

Role of Simulation Tool in Enhancing Teaching and Learning of Information and Communication Technology: A Case Study

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ABSTRACT

Simulation tool plays an important role within the frame of Information and Communication Technology (ICT) engineering teaching and research education across the globe. A greater understanding of the course taught in ICT curriculum during teaching and research can be achieved through the use of simulation software packages. The present paper summarizes the effectiveness of various simulation packages used in enhancing the teaching and learning in domain of ICT engineering. In addition, the paper also reports a case study of teaching and learning through MATLAB simulation tool in Faculty of Engineering and Technology at BPS Women University, Khanpur-Kalan, Haryana. The general student's positive reaction to incorporate the software package into their curriculum is reported.

KEYWORDS

Information and Communication Technology, Teaching, Simulation Tools, MATLAB.

1. INTRODUCTION

It is well known that teaching and learning existed since a long time ago. Many revolutions have seen in order to improve the art and technique of teaching and learning. Since the last three decades, the emergence of assessable powerful computing and ICT facilities have intersected all walks of teaching & learning and play a pivotal role in educational development. ICT integrated teaching and learning environment brings innovation in teaching, training, curriculum, pedagogy, assessment, professional development, administration, learning, web based education, conducting virtual laboratory and in other areas too. ICT assisted teaching and learning has the potential to improve teaching and learning significantly by supplementing simulation package during the course of studies. The integration of these simulation tools & software packages brings excellent results at the level of knowledge. Undoubtedly, the use of computing tools is fundamental for engineering education and consequently for the engineering professional practice. The advent of modern and more powerful computing facilities has contributed to a fast and a reversible change on the way of facing the research and development of science and engineering [1-4].

The last decade has also witnessed an assorted increase in professional education mainly in ICT engineering and its related programmes in India. In general, education in ICT engineering covers a wide variety of theoretical and applied knowledge which demonstrates their application in areas such as telecommunication, automation, defence, space & aviation, software & hardware, teaching & research and other diverse fields too. The economic development of any nation depends on its level of human resource development, particularly in science and engineering as well as technological advancements and industrialization. ICT engineering graduates should have an ability to apply knowledge of mathematics, science & engineering; ability to identify, formulate & solve engineering problems and ability to use the techniques, skills and modern engineering tools necessary for engineering practice [5-8]. It is arguing that the modern engineers are prepared to develop solid abilities to model, programme, simulate and visualized system dynamic behavior.

Simulation tool play an important role in understanding of basic theory, in analyzing complex system, to solve real world problems, to design the projects, raises the interest in technical profession, enable flexible study and consequently motivate the students in learning. Study of complex technological process using mathematical methods, modeling and simulation supported by the powerful computing facilities and multimedia technique for knowledge transfer are of great importance in engineering education and training. The benefits of these software packages within a university environment is also confirmed by a number of new text books and revision of previously printed text books incorporating new exercises and problems based on these package. Besides ICT engineering, the simulation tools are also beneficial to supplement teaching and learning in other disciplines of engineering and technology related to their topic of interest [9-23]. Although, Haryana state is making all efforts to provide and strengthen ICT engineering education at UG/PG/Research level in state but the integration of MATLAB as a part of curriculum in the field of engineering and technology has not been much explored in the state. In this direction author has made an attempt to understand and analyze the role and usage of MATLAB in UG curriculum at BPSMV Khanpur-Kalan, Sonapat.

The main objective of this paper is to show the effectiveness of simulation packages in teaching and learning of ICT graduate students with different educational backgrounds and to demonstrate the skills for enhancing the theoretical understanding of professional subjects. The forthcoming section summarizes an outline of various simulation tools in ICT curriculum.

