

Research Article

Three Dimensional CAPP Technology of Projectile Based on MBD

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Abstract: This study aims at the research goal of three-dimensional digital process design of projectile, which adopts three-dimensional computer-aided process design technology based on MBD and uses MBD to conduct parametric modeling of projectile that can reduce the input of projectile's process information and data conversion and produce reasonable, feasible and three-dimensional projectile manufacturing process to realize paperless three-dimensional process design of projectile. The application of three-dimensional computer-assisted process design technology of projectile based on model definition can shorten the design cycle of projectile, thus improving rapid manufacturing capacity of product and reducing cost.

Keywords: 3D-CAPP, MBD, projectile

INTRODUCTION

With the rapid development of economic globalization and information integration, especially the increasing popularity and wide application, it becomes possible for the human to apply three-dimensional model to express design purpose (Dakang and Yongfeng, 2003). In order to enhance technology level and efficiency and enhance market competitiveness, computer aided process planning, CAPP shall be used. As the middle link, the research and development of CAPP seems very important and hosts of manufacturing enterprises adopt the producing method of two-dimensional plus three-dimensional (Yanbin and Haibing, 2006). Moreover, quite a part of enterprises regard the two-dimensional as the center and the three-dimensional as producing method, making products' data delivering process complex, the efficiency low, the cost high and information using ration low (Fujun *et al.*, 2011). Therefore, how to conduct process design based on three-dimensional product model has become the pressing need of enterprises. It is necessary for enterprises to conduct technological research of three-dimensional digital process design, build a three-dimensional process model which is, integrated with design and supporting process information, a three-dimensional digital expression and convenient to the application of following process (Shengping and Lihong, 2010). Based on this, enterprises can study how to use three-dimensional model to conduct process design, which will promote the realization of intellectualization and atomization of process design, accelerate the digital manufacture and integrated application of three-dimensional product model,

effectively improve the technological innovation of enterprise products, shorten the development cycle of new products and enhance market adaptability (Chen and Lihong, 2010).

This study aims at three-dimensional digital process design on projectile products. Based on the projectile three-dimensional digital model and by using the MBD-based three-dimensional computer-aided process design technology, this study conducts parametric modeling on projectile by making use of MBD standard. The established three-dimensional digital process model contains not only information such as the geometrical information describing the manufacturing state of product parts, the technical requirements on the processing or assembly manufacturing techniques and the description information on the size and process, but also the process planning information which can directly be used in processing and assembly and can fully describe the manufacturing process of product parts (Fuzhou and Haideng, 2010). The three-dimensional computer-aided technological design can intuitively provide guidance and explanation for operation in processing and manufacturing and more importantly, it can provide intact structured process information for manufacturing implementation (Zhiqiang *et al.*, 2009).

METHODOLOGY

The projectile standard and modeling based on model: With the instant advance and development of Chinese weapon equipment business, the demands to the projectile have becoming more and more, which needs to enhance the corresponding technology, among

