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PARAMETERIZATION OF A TECHNICAL OBJECT IN SOLID EDGE

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Abstract

This paper presents the core of the elaborated system of automatic generation of design documentation for a family of technical objects. An indispensable element of the system are commercial CAD 3D computer tools. The method of using parametric models of objects for automatic generation of the design and technological documentation (to the limited extent) of the modelled equipment has been presented. Implementation of the system made it possible to execute orders for production of the equipment submitted by the clients who require (other than standard) features of an object. All the considerations have been illustrated on the basis of the devices intended for the companies dealing with production and distribution of cables. Assumptions and design solutions for a cable rewinder have been elaborated. An algorithm of a process of preparation of the design documentation for various variants (series of types) for the designed equipment, on the basis of a prepared three-dimensional parameterized model of an object, has been elaborated. The suggested solutions and elaborated programming tools have been implemented in practical applications. Placing the consecutive variants of the equipment on the market, in the production system under analysis (a real enterprise), was connected with manual modification of recording the designs of most of the parts of the base MCAD (Mechanical Computer-Aided Design) model of the specific product. The above solution resulted in design-and-technological errors, most of them being detected only at the production process stage. It was linked with longer term of execution of an order and with bearing additional costs. Implementation of the suggested system contributed to shortening order execution term, reduction of the equipment production costs and elimination of errors in the design documentation.

***Keywords**: designing, parameterization, parametric modelling, computer aided design, automation of numerical design recording*

1. Introduction

Due to an increased demand for products having features imposed by a client, the production companies were forced to implement quick modifications of already existing products. 3D CAD programs became one of the tools allowing a quick modification of a product. Along with growing requirements, concerning shorter order execution terms and product production capabilities according to the individual clients' requirements, the companies started to parameterize their products in order to be able to modify them quickly.

The paper presents benefits resulting from applying parameterization of a model of a technical object during the equipment designing process dedicated to the companies dealing with production and distribution of cables. Assumptions and design solutions for a cable rewinder have been elaborated. A cable rewinder is a device intended for bundling wires being unwound from reels,

bobbins and bundles [1]. It is quite often that after removing the bundling reel they also make it possible to wind wire on commercial plastic bobbins. Solid Edge with Synchronous Technology (Solid Edge ST) was applied to support the design process. Basing on the adopted design assumptions a 3D (Three-Dimensional Graphics) model of a cable rewinder (Fig.1) has been created using this software.

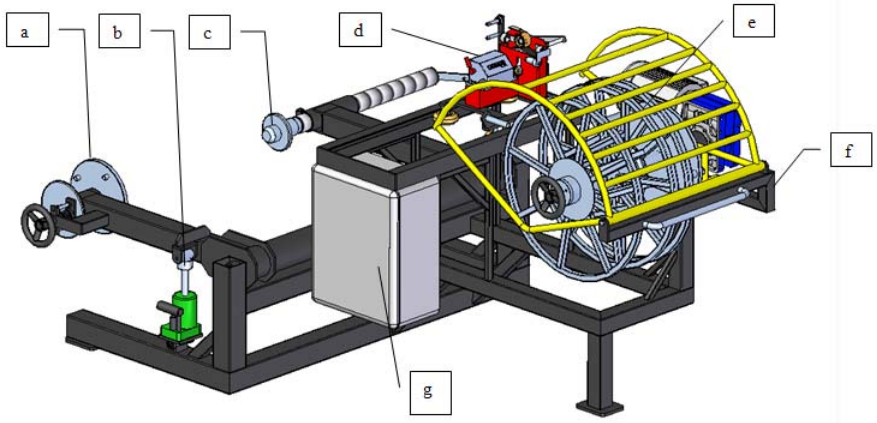

Fig.1. The most important subassemblies and components of a CAD model of a cable rewinder: a) unwinder journal with a brake, b) hydraulic jack, c) pressure journal, d) lying device with a measurement module, e) framework bobbin of a winder, f) supporting structure, g) electrical box (Source: own elaboration)

2. CAD model generation process for the specific product variant

Parameterization is a substitution of numerical dimensions of a 3D model with names of the variables (parameters) and a related possibility to apply equations and inequalities defining relations between those variables, and consequently automatic modification of a geometrical model. Parameterization is a kind of a span between a geometrical model and a mathematical model, and it assures mutual conformity of those models. Changing a value of one dimension in a design parametric record results in changing other resultant dimensions of the model [2]. By applying parameterization, a family of structures may be obtained very easily (including particularly series of types of standardised products) [4].

