Workflow: an Enabler to Collaborative Design Process

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Abstract: - Mass customization, globalization and short product development cycles, are pushing the manufacturing industry towards mergers and collaboration world wide. The strategy of product development is therefore transforming and concept of virtual and extended enterprise is emerging. Primarily important are enabling tools and technology for collaborating at global level. There is increasing need for tools to capture, represent, and exchange product development knowledge. Product development process, for complex product like aero plane, is featured with distributed workflows, and complicated collaborative lifecycle management issues. Product lifecycle management commonly known as PLM solutions is reshaping the processes, to address the need for integration through out the product lifecycle. This paper investigates into workflow as an enabler to collaborative design process for an aeronautical product. First we present an overview of the collaborative product development with a framework sketch. Then we review the workflow and workflow management system, followed by its capabilities as an integration tool. We also present a sketch of generic concept design process for an aeronautical product.

Key-Words: - Workflow, Lifecycle, PLM, Collaborative design process

1 Introduction

Mass customization, globalization and short product development cycles are pushing the manufacturing industry towards mergers and collaboration world wide. The strategy of product development is thus transforming and concept of virtual and extended enterprise is emerging. For collaborating at global level enabling tools and technology are of primary importance. There is increasing need for tools to capture, represent, and exchange product development knowledge. Product development process for complex products like aero plane is featured with distributed workflows, complicated collaborative lifecycle management issues. Product lifecycle management (PLM) solutions are reshaping the processes to address the need for integration through out the product lifecycle.

While outsourcing complicates the management issues, it brings with it opportunities and strengths necessary to remain competitive. For product engineers, it is important to decide, as to what should be manufactured at site and what should be out sourced depending on strategic importance of subsystems. Out sourcing offers, i) cost advantages, ii) reduced investments, iii) supplier empowerment, and more importantly, iv) technological improvements that suppliers can bring to the firm [1,2]. Aerospace industry has become a truly global industry, and design and manufacturing contractors from America, China, and Europe are "fully engaged in deploying world class capabilities" [4].

Product development process is crucial for the collaborating company, it is considered as a moderator, in improvement of operational performance of both the OEM(focal firm) and the suppliers within a supply network [5]. It is particularly relevant for industries with high outsourcing levels such as aerospace manufacturing. Collaborative product development in distributed discrete enterprise, mainly stand on three pillars. That is to say, people, technology, information and knowledge management[6]. In our opinion effective integration of people, processes and information/knowledge is indispensable for collaborative product development.

These days, distributed workflow management has been widely adopted to manage distributed interactive activities and monitor the collaborative product development process in product lifecycle. Workflow acts as the enabler, to managing collaborative design development in integrated workflow system by dynamically invoking its functions. Such system can enable automated product design process, which can result in increased efficiency, coupled with real time monitoring as well as auditing of design process. Yet another important aspect is that by deploying workflow model, the reusability of activity implementations in product design process can be achieved[7].

Overwhelming importance of, collaborative design development and workflow process, let us proposed [3], a PLM based frame work (figure 1). This paper is continuation of the same concept, with workflow being the new element to focus. The frame work signifies processes as well as related applications associated with product development. In this framework PLM layer has been introduced to provide the platform and much needed integration of data, based on concept of single source of product data (SSPD). The foundation technologies and components of the generic frame work have already been discussed in our referred paper[3]. Here, in this paper our context will be collaborative approach based on workflow management, workflow management systems and product lifecycles.
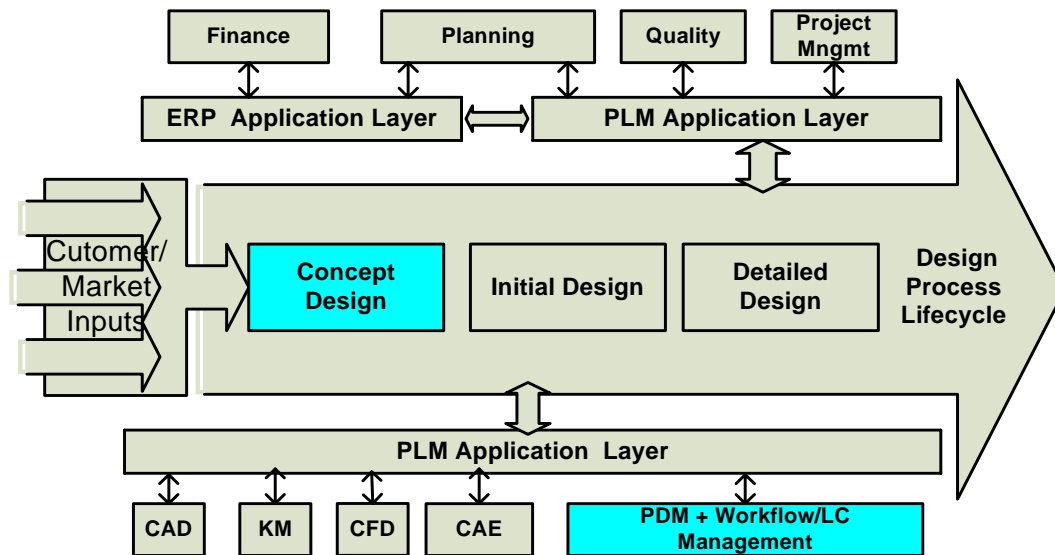

