Concurrent Engineering and based Applications for 3D Big Data

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***Abstract**: European companies' competitiveness depends on obtaining innovative products. In the last years, clients demand started to be higher and more complex. Because of that, managing products development processes have become a necessity. Product development processes need to be proficient and flexible: less complex and more competence-focused. 3DSpace brings more solutions in this matter. EXALEAD transforms large volumes of heterogeneous, multi-source data into real-time information intelligence to help users improve business processes and gain competitive advantage. EXALEAD enables organizations to gather and enrich Big Data to deliver that information in the process of integrated product development and allows customers to fully manage product programs, from 3D design to traceability of changes, cost, quality and issue analytics. Concurrent or Simultaneous Engineering is one of the fundamental approaches that meet the challenges mentioned above. EXALEAD uses CloudView to process big data flows. Concurrent Engineering represents a standardized approach to integrated product improvement which accentuates and gives priority to the customer expectations level. In this matter, 3DSpace's ENOVIA is used together with graphic software for manufacturing. It is about teamwork and confidence in which the decision-making process is consensual, even from the beginning of the product life cycle.*

***Key Words:** competitiveness, innovative products, competence, concurrent engineering, product life cycle*

1. INTRODUCTION

Big Data is a great amount of imprecise data spread in a variety of formats which is generated from different sources with high-speed. Lately, Big Data and 3D printing technologies is a new area of research and have been identified as types of technologies that will launch the fourth industrial revolution [1].

With the introduction of Industry 4.0, also known as the fourth industrial revolution, the customers' needs have considerably risen as the tendency consists in augmented and wireless

connected machines, intelligent platforms for production supervision, IoT networks, cloud computing and big sensor networks. In order to satisfy these elaborate requirements, concurrent and simultaneous engineering has emerged among many companies from European Union [2]. At the moment, multiple efforts are taking place for exchanging classic, sequential engineering with concurrent engineering.

This process aims to reduce production time by integrating different processes, such as design engineering, manufacturing, management, maintenance and marketing [3].

In order to achieve a systematic manner of designing and manufacturing a specific product, all of its life cycle elements should be taken into consideration, from conception to final results, ensuring a cooperative, collaborative, simultaneous and engineering work environment [4].

On the other hand, from the perspective of the European Space Agency, Competition Engineering is "a systematic approach to integrated product development that emphasizes the response to customer expectations. It incorporates the values of teamwork, trust and sharing in such a way that the decision-making process is by consensus, implying taking into account all the perspectives from the beginning of the product life cycle in parallel" [5].

They also believe that the concurrent engineering concept is based on five main components: a process, a multidisciplinary team, an integrated design model, a facility and a software infrastructure [6].

The main difference between concurrent engineering and standard procedures, consists in the design approach which means that even if the production process is in an early phase, the engineering team has a suggested design of the product [7].

Continuing on this idea, another advantage is the possibility of having a price and quality reference since the designing step [8]. To sustain this ideas, Figure 1 shows the stages of concurrent engineering in comparison to sequential engineering, the advantages and disadvantages of each method.

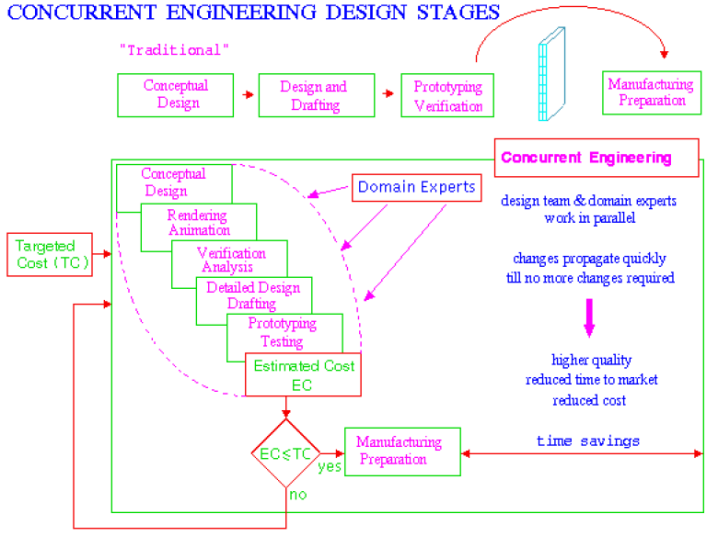


Figure 1. Concurrent engineering stages [7]

In addition, concurrent engineering consists of a team of experts who handle the entire production process from the initial idea of the product to the final stage of marketing.

