An Application of FONWebGPSS in Teaching Simulation

Marijana S. Despotović - Zrakić, Zorica M. Bogdanović, Dušan M. Barać, and Božidar Lj. Radenković

Abstract — **In this paper, we propose a new solution for learning discrete event simulation via web. Primary goal of the research is to develop interactive and user-friendly web based environment for creating, testing and analyzing discrete event system models. FONWebGPSS is a web application designed and implemented in Laboratory for simulation, University of Belgrade. Further, the application is integrated in existing e-learning system based on Moodle LMS. Additionally, we present an example of using FONWebGPSS in solving a typical discrete event simulation problem.**

Keywords — **FONWebGPSS, web based simulation, discrete event simulation, e-learning, Moodle LMS**

I. INTRODUCTION

Simulation has an important role in engineering education. It provides means to study, understand and make predictions of real-world systems while allowing numerous simplifications to the process under observation [1]. Courses that teach discrete event simulation are usually realized by using a specific simulation language. Key issue is to find the appropriate language for simulation. It is necessary for a language to be enough flexible and dynamic, so that it can support analyzing and solving different types of problems. Simulation language should be able to adapt to the up-to-date directions in science of simulation and to enable efficient simulation execution on modern computers [2]

GPSS (General Purpose Simulation System) is language for learning discrete event system simulation. It is oriented to processes. GPSS defines model's structure based on language commands [2]. Program in GPSS is composed as collection of processes descriptions, which specifies sequences of activities and operations that will be executed on the attribute of object model. GPSS

Marijana S. Despotović – Zrakić is with Faculty of organization sciences, University of Belgrade, Jove Ilića 154, 11000 Belgrade, Serbia; e-mail: maja@myelab.net.

Zorica M. Bogdanović is with Faculty of organization sciences, University of Belgrade, Jove Ilića 154, 11000 Belgrade, Serbia; e-mail: zorica@myelab.net.

Dušan M. Barać (corresponding author) is with Faculty of organization sciences, University of Belgrade, Jove Ilića 154, 11000 Belgrade, Serbia; e-mail: dusan@myelab.net.

Božidar Lj. Radenković is with Faculty of organization sciences, University of Belgrade, Jove Ilića 154, 11000 Belgrade, Serbia; e-mail: boza@myelab.net.

presents language interpreter for executing simulation of discrete, stochastic systems [3]. The most known versions of GPSS language for personal computers are: GPSS/PC [4], GPSS/H [5], GPSS World [3].

GPSS/FON [6] was created in Laboratory for simulation, at Faculty of organizational sciences, University of Belgrade, during 90s. GPSS/FON presents the extended version of GPSS. Because of its simplicity and accessibility, quick and easy model debugging, GPSS/FON language has been successfully used for teaching computer simulation at University of Belgrade [7].

A. Environment for learning simulation

GPSS/FON language has been studied within the scope of course Simulation and simulation languages for almost twenty years [8]. Course is organized at the fourth year of undergraduate studies in the area of information systems and internet technologies. Before attending this course, students are obliged to pass several exams in the field of programming and are familiar with programming concepts and several programming languages .

Main goal of the course is to introduce basic concepts and applications of computer simulation. Course is realized using blended learning concept [1], combining traditional classroom based teaching with e-learning technologies. As a support to teaching process, we use learning management system Moodle [9].

Moodle is web-oriented, open source platform for managing online courses. The Moodle platform supports forums, e-mail, notice boards, calendars, evaluation reviews, etc., thus allowing a complete communication framework. Teaching materials are presented through online lessons, tutorials, multimedia presentations, examples, etc. Assessment of students' work can be done through assignments, quizzes, workshops, etc.

The course lasts for three months. The course syllabus is divided into three main blocks: continuous simulation, discrete event simulation and 3D simulation. All the topics are explored by using appropriate simulation language (CSMP, GPSS, X3D, respectively). The course content is organized through tutorials with many examples and problems. Focus is on solving real-life problems with simulation models. Specific cases and problems are discussed in the scope of practical exercises. Students are obliged to implement their own models and solutions for different problems in simulation of complex, real systems.

. Area of discrete event simulation is studied for five weeks. In the scope of the course students learn about three types of problems in discrete event simulation: one process and one serving place, one process and many serving places, many processes and many serving places. Students are obliged to simulate three different systems, perform simulation using GPSS/FON, analyse simulation results and discuss solutions to the proposed problems. Finally, in the third part of the course, students develop their 3D model.

Throughout the course, students are encouraged to participate actively in discussion forums, to develop collaborative learning projects and, especially, to follow a scheduled assessment process. Students are invited to propose a real life problem and try to solve it with the help of the teacher who actively guides the solving process. It has to be noticed that the solving real cases by means of specialized software helps students to be highly motivated and contributes to overcoming possible deficiencies in their mathematical background. Finally, collaborative work and discussions increase interaction among students and between students and instructors.

