Title:
Decreasing Engineering Time with Variable CAD Models: Parametric Approach to Process Optimization

Author:
Goran Kukec, gkukec@tempera.hr, S Tempera d.o.o., Zagreb, Croatia

Keywords:
Process optimization, variable CAD, parametric, FBD

DOI: 10.14733/cadconfP.2014.167-169

Introduction:
Different customer demands and tailor-made products are nowadays one of the most important parts of product development and tasks of R&D department. To fulfill these demands in shortest time possible [1.], and/or to give reasonable response with lowest cost possible, company should have the possibility to make variable products. In this case, products from automotive industry were observed. Aluminum sub-assemblies made from main aluminum panel are connected together with forged parts and screw bolts. Different variants of observed sub-assembly can differ in size, quantity and even number and part variants. Variable model with GUI was given to R&D engineers in testing period of two months. Data was observed and processed.

Fig. 1: Observed aluminum sub-assembly, two variants.

Main idea:
Feature based modeling and parametric approach basically gives the opportunity to every user to make variable models. On the other hand, existing CAD software is limited to well-defined problem in narrow domain and possibly cannot fulfill all company needs or cannot be easily integrated as a sub-system. If we gather co-relations, restrictions, rules and engineering knowledge in general, of symbolic and topological information to the variable model as a core – database functional action model then it is possible to make clear, functional and fast sub-system integrated to the existing parent system.

The problem for the user could be the understanding of the variable/constant parameters, their core (standard) values and end (maximum/minimum) values and product variant prices, production times and 2D production documentation unless user itself doesn't finalize the whole variable model by himself (or in the team).
3D models and technical documentation of sub-assemblies used in automotive/fire-fighting industry were observed. Analysis showed that average engineer needs roughly 28 hours (3 ½ work days) to make functional 3D model and 2D technical drawings for each part and sub-assembly. Main idea was to reduce this time (cost).

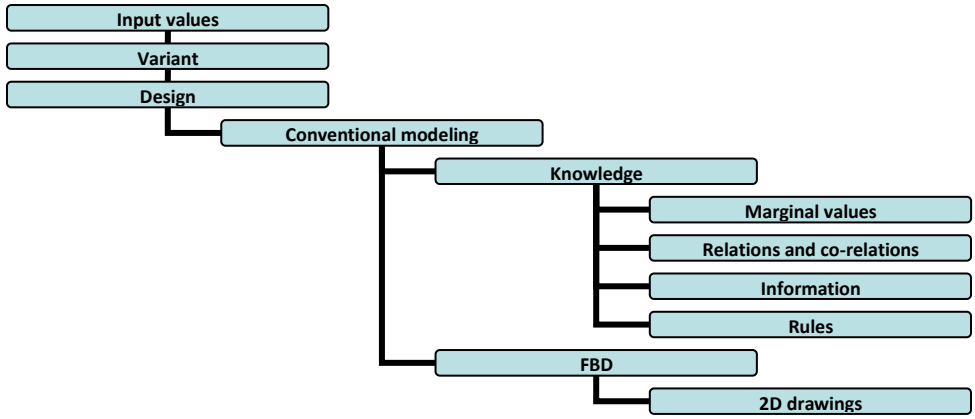

Fig. 2: Iterative optimization design model.

To reduce the modeling time, the process itself must be observed. Easiest way to reduce the whole process is to find a way to lose steps or the whole branches in the process. While conventional modeling consists of a whole tree of branches and demands from the user, variable modeling consists only from inputs. As it is logical to conclude that inputs will take less time than FBD, due the prior "Knowledge" step is also not needed, the hypothesis was that variable modeling needs less time than conventional.

Core parametric model was made in feature based parametric CAD modeler. Parameters are internal parameters (needed for the model – f/e dimension) or user parameters (needed for the user – f/e price), so end functionality of the model remains the same as with the conventional modeling process. Parameters are divided in variables and constants. Relations or sub-programs control variables, depending on the co-relation complexity.

In this case, the whole GUI was made, which gives the possibility to adapt to specific needs of any company/department as well as the fact that every new user can clearly understand the model, its parameters, values, prices and in the same time it takes away the ability from the user to assign meaningless values to the model without prior expert knowledge and experience. With this approach, user can make variable models with basic license without need for additional modules, which would conventionally be used for variable modeling. Drawings are re-generated automatically according the changes made to the model. Remaining problem are the dimensions. This problem was not solved completely due to the different parts, their shape and position and it is left to the user to open the auto-generated drawing and to put the missing dimensions manually, the same it would be done on every other drawing.

Testing and methods:

Testing of the variable model itself was made prior in comparison to the existing technical documentation and possible values as well as by method of refutation by combining marginal and not-allowed values/variants.

Testing of needed time was made for three different variants with different dimensions and different number of parts. Totally 5 users (mechanical engineers) were involved in the study. Data was collected and analyzed.

Conclusions:

By building the variable model and GUI for the specific case, testing showed that the time needed for building the functional 3D model and 2D technical drawings for each part and sub-assembly decreased from 3,5 working days to roughly one work day. Time for adapting to the new sub-system and design rules weren't observed in this paper additionally but data collected shows that the complexity of the model has less influence on the time than number of use for each user.

Therefore, it is expectable that during further exploitation the time will have decreasing tendency. Further on, it is not excluded that this kind of sub-system could be used by non-CAD specialists or

engineers but by f/e sales person. In this case, there is a possibility to use/adapt CAD variable models in other means than engineering. Future research will include sub-program optimization, 2D technical documentation variability and automatic variable model integration to parent assemblies as well as further time decrease.

References:

[1] Adeli, H.: Advances in Design Optimization, Chapman & Hall, 1994.
[2] Bojčetić, N.; Štorga, M.; Marjanović, D.: Product data and knowledge integration.
[3] Berg, W.P.: Pro/Engineer Tipps und Techniken, Carl Hanser Verlag GmbH & Co. KG, 2006. http://dx.doi.org/10.3139/9783446408050
[4] Cash, P.J.; Hicks, B.J.; Culley S.J.: A comparison of the behavior of student engineers and professional engineers when designing, Design Conference 2012.
[5] Mahajan, V.; Muller E.; Bass F.M.: New product diffusion models in marketing: A review and directions for research, Journal of Marketing 1, 1990, 1-26. http://dx.doi.org/10.2307/1252170
[6] Onwubolu, G.: Computer-Aided Engineering Design with Solidworks, Imperial College Press, 2013. http://dx.doi.org/10.1142/p761
[7] Šagolj, A.: Creation of the Alpas® frame of the fire fighting vehicle, University of Zagreb, Faculty of mechanical engineering and naval architecture, 2012.
[8] Štorga, M.; Pavlić, D.; Marjanović, D.: Reducing Design Development Cycle by Data Management Within the Design Office, 13th International Conference on Engineering Design - ICED 01, Glasgow, 2001.
[9] Walter, E.; Pronzato, L.: Identification of Parametric Models from Experimental Data, Springer, 1994.