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# INCREASING PRODUCTIVITY WITH THE COMBINED USE OF CAD/CAM/CAE SOFTWARE PLATFORMS FOR COLLECTIVE WORK DURING THE DESIGN OF THE MULTIPURPOSE TRAINING-PRACTICE MORTAR ROUND FOR SHORT DISTANCE ENGAGEMENTS

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***Abstract:*** *The paper investigates the capabilities for increased productivity, reduced lead times, and higher product quality with the concerted use of CAD/CAM/CAE and software platforms for workgroups. For the purposes of this report, the design of the reusable training-practice mortar round for short distance firing is used as an example.*

**Keywords: CAD/CAM/CAE systems, training mortar, MS Sharepoint Portal Server, engineering design**

## 1. Introduction

Technical advances and information innovations envisage the increasing involvement of virtual technologies in industrial environments, not only for design but also for realistic virtual visualization. The requirements and trends demand for a more interactive presentation of projects so that the virtual product is brought closer to the actual operating conditions.

The interest in mobile applications and the use of the cloud model is also increasing. In response to these requirements, CAD / CAM / CAE systems have reached an extremely high level of development and application, mainly due to advancements in the development of computer technology, applied mathematics and information technology. From the first generation of engineering software known as "electronic drawing", they have evolved into a fully integrated design, manufacturing and engineering systems with wide array of functions. Their application in product design and related technological processes has led to an increase in the quality of production, shortening the time from concept to product realization, flexibility in changes in the market and consumer requirements.

The idea of intelligent manufacturing also encompasses innovations in CAD / CAM systems. The pursuit of simplified management is particularly pronounced and has the goal to allow more engineers, not just experts the ability to work with the products. Furthermore, there is as an ongoing software trend about maximum independence between software and hardware. Modern CAD / CAM systems can be installed on different hardware platforms operating under their respective operating system as long as they meet the required minimum specifications [1]. Thus, decentralization of jobs is increasing. There is also an increased interest in mobile

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applications and the use of cloud models. Some software vendors already offer their customers a comprehensive portfolio of cloud services that are part of the subscription programs and support services for purchased licenses. This allows the users to easily take advantage of the software when needed and only pay for the actual usage time. Experts predict that more and more companies will overcome their insecurity about cloud applications and take advantage of them.

Over the past 3 years, there has been a significant increase in awareness of the following trends in engineering design [5]:

- 3D printing;
- Cloud Based CAD;
- Product lifecycle management (PLM);
- Concurrent engineering;
- Enhanced rendering in real time – rendering is the process of generating an image from a 2D or 3D model with the help of computer software.

Influenced by the requirements set by the engineering industry, state-of-the-art conceptual design software includes a wide variety of functions ranging from simple digital sketching and automated design to additional collaborative and modeling tools that allow design engineers to decide whether the designed products will move and function properly. Among the new capabilities of these tools are mobile capabilities and cloud technologies.

Increasingly, new CAD-oriented product lifecycle management solutions are based on joint work applications such as Microsoft Share Point and Windchill ProductPoint and are targeted at small and medium-sized businesses

Share Point give the user the ability to administer on different levels, grant access rights, track who and when opened a document. This solution also ensures the maintenance of an information site [2].

The next section of the report will evaluate the collaboration between CAD / CAM / CAE systems for mechanical engineering and Microsoft SharePoint and Windchill ProductPoint products, in particular for the creation of a reusable training-practice mortar round for short distance engagements.

## 2. The need for the development of a reusable training-practice mortar round for short distance firing.

A tendency aimed towards the modernization of NATO and other armed forces is seen during the recent decades. The modernization of the armed forces however requires not only new equipment but also the implementation of modern means and methods for training military personnel and in military education institutions .Part of these tools are the practical simulators. The most common disadvantage found in most practical simulators however is the fact that they cannot simulate the full range of the crew's combat functions.

One type of artillery system that is currently in service in the majority of armies are mortars.

In order for a high quality and effective practical, mortar training to be achieved, the development and implementation of a practical simulator is required. The created simulator must not only lower financial expenses but also guarantee a high level of immersion in real combat activities conducted on the firing position during live firing [3].

Based on the analysis conducted on already developed practical simulators for the training of mortar crews in different countries the following basic requirements for the designed simulator can be identified:

- The construction of the simulator must include the basic components that are required for live-firing: mortar, training-practice mortar round and fuze; (Figure1).