2. SIMULATION TOOLS: AN OVERVIEW

Various commonly simulation tools are used to supplement teaching and learning in the domain of ICT engineering. The integration of theory and practical in teaching and learning of ICT using simulation tool is quite important. The software packages such as PSPICE-OrCAD, Multisim, LabVIEW, VisSIM, Design Works, Modelsim, Questa, PSIM, Digislim, Easysim, XiLLinx, Mentor Graphics, Tanner, Mathematica, Maple, Mathcad, Polymath, Autocad, UMPS, MSAM, DEBUG, Microwave Office, Opnet IT Guru, VPI photonics, Quartus II and MATLAB & Simulink tools are used to develop and harmonize the hypothetical concepts of various domains explained in classroom of ICT programme and to conduct virtual laboratory across the globe. A brief description of some of the popular simulation packages used by ICT programmes to enhance teaching and learning is presented as follows:

2.1 PSPICE-OrCAD

PSPICE is an analog circuit and digital logic simulation software released in January 1984 by MicroSim Corporation. It is used for analysis for various electronic circuit & design such as AC/DC/frequency analysis. PSPICE with advanced simulation performance technology saves time, improves reliability, speeds convergence on larger designs and supports a wide range of component and system models. It is frequently used in various ICT courses at UG/PG level to enhance theoretical understanding of courses such as circuit theory, communication systems, analog circuits, power & control, digital logic simulation for more complex requirements in design flow.

PSPICE is very helpful in conducting electronic circuit simulation laboratories in the domain of analog circuits such as basic transistor circuits, linear & non-linear op-amp circuits, active filters, signal generators, voltage regulators, power amplifiers, high frequency amplifiers and data converters for students pursuing studies in ICT engineering and related programmes. PSPICE, now developed towards more complex industry requirements, is integrated in the complete systems design flow from OrCAD and Cadence Allegro with many additional features, like advanced analysis with automatic optimization of a circuit, encryption, a model editor, support of parameterized models, has several internal solvers, auto-convergence and checkpoint restart, magnetic part editor and Tabrizi core model for non-linear cores. The benefit of using this package have been long realized and reported by many educators. It becomes an integral part of almost all UG curriculum books. Further, the interested reader may refer the

websites and literature [24-31] for in-depth study of application of this software package in ICT courses. However, in recent years with the momentum of UG/PG/Research in engineering education, efforts have also made to incorporate MATLAB as a part of curriculum. MATLAB is currently not only used as a mathematical manipulation tool, but also for the design and simulation of various dynamic systems.

2.2 MATLAB

Besides PSPICE, the other most commonly used tool across ICT curricula is MATLAB & simulink. MATLAB is interactive numerical computation software developed in 1984 by Math Works Inc. It is one of the most popular and high performance platforms for scientific and engineering computing. It is particularly a tool for matrix computation. MATLAB because of its extensive mathematical, simulation, analysis capabilities, flexibility, reliability and powerful graphical capabilities, its generic nature is most widely used and preferred across teaching, research and industry. A very important feature of the MATLAB is collections of increasing add on application specific solution referred as toolboxes for numerous applications. Some example of tool boxes are: Math and optimization, statistics and data analysis, control system design and analysis, signal processing and communications, image processing, test and measurement, computational biology and computational finance.

Simulink is an integrated environment with MATLAB. It is an ideal package for modeling, simulating and analyzing highly complex linear, non linear and discrete system. It provides an interactive graphical environment and a customizable set of block libraries viz design, simulate, implement, test a variety of time-varying systems, including communications, controls, signal processing, video processing and image processing. Simulation of dynamic systems has proved to be immensely useful when it comes to control design, saving time and money that would otherwise be spent in prototyping a physical system. Any logic circuit or a control system for a dynamic system can be built by using standard building blocks available in simulink libraries. Various toolboxes for different techniques such as Fuzzy Logic, Neural Networks, Digital Signal Processing, Statistics etc. are available with simulink, which enhance the processing power of the tool. The software helps to make block diagrams with click-and-drag operations, change parameters of the model and display results during a simulation. The key features of the software packages are: (1) Enable ICT professional to solve technical problems faster than traditional languages and provides all features of traditional programming languages such as arithmetic operators, flow control, data structures, data types, debugging etc. (2) Support the matrix and vector operations and enable rapid development and execution. (3) Enable faster development of algorithms because there is no need of declaring variables, specifying data types and allocation memory. (4) Provides a wide array of functions: analyzing and accessing data, numeric computation, import & export graphics, visualizing data, integrating its code with other

