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Technology-Enhanced Learning meets CIM – Integrated Content Development Processes

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Abstract: In order to produce learning content on demand, many enterprises struggle with complex authoring tools, time-intensive development processes and lacking resources. Thus, the time-to-market of the learning content is too long to be relevant for sales or customers especially in times of fast moving product lifecycles. The reason for these impediments lies in the fact that content development and product development are still too distant from each other. Two decades ago, similar problems between logistics and product engineering in industrial enterprises have been tackled by the CIM approach and simultaneous engineering. Within this paper the content process is integrated into the most important representation of the CIM approach, the Y-CIM model, transforming the Y-CIM model to a W-shaped model which reintegrates processes of business logistics, content development and product engineering.

1 Motivation

Although progresses in learning technologies have shown quantum leaps in terms of maturity and interoperability, technology-enhanced learning at the workplace, particularly for product training, still could not ripe to its full potential. Many enterprises struggle with complex authoring software, time-intensive development processes and lacking resources to produce learning content for company-wide usage on a demand basis. Creating media material as well as engaging technical product experts for feeding their insights into learning units are expensive and time-intensive endeavours. Thus, the time-to-market of the product training content is too long to be relevant for sales or customers especially in times of fast moving product lifecycles. The reason for these impediments lies in the fact that content development and product development are too distant from each other although they share personnel and media resources. Two decades ago, similar problems between logistics and product engineering in industrial enterprises have been identified and tackled by the approach of computer integrated manufacturing (CIM) and simultaneous engineering. Applying these concepts to the development of learning content leads to an integration of workflows and repositories and promises great

leaps towards more efficient (and effective) content production. After motivating such process integration, this paper presents how the CIM approach nicely fits with today's challenges in workplace learning both from a process and a repository perspective.

2 Current Authoring Practices in Manufacturing Enterprises

Nowadays, the ability to create and utilize efficient learning content in order to train sales and service departments as well as end-users is seen as an important competitive factor for manufacturing enterprises [BBS01]. However, the process of content development (i.e. the authoring process) is extremely resource-intensive and complex. In order to develop learning content for product training in a meaningful manner, many employees from different departments have to collaborate and exchange relevant data across departmental boarders. Most enterprises cannot afford to assign the content development process to an external team of experts, but internal staff lacks didactical and technical expertise to develop the content in-house, or the enterprises are not able to release employees from their work for the production of content [Ni04]. In practice, enterprises usually hold views of the ideal process of content development that do not match their as-is situation; instead, ideal and reality often diverge by large. To enable an effective and efficient use of TEL at the workplace [LCM06], tools for content development support should be **low-priced** and **easy to use**, so that the content process can be carried out by internal employees. They should provide **didactical and conceptual** support, empowering technical experts to contribute their existing knowledge and material to the content process. Having such "smart" content development solutions in use, companies could circumvent outsourcing content projects to external service providers and avoid extensive pre-investments. Furthermore, all activities affected must be organized in **transparent and lean processes.** Engineering these processes towards efficiency and effectiveness must be of top priority. This entails integration of data, people and functions with the aid of collaborative and workflow-supporting systems.

Despite the desire of enterprises for complexity reduction, organizations express great quality demands on a potential use of learning technologies and ask for strong customer orientation and highest usability. However, reality in the area of authoring is still quite different: Processes of content development remain very intricate, irrespective of any tool support. Usually, multiple departments are involved in these processes, because many interdisciplinary competencies and detailed knowledge (technical equipment, tools, project management, media production, and didactic expertise) are needed. The time needed by internal experts (e.g. from R&D departments) is comparatively high, because their know-how is required for the development of content, but explaining their – often implicit – knowledge is not a routine activity at all [Po66]. Furthermore, already existing tools support only singular aspects of the content development, but do not provide holistic process integration within the overall ICT landscape of an organization. Internal experts have to be supported in conceptually designing and preparing training media production already during the process of product development.

3 Applying CIM to Content Development Processes

The introduction of business information systems (IS) in the second half of the 20th century, primarily in industrial manufacturing, initiated the need to integrate those systems, the processes they support, and thus the data they create and use. The concept of CIM, introduced by Harrington and extended by Scheer, tackled these issues providing methods and techniques to unify the data, process and functional dimensions supported by IS [Ha73], [Sc90]. The Y-CIM concept, proposed by Scheer in "CIM: Computer Integrated Manufacturing", postulated to facilitate the integration of industrial processes focussing on logistics and product engineering and their most relevant data. The shape of the letter Y is the outcome of the assumption that both logistics and product engineering processes are converging in the course of their operation (cp. Figure 1).