B. Defining problems and researching goals

During the period of exploitation, we have noticed some of GPSS/FON's disadvantages. Basic problem with GPSS/FON is that it is a desktop application, therefore needs to be compatible with operating system of students' computers. With each new version of operating system it is possible that a new version of GPSS/FON will be required. Another disadvantage of GPSS/FON is that as a desktop application it can hardly be integrated with existing e-learning system Moodle.

The goal of the research presented in this paper is to create web oriented application that will enable simulation via web [10]. Primary goal of the research is to develop interactive, integrated and user-friendly environment for creating, testing and analyzing of discrete event system model. Web version of the application should be easy to integrate in existing e-learning management system.

II. FONWEBGPSS APPLICATION ARCHITECTURE

FONWebGPSS is web application designed and implemented in Laboratory for simulation, University of Belgrade, created in order to overcome presented drawbacks of GPSS/FON. It enables students to configure simulation models, execute simulation and analyze results in a web page.

Structure and key components of FONWebGPSS application are presented in figure 1:

- user interface,

- application logic,

- simulator.

In the text that follows we provide detailed description of FONWebGPSS architecture and key components.
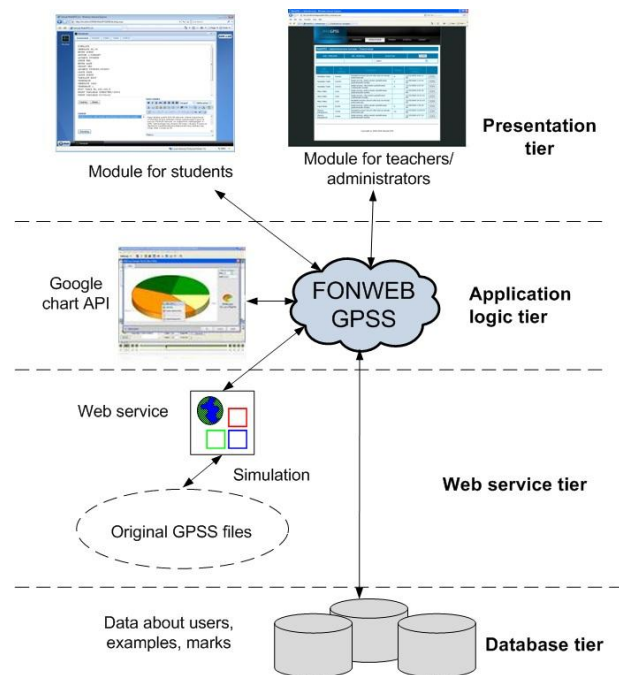

Fig. 1. FONWebGPSS application structure

A. User interface

User interface includes a module for teachers and a module for students.

Module for teachers enables them to create, update, test and manage cases and problems in discrete event simulation; assess students' work and create different types of reports. Teachers can also perform basic system administration tasks such as managing user accounts, grades, etc. Teachers can view students' submissions, perform simulation and check results by simple click on student's simulation model. The work of teachers is more efficient comparing to the old desktop application, because all actions can be performed in only a few clicks.

Module for students enables them to create and test simulation models, perform simulation for created models, adjust graphical environment and analyze simulation results. Students can also submit solutions for discrete event simulation cases and view grades.

Default page of module for students contains functionalities that are grouped into the following tabs:

1) Source code - this part of the page is separated in three areas: case (problem) description, case type choice and editor for writing GPSS code. GPSS commands are to be entered in the text editor. In order to improve editor, we provided students with autosuggest feature. Namely, when student starts to type any command in the editor, application itself suggest available commands related to the typed letters. Current version of application doesn't support creating models by using graphical building blocks, but considering the fact that our students have significant experience in programming, typing code is not a problem. After entering all the required data, by selecting option (button) simulate, simulation begins. If model doesn't have syntax errors, page with results is displayed.

2) Results – this page contains results of simulation. Results are presented in text format.

3) Errors – this page displays syntax errors in the source code, if there are any. Future versions of application will contain real time debugger.

4) Tables – this page enables showing results of simulation in the form of tables.

5) Charts – this page shows simulation results in the form of histograms.

Module for students is shown in figure 3. later in the text.

Presentation tier is realized by using technologies such as: HTML, XML, AJAX, JavaScript and ExtJS JavaScript Framework. Dynamic user interface enables easy and quick exploring of application for both students and teachers.

B. Application logic and web service tier

Users' requests are created on web page and submitted to application logic tier.