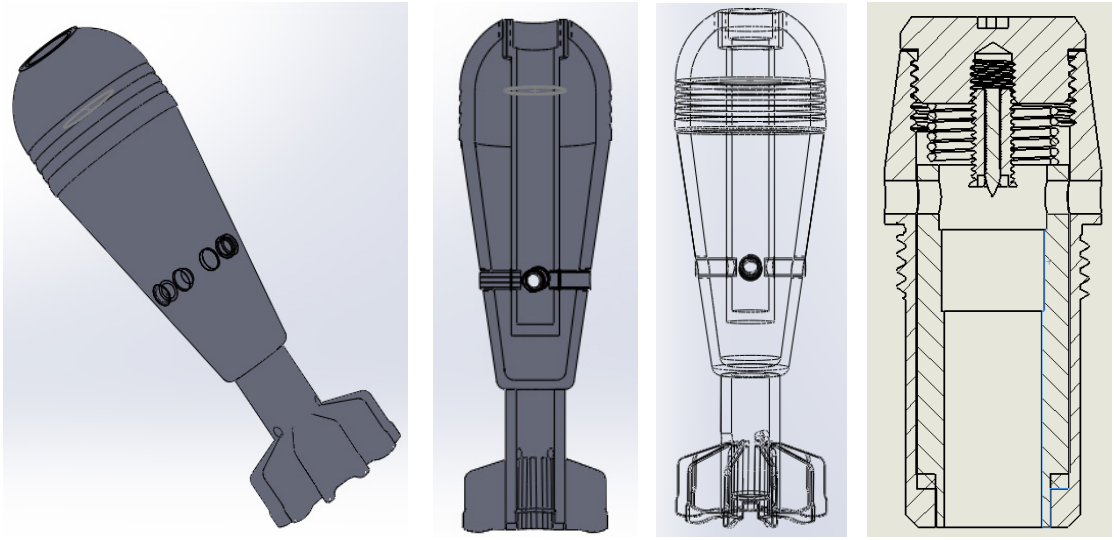

*Figure 1: Digital model displaying the elements of the reusable training-practice mortar round simulator for short distance firing.*

- The training-practice mine must resemble, as much as possible, its combat counterpart in terms of appearance, weight and dimensions. The abovementioned criteria are required in order for the round to provide better practical training and to create a true picture of the round's operation;
- The construction of the training-practice mortar round must have simple technological design that incorporates already manufactured elements from its combat counterpart;
- The training-imitational fuze must be able to mark the area where the round has made impact with the ground. The fuze must be unable to cause fire, but at the same time, must still be capable of clearly indicating the area where the round has made impact;
- The training-practice fuze must fiction reliably and have a simple design and reliable action;
- The construction of the training-practice fuze must incorporate a safety mechanism that does not allow detonation before the round is fired;
- The ignition cartridge must resemble the ignition cartridge used in the live round as much as possible in terms of appearance and dimensions;
- The maximum firing distance must be 100 m, allowing the system to be used on firing ranges and training grounds;
- The minimum firing distance must be 20 m, ensuring the safety of the mortar team.

CAD / CAM / CAE systems have been used during the development of the reusable training-practice mortar round for short distance engagements, for the three-dimensional medialization of the individual parts and the assembled unit. Using the abovementioned systems for automated engineering, the graphic part of the design documentation is made including-drawings, engineering calculations and analysis (CAE), a prototype (Rapid Prototyping-RP) and manufacturing preparations (CAP). During the final stage of development, control programs for NC machines are generated. The generated programs are capable of producing models with various complexity (CAM) included in the reusable training mortar mine.

Stress and kinematic calculations for weapon components are performed automatically using CAD systems when certain output parameters are set. The immediate results required for parts with

multiple and repetitive contact surfaces such as the housing and the movable sleeve of the training-imitation fuse of the training-practice mortar are immediately displayed.
For the fictional simulations, the joint work of the coupled lever systems, transmission mechanisms and the movement of different components is simulated, from which the normal operation is gathered and conclusions are drawn about the corresponding boundaries of jamming, collisions, gaps, etc. The simulation of stress-strain calculations is performed either on a single part or on an assembly of parts.
Stress-strain calculations for elements of the trigger mechanism of the training-imitation fuze of the training-practice mortar round.
Weapons that use the energy of combustion gases to propel the elements and mechanisms must take into account the stress characteristics of individual parts. In the reviewed system, due to the explosion imitation, high temperature gases and pressures occurs, which operate in a specially designed bushing fixed in the round. Passing through the centrally located bushing and the vent holes outside the mortar body, these gases exert a certain force on the surfaces of the holes and give their energy to them. Geometric CAD modeling allows the production of elements and mechanisms, regardless of their complexity. Furthermore, CAD modeling allows for stress testing in a simulated virtual environment before the models can enter the production process. This is a huge advantage for the manufacturing process, as it is economically saving which should not be overlooked.

## 3. Assessment on the joint use of the lifecycle management software MS SharePoint and CAD/CAM/CAE products.

In order to use the MS Project product in the process of digital design, computer-aided calculation and simulations on the working principles of 3D models of details and mechanisms, it is necessary to use software products for group work. They allow manage tools for publishing, collaboration with different individuals involved in CAD design and document management with the integrated Intranet Portal platform, work group and document control - Microsoft SharePoint Portal Server.
The Microsoft SharePoint platform fully meets the functionality requirements of the group development phase and the organization of the product-based conceptual design [4]:

- Software version support and history option for CAD files;
- Apply descriptive information that can be used to find a specific document;
- Control over the publication of the document;
- Automatic routing of documents for review;
- Web discussions and online commentary from multiple document reviewers;
- Control the access to a document based on user roles.