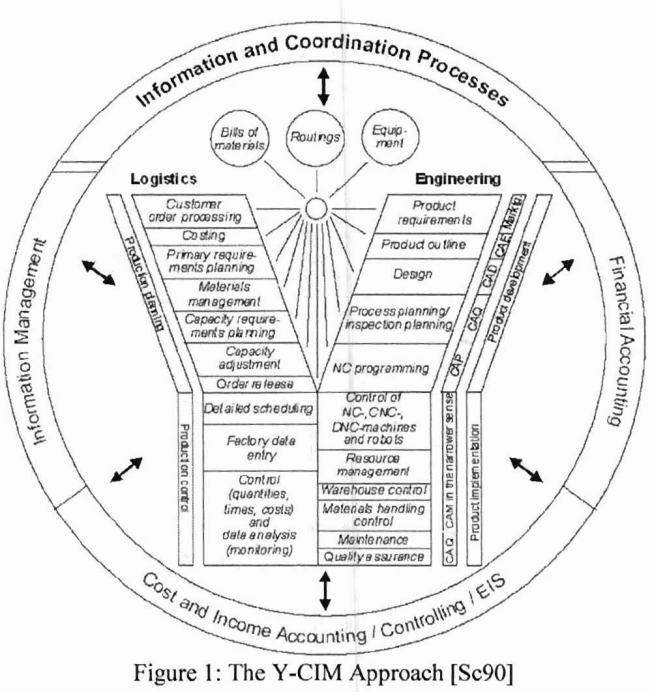

Figure 1: The Y-CIM Approach [Sc90]

Product engineering starts off with product development which is initiated by marketing activities providing the requirements basis for product engineering. Logistics on the other hand start with production planning which deals with customer order processing (sales activities), and production planning. Until here, logistics and engineering are separated, though connected by the shared use of the same data items such as bills of materials, routings, and equipment. After production and product planning are finalized, both process flows unite in the production process itself, with only different focuses. Whereas logistics rather includes business-related production control activities, product engineering is technologically responsible for computer-aided implementation of the product. Beyond the central processes of logistics and product engineering, the Y-CIM model includes their linkages to information and coordination processes.

These concepts have seen intense practical usage in the course of the past two decades and form the basis of today's enterprise IS. However, they have not been used as thoroughly as potentially necessary, leaving process and data gaps to overcome. Given the challenges of learning content development in manufacturing enterprises, epitomized as data redundancies and resource inefficiencies in section 2, the established CIM concepts offer a relevant approach to overcome these impediments as well. Applying the idea of integrated data repositories and process integration to content development within an industrial environment, the EXPLAIN project (http://www.explain-project.de), funded by the German Federal Ministry of Economy, takes advantage of the Y-CIM approach and transfers it to today's impediments in the content process (cp. Figure 2). This process can be structured into three major steps: content development, content delivery, and content evaluation [LCM06].

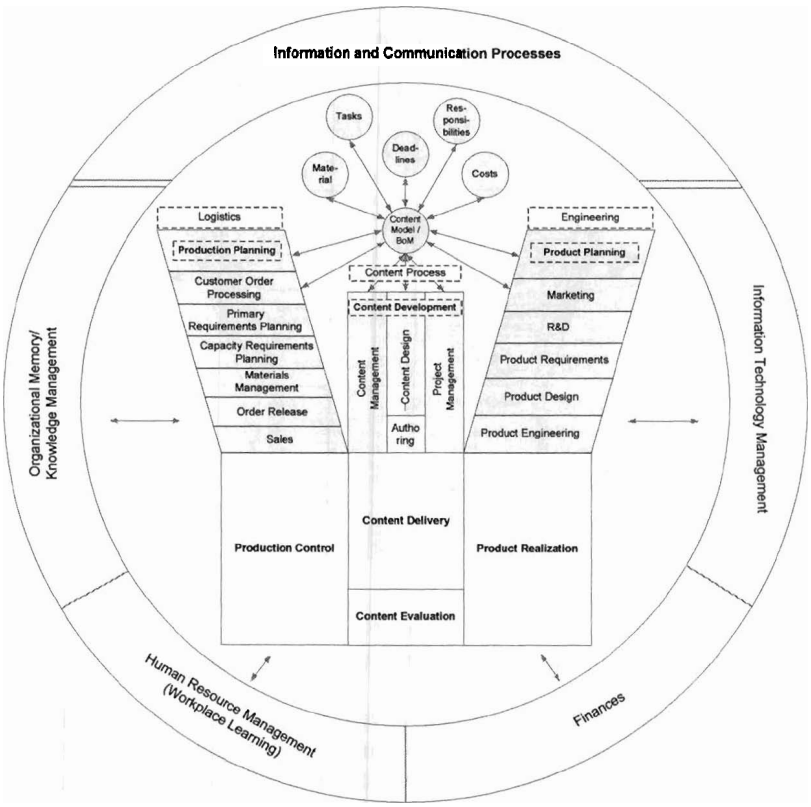

Figure 2: Integrated Content Development Processes

With the content process put between business-driven logistics and technology-driven engineering, the original Y-shape changes rather to a W-shape. In the upper part, content development starts off with three parallel processes: project management, content management, and content design, which gradually merges in authoring. Here, the separation between logistics, content development, and engineering reflects practical