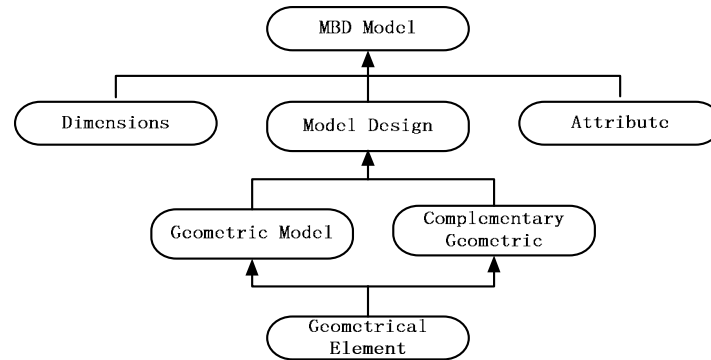


Fig. 1: MBD model

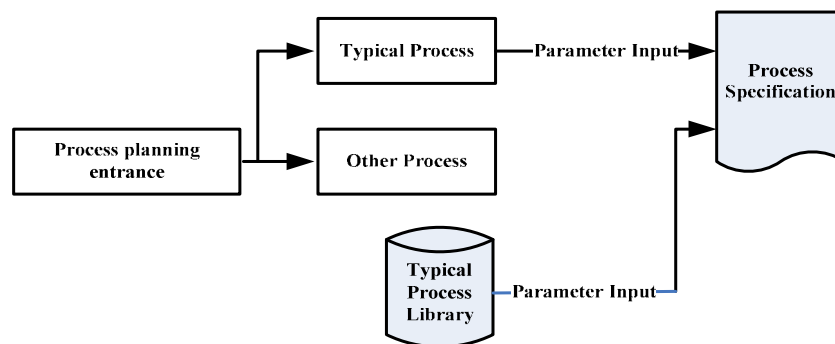


Fig. 2: Typical process using

which model based definition, digital technology of MBD is a key. MBD can produce information and design common information definition to three-dimensional digital product model to cancel two-dimensional engineering drawing and maintain design data's uniqueness. Nowadays, MBD has not been used in weapon equipment industry and received huge development in aircraft industry only. In order to get better application in weapon equipment industry, at first MBD standard suitable for projectile shall be formulated, which shall include 6 parts-general requirements; terms, definition and acronym; size and tolerance; comments and numbers; Pro/Engineer implementing guideline; projectile typical structure and system.

Digital technology is the basis of design manufacturing technology in modern world and parametric model is the basis of digital technology nowadays. Thus, on the basis of drawn-up MBD standard, parametric design and modeling shall be implemented. MBD modeling is mainly on the basis of three-dimensional model of designed particles, especially geometrical information and non-geometrical information, which use modeling software and programming languages to generate the model's picture and then implement many-sided operation. At first, on the basis of getting design manufacturing information relevant to products, expression method of geometrical

information (meaning products' geometry information, that is, products' three-dimensional centralized data) and non-geometrical information (including label of size and tolerance, surface roughness, surface treatment method, heat treatment method and material, painting scope and color of lubricating oil and specification and standard needed meeting) of MBD model (Fig. 1) shall be received. Three-dimensional CAD software's second development shall be implemented by procedure, making the established MBD model implement model's updating by man-machine interface established in the second development which can expose the model's geometrical information and non-geometrical information.

Typical process library and process model: In order to reduce heavy and repeated labor of technology design people and enhance production efficiency to bring the enterprise larger economic profit, the typical technology shall be put forward (Fig. 2). During CAPP system, by interactive interface, the existing typical technology shall be modified to finish technology design meeting the requirements. Since there are many kinds of typical technologies, a library badly needs to be formed, namely typical technology library.

With the constant research and penetration of typical technology, parametric typical technology has