The SharePoint product helps for share work cross individuals, get comments from reviewers, identify a document with descriptive information such as keywords, and publish the CAD document to the general public.
During group work with CAD files, different files can have different movement routes conforming to the standard rules for the movement and approval of documents adopted in certain structures. When an author chooses to publish a document the document can be automatically forwarded to one or more employees at different levels for review before the publication itself. Each of these employees, as reviewers, has the option to approve or reject the document, as well as to make adjustments to the geometry of the 3D CAD model, depending on their access rights.
The SharePoint product thus facilitates the automated exchange of documents and data

between officials. The published documents are made available to officials for search or review on a portal site.
Tracking changes and eliminating the possibility for employees to override modifications made by another user is provided by SharePoint Server by logging document history - create versions
Extremely important capability that SharePoint provides the ability to create document profiles (information for a document that can later be searched). This mechanism can easily add custom characteristics that meet the requirements of standards for templates (pads).
SharePoint uses roles to control access to the content of CAD documents that are published. Officials may be assigned with the roles of coordinator, author and reader based on the activities they perform. A group of specific rights to access and handle documents defines each role: the coordinators deal with management tasks; authors add and update files, and readers have read-only access to published documents. SharePoint also offers the ability to deny certain users access to certain documents (depending on the position in the particular enterprise / organization).
A major advantage of the SharePoint platform is its close integration with Microsoft Office products, which provides fast, easy and convenient handling of documents and a high degree of control over their handling.
The effect of using SharePoint is expressed in:

- Improving the design, calculation and virtual simulation efficiency of 3D digital models;
- Enabling quality and rapid preparation and exchange of necessary information regarding a particular step of the design phase.

## 4. Evaluation on the workgroup use of the software platform for product lifecycle management Windchill ProductPoint and CAD/CAM/CAE products.

Windchill ProductPoint is based on MS SharePoint portal server, a Microsoft collaboration infrastructure technology. SharePoint itself is well received by manufacturing companies as a core element of Office applications, originally for document sharing and management. ProductPoint enables SharePoint to identify and store CAD and CAE data sets and gives SharePoint access to the product development world.
SharePoint is a significant step forward for shared servers, commonly used today by smaller companies, with its most important features being: central storage, web based storage access, access control with document permissions levels, automatic document revision and detailed search capabilities. Deploying files in a central repository eliminates many of the problems associated with individual document ownership.
Microsoft views SharePoint as a social computing platform that allows data to be shared by different users [4]. ProductPoint builds on SharePoint by adding large file management extensions and complex file structures inherent to mechanical products.
The most distinctive features are document storage, search inside enterprise systems and productivity related to a fully web-based application. ProductPoint benefits companies of all sizes [6]. For smaller companies, installing SharePoint and ProductPoint provides a great start to collaboration and product lifecycle management (PLM). For larger companies that may already have SharePoint installed, ProductPoint further develops their SharePoint strategy by extending the product development system to a wider user community. ProductPoint capabilities include:

- Multi-CAD SharePoint services offering basic Pro / ENGINEER data

management features as well as other CAD file formats and interactions;
- ProductView services that allow visual product interaction with 3D thumbnails, lightweight product previews, and web-based editing tools for design editing;
- Visual navigation and querying for file dependencies;
- Windchill PLM Connector, which enables CAD data sharing between Windchill-based systems to assist customer or vendor collaboration or internal collaboration across departments.

Among the benefits of integrating automation platforms in design and production on the one hand and PLM platforms for shared teamwork are the following:

*Minimize project redesign.* It is a fact that projects of all kinds are becoming increasingly more complex. Against this background, any reworking of the project is complicated and expensive. The benefits of being able to identify and eliminate design problems at the conceptual design stage are enormous.

*Agile project management.* As in many other fields, conceptual design has also recently benefited from the Agile project management methodology, focused on breaking down a project into smaller tasks. Modern tools for conceptual design enable the user to deal with complex projects, working separately on their shape and the choice of materials and aspects related to the physical and environmental impact, etc.

*Advanced collaboration opportunities.* Better collaboration with clients and other project stakeholders results in fewer reworks, greater customer satisfaction, and a shorter project implementation cycle. New conceptual design software enhances collaboration, both within the company and with partners outside it, exploiting current technological trends, including cloud and mobile technologies.

## 5. Conclusion

In conclusion, it can be summarized that the transition from rough paper sketching to digital sketching at its current stage is advancing quickly, and it can be expected that the future evolution of this process will continue to evolve as rapidly as the developers constantly refine the tools available, with the consumer engineers being quick to adopt them. For their part, users demand more realistic rendering, better means of project variant comparison, larger toolbox libraries, etc. This inevitably necessitates the implementation of appropriate software products and collaboration platforms in the design and calculation phase. Furthermore, the implementation of product lifecycle management platforms is also necessary for the synchronization of the activities of geometric identification of 3D models, engineering calculations, prototyping and product manufacturing.

These conclusions and summaries are supported by the results gathered from the experimental research from fire-missions with the training-practice mortar round. The round's element design, engineering calculations and simulations were conducted in an environment of systems for automation of engineering work.

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