Figure 1: Collaborative Product Design Framework

2 About the Workflow

The discussion for alignment of organizational structures with business processes dates back as early as 1930s,(NORDSIECK and ENNING). Despite this early interest in the topic, the process-oriented structuring of organization did not gain overwhelming acceptance in corporate practice until 1985. Today, the creation of process-oriented organizational structures is widely seen as a suitable way to overcome coordination problems between different functional units. Conventionally coordination problems result, in long cycle times, low product quality, and redundant task fulfillment in enterprise[7,8].

Though convinced of its benefits, enterprise have largely remained elusive to its implementation, because of complex nature of process oriented structures. Production workflow strictly speaking fall in category of highly structured and process driven workflows (see figure 2). Significant part of the difficulty lies in information technology transformation towards process oriented structure development tools. Workflow management systems of today, address this problem to large extent. These systems enable coordinate activities (processes), resources and data according to the formal presentation of the process logic, the workflow

model. The basic concept of workflow management system(WFMS) is shown at figure 3.

Implementing process concepts within organizations is only one step toward achieving a corporate process focus. In order to reap ongoing benefits from a process-oriented organization, continuous maintenance and control of the business processes is needed. To execute business processes efficiently and effectively process management is important. The new concept of integrated lifecycle that may lead to continuous process improvement should include management of planning, implementation, enactment and controlling of processes[9].
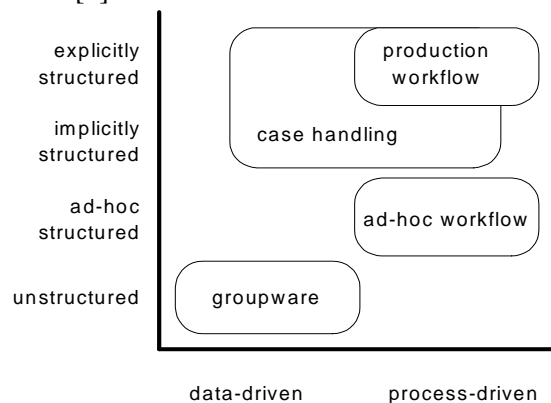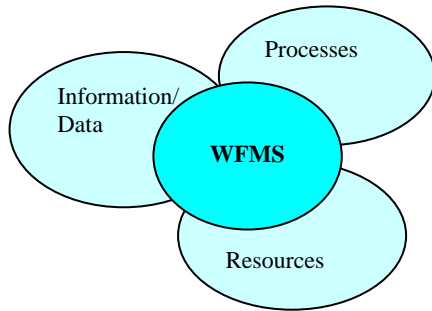

Figure 2: Adapted from [12]

Figure 3: WFMS Basic Concept

Real time collaboration between the different players involved in a process at any enterprise or extended enterprise have significant role in realization of efficient collaboration process. The four functional segments of the Real-time Extended Enterprise (REE) may include[10]:

- Collaboration Management
- Product Management
- Process Management
- Resource Management

2.1 Workflow Management

In order to make work controllable and to encourage communication between participants, workflow management systems have evolved. It is new class of a software package that can be used, to support the definition, management and execution of workflow processes[11]. Workflow system (WFS) is a system based on a WFMS that supports a specific set of business processes through the execution of computerized process definitions. Work flow management can be divided into four parts as shown in figure 4. Workflow planning and implementation processes have been further elaborated in the figure.