Two types of parameterized variables: geometrical and relational have been used to create a 3D parametric model of the rewinder. The geometrical parameters of the model may be edited by editing a sketch (a sketch in Solid Edge ST is a profile for extrusion and cutting commands made on a reference plane) from which it was created, or by changing the value of the parameters of the feature used to create it [3]. For instance it is possible to change the extrusion length for the extruded part, by entering new value for the item “extrusion” in the structural tree of the model. Relational parameterization allows to change the design record by changing the values of the dimensions obtained relationally for the specified independent variable, e.g. values of characteristic features, significant dimensions [2]. The relations between the independent variable and the values of the dimensions are recorded in an appropriate editor. After entering the specific value of an independent variable the dimension values are calculated, and then the existing records of the design are updated.

A producer offers several variants of a selected model of the cable rewinder to its clients, thus it may satisfy the needs appearing in the market. Placing the consecutive variants of the equipment on the market was connected with manual modification of recording the designs of most of parts of the base MCAD (Mechanical Computer-Aided Design) model of the specific product. The above solution resulted in design-and-technological errors, most of them being detected only at the

production process stage. It was linked with longer term of execution of an order and with bearing additional costs.

It was suggested to build a system of automatic generation of design documentation, and to the limited extend of technological documentation for a family of the equipment being analysed. Implementation of the system, apart from brining economic benefits, eliminated the necessity to edit manually the design documentation and thus it limited the errors made at this stage of object production preparation.

In order to shorten the design and construction process, the structure of the base MCAD model of the analysed product [6] was reanalysed. Such items have been distinguished the values of which differ from one another in case of various variants of the product. Some variables were assigned to those items, the values of which are controlled by means of a generator written in Visual Basic language. New values on the basis of a choice made by a user (thus obtaining quite a new form of the product design record) may be assigned to the appropriate variables by means of the application. The procedure algorithm of a user of Solid Edge when working with parameterized model of the rewinder is presented in the Fig. 2.

