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Simulation software in industrial engineering and its impact on medicine.

Softwares de simulación en ingeniería industrial y su impacto en medicina.

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Abstract: The following article aims to highlight the activities that industrial engineers could perform, using their knowledge and experience in simulation software to positively impact the area of medicine. First, we will highlight key concepts related to the use of simulation software in both medicine and industrial engineering. Second, based on the understanding and use of software in different areas, we will discuss the possibility of industrial engineering entering the field of medicine to more optimally solve health problems and improve the quality of life.

Keywords: Medicine, Industrial Engineering, simulators.

Resumen: El siguiente artículo tiene como propósito denotar las actividades que podrían desempeñar ingenieros industriales, usando sus conocimientos y experiencias en softwares de simulación para impactar de manera positiva en el área de la medicina. Primero, destacaremos conceptos clave en relación con el uso de softwares de simulación tanto en medicina como en ingeniería industrial. En segundo lugar, partiendo del entendimiento y uso del software en las distintas áreas, se debatirá la posibilidad de que la ingeniería industrial entre al campo de la medicina para resolver de manera más óptima problemas de salud y mejorar la calidad de vida.

Palabras Clave: Medicina, Ingeniería Industrial, simuladores.

1. Introduction

The history of the use of simulators in medicine dates back to ancient times, when models of human patients were built in clay and mud to demonstrate the clinical features of diseases and their effects on humans. In Paris in the 18th century, Grégoire father and son developed an obstetrical mannequin made of a human pelvis and a dead child. The phantom, as the mannequin was called, enabled obstetricians to teach and learn childbirth techniques, resulting in a reduction of maternal infant mortality rates [1]. Medical simulation was born in the second half of the 20th century, when three movements were identified as the driving forces behind its advancement: 1. A group of anesthesiologists and a toy factory developed a model of cardiopulmonary resuscitation. 2. Creation of the SimOne simulator, developed by Abrahamson and Denson in the late 1960s at Harvard University. The simulator had features such as respiratory and cardiac sounds and synchronized carotid and temporal pulses. The maneuvers performed were in real time using a computer program [2].

It was considered the first realistic anesthesiology simulator, but it was abandoned due to its high cost and lack of microcomputer support at the time; it was never commercialized. 3. Worldwide educational reform with the search for new teaching strategies applying new technologies.
In 1999, in the United States, the report to err is human: building a safer health system was published, in which it was determined that human error is the main cause of adverse events that lead to unfavorable patient outcomes. Since then, the need has arisen to integrate the concepts of patient safety into teaching programs. In the 1990s, the Dextroscope became the prototype of the virtual surgical field, since through the use of a mirror, the image of a monitor is reflected using stereoscopic glasses, forming a three- dimensional holographic image [2]. Combined with the VizDexter software program, this system provided users with the tools to manipulate and navigate in hard-to-reach spaces. Later the Virtual Temporal Bone model was released; after several more attempts, the ROBO-SIM was invented, then the NEUROBOT, which is used during live surgery. In our country, simulation with applications in medical education began in the 1980s. In 2003, the Center for the Development of Medical Skills (CEDDEM) of the National Institute of Medical Sciences and Nutrition "Salvador Zubirán" was created, which was formally inaugurated in early 2004, and became the first center of its kind in Latin America; it had a multidisciplinary approach and for medical and surgical areas.

On the other hand, the evolution of simulation in industrial processes has its origins in computer simulation techniques, which tries to make a model of a real or hypothetical system in such a way that it is possible to study its operation and predict its behavior in order to make decisions. Advances in industrial engineering simulation have grown in parallel with computer innovations, generating benefits of great relevance for companies. This tool has been part of automated industries for at least 40 years and during this period new mechanisms have been created to strengthen its performance characteristics, all with the purpose of maintaining or improving the quality of a specific product. The first recorded simulation is the Monte Carlo Method, developed in World War II, which was applied to solve a problem related to the behavior of neutrons. Later, during the Cold War, the use of simulation to solve problems of military origin was more intensive, i.e. continuous simulation based on calculation; by the sixties, the first programs for the simulation of discrete events with civilian application appeared on the market, such as GPSS (General Purpose System Simulator, developed by IBM) and SIMSCRIPT. In the eighties, with the computer revolution, there was an important advance in computer simulation.

