# Tutoring Tool for Logical Schemes Design

Vladimir Mateev, Plamen Manoilov, Mihail Iliev

*Abstract: Tutoring tool for logical schemes design with a Graphical User Interface having been a part of an intelligent environment for analysis and synthesis of Boolean functions is presented in this paper. The tool affords an opportunity of drawing logical schemes in a defined basis. It determines and if the user desires brings out the truth table of the synthesised structured scheme. It offers a list of Boolean functions for structured synthesis, formed like a number of tasks which the user can choose. The tool has a possibility to estimate the rightness of the drawing scheme and can save it as a file. It is designed to help the students giving them a way to practice and improve their skills in the area of logical schemes design. It can be used for testing or self-learning. Java programming language has been used. That allows to create it as an applet and to incorporate it in a Web document or as a stand-alone application. Thus this tool can find a large area of its application in the virtual universities, distance education and e learning.*

*Key words: tutoring tools, logical schemes, Boolean functions*

## INTRODUCTION

Digital design and the corresponding necessity of analysis of the synthesized devices is one of the major components in university education for Computer, Communication and Electrical engineering all over the world for many years. This subject has also been included in university programs. However often in this programs there is a lack of practical experience. In order to provide an actual laboratory usually it is necessary to make rather high investments, which is not always possible. However without enough practical experiments, it is quite difficult for the students to acquire the proper understanding of the subject. The students need assistance to enhance their design knowledge to achieve better practical understanding. And a tutoring tool for logical schemes design can be put into practice.

It is already in the past the time full of heated arguments about the necessity to introduce the students from the "Computer Systems and Technology" degree course to computer science details, such as microprogramming control units [1], and similar components. Now it is obvious that it is absolutely necessary. The logical schemes synthesis and analysis is in the background of understanding the operation of these units and the improvement of students skills in the area of logical schemes synthesis and analysis is of very high importance. The students cann't achieve a complete understanding on operation of electronic digital units used in computer and information technologies without a deep knowledge on the logical schemes and enough skills in their design and analysis.

For the course on Analysis and synthesis of logical schemes to be effective, it is normally accompanied by laboratory sessions. During these laboratory sessions students are exposed to the actual design activities involving real digital logic components. A lot of students have difficulties in this activity. They need deeper understanding on the basic concepts of digital design and more practice in designing of logical schemes. In order to be able to create a working digital device with real wires, students must be able to design the corresponding digital device and to draw its scheme (the scheme of the logical device with the desired truth table). Then they must be able to check the rightness of the scheme proposed. In order to accomplish this task the students need a tool which can help them in analysing the schemes. So the students need a lot of practice and assistance in this activity. And here an appropriate tutoring tool will be extremely useful. The tool has been designed not to replace the laboratory session. It is meant as smart tutorial software, which provides GUI and resources to draw a given in advance Boolean function, to expose its truth table and to estimate the proposed decision. After acquiring more design practice it will be easier for the students to create real digital devices.

The modern education is impossible without computerised totoring tools which have interactive and user-friendly graphical interface. The solution is to design learning systems [2] which can take advantage of new technologies and apply them to traditional learning paradigms. The way in this area is to develop learning systems which can utilize artificial intelligence [3] capable of automating its decision making processes to adapt to the needs of the learner and be 'cognizant' of all the implications and nuances of that 'style' or model presented to the learner.

The tool presented is a resource, which the student can use not only for learning how to build and analyse digital schemes but to create his own schemes. In the process of education it is necessary to create the scheme in a strictly defined in advance manner. It means that the task involves the kind of the logical elements and its number. These schemes are not always the best for practical use, but very useful for educational purpose, because the process of its creation teaches the students to design exactly the given in advance function, not anyone else.

Web-based course delivery can offer a vibrant learning environment created through different teaching strategies, activities, and technologies. E-learning [4] and distance education grown rapidly these days using the new internet and communication technologies. But they need more tools to accomplish their tasks. And here is the place where the tool presented in this paper contributes to this evolutionary path with a practical system whose design and implementation are quite simple. And the tool is extremely easy to use. Simplicity is achieved primarily by exploring modern programming technologies such as object and platform independent programming, implemented in Java programming language [5,6].

It happens that the logical schemes synthesis is not an easy task for a lot of students. The scheme must reflect the given function exactly as it is – the scheme must be realized in a concrete basis, with a number and type of logical elements, corresponding to the given function.  A tutoring tool, which is useful in improving the students' skills in synthesis of logical scheme, is described in this article.

