Simulation plow's body in SolidWorks by geometric data

Tojiddin Juraev[1,3*], *Tulkin* Abdukarimov[1], *Dilorom* Ubaydullayeva[1], *Amrillo* Fayziyev[1], and *Rustam* Xujakulov[2]

[1]Bukhara Institute of Natural Resources Management of the NRU "TIIAME, Bukhara, 200109, Uzbekistan
[2]Karshi Engineering Economics Institute, 225, Mustaqillik, Karshi, 180100, Uzbekistan
[3]INTI International University, Persiaran Perdana BBN Putra, Nilai, 71800, Malaysia

Abstract. This article discusses the problem of finding the optimal design using SolidWorks simulation. A number of solutions to the problem using simulation are proposed. Flexible and rigid computational models for solving the problem are described; the disadvantages and advantages of the plow's body are indicated when calculating automated SolidWorks modeling programs.

1 Introduction

The core for simulations intends modeling. When there are desired or expected states in the model. Usually, possible errors, risks, and malfunctions can be seeing. Simulation provides a more complete picture of the problem under study. This is due, among other things, to its ability to simulate and monitor individual processes' stochastic and dynamic properties and thereby predict their behaviour. With the help of modelling, there is a possibility to create and test different solutions. Within the framework of experiments, various scenarios, and solutions to situations were comparing. The experience of creating a model can lead to suggestions for improvement. Modeling can also be using to verify the results obtained using other methods. The possibility of use the created models in other areas of human activity. The designing of complex technical objects is basing on the application of ideas and principles outlined in a number of theories and approaches. The most common approach is a systematic approach, the ideas of which are merging with various methods of designing complex systems. In modern conditions, it is important to conduct engineering design based on the automation of technology processes using simulation modeling methods and systems. The purpose of modeling is to reduce costs and make work more efficient even with more delayed changes, this is especially in demand in the design process of complex technical surfaces, such as mouldboards. Plow's mouldboards are one of most common used and very complexity working bodies of the agriculture machines. Main complexity of these is used them complexity geometric surface, which requires geometric modeling by CAD system and its implementation in CAE system that are actually problem in research tasks [1-3].

* Corresponding author: tjuraev931@gmail.com

2 Methods

2.1 Connecting the modeling and simulation processes

There have many geometric parameters in product development, which can be dividing in to input and output geometric data. The process of geometric modeling is the development of geometric models and algorithms, called output geometric data, based on the operation of input geometric data. The geometric information processed in the modeling process is applying to the simulation process as primary product data (Figure 1).

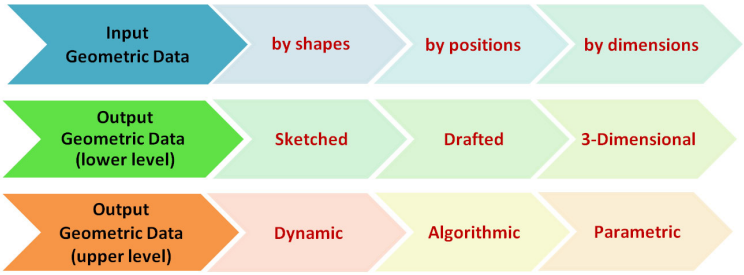


Fig. 1. Types of the input and output geometric data used in simulation process.

The product development, in case of design process of the technical products, especially those with complex functional purposes, requires engineering calculations and tests. This establishes the connection between geometric and technical-technological parameters of the designing products as engineering data. This connection can be realizing by exporting geometric models as input data in the simulation environment. In this process, the geometric model should provide the simulation process with the necessary algorithmic and parametric geometric data to control the technical and technological data of the developed products. Thus, the process of simulation of designed technical products is mandatory for successful commercialization of projects (Figure 2).

