, such as Defense, Avionics, and Life Sciences, the Oil Industry has the needed solidity and strength to make this change happen. The change must not be done by means of isolated and haphazard initiatives but, rather, by a common and consensus-driven effort among its main market players and stakeholders.

While a specification roadmap can take up to eight to 10 years to crawl up the ladder from pioneering R&D efforts to widespread adoption of official standards, once adopted, the return on investment rapidly increases in what many recognize as the Hockey Stick Effect (Fig. 8).

Considering the long standards roadmap and the valuable ROI of standards adoption, a well established best practice, proven by other sector initiatives, is not to develop new specifications or standards from scratch. Rather it is best to define a common abstract reference framework. Such a framework includes current and possible stakeholders, present and future services and business models, which enable stakeholders to forecast all needed interoperability boundaries and related interfaces. As a result, technical data bindings and protocols (for example, XML schemas and Web Services) can be proposed so as to better serve the existing and future stakeholders distributed within and across the industry.
An Abstract Reference Framework needs, as a minimum:

- An Abstract Reference Architecture defining its sub-components and boundaries, data formats and protocols
- A selection of best-of-breed subsets of existing and proofed standards, “profiled” to serve all foreseen needs and the demands of the target industry (Application Profile)
- A set of Open Guidelines and Recommendations to guide the wider adoption and certified compliance with the proposed profile
- A set of demonstrative implementations to showcase adoption, both across and between different vendor and user implementations of the profile (PlugFests)

SCORM, MedBiquitous and AICC are just some examples of different Abstract Reference Frameworks and Application Profiles that were developed respectively by the US Defense, Life Science and Avionics Industries on a host of pre-existing specifications that were designed and maintained by the IMS Global Learning Consortium. The IMS GLC is a well known body that groups leading educational technology service and solution providers, and designs and manages a general purpose learning specifications lifecycle that needs profiling within specific industry verticals.

Emerging technical documentation XML standards, such as DITA (http://www.dita-xml.org/) and S1000D, should be considered when training and performance support materials are embedding references to technical documentation. Once adopted as the “de facto” industry reference standard within their respective international communities of vendors and suppliers, the forecasted Hockey Stick Effect will take place, granting ready access to more affordable learning solutions and materials. The PEARL Initiative targets a similar development for the Oil Industry.

The Pearl Initiative: Towards Common Petroleum Engineering Abstract Reference Framework for Learning Content

To bring about the change it requires, the Petroleum Industry needs:

- An agreed and shared reference framework that will facilitate reconsideration of future Training & Development practices and solutions
- A place where engaged stakeholders may join to make a common move towards next generation architectures and services
- Clearly defined components and boundaries, as well as related data interchange bindings and protocols for future-proof interoperability and reusability of developed solutions and learning content

eXact learning solutions establishes the goals of the PEARL Initiative as the aim to define:

- PEARL AREAS, a set of Abstract Reference Educational Sub Architectures & Services detailing the expected architectural models and business stakeholders for specific processes and services of the Petroleum Training Industry. It also details components with their related boundaries, interoperability data and protocols. Expected outputs are Unified Modeling Language [UML] and Graph Charts for each addressed sub architecture)
• PEARL GOALS, a set of Guiding Open Application profile guideLines & Specifications detailing the specific XML bindings and Web Service interfaces for adopted standards. It also includes descriptive papers for effective implementation and certification practices. Expected outputs are PDF and Word documents for each addressed specification in the PEARL Profile, together with XML schemas and Web Services Definition Language [WSDL] descriptors of adopted data formats and interfaces.

• PEARL PARTS, a set of Pilot Applications and Reference TrialS testing and showcasing the benefits of a shared PEARL reference framework and application profile. Demonstrations will be held at live events and in a demonstration area named PEARL Plugfests, a term inherited from the successful events launched by ADL at the beginning of the SCORM community building which brought together vendors and suppliers to demonstrate the benefits of a common sector specification.

At the following SPE meetings, held in Rio de Janeiro (Brazil, April 2010) and Florence (Italy, September 2010), the first PEARL activities and achievements were reported and demonstrated, including:

• The PEARL CORE, Content Objects Reference Echo system (Fig. 9), a first AREA sub-architecture addressing all engaged stakeholders, components and workflows for learning content production, brokerage and consumption within a comprehensive content echo system towards new generation personal learning.

• The PEARL DROPS, a first set of GOAL production and indexing guidelines and schemas for the creation and classification of Digital Repository Objects for Petroleum Skills development and their incremental packaging within PEARL FLOWS, or Flexible Learning Objects packages for Workspace Support.

Innovative Single Source Input, Multiple Channel Output XML technologies, and best practices will be considered to experiment with device, platform and context driven personalization of PEARL DROPS (Fig. 10).

Multiple content packaging standard formats will be considered for the creation of PEARL DROP packages (PEARL FLOWS, Fig. 11) that will support simple content structuring (SCORM 1.2), adaptive navigation (SCORM 2004), multi-user role playing (IMS Learning Design) and/or learning tools and assessments, added on to the content flows (IMS Common Cartridge).

In order to pull or push DROPS or FLOWS across different DR, LCMS and LMS systems in the PEARL Echo System, Open Web Services and Repository Query protocols will be specified. If third party systems do not fully support recommended standards, DROPS and FLOWS could be delivered through run time players named PEARL GLOVEs (General Learning Objects Viewing Environments) in the abstract architecture. PEARL GLOVEs will render PEARL DROP and FLOW sequences in a distributed manner on behalf of third party LMSs that do not support the devices and packaging formats that are supported by the PEARL profile, returning tracking information via web services to call Enterprise systems as needed.