Industrial engineering and medicine have never been linked in the area of simulation, so what would happen if for some reason we tried to share knowledge in this regard? Could industrial engineering simulation impact in some way on medical simulation processes? This article will show the possibility of linking both disciplines, all through knowledge, criteria and perspectives that one has as an industrial engineer.

2. Materials y Methods

In medicine, there is a need to use simulation to reproduce real patient experiences through appropriately guided and controlled scenarios.

2.1. Simulation in medicine

If we refer to the educational process, simulation can achieve two main uses; during teaching and evaluation. During teaching and learning, the various types of simulation available can be used not only to improve diagnostic, treatment and problem-solving techniques, but also to improve psychomotor and interpersonal skills, where they can sometimes be more effective than many traditional methods, all of which depends primarily on the fidelity of the simulation.

In terms of evaluation, the results obtained indicate that simulation is particularly useful for assessing: the ability to search for and interpret clinical data and paraclinical examinations, the identification of health problems, judgment on the therapeutic approach to follow with a patient, and practical knowledge and professional skills.

Currently, medical schools are implementing software that develops clinical simulation scenarios that include integrated learning, exercises and assessments to help students fully understand cases and remediate them when they make incorrect and incomplete decisions. It helps develop diagnostic competencies and clinical judgment skills. Also, noteworthy is the implementation of simulators that present respiratory and heart sounds, carotid and temporal pulses, and simulators that blink, breathe, cry, sweat and bleed, with pulse and heartbeat and even vital signs.

2.2 Simulation in Industrial Engineering.

In industry, simulation is applied at various stages, for example, at the design stage to help with the improvement of a process, or to an existing system to explore modifications. In the area of industrial engineering, simulation is often used to increase efficiency and quality levels substantially in factories and manufacturing companies. This allows them to have a wide range of possibilities when it comes to virtual testing of:

Simulation of workflows, projecting results to be obtained from the execution of different actions and work instances. Simulation of plastics, PVC, PP, PS, HDPE, or any other type of plastic, an industrial engineering simulation solution will allow you to perform virtual tests on their use, handling and integration. Sustainability simulation, which can be applied directly according to the characteristics, materials and functions of the product to be developed, in order to evaluate its environmental impacts.

Structural engineering simulation, which allows to project in a wide and integral way everything related to the logical feasibility, coherence and assertiveness of the work and production cycles. Structural design simulation, which allows to know the potential physical behavior of the product by performing virtual tests of the design. Early detection of failures, inconsistencies and problems that may compromise product quality.

Among the main benefits of simulation in industrial engineering are the reduction of product or process rejections due to lack of quality, which compromises the finances and operations of industries and manufacturing companies, since through simulations it is possible to anticipate the failures that this event may cause. Acceleration of the work cycle, the simulation allows them to develop more efficiently. And, probably one of the most important benefits for any company, cost reduction, by reducing rejects and accelerating production cycles, simulation in industrial engineering allows to reduce the costs of product development cycles and, consequently, to increase profitability indexes.

2.3 Industrial Engineering; field of work in relation to medicine.

Industrial engineering has rarely been related to medicine. The collaborations of industrial engineers in the area of medicine date back to 2012, in Madrid, when the Commission of Medical and Health Engineering of the College of Industrial Engineers was born. Its mission, was to enhance and dignify the role of industrial engineers in the health sector, evidencing their presence in the business field, in research and public administration. Likewise, to give prestige to the group of industrial engineers by positioning the profession of biomedical engineering and other engineering disciplines in healthcare environments within the scope of industrial engineering. In addition to providing value in these areas to different stakeholders (patients, public institutions, companies, universities and professional groups). In 2018, TEC de Monterrey and the General Hospital of the State of Sonora signed a collaboration agreement. This collaboration aimed to implement several Lean Manufacture tools in order to optimize the operating room area. This methodology consists of improving communication and teamwork in order to deliver a valuable product or service to customers.