The basic mathematics needed for the study of logic design of digital systems is Boolean algebra. [7]. Boolean algebra has a lot of applications but here we'll focus our attention on its application to switching networks. Boolean algebra in which all variables assume only one of two values is often referred to as switching algebra. The symbols "0" and "1" are used to represent these two different values. The first step in the design of a combinational switching network is usually to set up a truth table that specifies the output as a function of the input variables. The next step is to derive appropriate algebraic expression for the output function. And the last step is the creation of a logical scheme, where this tool finds its place.

### TOOL'S OBJECTIVE

The main objective of the tool is to assist students in understanding the basic concepts of digital design. It provides facilities of doing smart online exercises and so gives the students a possibility to improve their skills in the area.

### BASIC FACILITIES OF THE TOOL

The application is realized as a single document interface application which graphical interface is shown in Fig. 1. It has a typical for a window application visual presentation – a main window with a menu bar, tool bar, status bar and the biggest area of the window is covered of the drawing area - graphical editor to design a circuit.

The menu bar consists of five menues. First of it is File menu with a common for Window based applications commands for opening a new document or an already created
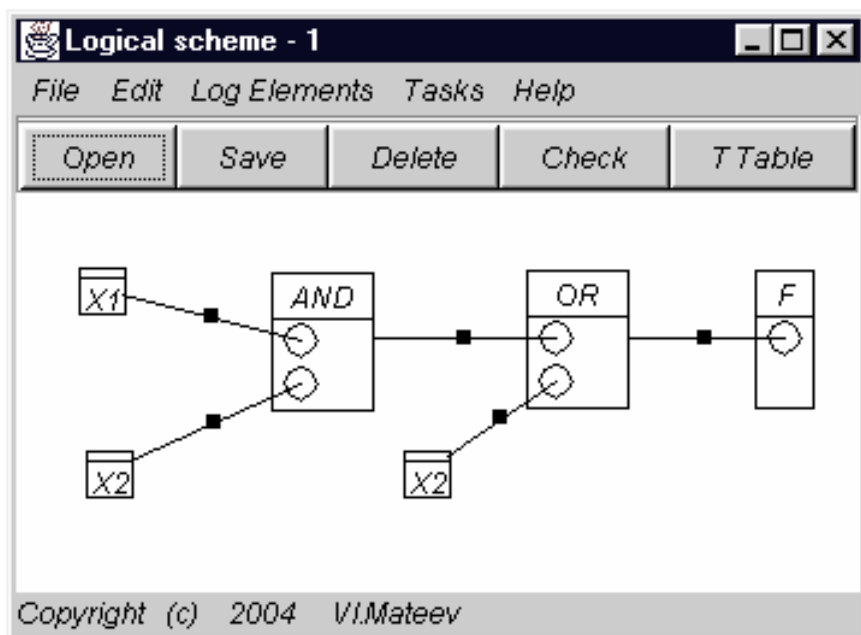


Fig.1. GUI of the tutoring tool

one, for saving a document and exiting the program. The program offers a possibility to retrieve and save a logical scheme as a file. The next menu – Edit contains just one command - Delete. It gives the possibility to delete the marked element, which can be a graphical presentation of a logical element or a connection between two logical elements.

The most important menu is LogElement menu. It provides means for visual creation of the corresponding scheme. A block called Function with corresponding graphical presentation presents the output of the scheme or the function itself. There is a submenu Arguments which gives function's arguments. The scheme can be created with Boolean elements AND, OR and NOT or in so called basis 1. So the LogElements menu has commands for this basis: command Adder for adding a logical element fulfilling OR operation, Multiplier for AND logical operation element and Inverter for NOT operation element. There are still some limitations, which will be overcome in the future. At the moment the tool gives the possibility to create logical scheme for a function that has two arguments only and logical elements AND and OR that have only two inputs each. But there is no actual restriction of the logical elements that could be involved in the tool.

The next menu is menu Tasks. At the moment it consists of only two commands which give the user a possibility to declare a function which has to be synthesized. After a function has been chosen it appears in the status bar and the user can see it every moment while creates the scheme. The last menu is Help, which now has just one command - About. It provides information about the author of the tutoring tool.

At the toolbar there are buttons for fast execution of the commands Open, Save, Delete. The Check button starts an operation on estimation the drawn scheme. There are a number of warning and result messages, which appears when the Check button is pressed. They direct the user towards the correct decision and inform him about his achievements. And after a click on the TTable button the tool displays a truth table of the drawn scheme.