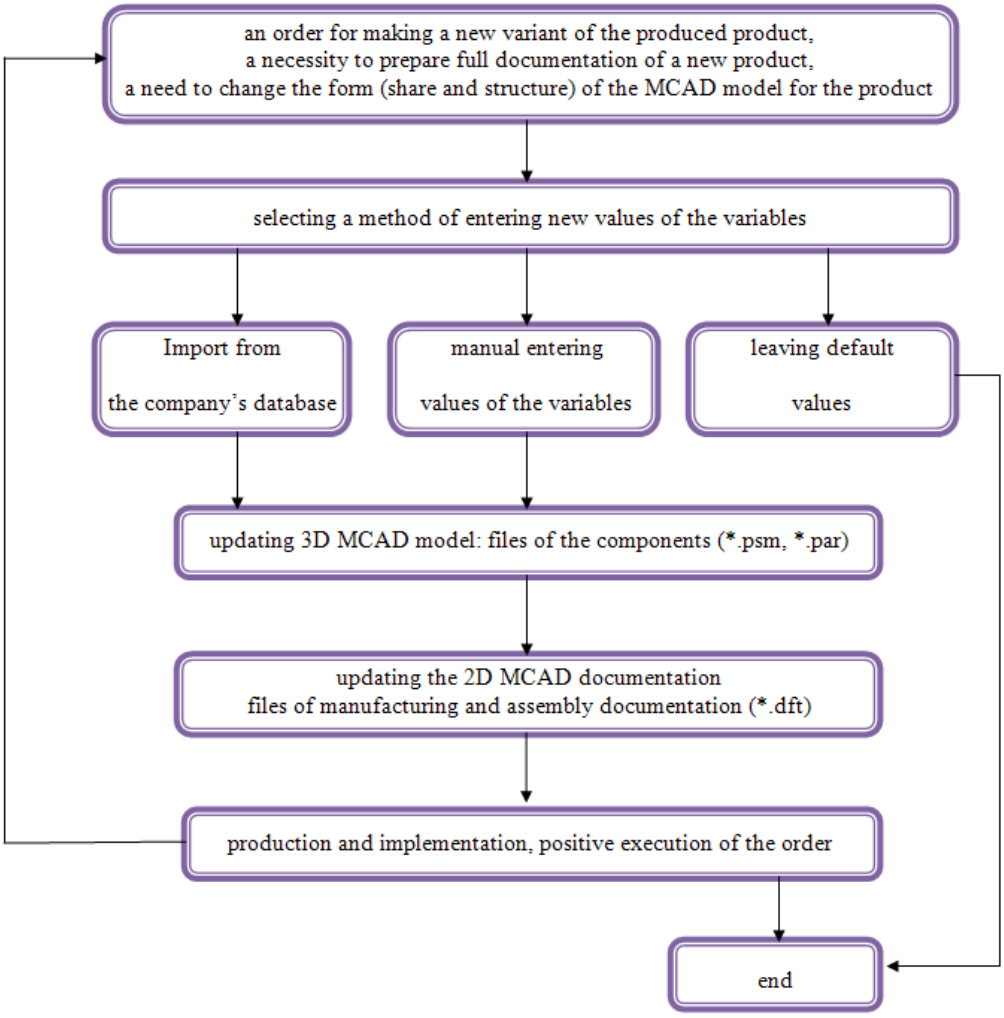

Fig. 2. Simplified algorithm of automation of the design documentation creation process (Source: own elaboration)

Two types of variables have been distinguished, to which new values may be assigned:

- logical variables:
  a) presence of an automatic lying device (yes, no),

b) presence of an electronic meter (yes, no),
c) presence of a travelling device (yes, no);

- metrological variables:
  a) dimensions of the winder,
  b) dimensions of the unwinder,
  c) dimensions of the structure,
  d) dimensions of the cable lying device guide rail.

After geometrical transformation of the product model, for instance the following items are automatically updated:

- values of the features of a complete assembly (of the rewinder 3D model),
- assembly documentation of the product,
- detailed design documentation,
- database for production orders.

3. Controlling the values of the variables by means of the 3D CAD model generator

Before starting to parameterize each model the forms containing parameters have been prepared [5]. The parameters of the considered models may be divided into two groups:

- directly defined parameters,
- indirectly defined parameters.

The directly defined parameters are the ones which are directly defined by a user and do not depend on one another or on other parameters. The exemplary parameters being defined directly are presented in the Table 1.

Tab. 1. Exemplary parameters being defined directly (Source: own elaboration)

Parameter name	Unit
Reel diameter	mm
Reel width	mm
Core diameter	mm
Unwinder diameter	mm

The indirect parameters result from various dependencies between the parameters or they are an outcome of the design assumptions. The exemplary parameters being defined indirectly are presented in the Table 2.

Tab. 2. Exemplary parameters being defined indirectly (Source: own elaboration)

Parameter name	Unit
Retaining shield generator	mm
Retaining shield hoop	mm
Fixed reel shield generator	mm
Fixed reel shield hoop	mm
Length of the section fastening the guard	mm
Fixed reel core generator	mm

In order to illustrate considerations, the Fig. 3 shows how the geometrical form of the winder is changed (depending on modification requirements, both dimensions and geometrical form may get changed) after determining the input values of the parametric three-dimensional model of the rewinder. Values of such items as: reel external diameter, reel width and reel core diameter are

defined directly. Individual lengths of generators, a driver, bearing pipe, base ring etc. are defined indirectly based on dependencies between the specific elements of the structure.

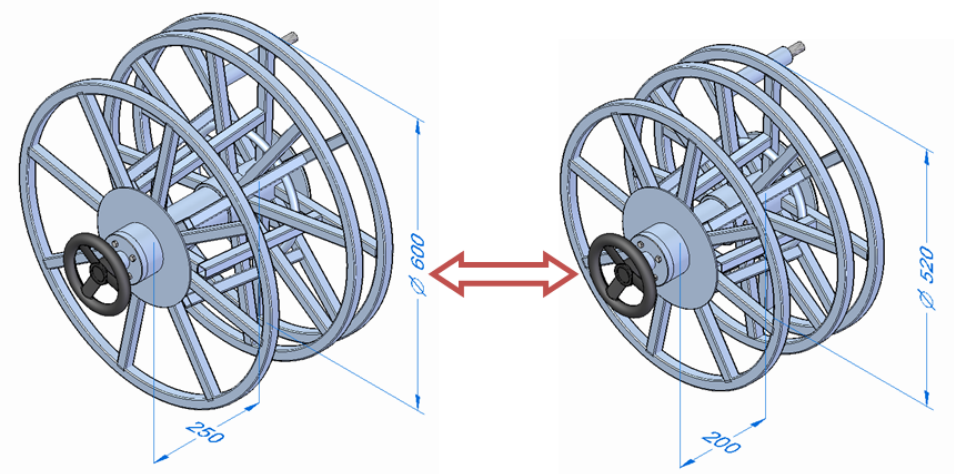

Fig. 3. An example of changing the values of the structure element features after changing the values of the model parameters (Source: own elaboration)