languages etc. (5) Extensive and expandable libraries of predefined blocks. (6) Interactive graphical editor for assembling and managing intuitive block diagrams. (7) Ability to manage complex designs by segmenting models into hierarchies of design components. (8) Model Explorer to navigate, create, configure and search all signals, parameters, properties and generated code associated with model. (9) Application programming interfaces (APIs) that enables one to connect with other simulation programs and incorporate hand-written code. (10) Embedded MATLAB function blocks for bringing MATLAB algorithms into simulink and embedded system implementations. (11) Full access to MATLAB for analyzing and visualizing results, customizing the modeling environment and defining signal, parameter and test data. Moreover, MATLAB tool can be used in various courses in the domain of electrical, electronics and communication, computer science & engineering, information technology etc. at UG/PG/research level. Among other applications, MATLAB is also used in ICT curriculum to solve problems in domain of mathematics, physics, numerical methods, statistics, research methodology etc and also to handle the data generated from various laboratories. The usage of MATLAB across ICT curriculum is reported in a number of literatures. The ability of MATLAB to interface with other dynamic simulation program makes it a powerful tool in ICT engineering curriculum [32-38].

2.3 MULTISIM

Multisim is an electronic schematic capture and simulation program developed by Electronics Workbench a division of National Instruments (NI). This software package is used in ICT curriculum at UG/PG level for circuit design and prototyping. It is frequently used in academia and industry for understanding the circuit concepts, electronic schematic design and SPICE simulation.

The understanding and easy-to-use software platform combines schematic capture and industry-standard SPICE simulation into a single integrated environment. Multisim concrete the complexities and difficulties of conventional syntax-based simulation. This package meet the teaching needs of ICT educators or the design needs of professionals:- (1) Multisim makes it easier to engage students and strengthen theory to make capturing designs, simulating behavior and defining board layout faster and easier. Professionals worldwide are using the academic features of the Multisim education in learning and guiding student exploration in deeper understanding of circuit concepts using “what-if” experiments and simulation-driven instruments to visualize circuit behavior. (2) Multisim tool is used by ICT engineers, researchers and domain experts for schematic capture, SPICE simulation and circuit design & prototyping. Without needing any expertise in SPICE, professionals can use simulation to reduce prototype iterations earlier in the design flow. Multisim can be used to identify errors, validate design behavior and prototype faster.

Schematics can then be transferred to NI Ultiboard layout to prototype completed printed circuit boards (PCBs).

Moreover the integration of Multisim, Ultiboard and LabView bridges the gap between design software and hardware. Integrating design and test creates a predictable, unified and streamlined flow for PCB design, verification and test. Simulation can be improved by introducing real measurements. Further, the interested professionals who want to read may refer the websites and literature for complete coverage of Multisim in ICT engineering courses [39-40].

2.4 VISSIM

Besides above stated simulation packages, VisSIM is the fastest simulation package used in different courses and projects of ICT. It is developed by Visual Solutions of Westford in 1989. It is a visual block diagram language for simulation of dynamical systems and model-based design of embedded systems. This package is influenced by C, laboratory workbench, advance visualization system (AVS) with the operating system windows and Linux. VisSIM is widely used in control system design, digital signal processing, communication systems, neural networks, embedded systems for multi-domain simulation and design. It includes blocks for arithmetic, Boolean & transcendental functions as well as digital filters, transfer functions, numerical integration and interactive plotting. Moreover, it can also be used in the areas such as biomedical devices, chemical process, digital power, aeronautical, electric motor, power generation, RF data communication, wind power etc.

VisSIM is up to 10 times faster than competitive simulation products. Its unparalleled power, ease of use, and reliability has made it an essential tool on thousands of ICT engineering projects with a leg on each side of a diverse range of industries and disciplines. It provides fast and accurate solutions for linear, nonlinear, continuous time, discrete time, SISO, MIMO, multi-rate and hybrid systems. Moreover, VisSIM's tightly integrated development platform makes it easy to pass freely between model construction, simulation, optimization and validation which create virtual prototypes on desktop to make design works properly before committing to prototype. VisSIM/Comm is a window-based software program for the modeling and simulation of end-to-end communication systems at the signal or physical level. It is based on the core VisSIM engine. With a full complement of communication blocks and powerful, time-domain simulation engine, VisSIM/Comm provides fast and accurate solution for analog, digital and mixed-mode communication system designs. Apart VisSIM/Comm, VisSIM/embedded controls developer is a development environment for the rapid prototyping and development of embedded control systems which simulates high-level block diagrams and generates efficient C code for embedded targets. Interested reader can refer the websites and literature for deepening the effectiveness of VisSIM in ICT engineering courses [41-44].