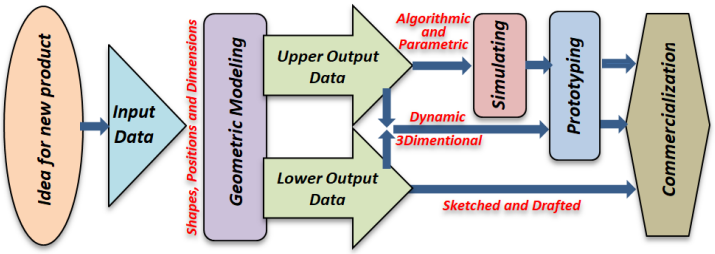


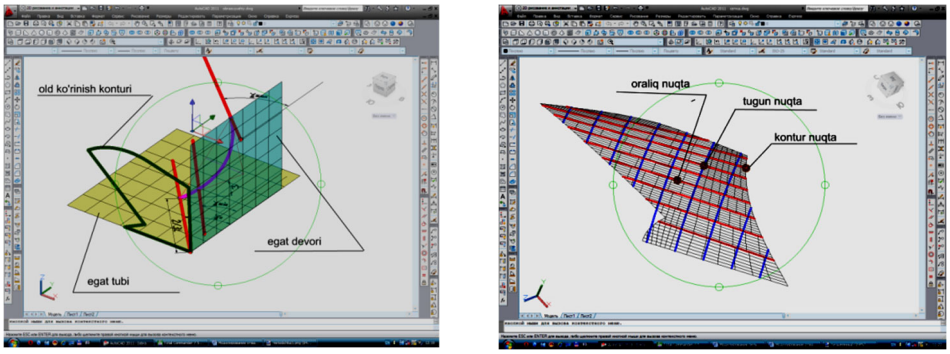
Fig. 2. Role of the simulation process in developed project commercialization.

2.2 CAD modeling for simulation processes

Following the above there were propose some R&D projects of the moldboard's models and algorithms by author. Based on these developments, the author offers a method of computer modeling of the moldboard surface in the AutoCAD system. This method provides visualization, quality, and increases the efficiency of the design process by exporting models to simulation process. This method greatly simplifies the developing process, provides the necessary accuracy of the manufactured product, and is an affordable tool for universities,

design studies and enterprises. As it knows, the three-dimensional modeling of the plow's moldboard in CAD system is different from traditional methodology, which based on drafting (Figure 3).

It has many advantages, and one of them using these models on simulation processes of the developing products by CAE systems. For example, geometric parameters of the moldboard's in CAD models give possibility to dividing working surface to discrete elements for simulation testing. As geometric parameters of the model can be give, also front contour of the moldboard, directive curve of the working surface and location of the surface generators.



a) b)

Fig. 3. Input (a) and output (b) geometric data for plow's body model.

The proposed structural geometric model of the working surface of the sample allows the development of multifunctional tools used in agriculture, mechanical engineering, road construction, mining, and municipal industries, as well as the use of mechanisms in other industries [2-3].

2.3 PLM and importance of the simulation processes

Geometric parameterization of the working surface of the sample facilitates the work of designs increases the choice of options when developing the sample being surface, and allows to effectively solving constructive problems. Integration of the CAD/CAE systems makes it possible to effectively using not only in the design process technical objects but also in the production and service processes. The creation of a somewhat geometric product database using CAD technologies has become one of the necessary tasks of production, in particular, of mechanical engineering (agricultural) products. In modern conditions of using CALS technologies "conceptual projects", are the stage of creating an innovative product by methods and means of automated systems of modeling programs determining the stage of the product life cycle. Visualization of the design-development process allows you to develop a new product in accordance with technical criteria.

The effective use of this method reduces the time of the design process, labour, and material costs when developing a new product. Although the engineering product development process is bases on geometric modeling, the simulation process (figure 4) is of particular importance in the completion of the project. In contrast to the traditional design process, modern engineering design methods and tools allow virtual testing of designed objects. This capability allows rapid and accurate engineering analysis of the designed object before manufacturing its prototype, which greatly reduces product development costs. Therefore, in the modern product life cycle, the simulation process is an important step as a link between the conceptual and engineering design processes.

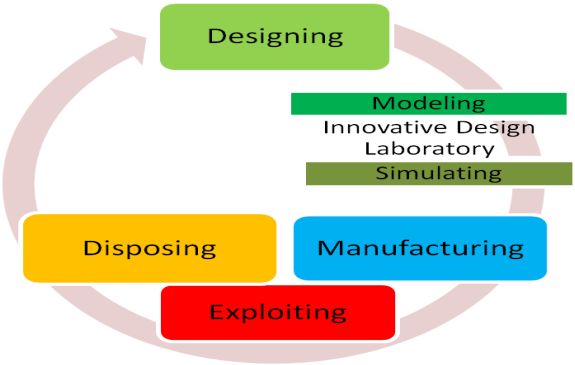


Fig. 4. Simulation process as connection between design and manufacturing stages of the PLM.