**USING THE TOOL**

The tool can be used by a teacher, and by a student. It gives a teacher a mean to estimate students' achievement and the student - to practice in designing logical schemes. But the "teacher" may be the student itself. So the tool can be used for both - estimating the students' achievements in the area of Boolean functions synthesis or for self learning and training. The use of program is extremely easy for the user. He has a task or wants to create a scheme of a known in advance for the program Boolean function. It can be chosen from a number of given in advance functions that can be found in Tasks menu. By drag and drop the user gets the desire element from the corresponding command in Log Elements menu and puts it in the drawing area. He can move elements in the area simply by dragging them. Creation of a connection can be made easy simply by dragging the mouse from one component to the desire input of the other. A connection can only start from an argument and from a logical element and its end can be only at an input of a logical element or the input of the function. It is impossible for a connection to begin from a logical element's input. If the user wants to make a connection he or she has to press the left mouse button at the point where it starts, dragged the mouse to the desire destination and release the mouse button. During the process the connection is visible. The user must drag the mouse to an input of a logical element and then to release the button. Otherwise the connection will not be created.

Arrangement of the scheme can be made extremely easy just by the mouse. If there is a necessity of deleting an element or connection it can be marked simply by clicking on it by the mouse and pressing the Delete button will erase it.
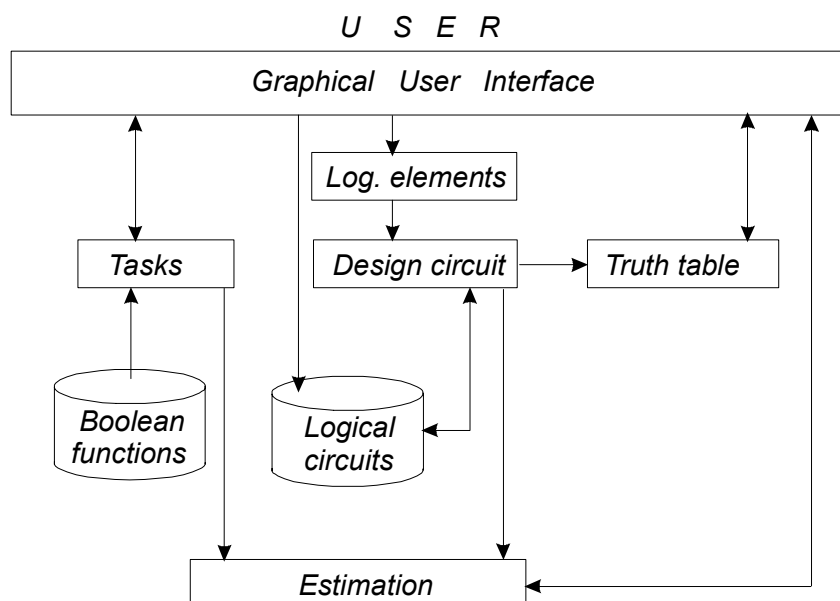
**TOOL'S ARCHITECTURE**



Fig.2. Architecture of the tool

The architecture of the tool is shown in Fig. 2. The user interacts with the tool by its friendly graphical user interface. There are four main blocks. The principal is the Design Circuit block, for drawing the scheme. Tasks block is for choosing a task from a list of tasks created in advance. The Truth Table block, which gives the possibility to obtain the truth table of the designed scheme. And the Estimation block which determines the rightness of the scheme. The scheme can be saved in a file, or can be read from a file.

## CONCLUSIONS AND FUTURE WORK

The tutoring tool with graphical user interface has been presented in this article. It makes the construction of logical schemes as easy and straightforward as if the user draws it on a sheet of paper. And the tool estimates the rightness of the scheme - does it realize the Boolean function, given in advance or not. The tool can be used in both - testing and self-learning. Its functionality will be enriched in the future. The tool will be a part of a computer aided learning environment in the area of digital circuits design and analysis based on Boolean functions. This is the beginning of its creation and the efforts were on the creation of simple and easy to use graphical interface with drawing possibilities.

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## ABOUT THE AUTHORS

Principal assistant Vladimir Mateev Mateev, Physics department, University of Russe, phone +359 888 583, e-mail vmateev@ru.acad.bg.

Principal assistant Plamen Kirilov Manoilov, Department of communication ingeneering and technologies, University of Russe, phone +359 888 842, e-mail pmanoilov@ecs.ru.acad.bg.

Assoc.Prof. Mihail Petkov Iliev, PhD, Department of communication ingeneering and technologies, University of Russe, phone +359 888 673, e-mail miliev@ecs.ru.acad.bg.