reality. Section 4 of this paper tackles the collaborative interactivities between those processes and introduces an authoring management platform designed to support such collaboration. The necessity to link business logistics, product engineering, and content development through shared data assets is emphasized by the set of data items related to the content model, like Material Assets, Deadlines, Tasks and Cost Parameters. Section 5 outlines how they are to be stored in a common repository of the authoring management system, and integrated into an overall content model, easy to edit by anyone involved in these three processes. The lower part of the W-shape leads all process flows together, pointing out the close integration between production control, content delivery / evaluation, and product realization itself. Due to the added focus on the content process, the supportive functions in the outer circle of the Y-CIM model have been adapted as well. They are all closely related to the core processes as the double-sided arrows indicate: Organizational Memory and Knowledge Management approach the content development process from an organizational and management point of view [AS96]. Human Resource Management esp. Personnel Development is responsible for training, thus for TEL at the workplace according to business needs as well as adequate staffing [SWC02]. Finance supports resource planning activities of the project management within the content process whereas Information Technology Management drives integration purposes through integrating data repositories, program logic, etc. [Me05]. Given the broad acceptance of the Y-CIM model in the manufacturing industry and the urgent need to organize content production more efficiently, embedded into operational activities, the adjusted W-shaped model serves as a solid conceptual basis for integrated content development targeted by the EXPLAIN project.

4 Integrated Content Development – A Process Perspective

From a process perspective regarding the integration of content development processes, the challenge is to provide an integrated, tool-supported content process with all involved departments sharing required information while seamlessly collaborating with each other. The content process has many interfaces with the processes of product engineering and product logistics as shown in Figure 2, and therefore provides possibilities for reduction of complexity, redundancies and optimization of effectiveness and efficiency in the case of integrated processes.

These issues are to be analyzed and conceptually overcome within the EXPLAIN project. EXPLAIN focuses on content processes and aims at an intelligent ICT environment that empowers organizations to flexibly implement their content in the course of their major business processes. The main objective of the project is to develop a new generation of authoring management platforms [Zi05]. This will facilitate a simplified proprietary content development process and will enable organizations to produce their own multimedia trainings. The project's development approach is based on a systematic analysis and reengineering of as-is content processes in cooperation with professional content development companies and industrial enterprises. This approach should link content processes, product engineering and logistics in an integrative manner through utilization of existing interfaces and, together with easy-to-use and low-priced implementation tools, improve the acceptance and usage in enterprises. From here, an

integrated platform supporting the authoring processes of media collection (content management), content design (content development) as well as project management including open interfaces to learning management systems and authoring tools is developed step-by-step (cp. Figure 3). Beyond process integration, a variety of additional services will further facilitate specifying, producing and managing media and content.

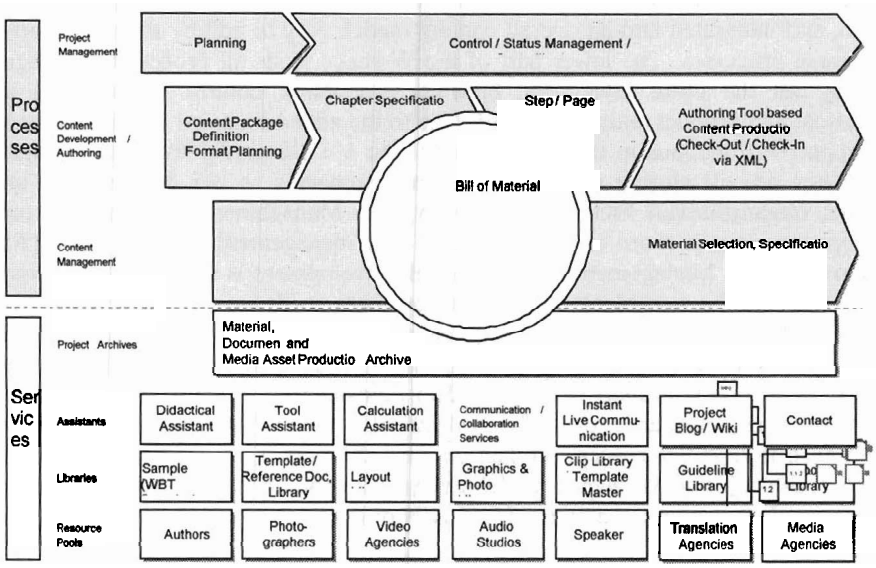

Figure 3: Process and Service Landscape of the EXPLAIN Authoring Management Platform

