Concept of Re-Utilization in Engineering Design Projects with Commercial Catalogues

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Abstract

The use of CAD/CAE systems in industry is ubiquitous nowadays. All graduates from technical careers are expected to have a working knowledge and skills on these engineering tools. The expectation at most industries is that designers will perform modeling and analysis tasks during their work. The reutilization of existing work, or of commercially-available components, has not been emphasized in the curricula. This manuscript describes the efforts that are being implemented in design courses in order to address the idea of reutilization during the engineering process. Teams of students are exposed to design exercises with the requirement of utilizing commercial part catalogues. Initial results indicate a level of interest on the use of such information.

Introduction

The use of the computer in the engineering design process has evolved from the CAD, as in Computer-Aided Drafting, from decades ago, to the CAD (Computer-Aided Design) of nowadays. There have been a variety of developments and trends that have been proposed and implemented during this time. Some of them are the application of CAD techniques and results into Computer Aided Engineering (CAE), and for the entire lifecycle of the product or system (PLM – Siemens 2015). One of the factors that has justified many of the existing trends and methodologies being currently used is the improvement of (engineering) design efficiency.

Studies indicate that there is a potential for significant reduction in design cycle time (up to 45%, as stated in Thomas 2015) whenever reutilization of models is carried out. The use of parts libraries and catalogues has been proposed since the initial uses of CAD tools for drafting (Weisburg 2008). As well, even with the significant change to solid modeling and parametric technology, adaptation of techniques such as variational geometry have been implemented with the use of,

among other characteristics, UDF (user-defined features) and family tables. These implementations are in support of the classical libraries and catalogues.

Manufacturing and supplier industries have not been blind to such developments, even when their timing can be considered a bit off with respect to the need. These industries have released great improvements in recent times, partially due to competition and globalization. Several industries started providing 2D representations of their selected parts in order to be used in the final documentation of their designs. However, now the trend is to provide complete 3D models of candidate components, and furthermore, to provide the option to either configure their selection or to customize it.

This report describes the approach being implemented to expose students to the CAE reutilization/configuration concept. These efforts are in a design curriculum at an institution of higher education, and it is planned to expand its use at other institutions.

Methodology

In order to have emphasis on the concept of reutilization during design, that translates into use of commercial catalogues in a CAD environment, a set of exercises have been created for an introductory design course. The course is at the junior level, in the 2-hours lecture and 3-hour lab per week format, and it is a required course in an engineering design program at a 4-year institution. The set of exercises are assignments for the lab portion of the course, and it consists of one demo/tutorial exercise and two assignment exercises. This set is given to the students as in-lab (demo/tutorial exercise) and as homework two (assignment exercises) in a 3-week period. The sequence is presented in Table I.

Table I. Proposed Activities for Introduction of Concept of Reutilization.

	Week 1	**Week 2**	**Week 3**
	Survey Pre1	Survey Post1	Survey Post2
In-lab	*Demo exercise*	*Assignment 1*	*Assignment 2*
	Tutorial exercise		
Individual	Components T1		
Team (E2)	Components T2	Components 1-1 to 1-4	Components 2-5 to 2-8
		CAD work - Report A1	CAD work - Report A2
Homework			
Team(E3)	*Assignment 1*	*Assignment 2*	

For the first session the students are provided with introductory information about the computer tool to use (i.e., PARTsolutions), and then are given the demo on the use of the software. The demo illustrates the utilization of the software tool for the selection of different standard parts, mainly

pneumatic piston and brackets. The tutorial exercise implies the reutilization of the demo components based on new specifications. The change in specifications are in terms of expected performance, with no geometric limitations. The results for these changes are provided as an individual's task, and the result for the assignment are discussed in teams in order to have additional discussion regarding the use of the software tool. Each team has two students during this in-lab assignment, and the task is selection of standard components out of the available catalogues in the software.

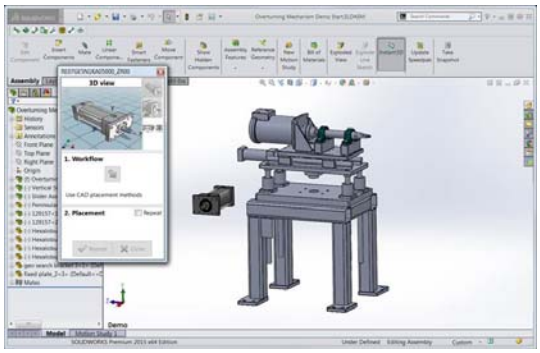

Figure 1. Screenshot Illustrating Placement of Pneumatic Component in CAD.

The assignment exercises are brand new problems. The first one requires the selection of four main standard components, and the second one includes at least eight components, with the requirement to modify standard components. Figure 1 illustrates the CAD work done for standard components. This second exercise (E2) implies design of additional components, but only some of them are based on reutilization or selection/configuration. The third exercise (E3) implies the use of some of the components designed by other teams in the previous exercise. Figure 2 illustrates the parameters that describe a catalogue component, with the option to specify them according to design calculations. The commonality in these problems is automation with fluid power, and the specifications for each team are different, so that unique solutions are expected for each situation. These assignments are done in teams of three students, with each team submitting a report.

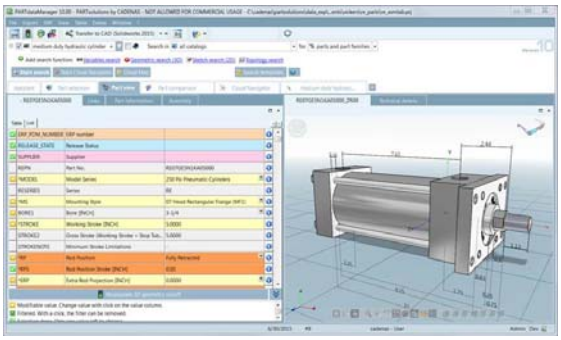

Figure 2. Screenshot Illustrating Specifications for Cylinder Based on Requirements.

The first assignment problem is a 'positioning mechanism' that requires selection of source/control of power, linear actuator, and power transmission with emphasis on position. The second assignment is a 'pushing mechanism' that adds the need for a load-based device, with the expectation of some reutilization. The expected delivery at the end of the week-long project is the basic engineering of the proposed system, with specifications for the main components and CAD representation of the system.

Evaluation

The evaluation for this project is based on the objective of providing exposure to the concept of reutilization. The information will be collected with the use of surveys where students indicate their agreement or disagreement with respect to their knowledge and perception of the concept of reutilization, and the use of commercial catalogues. The survey is initially administered before the concept is introduced, and then after each one of the assignment exercises.

As indicated, the report is on the development and implementation efforts. The proposed set will be implemented during the Fall'16 semester, and initial results will be available for the presentation at EDGD 2016. The expectation is that this initial implementation results in positive trends in three main aspects: a) to place in the mind of the students the concept of reutilization, b) to introduce students to current computer tools that facilitate the design process, and c) to have the basis for improvement of the implemented set, at this level and at advanced levels.

Conclusions

The proposed set of assignments to introduce reutilization in design courses requires well linked concepts and exercises in order to focus the efforts on the goals. It is very easy to get into aspects that are not the focus of the task, such as software-use issues.

Survey results are expected to indicate a positive trend in the objective of presenting the concept of reutilization to students. However, it is an initial concept that needs to be emphasized in consequent courses. The authors plan to improve on the initial implementation, and expand its use in subsequent courses (i.e., advanced design course).

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