This team is formed with the help of design, engineering and manufacturing expertise. The diversity of the team using concurrent engineering concept is described in Figure 2.

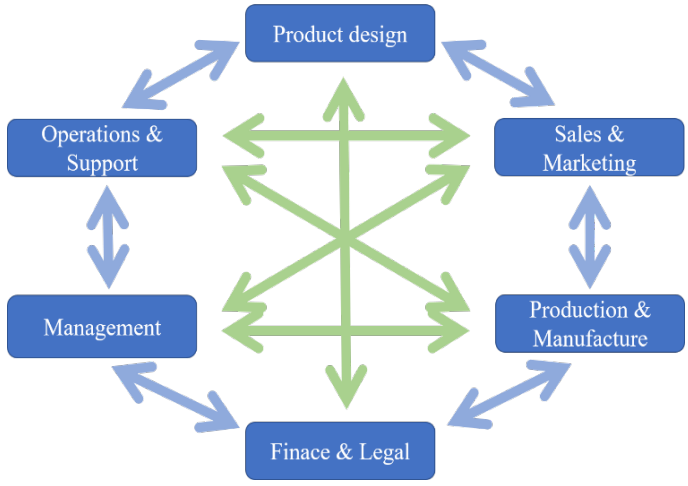


Figure 2. Diversity of concurrent engineering team [7]

The rest of the paper is organized as follows: Section II presents an overview of the concurrent engineering features and the concept itself. Section III and IV describe and show experimental results performed with ENOVIA and EXALEAD, two different solutions, which can be interconnected in order to allow the administration of the documents within a company and sharing documents with members of the company to improve the concurrent engineering concept. Section V concludes the paper.

2. RELATED WORK

Concurrent engineering represents a concept widely used in areas of electrical engineering, IT, aerospace, telecommunications, product manufacturing, etc. We will further present a couple of different use cases of concurrent engineering.

The paper "Achieving a More Electric Aircraft: a comparative study between the concurrent and traditional engineering models" [3] displays the process of concurrent engineering implemented in the development of an electric motor within a small electric aircraft. The main advantage is that all production stages, including the study, design, production, marketing, operation and dismantling, are done in one step, contract to the sequential execution of traditional engineering.

Thus, the price of the product is lower and the manufacturing process is less time consuming. The authors emphasize the need of concurrent engineering at an economic level. Due to the complex projects that companies need to achieve, this concept gives them the opportunity improve the quality of the products, the durability and lower fabrication costs.

The second case of concurrent engineering application is presented in [6] where the authors discussed the achievement of collaborative work in concurrent engineering accomplished by interconnecting the numerical simulations with the electromechanical design, reducing the time and costs of execution.

Furthermore, the concurrent engineering approach requires solving interdependent problems about stationary and magnetic-stationary electric field including problems of materials strength.

Article [4] presents Concurrent or Simultaneous Engineering as one of the key concepts that can satisfy the necessity of managing product development processes. These processes need to be more effective and efficient in order to reduce the complexity of work. In addition,

all companies need to understand that competitiveness will be more and more defined through their ability to adapt to a new market structure, so all of them will have to introduce the new global concept of concurrent engineering which is based on a competing engineering team responsible for the entire product life cycle.

3. ENOVIA

ENOVIA unlocks a different area of opportunities to the companies in order to provide ultimate products and business novelties which aims at creating unique experiences for the customers.

ENOVIA offers a large spectrum of technical and business applications and thus enables customers to safely work and improve together, to develop and execute an effective plan, that has the following features: real-time tracking and conformity with standards and regulations in order to change the market opportunities into marketplace advantages.

Powered by the 3DEXPERIENCE® platform, ENOVIA enables stakeholders to contribute to the economic development.