Because of the space limitation of the paper, it is difficult to discuss all software packages. The software packages such as Logic Works, Design Works, Mathematica, Maple, Mathcad, Autocad, LabVIEW, UMPS, MSAM, DEBUG, Microwave Office, Opnet IT Guru, VPI photonics and Quartus II can also be used in conjunction with other teaching aids to enhance student learning in various courses and truly provide a modern environment in which students and faculty members can get in depth study of science, engineering & technology.

In the forthcoming section a case study of integration of MATLAB in a UG curriculum at BPSMV, Khanpur-Kalan, Sonapat is presented. The same is currently being used by the authors to teach signal & systems, control system, DSP which helps the student to understand the concepts & principles in a better manner.

3. BHAGAT PHOOL SINGH MAHILA VISHWAVIDYALAYA (BPSMV): AN OVERVIEW

This section provides a brief description of ongoing plan for courses and innovation in ICT curriculum at BPSMV, Khanpur-Kalan, Sonapat. BPSMV is established by an act of Government of Haryana in 2006 to empower women education in state. It is the first women multi faculty, residential University of North India imparting education in various faculties such as physical science, Engineering and Technology, Commerce & Management Studies, Laws, Humanities, Education and others too etc. It is also the youngest University in India to get the Academic Staff College from UGC in record time of two years of its establishment for organizing the orientation programmes, refresher courses, workshops, conferences etc. The university adopts all academic and examination reforms recommended by UGC like semester system, credit system, continuous and internal evaluation right from inception. The University has experimented many innovations like state-of-the-art language labs compulsory for students to improve their communication skills, personality development courses, computer literacy and at least one foreign language is also taught compulsorily as a part of curriculum to students to instill confidence among them.

School of Engineering & Sciences (SES) of BPS Women University is established in 2008 to impart Engineering & Technology education in Computer Science & Engineering, Information Technology, Electronic & Communication Engineering, Fashion Technology and a 5 year dual degree programme in MBA (Tech). During the design of UG curriculum in Faculty of Engineering & Technology, BPSMV, an effort is made to incorporate MATLAB as a part of UG curriculum right from the 1st year. In the forthcoming section the student's feedback about the usefulness of MATLAB in teaching and learning is reported [45].

STUDENT EVALUATION

In this section an outline of student perception about the usage of MATLAB software package in teaching and learning of various courses in engineering and technology during 1st year, 2nd year and 3rd year of ECE/MBA (Tech) programmes in

Faculty of Engineering and Technology at BPS Women University is presented. At the end of semester, a survey was conducted to get direct feedback and to evaluate student perception about effectiveness of MATLAB. It is important to note that the survey was only the method of assessment the students. The survey is composed of total 15 questions which are shown in table 1. All the results of survey are shown in the same table. Most of the faculty members of Electronics & Communication Engineering (ECE) discipline at SES utilize the MATLAB/simulink in teaching and learning of various subjects.

According to the questions 1 to 15, students seem to feel more comfortable and indicate wide acceptance of the usage of MATLAB as the pedagogical tool in learning. Most of the students expressed positive feeling about the usefulness of MATLAB in their learning as it provides opportunities for visualization, ease of graphing, computation and exploration. The response received from the students is an increased interest in the subject contents by using MATLAB which enable them to solve and design complicated systems. It is worthwhile to mention that the students had only one lab about MATLAB programming in general, hence we believe that students can learn more easily and perform better if project based learning using MATLAB is incorporated in various subjects supplemented by laboratories and thereby enabling them to aware about modeling and simulation, GUI system and thus provides better understanding of engineering practices.