By establishing relationships between geometric and technical-technological parameters as input engineering data, simulation tests of the designed object are performing. As a result, engineering calculations and testing can be performing at the lowest cost and in the shortest time. In order to successfully performing both modeling and simulation processes, it is advisable to organize an innovative design laboratory [2-3].

3 Results and discussion

The stability of the hull stroke depends on the ratio of the values and directions of the forces acting on it (Figure 5). The condition of balance of the body in the horizontal plane is observing when the sum of the acting forces and the sum of the moments of forces are equal to zero. At the same time, the resultant of all forces acting on the body. The plow's body includes a blade with wings mounted on a rack at an angle to each other, a plowshare, a field board, a chest of the blade, and a shoe of the body. Plowing is the main deep tillage before preparing the area for sowing and has the highest energy consumption in crop cultivation technology [4-5].

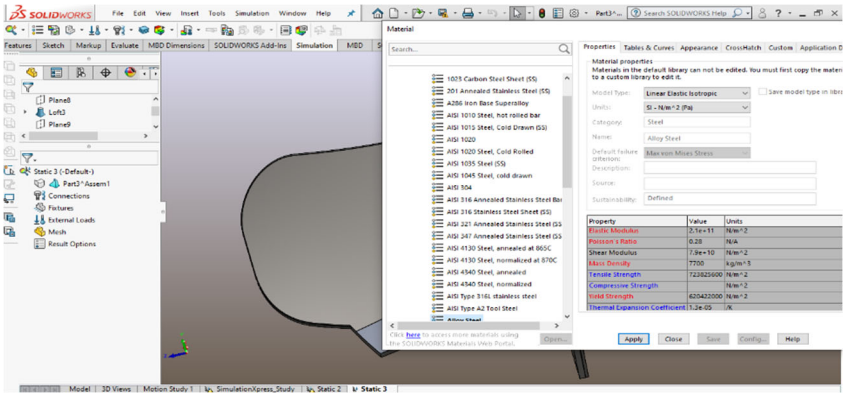


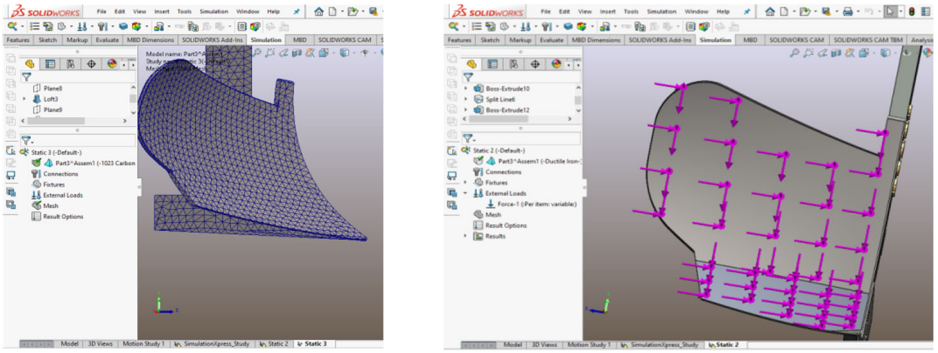
Fig. 5. Material selection for plow's body model.

Processing is a deep loosening of the soil and sealing of crop residues, providing: fertility regeneration, moisture accumulation and favorable physical condition of the soil for pre-sowing treatment. In the technology of cultivation of agricultural crops, according to the time of carrying out, the main processing can be spring or autumn — under the chill. Winter plowing implies tillage in autumn for sowing spring crops in spring. The positive aspects of

such treatment are that the plowed soil remaining in winter freezes well, ensuring the destruction and destruction of the root systems of weeds and their seeds.

In addition, the soil loosened for the winter is easier to prepare for sowing and accumulates moisture after the snow melts, increasing the potential for good germination of future crops. The constructive design of the plow makes it possible to exclude the lateral withdrawal of the tractor and ensure its stable rectilinear movement because the rigid connection of the plow with the tractor is broken, and the tractor under the action of transverse forces on the plow presents an insurmountable load for it. Automation tools for engineering calculations, analysis and simulation of physical processes, carry out dynamic modeling, verification and optimization of products [6]. Engineering analysis systems are designed to study the behavior of a product using its geometric model.