Even though mid-sized enterprises (SMEs) share comparative needs as bigger organizations and comprehend the significance of Product Lifecycle Management (PLM), there are concerns regarding the implementation of PLM, including the restricted IT assets for administration and training, etc.

The ENOVIA platform provides a collaborative framework for any function within a company. The platform is designed from an application that provides an easily configurable interface called Business Process Services (BPS).

BPS creates a working environment for applications, facilitating collaboration between internal and external users (for example, providers), while maintaining control over access to content.

It also provides metrics reporting capability to evaluate performance considering the content of the product.

ENOVIA allows the configuration of bill-of-materials BOM for a certain product. For example, the HE-R1000[11] pilot project presents an EBOM calculation in the following description.

The HE-R1000[11] equipment is used as part of the evaluation of the application of the new MES system in the corporate Information System architecture. The “Core business of the Turin site” explains the purpose of this pilot project.

In brief, this is a mechanical platform with the purpose of being used in different projects, because of its modularity.

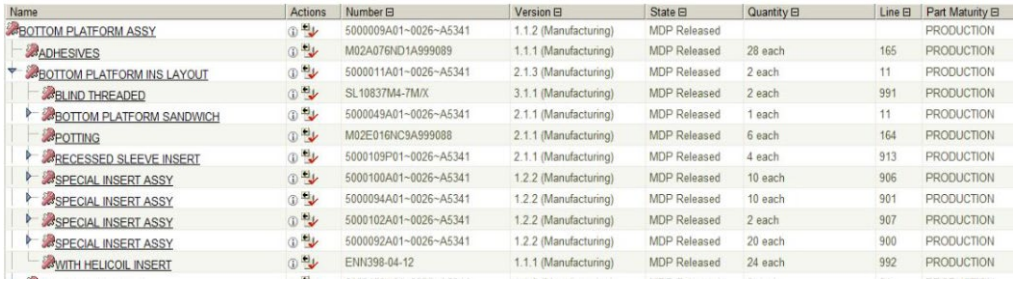
This mechanical system comprises three structures: primary structure is the mechanical stability to the configuration item; secondary structure is the support for other systems (e.g. sensors and antennas); tertiary structure has complementary parts that do not appear in the first and second structures.

The HE-R1000 primary structure has 134 part numbers meaning the quantity of items required to obtain it.

Having the Bottom Platform Assembly, an evaluation of more dataflows from WAND, DELMIA Apriso and SAP took place. To this evaluation, one of the HE-R1000 items was included. With the consent of Enovia and WAND, this table presents the EBOM and the MBOM of the Bottom Platform Assembly [11].

Name	Actions	Number	Version	State	Quantity	Line	Part Maturity
BOTTOM PLATFORM ASSY		5000009A01~0026~A5341	1.19 (Engineering)	Released			PRODUCTION
ADHESIVES		M02A076ND1A999089	1.3 (Engineering)	ACTIVE	28 each	165	PRODUCTION
BOTTOM PLATFORM INS LAYOUT		5000011A01~0026~A5341	2.7 (Engineering)	Released	2 each	11	PRODUCTION
BLIND THREADED		SL10837M4-7M/X	3.4 (Engineering)	ACTIVE	2 each	991	PRODUCTION
BOTTOM PLATFORM SANDWICH		5000049A01~0026~A5341	2.3 (Engineering)	Released	1 each	11	PRODUCTION
POTTING		M02E016NC9A999088	2.3 (Engineering)	ACTIVE	6 each	164	PRODUCTION
RECESSED SLEEVE INSERT		5000109P01~0026~A5341	2.2 (Engineering)	Released	4 each	913	PRODUCTION
SPECIAL INSERT ASSY		5000100A01~0026~A5341	1.10 (Engineering)	Released	10 each	906	PRODUCTION
SPECIAL INSERT ASSY		5000102A01~0026~A5341	1.7 (Engineering)	Released	2 each	907	PRODUCTION
SPECIAL INSERT ASSY		5000094A01~0026~A5341	1.6 (Engineering)	Released	10 each	901	PRODUCTION
SPECIAL INSERT ASSY		5000092A01~0026~A5341	1.6 (Engineering)	Released	20 each	900	PRODUCTION
WITH HELICOIL INSERT		ENN398-04-12	1.4 (Engineering)	ACTIVE	24 each	992	PRODUCTION

