GRAPHICAL METHODS FOR DESIGNING HOUSE HEATING SYSTEM

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Abstract. This article analyzes graphical methods for designing engineering system. The creation tasks of the house heating automated design system are solved with Unified Modeling Language. Graphical system can select types of radiators and valves, design pipes and specification. It discerns objects-classes: radiator, valve, pipe and specification, which have some properties and methods that ease programmer's work. The program selects geometry parameters of radiators from radiators database by using ActiveX Data Objects technology, which by programming method connects drawing and database. Drawing's graphical objects have additional data from which exchange of data between graphical system and database is executed. The program, knowing radiators' and pipes' geometry, designs house heating system. Design system and example of the house heating project are presented. Graphical methods of the house heating automated design system are discussed and conclusions are made.

Keywords: **O**bject-oriented programming, house heating design, Unified Modeling Language, Visual Basic for Application programming language.

1   Introduction

Unified Modeling Language (UML) is still being advanced today. It evolves theoretical fundamentals and creates programming systems for automation modeling process. Modeling language UML is used for designing varied programs and systems [1, 2]. Projects of house design are presented by modeling language UML implemented with Computer Aided Design (CAD) systems [3, 4].

Now we can use object-oriented programming language Visual Basic for Applications (VBA), working in the graphical system AutoCAD environment. Various CAD systems use VBA language for solving data analysis and preparation in geographic information system [5], to design programs for input data access, text output data generation, and output map creation [6], the ray tracing procedure [7], generated programs can be used to perform automatically the drawing work of 3D modeling of gears via the usages of instruction commands form SolidWorks software [8], an environmental changes model is applied within a geo-referenced database of the selected region [9].

This article analyzes graphical methods of the house heating automated design system.

2   Modeling of systems objects

Collaboration diagram describes collection of objects, which in special situations work as united ensemble. The diagram presents ensemble's static (connections that link objects) and

actions (sending messages). It accents the static ensemble structure. The messages in collabo-ration diagrams are numbered for showing the sending order. Collaboration diagram describes particular situation and is useful to present objective range analysis results, but is limited be-cause we can show few messages in the diagram.

In this collaboration diagram (Fig. 1) user controls a form from which it begins to de-sign the house heating system. Then the system automatically finds fund-required radiators in the database and draws the heating devices. After that, the system automatically finds fund-required pipes and valves in the database and draws the pipes and valves. Finally, the system automatically designs the house heating system with specification and draws it.
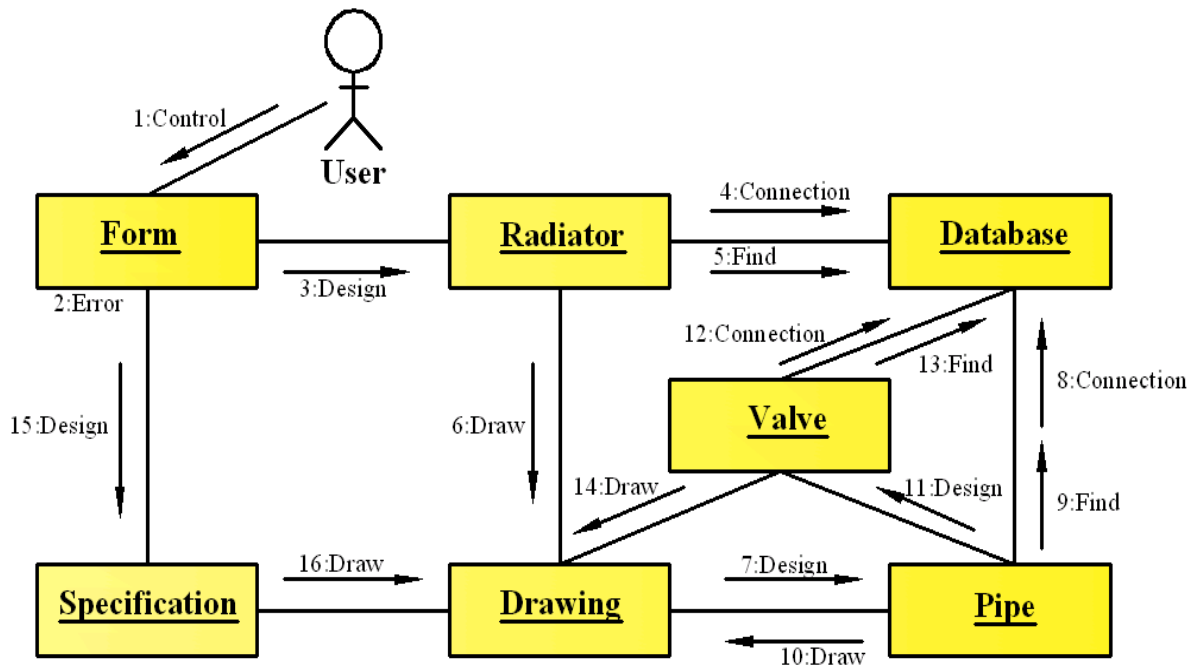

Fig. 1: Automated house heating design system collaboration diagram

The collaboration diagram presents the overall scheme of all objects belonging to en-semble and their functions. It is possible that not all objects shown up in the collaboration diagram are going to end up in the final class structure. Designer can change some objects to other class properties or define additional methods.