The next-generation workflow products are characterized by[10]:

- Real-time multi-user collaboration in virtual Workspaces.
- Task-specific, real-time contextual content and simulation embedded in the workflow.
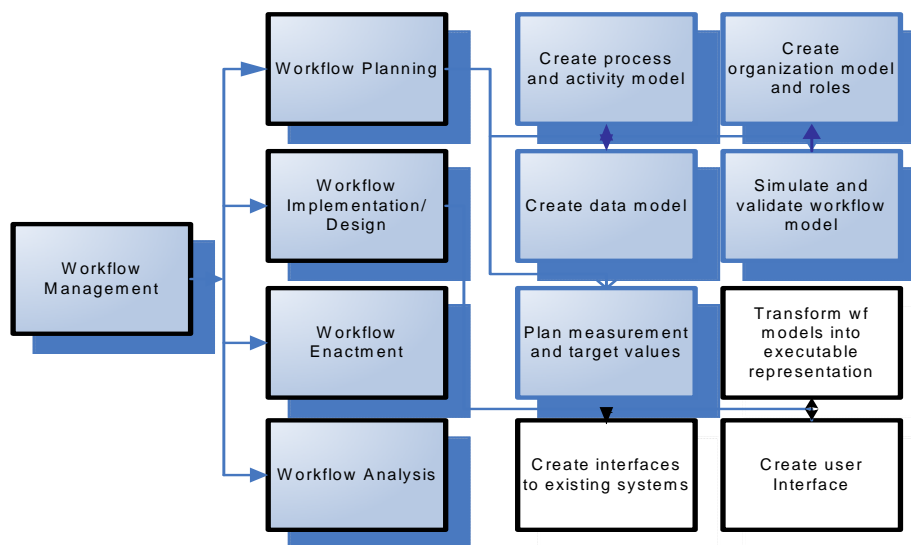

Figure 4. Source[8], Modified to cover only workflow planning and implementation

3 Workflow and Process management

Most of the modern product management systems/solutions, provide workflow and process management capabilities that enable processes and procedures to be modeled and managed electronically. Product data created using these systems can be submitted to the appropriate workflow or lifecycle for processing. The workflow can transfer data and information to nominated users, groups, or roles in the project, to carry out specific business processes. As lifecycle progresses its

history and related information can be accessed, thus tracking the process become possible.

Design process of an aeronautical product consist of three distinct phases, namely, concept design, initial design and detailed design. With introduction of complete 3D digital definition of the design process, digital pre-assembly forms, yet an other distinct phase in digital design process. A generic definition of concept design processes has been shown in figure 6, for basic understanding of the process. Designers in this phase, define main layout, system orientation and interfaces. Profile outline,

aerodynamics and structure loading including initial structure estimates is prepared. Wind tunnel and initial CFD validation is done on the prototyped scaled model. The information created during this phase is used as input to the next phase and so on. Most phases in design process are interdependent and can not be worked upon in isolation with each other. The overall process is thus iterative and information goes through refinement and changes as the processes evolve. Knowledge management and process control, is therefore fundamentally important. Information management is another key supporting process for efficient management and reuse of information.

Workflow and process management tools, are used as they help define and control changes to product configurations, part definitions, data relationships, versions, and variants. Lifecycle management can be used to define and control review and approval of changes to product definition information.

Workflow management systems enable process of approval and rejection to be automated through assignment of lifecycle to the roles. Participants in the process are assigned with different roles they play in completion of various projects. Tasks routed to the roles or participants are released to the vault at the next version level after the action is completed. Users can be notified that the version of the information has been incremented if appropriate triggers have been set. Workflow can automatically route electronic folders or "packages" of information or work packages to reviewers either serially, in parallel, or a combination of both. Workflow can be used to monitor processes ensuring that one process finishes before another starts, and provides management reporting information. The work flow tools can ensure automation and support of the full process, by assembling and controlling all the process parts previously defined. Putting all that to work, however is not as simple, especially for complex products like airplane. End to end workflow for product like airplane is thus mostly managed in parts. Workflow tools, however can assist the whole process regardless of the participants, departments etc, which contribute to it. If successfully implemented workflow tools can enable following[13]:-

- Automatically generate alerts or warnings during the complete processes, when desirable.
- Pinpoint the place where the bottlenecks are encountered.
- Report and furnish the status of the process, thus helping continuous update.