Figure 3. Bottom Platform Assembly EBOM structure



Name	Actions	Number	Version	State	Quantity	Line	Part Maturity
BOTTOM PLATFORM ASSY		5000009A01~0026~A5341	1.1.2 (Manufacturing)	MDP Released			PRODUCTION
ADHESIVES		M02A076ND1A999089	1.1.1 (Manufacturing)	MDP Released	28 each	165	PRODUCTION
BOTTOM PLATFORM INS LAYOUT		5000011A01~0026~A5341	2.1.3 (Manufacturing)	MDP Released	2 each	11	PRODUCTION
BLIND THREADED		SL10837M4-7M/X	3.1.1 (Manufacturing)	MDP Released	2 each	991	PRODUCTION
BOTTOM PLATFORM SANDWICH		5000049A01~0026~A5341	2.1.1 (Manufacturing)	MDP Released	1 each	11	PRODUCTION
POTTING		M02E016NC9A999088	2.1.1 (Manufacturing)	MDP Released	6 each	164	PRODUCTION
RECESSED SLEEVE INSERT		5000109P01~0026~A5341	2.1.1 (Manufacturing)	MDP Released	4 each	913	PRODUCTION
SPECIAL INSERT ASSY		5000100A01~0026~A5341	1.2.2 (Manufacturing)	MDP Released	10 each	906	PRODUCTION
SPECIAL INSERT ASSY		5000094A01~0026~A5341	1.2.2 (Manufacturing)	MDP Released	10 each	901	PRODUCTION
SPECIAL INSERT ASSY		5000102A01~0026~A5341	1.2.2 (Manufacturing)	MDP Released	2 each	907	PRODUCTION
SPECIAL INSERT ASSY		5000092A01~0026~A5341	1.2.2 (Manufacturing)	MDP Released	20 each	900	PRODUCTION
WITH HELICOIL INSERT		ENN398-04-12	1.1.1 (Manufacturing)	MDP Released	24 each	992	PRODUCTION

Figure 4. Bottom Platform Assembly MBOM structure

This is the ENOVIA EBOM Management interface:

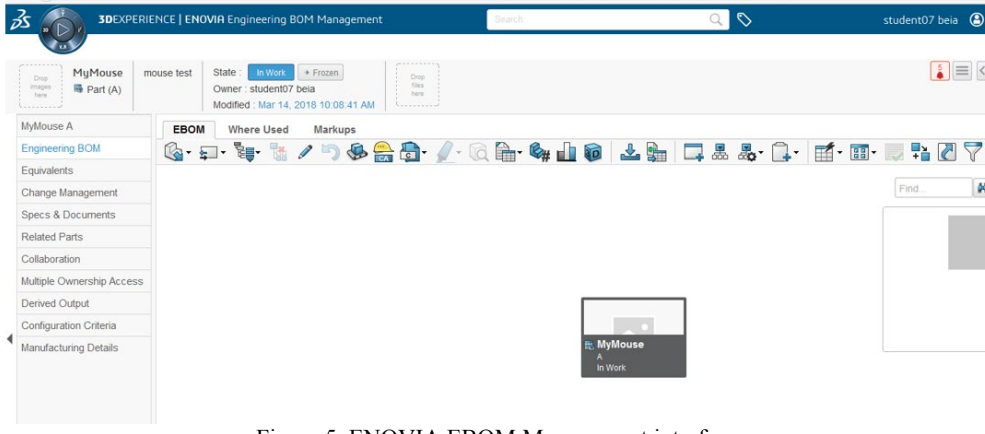
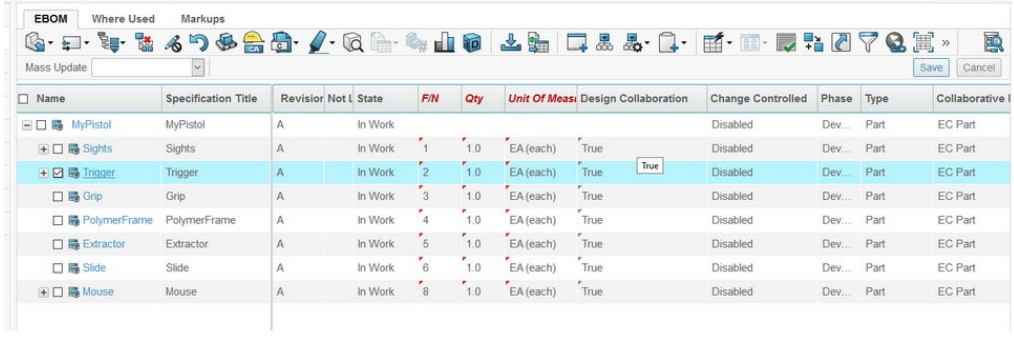