3   Class objects of a house heating drawing

The class diagram presents system's static structure. The house heating system in the drawing is composed from aggregation links connected classes: radiator, valve, pipe and specification (Fig. 2). All messages from collaboration diagram example for the object's ra-diator (design, connect, find, draw) are presented as class operations. Object-oriented pro-gramming greatly facilitates a programmer's work because tasks are divided, as you can see from Figure 2, into four parts; and from Figure 1 you can see these parts' dynamic links, which we need to embody into the program.

Let's create class radiator from object radiator in the class diagram. All operations (de-signing, connect up, finding, drawing) are programmed as class procedures. In this way, class procedures become class methods, common variables – class properties [10].

Other procedures such as building envelope appreciation and heat waste calculation system have formed a database table with rated thermal power of each room of a house. Then we make the following operations: first, by programming method we connect to the radiators database. Secondly, we automatically find useful record in the database. Thirdly, according to that information we design radiator. Finally, we draw the designed object and analogically, valve and pipe classes are created.
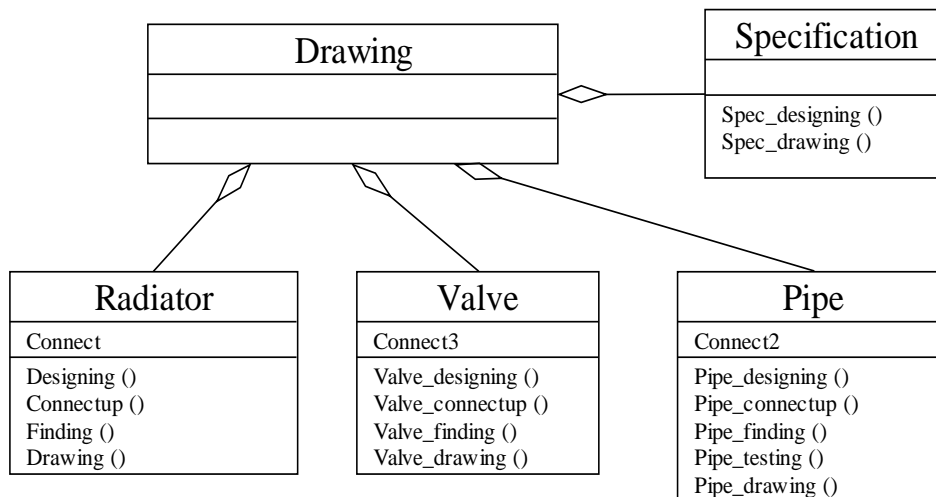

Fig. 2: Class objects of a house heating systems drawing

Modern programming database control technology is ActiveX Data Objects (ADO) [11]. An example of procedure with variable *connect* can read a concrete record *rec* from the database *"Heating.mdb"* table *"Radiators"* (Fig. 3).

Fig. 3: Database table radiators

We automatically find useful record in the database and according to that information we design radiator in the room. We quarry for power of radiator that is not less than the one presented in the procedure fragment:

Public Sub Finding(rec, pow)	(1)
rec.MoveFirst	(2)
rec.Find "[Power]>=" & pow	(3)
End Sub	(4)

We will study information about drawing in Drawing Interchange Format (DXF), a format which occurs in many graphical systems. Extended data are grouped by registered application name. Each registered application's group begins with a 1001 group code with the application name as the string value. The group codes 1000 through 1071 describe extended data. We can append additional data, which are named extended data, to the graphical entities.

Knowing DXF file structure and codes, we can create programming methods for creating elements' specifications in the drawing [12].

Fig. 4: Drawing Interchange Format

The next procedure is drawing graphical object the radiator with record *rec* from the database of graphical object parameters and creating the extended data of new graphical object. Information is named 'Radiator'. There are four extended data name of object, length, height and power of the radiator. Names and values attached with codes "1000" and "1040":

The next procedure selects graphical objects with extended data in the drawing and form specification of graphical objects [13].

4   Example. Automated design system of the house heating

An engineer frequently designs the house heating system. This work is done faster if special programming procedures for calculating and visualizing graphical objects are used. In the presented automated design system of the house heating a user writes to programs form information about house. Program's control building envelope appreciation and procedure results for heat wastes calculation shown in Figure 5. Program's procedure results for designing house heating systems drawing are shown in Figure 6.