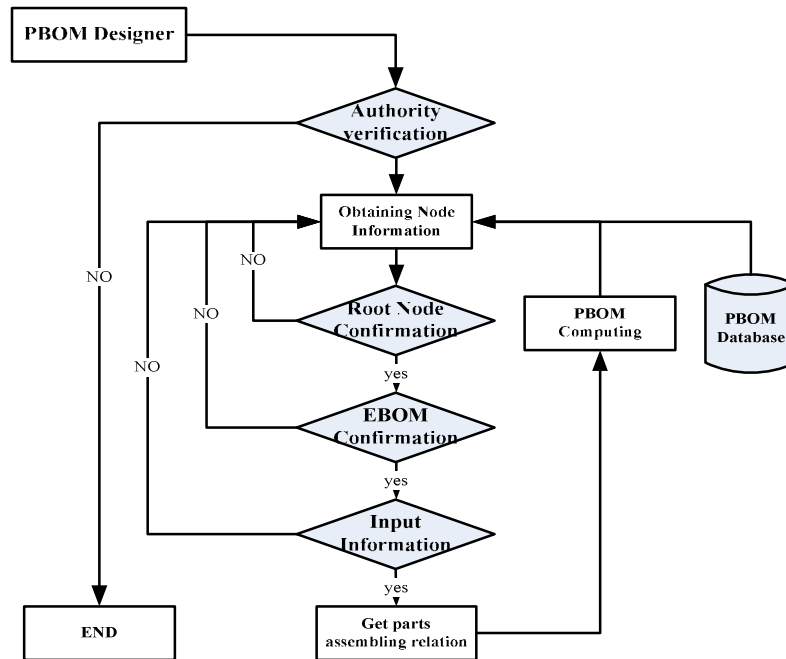


Fig. 3: PBOM generative process

been used widely, whose basis is established by technology property and establishment and the both have relation. Besides, a serial of technology parameter established in the technology can make out the technology by technology property value and relationship with parameter. It is technology property and formal parameter that finish the founding of parametric typical process. By inputting relevant parameter, the modification of typical technology can be finished, meeting products' technology requirements.

Technology design cannot live without procedure, which is the basis unit of finishing product manufacturing. Under the three-dimensional, the reason why the human researches and explores basic method of technology design is to extract manufactured information according to particles' design model and then according the processing information do processing technology plan. During particles' manufacturing, because hosts of middle features cannot be exposed from design model, accuracy and directness of technology design can be influenced. Thus, under this condition, processing model is introduced, whose basic thinking is to begin with particles' model, plan every procedure to produce a processing model and then the process model will be planned in the next process until the completion of technology planning.

Technology material list: Three-dimensional CAPP formation cannot leave bill of material, BOM, whose important part is PBOM which the basis of technology design and plan, at the same time the basis of all the technology managed by PDM. In accordance with the

data of engineering bill of material, EBOM, technology designers formulate processing information and generate PBOM information to reach technology demands of the products. The process generated by PBOM is showed as Fig. 3.

During the PBOM when PBOM is formed on the basis of EBOM, a knot shall be taken out from EBOM configuration tree and at the same time such data information as the products' manufacturing type and products' No. can be taken out. Then, in accordance with property table's contents, the extracted particles' data information shall be transferred to each sub-item of PBOM, which can formulate technology contents meeting the demands according to different production types. At last, according to products' different demands, many knots can be produced of technology tree which shall be put forward. By repeating the former 2 operations, the products' technology design shall be finished finally.

Auxiliary-craft technology design technology of three-dimensional computer: Generally speaking, the product research can pass such 5 main links as product design, technology design, frock design, product manufacturing and inspection and detection. When the products based on MBD is designed, the subsequent technology and manufacturing must be considered, which can largely reduce technology staff's working hours and rapidly enhance products' production efficiency.

The application of MBD digital technology makes production design, process planning, production manufacturing and data management change, however,