Figure 5. ENOVIA EBOM Management interface

ENOVIA EBOM Training [12] shows the following examples about how reports are managed:



Name	Specification Title	Revisior	Not L	State	F/N	Qty	Unit Of Measi	Design Collaboration	Change Controlled	Phase	Type	Collaborative
MyPistol	MyPistol	A		In Work					Disabled	Dev...	Part	EC Part
Sights	Sights	A		In Work	1	1.0	EA (each)	True	Disabled	Dev...	Part	EC Part
Trigger	Trigger	A		In Work	2	1.0	EA (each)	True	Disabled	Dev...	Part	EC Part
Grip	Grip	A		In Work	3	1.0	EA (each)	True	Disabled	Dev...	Part	EC Part
PolymerFrame	PolymerFrame	A		In Work	4	1.0	EA (each)	True	Disabled	Dev...	Part	EC Part
Extractor	Extractor	A		In Work	5	1.0	EA (each)	True	Disabled	Dev...	Part	EC Part
Slide	Slide	A		In Work	6	1.0	EA (each)	True	Disabled	Dev...	Part	EC Part
Mouse	Mouse	A		In Work	8	1.0	EA (each)	True	Disabled	Dev...	Part	EC Part

Figure 6. An EBOM dataset [12]

BOM report comparison example: TriggerGuard with F/N=1 and TriggerPart with F/N=2.

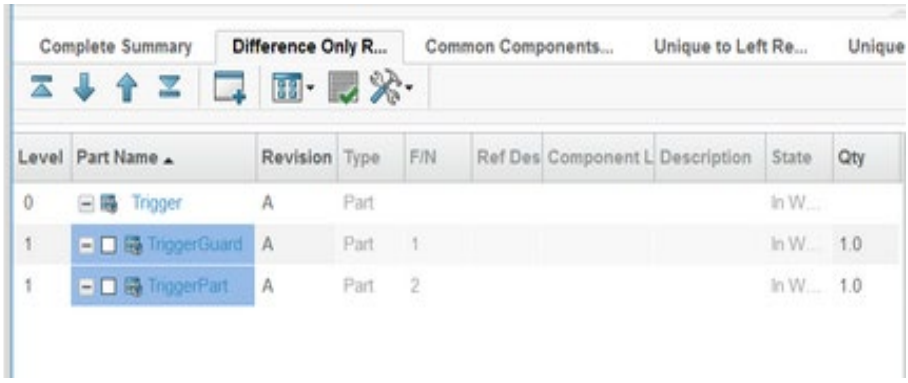


Figure 7. The two BOM reports [12]

