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Innovative Students-Based Course Project Methodology for Modeling and Simulation of Industrial Systems

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Abstract

This summary provides an overview of the project methodology utilized in the Modeling and Simulation of Industrial Systems course, which is offered in the final year of the Industrial Engineering Program at Fayoum University's Faculty of Engineering in Egypt. The course covers a range of topics, including Simulation Modeling Methodology, Queuing Models, Monte-Carlo Simulation, Spreadsheet Simulation, Discrete-Event Simulation, Input Modeling and Output Analysis, as well as Verification and Validation of Simulation Models. Additionally, students gain practical experience and ability in a specialized discrete-event simulation package as an integral part of the course.

Given the challenges faced by developing countries in accessing industrial systems that provide real data for simulation studies in mini-course projects, it became necessary to explore innovative approaches to implement simulation projects, primarily utilizing the available educational resources within the faculty and engaging students actively. One such method employed in this project involved students conducting practical simulation experiments on virtual manufacturing systems (Physical Simulation), using these experiments to gather the necessary data for simulation studies. This approach enables students to identify the stochastic characteristics of real systems and the factors influencing their performance. It also allows them to observe existing issues and proposed solutions, which can be tested through simulation modeling prior to real-world application. Additionally, this approach facilitates the acquisition of fundamental principles and concepts associated with lean manufacturing, as well as the design and analysis of industrial systems.

In the mentioned course, a simplified assembly line, requiring minimal resources, was proposed for implementation, and physically simulated by the students in the program's laboratories. The assembly line consisted of four consecutive production processes. Four student groups were formed, each assigned specific tasks and deliverables shared among the groups. The first group was responsible for conducting physical simulation experiments, recording the experiments via video to facilitate data collection and time study analysis. The experiment was designed to yield a sufficient sample size for statistical analysis. The primary outcome of this group was the experiment video, which was then handed over to the second group. The second group's task involved gathering data on the production time for each process. The second group collected and analyzed the data, determining the probability distribution of production time for each process on the assembly line, representing the probabilistic inputs to the simulation model. Subsequently, the second group prepared a report on the statistical analysis results and passed it on to the third and fourth groups. The third and fourth groups utilized a simulation program to develop the simulation model and conducted the necessary simulation experiments to ensure the model's validity and accuracy. Furthermore, a series of simulation experiments were conducted to test some proposed improvement scenarios for the original assembly line's performance. Each group prepared a report summarizing the outcomes of their respective simulation experiments. Finally, an evaluation for the outcomes of the different groups was conducted through the course instructor.

This project provided students with a valuable opportunity to apply the simulation modeling methodology and the theoretical concepts covered in the course in a practical context. As a result, students gained the necessary skills to apply simulation modeling to the analysis of real-world industrial systems. Throughout the project, students also gained proficiency in various computer programs such as Minitab, Stat::Fit, SIMUL8, Anylogic, and Excel. Additionally, they developed effective communication skills, learned how to work collaboratively in teams, and mastered the skills of coordinating tasks among different teams, replicating real work environments. The students'

evaluation of the experiment was positive, highlighting its usefulness in enhancing their understanding of theoretical topics and their practical application. Above all, they recognized the significance of simulation as a decision-making method.

Keywords
Modeling and Simulation of Industrial Systems, Discrete-Event Simulation, Physical Simulation, Assembly Lines, Student-Based Course Project Methodology, Experiential Learning, Developing Countries, Egypt.

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Biographies

Faris Ashraf is an undergraduate student in the Industrial Engineering Program at the Faculty of Engineering, Fayoum University, Egypt. He was the groups coordinator in the above-described simulation project.

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Ahmed Shaban is an Associate Professor in the Mechanical Engineering Department at Fayoum University, where he is involved in research and teaching activities relating to IE & operations research. He received his BSc in Industrial Engineering with honour degree from the Industrial Engineering Department at Fayoum University, Egypt, in 2006. He obtained his MSc in Mechanical Design and Production (IE specialty) from the Mechanical Design and Production Department at Cairo University, in 2010. He received his PhD in Industrial Engineering from the Sapienza University of Rome, Italy, in 2014. He His current research interests involve modelling and optimisation, simulation, supply chain, healthcare systems and energy systems. He has published numerous research papers in high quality journals. He is a reviewer for many international journals. He is also appointed as an editorial board member for a number of journals. He is the Associate Editor of the Fayoum University Journal of Engineering (FUJE). He is the PI and Co-PI for a number of research project.

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