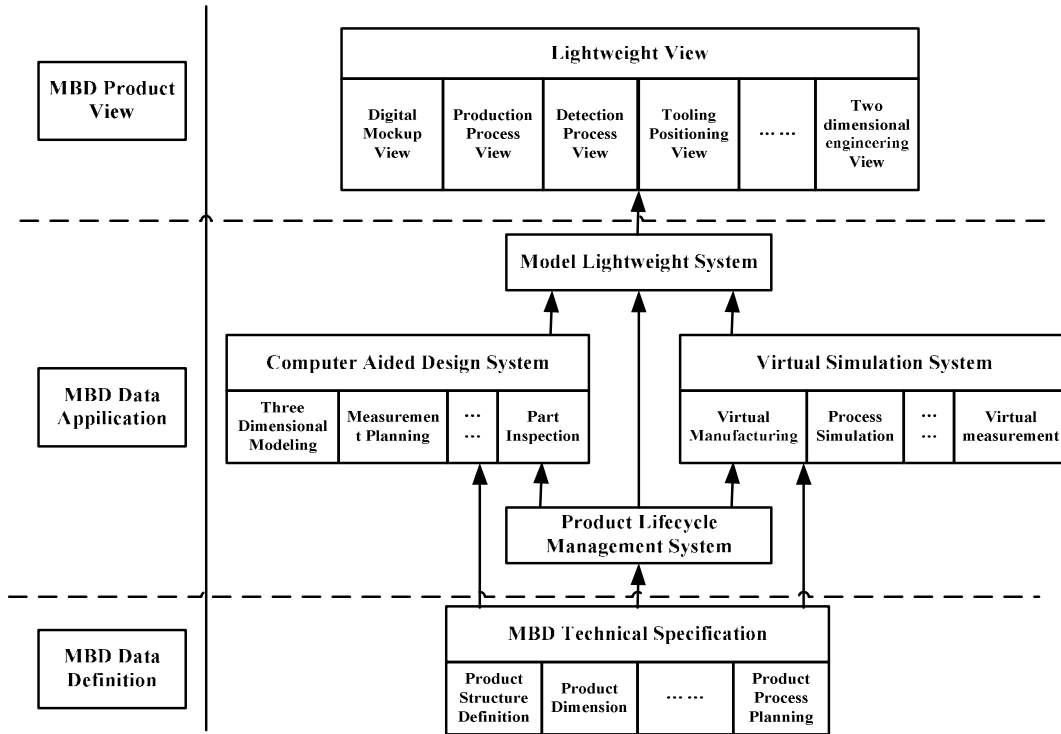


Fig. 4: MBD technology application system

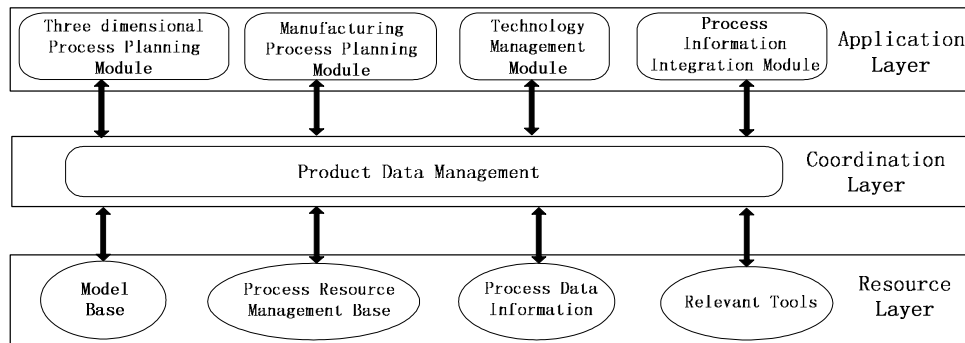


Fig. 5: Three-dimensional CAPP system

Product Life circle Management (PLM) shall center on application system based on MBD (Fig. 4). The definition based on model (MBD) is the basis of technology system, which complies with MBD standard to establish MBD three-dimensional model including complete production information. On the basis of MBD model, it is more convenient for craft staff to implement product's craft design.

Three-dimensional CAPP realization is based on MBD product model, mainly including geometrical information, non-geometrical information, management property, MBD digitization, etc. The system shall be realized by gathering products' researching and manufacturing information. And the interface of modeling and standard data shall be drawn up to realize information flow's transferring and sharing. Three-

dimensional CAPP system (Fig. 5) mainly owns 3 layers-application layer, coordination layer and resource layer. The application layer is the formation of each of module, coordination layer is to transfer applied data into PDM to manage and resource layer is to store model base, process resource management and design knowledge base, that is, design information data and relevant tools. In turn, the data in application layer, coordination layer and resource layer can be transferred and shared mutually.