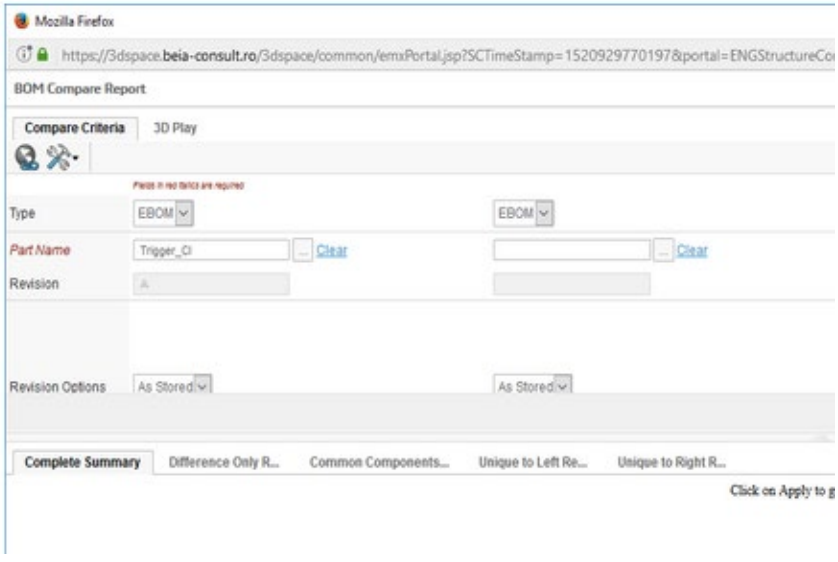


Figure 8. The reports are compared by criteria [12]

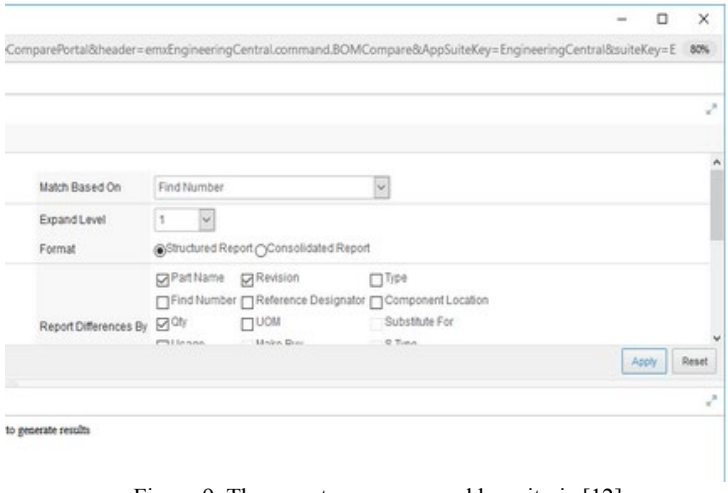


Figure 9. The reports are compared by criteria [12]

The format used is Structured Report. The two reports received a variable to be arranged and classified: Revision, F/N, Qty Maturity, Type. Initially Qty=1 for both reports. After the comparison, TriggerGuard has a Qty=3.

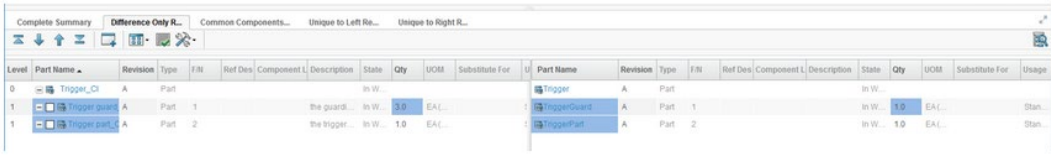


Figure 10: Qty parameter changed [12]

These pictures present several functionalities used in ENOVIA applications, which allow the content management and collaboration between the team members.

The ENOVIA envelope comprises different products, which can be categorized by function, by having various user roles in a company, as follows:

- **Governance** enables organizations to dispatch undertaking wide new item presentations on-schedule and on budget.
- **Global Sourcing** permits organizations to utilize the supply chain abilities all through the item lifecycle and make their providers an indispensable piece of item improvement.
- **IP Lifecycle Management** eliminates the mistakes of advancing expensive items, by empowering improved cross-functional product design, producing outlining and accomplishment simulation.
- **Unified Live Collaboration** enables organizations to deploy item lifecycle techniques across organization, providing a unique perspective on areas of IP general business procedures, effective administrative skills of the cooperation process and an SOA that incorporates with another endeavor framework.