Fig. 5: Main menu and house information, the building envelope appreciation and heat wastes calculation
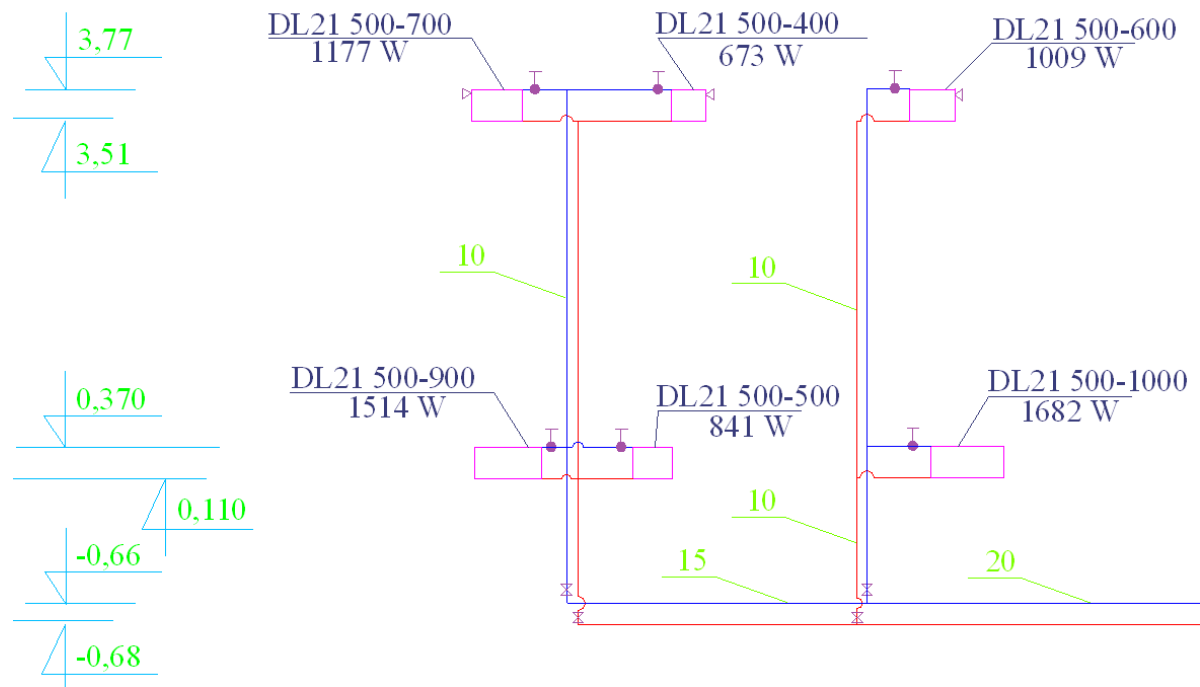
Fig. 6: A part of a house heating systems drawing

5   Conclusions

Graphical methods of the house heating automated design system:

The system is modeled by UML. Presented project shows system's object classes and their methods and properties.

Object-oriented programming language, which directly allows to implemented UML project, is used for designing the graphical system. Breaking down the system into classes with specific properties and methods allows writing a program with individual modules, which simplifies and clarifies programmer's work.

Designing systems' connection with databases is necessary. Engineering objects are selected from objects' assortment tables. Such tables can easily be written to the database tables and the program automatically finds the right parameters of graphical element.

Extended data with object's actual information is attached to the drawing graphical objects. That makes it easy to form specifications for the drawing's objects.

A graphical environment and a working programming language in this environment are required for design of such systems. For example, Visual Basic for Application programming language works with the AutoCAD environment.

Four graphical objects are defined: radiator, valve, pipe and specification. The radiators, pipes and valves are selected from the database and while drawing them the extended data with object's actual information is appended.

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METODY GRAFICZNE W PROJEKTOWANIU SYSTEMU OGRZEWANIA DOMU

W artykule dokonano analizy graficznych metod inżynierskich systemów projektowania. Zadania tworzenia automatycznego systemu projektowania ogrzewania domu rozwiązywane są z pomocą Unified Modeling Language. System graficzny może wybrać typy grzejników i zaworów, rur i specyfikacje projektu. Rozróżnia obiekty-klasy: chłodnicy, zawory, rury i specyfikacji, które mają pewne właściwości i metody, które ułatwiają programiście pracę. Program wybiera parametry geometrii grzejniki z bazy danych grzejników za pomocą technologii ActiveX Data Objects, które metodami programistycznymi łączy z rysunkami. Graficzne obiekty rysunkowe mają dodatkowe dane, z pomocą których wykonywana jest wymiana danych pomiędzy systemem graficznym i bazą danych. Program, znając geometrię grzejników i rur, automatycznie projektuje ogrzewanie domów. System projektowania i przykład projektu ogrzewania domu zostały przedstawione w pracy w kontekście graficznych metod zautomatyzowanego systemu projektowania.