- It can provide statistics for each function contributing to the process and help assessing performance.
- It can provide cost analysis per process type and can help improve process.

4 Workflow a Tool for Integration

With the introduction and adoption of workflow standards from WfMC, the interoperation of workflow applications via internet, spread over different units has become possible. This is a big leap forward, towards realization of collaboration in extended and virtual enterprise.

Workflow applications act as the integration point for various applications like document management, material resource planning, e-commerce and other enterprise data management system. The distributed workflow applications handle the processes states, and keep their context up to date. They monitor whole behavior of each process and alert responsible actors of any problem that requires any attention. communicate to transfer part of information needed. Figure 5 presents a schematic view of workflow connecting the various processes along the lifecycle.

In modern, discrete enterprise, process view is centric to an activity. As the processes in such enterprise are highly structured the resources required to support, including their ownership, location and control all become relevant in the context of workflow. The virtual result is better coordination and integration. Following important activities of any discrete enterprise are strictly related to the workflow[9]:-

(a) **Definition of supporting processes**. Workflow definition requires that all the supporting processes are fully defined and evaluated. As a result feasibility of the planed project is much more seriously established, and teams get comprehensive specification and functional understanding.

(b) **Map on Resources**. Workflow predominantly help to define processes and activities. Once the processes and activities are clearly defined each activity in the process can be mapped on resources to take control.

(c) **Contract Resources.** One will have clear vision as to which resources will be needed at which stage, so the arrangement can be efficient and economical.

(d) **Operate the service**. When all the process is well defined and it is possible to monitor its status it will be very easy to operate, manage and control.
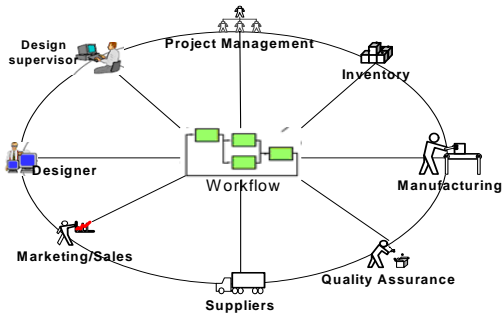
Figure 5. Workflow a central link to all players

The real-time Extended Enterprise workflow is marked by following characteristics [10]:-
- Deep and wide technical integration.
- Business process automation and extension (across and outside the enterprise).
- Zero latency.