Each function is additionally separated into orders that incorporate items focused on upgrading a client`s competitiveness. These items might be sent together as a major aspect of a solitary ENOVIA framework or independently. Subsequently, the functionalities used in the ENOVIA applications, permit content management, as well as collaboration with other company members. Figure 11 illustrates the interface of the ENOVIA platform.

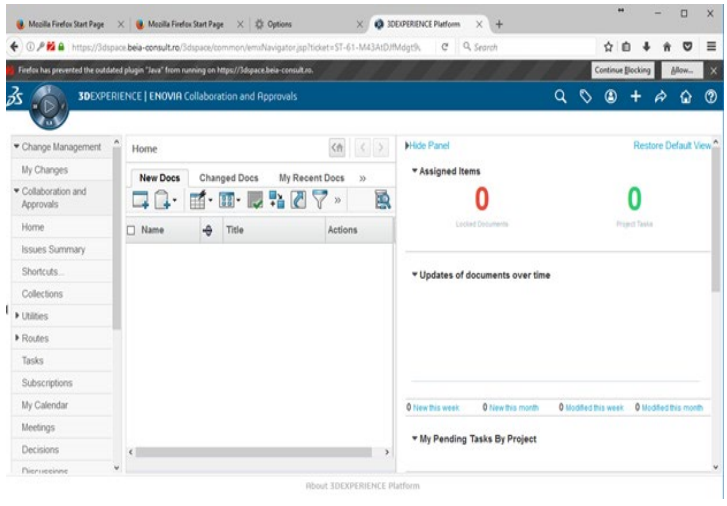


Figure 11. ENOVIA platform interface

The documents can be managed in a workspace and users can allow other users access to certain documents from the workspace.

ENOVIA has the following functionality: templates already existing in the platform can be used when starting a new workspace. Thus, new templates can be easily created. Another functionality of the platform is the organization of meetings (Meetings), which can be structured in a workspace. The accomplishment of a new "meeting" is shown in Figure 12.

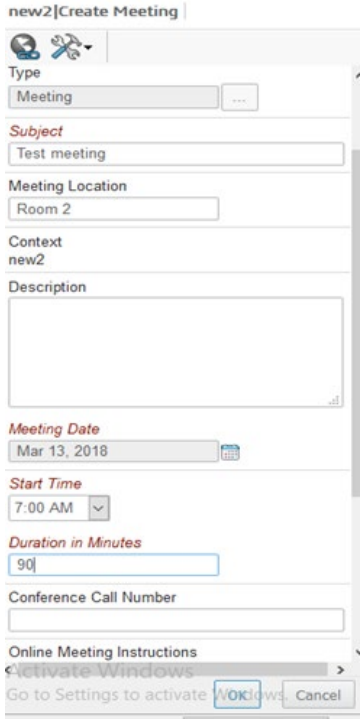


Figure 12. Accomplishment of a new meeting

In the meeting, users can also add an agenda, can assign decisions, tasks, and after finishing creating the meeting, it can be switch to "Complete" mode.

Within 3DSpace, ENOVIA, Exalead's search engine and CloudView can work together. The EXALEAD interface is shown in Figure 13.

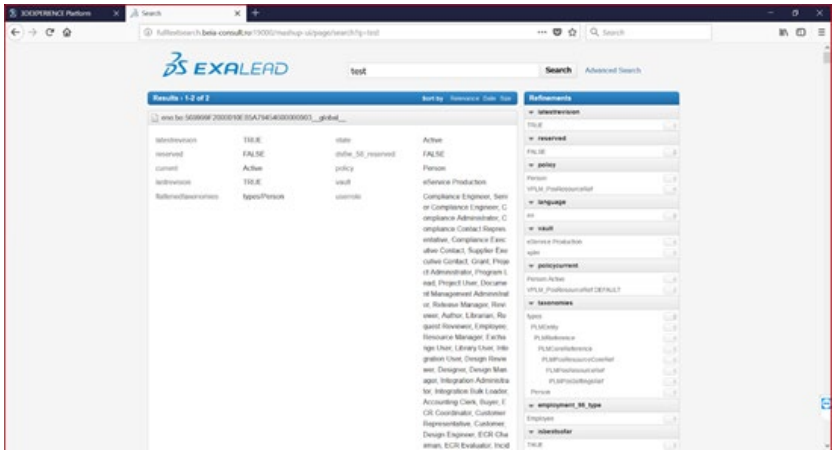


Figure 13. Exalead CloudView interface

At the same time, EXALEAD offers the Common Document Model (CDM) solution that allows managing documents and files and also sharing them with other members in different applications. The objects can be contained in the form of documents and files associated with them. The documents serve as a container object for files.