The resulting EXPLAIN authoring management platform follows the thesis that it does not make sense for corporate training managers to run and maintain an own authoring infrastructure within the enterprise and have all the skills in an internal team – unless the volume of media production is on a very high level. The intelligent integrated solution will instead provide a multitude of authoring tools, assistants and services on-demand over a web-based platform. The idea is that enterprises can use these services whenever they need it. By this, services and tools can also be provided at the newest level of technology. Corporate training departments avoid pre-investments into own infrastructures. The provided value-added services in the platform will also support communication and collaboration activities within the team and by this increase the process efficiency for review and creative team processes [EX06], [Zi05].

5 Integrated Content Development – A Repository Perspective

The repository is responsible for the storing and provision of the relevant information provided by the content model. As shown in Figure 2, the content model is the central instance and anchor point for the surrounding processes along the lines of the bill of materials in the original Y-CIM model (cp. Figure 1). Thus, all objects, that are used in the content development, like media assets for example, should be linked with the content model. If at design time a certain material is not available, a so called material

notice, where the desired asset is described, replaces it for the bill of materials to be complete. Thus, the content model provides all the information the processes need in order to work. These are "driven by status", that means, that, according to the status information they receive from the content model, different process steps are triggered. This is beyond the capabilities of most standard repositories, because on the one hand the data model of the content model itself has to meet certain requirements, while on the other hand special metadata and status information has to be stored and provided with the content model and the linked materials. Therefore, the EXPLAIN authoring management platform uses a customized modeling language and metadata schema fitted to these special needs. In the following, the special requirements for each of the processes related to the content development are described [Le06].

The ***content design*** process demands a content model with a concise structure, which can be modeled by easily. The book paradigm is used here, because it is intuitive and understandable. What results is a hierarchical structure of chapters which represent the logical structure and pages or page groups representing the physical structure. Materials like media assets are added to the pages or page groups in the course of the content design process. To support the ***project management*** process, diverse status properties have to be stored within the content model and the related material. This encompasses responsibilities, cost parameters, time parameters, deadlines, status information and tasks. The process status determines the progress of the current process step and may possess values like "in work" or "under review". Cost parameters are needed to control the preserving of a given budget and to create financial reports, while time parameters include deadlines as well as start and finish dates of the different process steps. The responsibilities determine whom to notify, if special events, like a finished review or a deadline violation occur. These status properties are necessary not only for the steering of the content development process but also for the coordination with the logistics and engineering processes. The ***content management*** process – mainly dedicated to media collection spanning various departments such as marketing, R&D, manufacturing, sales and even external media providers – is manifold and makes high demands on the content model and thus, the modeling language used. The main challenge here is, besides the classical content management issues, the referencing and representation of materials. Although a simple reference to the ID of the desired material may be sufficient, the material still has to carry enough information for the platform to handle issues like cross-format referencing or versioning. Versioning information encompasses references to previous and following versions, while the access status can be set to prevent access conflicts, which is especially important in an environment where different actors in different roles and from different processes access the stored data.

6 Conclusion

This paper has demonstrated how content processes relate to other business processes like business logistics and product engineering in manufacturing enterprises. The CIM approach, postulated to facilitate the integration of business processes in industrial enterprises, provided a basis for further considerations. The Y-CIM model, focussing on the convergence of logistics and product engineering and their most relevant data, was

extended to a W-shaped model which reintegrates these processes with the processes of content development. Thus enterprises are empowered to experience an integrated content development process sharing all relevant data and collaborating with all involved departments. Such process integration provides a general simplification of the content processes, reducing redundancies as well as financial and time efforts in producing content. The professional efforts of internal experts on content development decrease and the amount of time needed for implementation are shortened enormously, so that profitability for the creation of product training with very short lifecycles is assured. The presented EXPLAIN Authoring Management Platform as a demand-oriented approach has been designed based on these insights and is now in the implementation phase. It will provide a number of advantages for the user: On the one hand, corporate training departments avoid pre-investments into own infrastructures. Instead, appropriate tools can be utilized on-demand over the web-based platform and can be integrated into the overall project. In a similar way, this applies also for media production, which can be outsourced to external service providers or carried out in-house over the platform. The content model as a central element in the overall process integrates all required activities along the structure of a learning module. Thus, it provides an interface between content and business processes, which will open the gates for a wider utilization of TEL in manufacturing enterprises. Thus, even small education departments will be released from the necessity to provide all expertise, technology and resources by themselves, but nevertheless, they will still keep their leading position within the learning projects.

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