The result of such an integration and assimilation is improved performance. Some of the reported achievements by implementing workflow are: Safari cites 50% savings in time spent searching for information by embedding content in workflow. Microvison's Nomad System claimed shaving off 50-80% of time required to do manufacturing and equipment repair, while Epiance said it was able to cut 80% off development time [10].
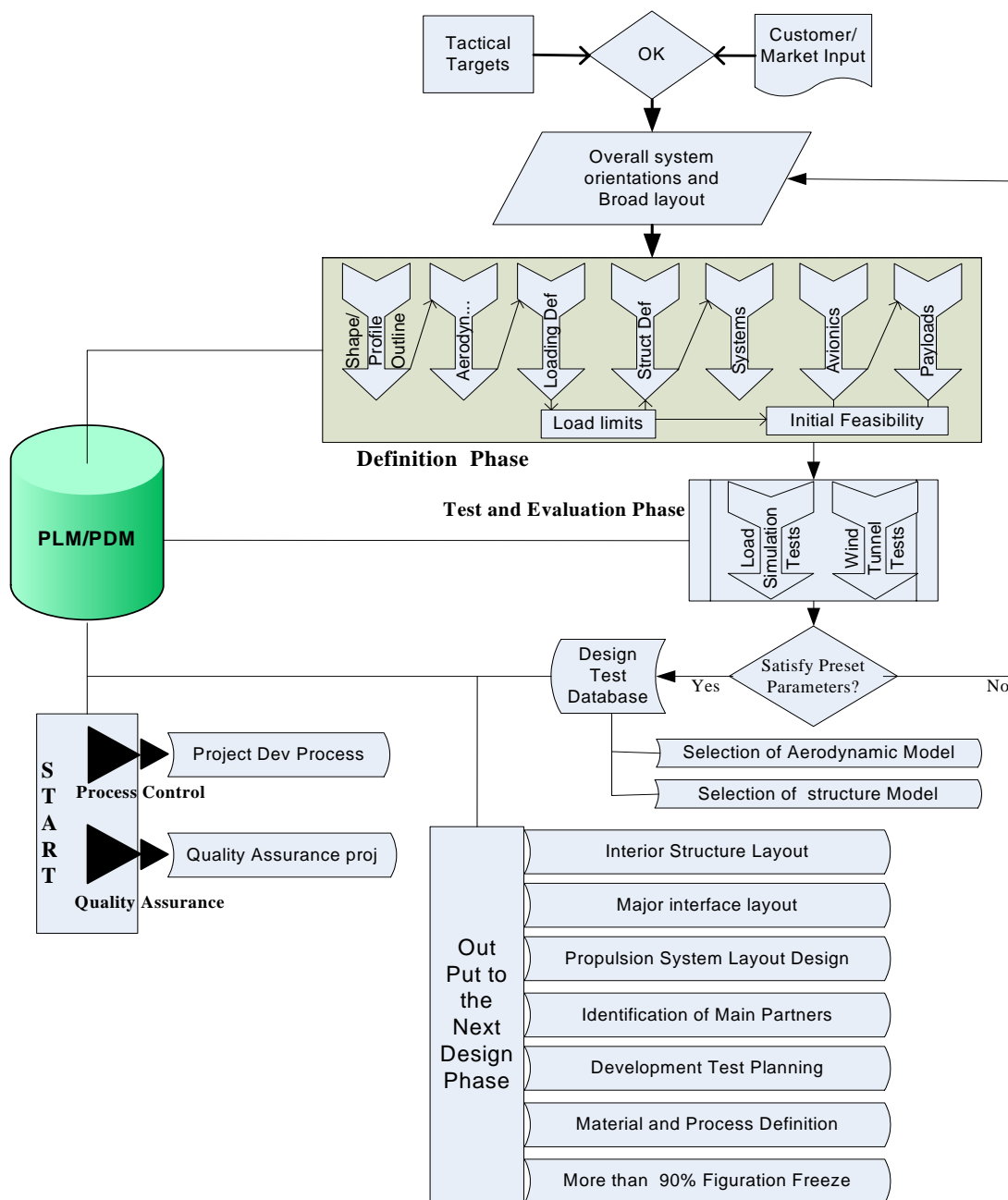

Figure 6. Process flow, Concept design process in airplane Design

5　workflow/Lifecycle models

The vision to develop and adopt, a generic model of lifecycle, stems from the need to create environment that accelerate the use of, common global exchange standards and reduce the effects of greater fragmentation in Aeronautics sector. Most of the large companies have developed their own Lifecycle models which are partially or fully integrated in their own ways, operating in terms of their quality systems and risk management. Aircraft development lifecycle model which is recognized and operated across the whole of the Aeronautics supply chain can improve the synchronization and integration of tasks across the future extended enterprise. From this view point we identify following lifecycles in the aircraft design as most critical universally.

(a) Airframe and power plant integration
(b) Avionics and all other related systems integration to include electrical, airframe and in case of military airplane it may involve more advanced and extensive equipment integration.
(c) Airframe and Landing gear systems integration.

Collaboration is about developing, structured events, processes and experiences. Workflow is a potent tool for defining, and structuring of events. With workflow approach we are predominantly moving towards automation of processes. That should make the events/process management more flexible and simple.

6　Conclusion

In this paper we investigated the workflow concepts in respect of discrete and complex product like airplane. A PLM based collaborative framework for design was presented, including the concept design flow process for airplane. Most relevant aspects of workflow and collaborative approach were analyzed. It can be safely concluded, that workflow has strong relationship with coordination and integration of events in collaborative design process.

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