4. Transformation of a parametric model into a resultant design record

An element of the system of automatic generation of design documentation is a developed computer application executing the algorithm of transformation of a parametric model into a resultant design record of the specific variant of the modelled object. Implementation of the algorithm (Fig. 2) was performed in Visual Basic language, and then compiled into the executable form (the application is called "Generator v1.1"). The exemplary application window is shown in the Fig. 4.

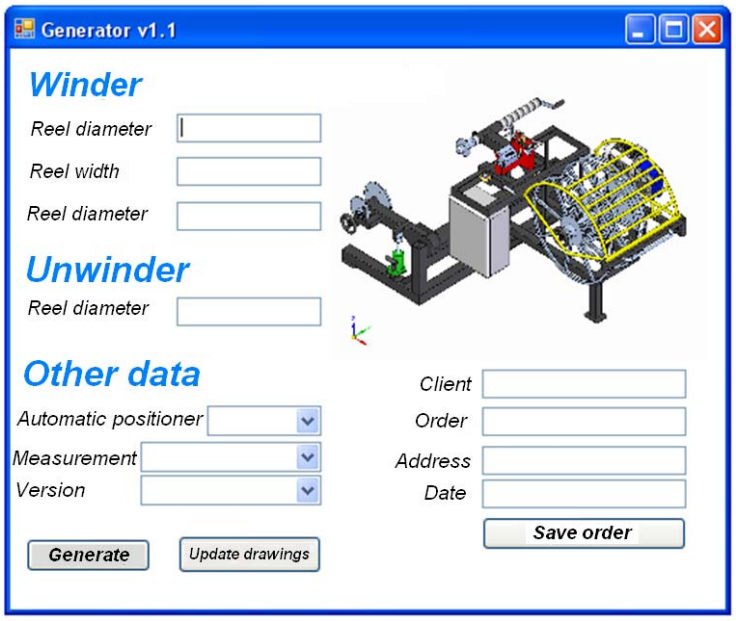

Fig. 4. View of the "Generator v1.1"window program (Source: own elaboration)

After entering the numerical data in the "Winder" and "Unwinder" boxes the input data necessary to edit the model are defined. The next step is the user's selection of the equipment variant (Table 3).

After filling in all the options, the model updating is confirmed by clicking the "Generate" button. The "Update drawings" button is to update the drawings of 2D documentation. The next "Save order" button allows to save the client's data, as well as the parameters of the ordered equipment in a spreadsheet.

Tab. 3. Variants of the equipment selected by a user (Source: own elaboration)

Option	Variant
Automatic lying device	Yes, no
Measurement	Mechanical, electronic
Version	Stationary, moveable

5. Summary

All the fragmentary solutions elaborated if being combined together make a system of automatic generation of design documentation for a family of objects that may be represented by means of a parametric model.

The elaborated algorithm of the design documentation creating process for various variants (series of types) of the designed device on the basis of the elaborated three-dimensional parameterized model of the rewinder and the elaborated computer program (executing the algorithm built) significantly contribute to:

- shortening the order execution term,
- reduction of the equipment production costs,
- elimination of the design errors occurred when changing manually the equipment parameters.

On the basis of the presented possibilities to modify numerical records of the rewinder structure it may be stated the number of the product variants that may be modelled is in fact unlimited and depends on the individual clients' needs.

The elaborated programming tools have been implemented and verified in a real system of production of products dedicated for the enterprises operating in the field of production and distribution of cables.

The decision makers of an enterprise in which the elaborated solutions are implemented have eliminated the errors occurring during traditional elaboration of new variants of a product. After implementing the design parameterization methods, described herein, and after expanding them additional, the equipment producer significantly increased the scope of its commercial offer and shortened the time to place new products on the market accompanied by simultaneous reduction of the total production costs.

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