Three-dimensional CAPP technology based on MBD is full-three-dimensional solid model established by craft staff under three-dimensional CAD digital environment according to MBD standard. And on this basis digital craft model shall be established to produce craft data and draw up three-dimensional digital

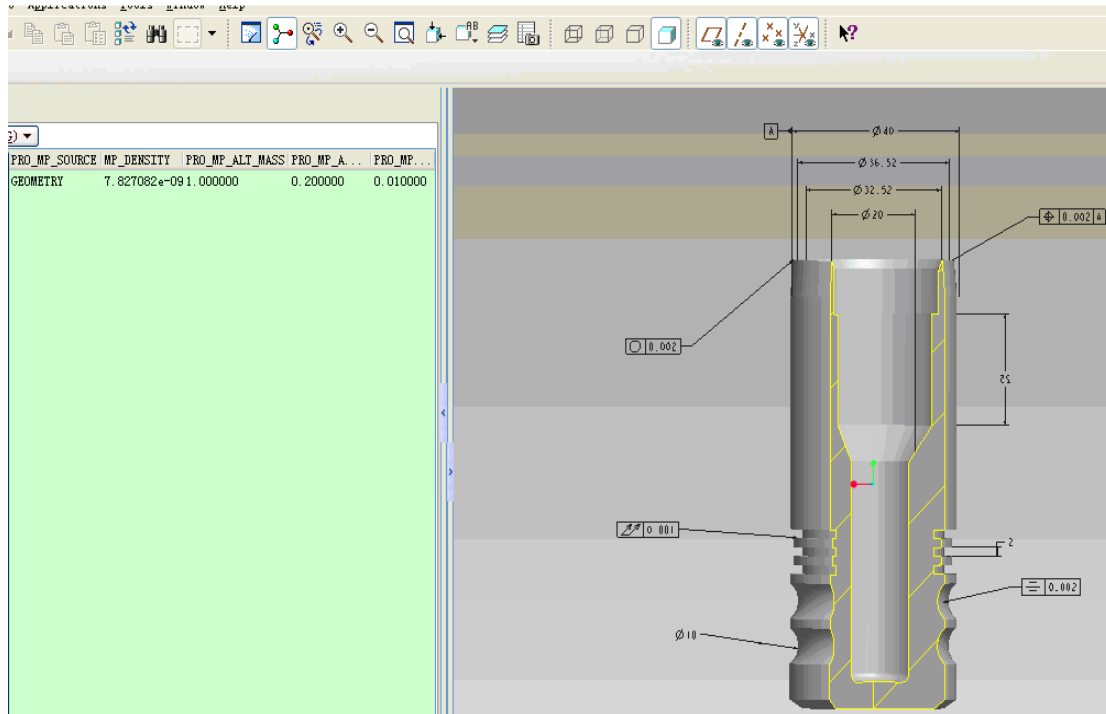


Fig. 6: Projectile process planning based on MBD

manufacturing craft. The technology adopts digital researching system to maintain data's uniqueness which can accurately and rapidly transfer the information relevant to products and reduce data transferring. During manufacturing, technology staffs do not be needed to input product information, reducing repeated labor caused by the error due to the staff's intervention and disjoining between paper-quality solid system and computer system during researching and manufacturing.

THE RESULTS OF THREE-DIMENSIONAL COMPUTER AUXILIARY CRAFT

According to the above-stated contents, weapon particles shall be modeled with the sample of projectile bodies, the platform of Pro/Engineer, Pro/Toolkit of Pro/Engineer 4.0 development tool, VS 2005 programming tool and the basis of MBD standard, realizing three-dimensional CAPP technology based on MBD. As is shown in Fig. 6, at first MBD shall be modeled to produce three-dimensional model with products' geometrical information and non-geometrical information. At the same time when MBD is modeled, subsequent technology and manufacturing demands have been considered which can be expressed in model tree, making craft developer establish kinds of three-dimensional digital solid models by MBD and digital craft model. By analog simulation, reasonable and plausible manufacturing craft shall be ensured.

CONCLUSION

Process planning technology based on full three-dimensional model shall shorten analysis modeling and particle information description, reduce craft information input amount and data transferring and ensure uniformity and efficiency of the data of CAPP system and CAD system beginning with MBD model as CAPP system's information input. By MBD, craft staff can establish kinds of three-dimensional digital solid model, build digital craft model and by analog simulation confirm reasonable and plausible manufacturing craft, which can largely shorten product's design period, enhance product's rapid manufacturing ability and reduce the cost, playing an important role in Chinese weapon equipment industry.

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