4. EXALEAD

EXALEAD is about data discovery and managing Big Data. Its products are PLM Analytics, One Part and One Call. It has a powerful search engine [9], a tool that allows organizations to store Big Data and to offer the precise information searched by the user. Within 3DS, Exalead works together with CloudView uses advanced semantic to bring the structure and the meaning of previously unused data.

This tool represents one of the most dominant semantic engines, as it enables associations to gather Big Data, either internally or externally, structured or unstructured, and to convey this data to explicit clients who are keen about this topic. This arrangement intends to change a high quantity of information into a significant, clever, continuous data which will improve the business processes [10]. A solution integrated within the 3D Experience Platform is EXALEAD OnePart that enables a company to manage and monitor the implementation of its policy. The software, that presents a user-friendly interface, was installed on a Virtual Machine. Exalead OnePart tool has the features of reusing 3D parts, drawings or test results in an organization by suggesting the components that match the author or the material, as in the example from Figure 14.

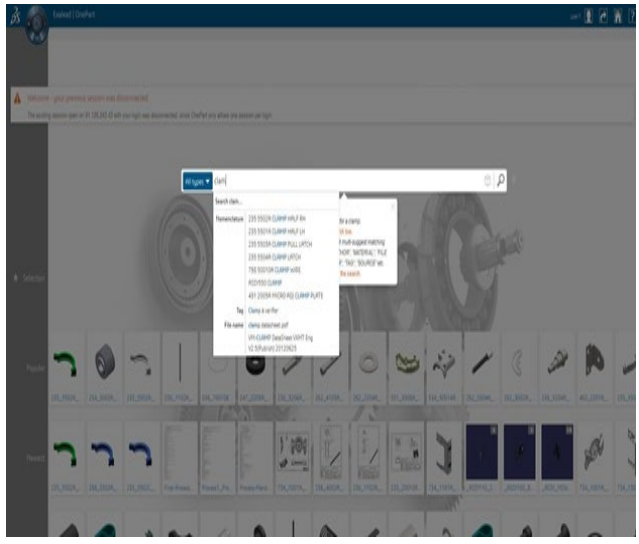


Figure 14. Search of a component based on its name

It shows some facets that can be utilized to filter the search. Also, it can detect parts that might have issues. When a part from the database is selected, a preview with its attributes will be shown. Moreover, a comparison between the selected components and their reference is presented, highlighting in red the ones which are different. Through EXALEAD One Part, which can compare the costs, the best alternative solution can be chosen. By using users interrogation, text searches were performed. Furthermore, 3D mechanical related searches found parts based on different types of characteristics, such as holes. The data can be better understood, and the reports can be more easily labeled by the users, through the use of

diagrams. Another solution offered by EXALEAD is the CloudView platform, which utilizes modern semantic techniques to fetch structure, significance and availability to beforehand unused or under-used data in the novel hybrid company and Web data cloud. CloudView gathers information from any source, in any format, and turns it into organized, universal, contextualized blocks of business data that can be investigated and questioned straightforwardly, or utilized as a basis for another type of lean, innovative data access applications, its interface being shown in Figure 15.

Figure 15. Exalead CloudView interface

EXALEAD empowers companies to satisfy needs for in-context, precisely conveyed Web and Big Data information, comprised, categorized and simple to reach [11].

5. CONCLUSIONS

Big data is not just an advertising strategy utilized by system suppliers, it is a substantial component of the digital marketplace that businesses of all sizes can take advantage of. Organizations should learn how to accept and assimilate it. Moreover, the concurrent engineering, more precisely, the Big Data within PLM, with the IoT-based products, represents an opportunity to change the way businesses are run.

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