At the first stage, we launch the SolidWorks simulation program, the simulation function after that, a new window with simulation functions will open for us here we can find the environment where we can give the necessary material to the object (Figure 6, a) and impose the intended force, fix it, make it not mobile, conduct research (Figure 6, b).



a) b)

Fig. 6. Dividing the plow's body model into finite elements (a). Giving the strength (b).

However, the implementation of these conditional objects in the program is such that the model becomes less pliable than in reality. To calculate the load, we need to divide the object into certain limited elements for this we use the SolidWorks simulation program mesh function (mesh) the coarser the mesh, the accuracy will be low. After the working body has been divided into finite elements, we attach a firm force to certain points in this we will not have difficulty since we do all this in simulation mode at different values of the real mode of the width of the grip, the angle of the blade of the plowshare to the furrow wall, the speed of the unit and the location of the stabilizer on the plow; determination of the permissible lateral force on the furrow wheel and stabilizer at different values of the plowing depth; determination and comparison of agro technical and energy indicators of arable units with a plow with variable parameters and with a serial plow [7].

To determine the traction forces, load cells placed in the tractor suspension mechanisms were used. Turquoises are determined using tensors and tensor axes with current collectors. The proposed method of using simulation should be done sequentially in the program and then you can start the calculation of the result operation and as we see in Figure 7, we can in which areas of the working plow there will be more load and quickly reduce costs and make labor more efficient even with later changes "for the design of assembly sites of multi-nomenclature production is relevant, he allows you to increase the productivity of assembly sites by optimizing material flows and reduce labor costs when assembling products [8].

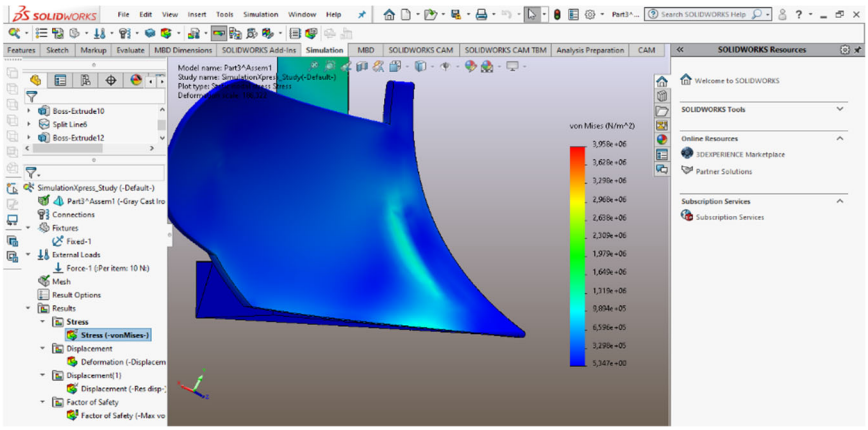


Fig. 7. Loading the result of the plow's body model.

4 Conclusion

Based on the fixed component method, a computer model of the moldboard as plow's body was build. As a CAD/CAE system, AutoCAD and SolidWorks systems were using. SolidWorks simulation is a Finite Element Analysis (FEA) tool that allows users to analyse structural characteristics such as displacement, stress, and bending load. The analysis combines elements of kinetic studies and connections in the calculation of motion. Movement restrictions, material properties, and contacting parts are also takes into account when calculating kinematic solutions. SolidWorks simulation allows view the results of FEA, including graphs and animations. Static studies calculate displacements, reaction forces, loads, stresses, and safety margin distribution. The material is destroying where the loads have exceeded a certain level. The calculation of the safety margin is bases on the criteria of destruction. The program offers 4 criteria of destruction. Static studies make it possible to avoid destruction caused by high voltage. A safety factor of less than one means the destruction of the material. High strength coefficients in some area indicate low loads and that it is possible to extract some material from this area. Because of the analysis in SolidWorks Simulation, the results of stresses, displacements and deformations acting on the model of the main working body were obtains, which made it possible to identify weaknesses of the working body, which will allow these impacts to be taken into account in the design being developed.

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