Key part of the application is component marked as FONWebGPSS (Figure 1). This component accepts and handles requests, provides and implements all the applications' features:

- Receiving users' requests

- Communication with database

- Managing application's features

- Invoking web services

- Receiving simulation results

- Sending data to the component that draws simulation statistics.

Web service tier receives data sent from application logic tier and calls the method that executes simulation. This method calls a legacy method from GPSS/FON application written in Pascal and Delphi. Results are sent back to application logic tier. Communication between components is realized using XML technology.

Results gained in the process of simulation are usually presented using charts and histograms. For creating charts in web interface we have used Google Chart API. Upon simulation results, tables are filled with data from data source. After that, application shows all required statistics.

Application logic tier is implemented using dynamic web technologies (ASP.NET, ADO.NET). Code behind pages is written in C#.

C. Simulator

FONWebGPSS simulator is derived from older version of GPSS/FON simulator [6]. Simulator is integrated in web service. Web service implements three-phase simulation.

Key advantages of FONWebGPSS applications include [7][8]:

- New and efficient environment for learning discrete event simulation
- Effective integration with e-learning system
- Discrete event system simulation over web
- Clearly defined roles in system
- Simple and intelligible interface provided with variety of options for each type of users' authorization
- Improving application scalability and interoperability by using web service technology

The web application uses all advantages of GPPS/FON language, but adds new features. Dynamic interface provides effective work and adapts learning to students' needs and requests.

III. INTEGRATION IN MOODLE LMS

Next step in developing FONWebGPSS was its integration in the existing e-leaning system – Moodle LMS. Essential idea was to improve our e-learning courses in the area of computer simulation by providing students with possibility to learn simulation over web. This application is placed on the main page of Moodle course Simulation and simulation languages, as additional module. It is available for all students that attend our courses. By clicking on the FONWebGPSS link, students and teachers are being redirected to the start page of FONWebGPSS.

After redirection, users are automatically logged into FONWebGPSS with the same user account and role they have in Moodle. Roles in Moodle and roles in FONWebGPSS are automatically synchronized. When one role (student, administrator, teacher) is assigned to someone in Moodle, they get the same role in FONWebGPSS. Thus, user management is being performed in Moodle LMS.

Assignments that students do and upload via FONWebGPSS are stored in Moodle, too. Teachers can choose, whether they want to assess student's assignments in Moodle course or directly in FONWebGPSS.

Figure 2. shows integration of Moodle LMS and FONWebGPSS application. These two software applications are connected through MySQL database. The database stores data about users and tasks within the course in Moodle LMS, but at the same time, data about users' activities in FONWebGPSS are stored there. Applications share common data: data about users' activities, marks, assignments, etc.
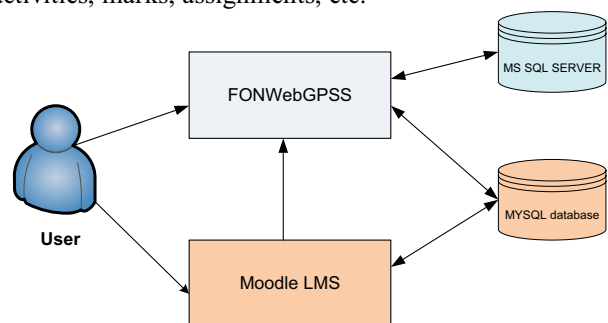

Fig. 2. Integration of FONWebGPSS and Moodle LMS

IV. USING FONWEBGPSS IN SOLVING TYPICAL PROBLEM OF DISCRETE EVENT SIMULATION

In the following text, we present a FONWebGPSS application in simulation of a typical discrete event system.

GPSS has been successfully applied in analysis of complex systems with discrete changes of the system's state, such as airports, hospitals, factories, etc. These are also typical cases that students solve during the course. When using FONWebGPSS application, students need to choose type of the case. Then, they are obliged to enter case description (verbal model) and finally, GPSS commands. Verbal model students write by themselves, using information from literature or collected in real systems.

In this example we observe passengers that wait for the bus, process of bus entering the station, passengers getting off and on the bus.