CONCLUSION

The paper presented an outline and the applications of PSPICE-OrCAD, MATLAB, Multisim, VisSIM simulation tools in enhancing teaching and learning of ICT engineering curriculum. A case study of incorporating MATLAB software package in various B.Tech programmes at School of Engineering & Sciences, BPS Women University, Khanpur-Kalan, Haryana is presented. The student's observation on the usefulness of MATLAB package and their involvement to use the same are reported on the basis of survey. It has been observed that student's response concerning the MATLAB is very much favorable to understand the theoretical concepts and principles. It has observed that integration of MATLAB in UG curriculum result in shifting from teaching centric to learner centric. Thus there is a need to reform the curriculum of the other technical university in the state to incorporate the same as a part of UG curriculum during 1st year.

FUTURE SCOPE

In the future an effort is made by individual faculty member of ECE discipline in School of Engineering and Science, BPSMV to encourage students to perform small independent project during the teaching of course such as control system, signal and system, circuit theory, digital circuit and system, communication system, digital signal processing etc. Moreover, the interested students are encouraged to compile their minor and major project work during their final year course of studies

as a part of curriculum. The students are encouraged to model a system by mathematical equations and develop a corresponding graphical simulink model. Effort is also made to supplement teaching and learning MATLAB across other faculties of universities in teaching departments such as economics, management and mathematics. Further, effort is also made to conduct special training programmes on the usage of this package in the academic staff college of University. Keeping in view the experience of BPSMV, other Universities of state may also make an effort to introduce MATLAB as a part of curriculum.

Some recommendations in this direction are: (1) State technical universities and department of technical education should participate actively in conducting workshops and laboratories using MATLAB for engineering graduates to enhance quality of teaching, learning, training and research and also promote inter departmental interaction and interdisciplinary research. (2) Industry academia cooperation in the area of teaching, training, research & development with a view to conduct live projects, dissertation using MATLAB to enhance industrial experience

to both teachers and students. (3) Regulatory and professional bodies such as department of technical education should be engaged in modernization, standardization of quality assurance, restructuring of curriculum of various technical institutions and inclusion of MATLAB as a pedagogical tool. (4) Establishment of central learning resource centre for both teachers and technocrats to create awareness and effectiveness of ICT assisted simulation tool in engineering and technology.

S.No.	Question (Number of respondents)	1 st Year (116)	2 nd Year (116)	3 rd year (66)
1.	Whether simulation package is available in SES and students are familiar with simulation packages?	Yes	Yes	Yes
2	Is faculty uses MATLAB/simulink to teach control system, signal & systems, communication system, digital circuit systems mathematics in theory lectures and laboratories?	Only MATLAB programming in general	Yes; signal & system only	Yes; control system only
3	Are the tutorials and demos using MATLAB is helpful in clarifying the material discussed in class?	Yes	Yes	Yes
4	Is the tool helpful in understanding theoretical concepts?	Don't know	Yes	Yes
5	Use of simulation package in solving exercises, and assignments of tutorial.	Not Aware	70%	55%
6	Is the software improves the knowledge of circuit theory/control system/signal processing and other courses of curricula?	Not Aware	Strongly agree	Strongly agree
7	Role of tool in understanding theoretical concept & principal and preparation of theory examination.	Not Aware	70%	50%
8	Is the software package time consuming in tutorials and laboratories?	No	No	No
9	Whether the tool improves the professional growth?	Not Aware	Yes	Yes
10	Is this software package beneficial for all learners of ECE discipline?	Yes	Yes	Yes
11	Whether use of simulation tool would be helpful?	Yes	Yes	Off course
12	Whether the students are able to work with Mathematical description programming, GUI and block schematic capture feature of MATLAB?	Only with mathematical programming	Yes with block schematic & GUI	Yes, mathematical programming , block schematic & GUI
13	Whether the students are able to do their minor/ major projects using MATLAB?	Not Aware	Aware & efforts are under way	Aware& efforts are under way
14	Among C, C++, JAVA & MATLAB which language do you feel comfortable?	Not Able to decide	Not Able to decide	Not Able to decide

15	Whether the MATLAB is used in other engineering programme?	Yes	Yes	Yes
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Table 1: Student’s response to survey

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