Fig. 9. The PEARL CORE Content Open Reference three-tier Echo system. This is an abstract reference model sub-architecture for reference, learning and knowledge content production, brokerage and consumption within and across the Oil Industry, from back end production, through middle tier brokerage to end user consumption.
PEARL GLOVES running on deck of Personal Media will also be available to empower just-in-time oil field delivery, supporting the Oil professional when and where needed.

Exploiting devices supporting location-based GPS and Wi-Fi detection will also be possible through the addition of geo-location metadata to the indexing profile of DROPS and FLOWS as needed.

Initial PEARL PARTs (Pilot Application and Reference Trials) have been implemented by eXact learning solutions:

1. A PEARL BROKER, (Fig. 11) a server based brokerage service available to any third party PEARL Services Producer or Consumer who is able to:
   - accept requests for PEARL learning materials through any third party rapid authoring tool,
   - dispatch a synchronous query to a federated network of PEARL compliant Repositories through the use of a common query protocol (based on OKI’s OSIDs Open DR specifications), and a set of mandatory and optional metadata (based on IEEE LOM and Dublin Core Specifications), as well as a Skills taxonomy vocabulary expressed in a IMS VDEX, Vocabulary Data Exchange, binding and harvesting metadata;
   - download materials to create multi-channel PEARL DROPS and FLOWS that will be accessible by any third party LMS that supports the PEARL profile or
   - just link learning content by means of a run time PEARL player.

2. A PEARL LCMS-CAT interworking pilot, interfacing the eXact LCMS implementation of the PEARL Profile for skills taxonomy mapping.

Further PEARL PARTs, using the PEARL Service Oriented reference architecture and profile, such as the PEARL FEDEX a standard Repositories Federation Exchange protocol for searching, retrieving and exchanging PEARL content across the different repositories (as well as the PEARL DOME, a Digital Objects Marketplace Environment for trading PEARL DROPS and FLOWS with e-commerce) are expected to be specified and, possibly, demonstrated by PEARL stakeholders during the PEARL showcase events expected at future meetings.
Conclusion

Today, the demographic drift in world population brings new challenges to the Oil Labor Market. Together with the oil supply trends affecting the world economy, this drift can radically change the topology of Petroleum Engineering and labor in the near future.

Higher degrees of knowledge personalization become the main challenge for leading stakeholders of the Oil industry who are aiming to keep their high stake ranking in such an evolving scenario; or to gain new positioning. Personalization may be achieved through wider uptake of new learning solutions and personalized media offerings via location based and context aware access to Knowledge, together with increased adaptability to learners’ skills, capabilities and backgrounds.

Underestimating the urgency for promoting such knowledge access, reuse and personalization methodologies and technologies is a great risk to current leading economies in the evolving world. The PEARL initiative proposes an Abstract Reference Model for the development and implementation of new solutions and services within the Petroleum Industry together with an open community and working platform for the definition of a common standards profile and the provisioning of new tools and applications.

The PEARL Initiative is open to any solution provider, adopter or broker which might be interested in contributing to the Oil Industry’s fast paced evolution towards membership of the Knowledge Society.

Author’s Biography

FABRIZIO CARDINALI was born in London, UK. He studied Electronic Engineering and obtained a degree in 1988, specializing in Artificial Intelligence and Machine Learning at the University of Genoa (Italy).

After launching and managing the Expert System and Multimedia division in Hay Space Consulting Technologies (the European Hi-Tech branch of the World-leading HR consulting firm, HAY Management, Boston, US), he set up Giunti Interactive Labs, a new media and eLearning Company, part of Giunti Editore, a leading Publisher in Primary Education and Cultural Heritage in Southern Europe.

In 2010, after a management buy-out, Giunti Labs rebranded as eXact learning solutions. This organization is one of the main private eLearning Standardization and R&D contributors worldwide, with official positioning in all major international sector standardization bodies and engaging in more than 30 ongoing R&D projects on the future of eLearning, knowledge management and ePublishing.

eXact learning solutions is licensor of the eXact LCMS and Harvestroad Hive Digital Repository. These world leading Content Management and Digital Repository Solutions for learning, reference and knowledge content management are now installed in more than 150 leading Enterprises worldwide. The eXact LCMS and Harvestroad Hive DR technologies are now moving to new mobile, location based content personalization (eXact Mobile).
Fabrizio Cardinali is CEO of eXact learning solutions North America, Inc. and one of the main international eLearning standards experts. He is also the author of numerous papers in international journals and conference proceedings on the future of eContent, with official roles in main international eLearning Open Specifications bodies (Board of Directors of IMS Global Learning Consortium, Chair of European eLearning Industry Group, MIT’s OKI Global Strategy Advisor and ADL SCORM co-writer and reviewer). He serves as a regular expert for the European Commission Experts Group on eContent and eLearning from DG Information Society, DG Culture & Education and DG Enterprise and contributes to several National Governments’ eContent strategy plans for eLearning uptake towards the Knowledge Society (for example, recently, he has been working on Italy’s, Russia’s, Saudi Arabia’s, the United Arab Emirates’ and Hungary’s national eLearning plans).

**eXact learning solutions**

eXact learning solutions, formerly Giunti Labs, is a leading online and mobile learning content management and digital repository solutions provider, offering a wide range of tools and services for content development, management and delivery, covering:

- Multi-language bespoke learning content production
- Content management and digital repository platforms
- Mobile learning technologies
- Consulting and professional services

The company has over fifteen years of experience and more than 100 clients worldwide. Our technological innovations allow enterprises to improve their organizational performance, and achieve significant reductions in business costs.