Figure 3 shows main page of the FONWebGPSS web application. In upper part, GPSS code for creating model is presented. Verbal description of the problem is provided below. After simulation has been executed, user gets a notice whether the simulation succeeded or failed. If there are any syntax errors, student will get an error message.
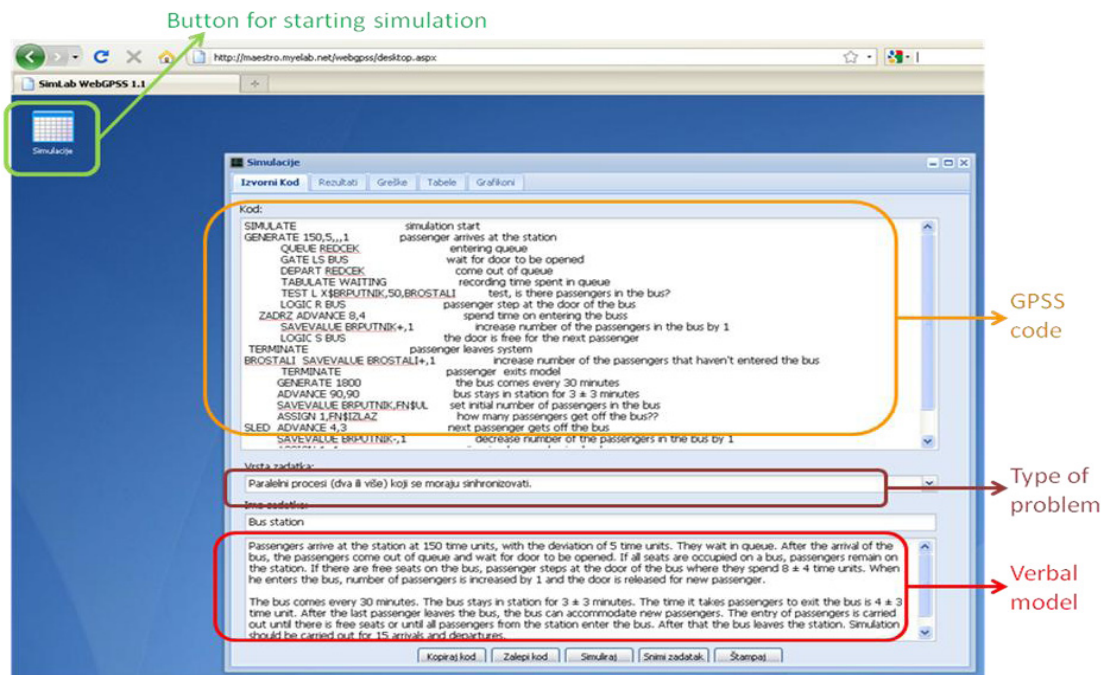

Fig. 3. Window with case description and GPSS code editor

V. CONCLUSION

Main contribution of this paper is reflected in the development of new and efficient web based environment for learning discrete event simulation - FONWebGPSS. Further, the application was integrated in existing e-learning system in Moodle LMS. Architecture of FONWebGPSS application was presented, as well as technologies used for developing the application. We described key features of FONWebGPSS application with emphasis on user interface.

Future research is directed toward improving application interface and enriching it with graphical blocks that can be used instead of writing GPSS commands. FONWebGPSS will be improved to enable collaborative modelling of discrete systems. It would be useful to analyze and evaluate new approach to teaching discrete event system simulation. It is also necessary to develop additional features and provide full integration of FONWebGPSS with the existing e-learning system

REFERENCES

[1] P. Fonseca, A.A. Juan, L.M. Pla, S.V. Rodriguez, and J. Faulin, "Simulation education in the internet age: some experiences on the use of pure online and blended learning models," in *Proceedings of the 2009 Winter Simulation Conference*, 2009, pp. 299-309.

[2] I.Stahl., "GPSS: 40 years of development," *Proc. of Winter Simulation Conference*, 2001., vol.2, pp. 577-585.

[3] S.W. Cox. "GPSS World: a brief preview," in Proc. of the 23rd conference on Winter simulation, 1991. pp. 59-61.

[4] S.W. Cox, "GPSS/PC graphics and animation", in *Proc. of the 20th conference on Winter simulation*, 1988, pp. 129-135.

[5] R.C. Crain. "Simulation with GPSS/H," in *Proc. of the 30th conference on Winter simulation*, 1998, pp. 235-240.

[6] A.M.Zikic and B.Lj. Radenkovic. "An application of GPSS/FON in teaching simulation," *International journal of applied engineering education*, pp. 247-253, 1993

[7] A.M.Zikic and B.Lj.Radenkovic, "New Approach to Teaching Discrete Event System Simulation," *International Journal of Engineering Education*, 12(6), 1997.

[8] Despotović M., Radenković B., and Barać D., "GPSS for e-learning environment," in *Proc. of TELSIKS 2009*, Nis, Serbia, 2009. pp.318-322,

[9] Radenković B., Despotović M., Bogdanović Z., and Barać D., "Creating adaptive environment for e-learning courses," *Journal of Information and Organizational Sciences*, 33(1), pp.179-189, 2008.

[10] J. Byrne, C. Heavey, P.J. Byrne, "A review of Web-based simulation and supporting tools," *Simulation modelling practice and theory*, 18(3), pp. 253-276, 2010.