So, an industrial engineer turns out to be fully qualified to work in collaboration with medicine, both in a project in design, logistics, application of maintenance techniques, advice on procurement and purchase of materials, equipment and services, but the possibility of an industrial engineer going beyond the administrative area of the health sectors has never been considered.

4. Discussion

It is a fact that industrial engineers can work in a wide variety of fields. They find work in factories, hospitals, service organizations and consulting firms. Industrial engineers may specialize in certain sectors, such as health services, transportation or finance. Some industrial engineers also work in the human factors field, referring to the study of how people interact with machines and systems. Below is a graph of the areas in which an industrial engineer commonly works, making it clear that in any company where these departments are found and regardless of the line of business, an industrial engineer will be able to perform without problems. In addition, the percentages show an estimate of how many industrial engineers work in the areas mentioned (Figure 1).

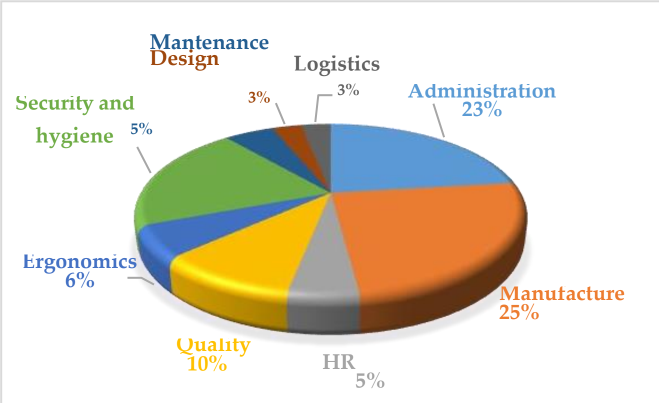

Figure 1: Areas of performance of the industrial engineer.

Taking the above into account, if we take engineering to the hospital area, it is necessary for engineers to be in charge of the health branch, which is oriented towards management, planning, analysis and design, thus covering a large administrative part in order to offer alternatives and improved solutions to the problems of the hospital environment.

Once it was explained the relationship that industrial engineering has had in the field of medina or rather in the area of hospitals, it is understood that it is based on works merely aimed at a better organization and operation.

Now, let's talk about the possibilities and arguments that could make it possible for industrial engineering to improve the quality of life of patients through simulation supported. Nowadays, technology allows doctors to have access to equipment that allows them to enter our body without opening it, to perform measurements or diagnoses more accurately than in the past. For all this to be possible, medicine had to rely on engineering, and what better way than to rely on biomedical engineers, who help to improve human health through interdisciplinary activities that integrate engineering sciences with biomedical sciences and clinical practice.

The biomedical engineering degree prepares them to perform activities such as:

Hospital administration and clinical engineering.

Development of biomechanical devices, such as prosthetics and orthotics, sports and rehabilitation engineering.

Research in the area of biomaterials, molecular and cellular engineering, and biological systems.

Development of medical instrumentation systems, biosensors and devices for obtaining and analyzing medical images.

Industrial engineering and biomedical engineering, being engineering, have in common their performance in the design, projection and construction of equipment, processes and products. In addition, like biomedical engineers, we can also perform hospital administration activities and, in turn, we are trained to use simulation software. Biomedical engineers are prepared to develop devices through simulation. The main benefit of these devices is that the simulated patient can become complicated to the point of death but without a real fatal consequence; on the contrary, the physician can learn from his mistakes. On the other hand, industrial engineers use simulators to design processes and find possible bottlenecks, to simulate workflows, etc., benefiting in the reduction of errors, cost reduction by not bringing a process to reality without knowing if it will work.

Considering what both disciplines have in common and also the great difference in the simulation approach we can mention the following:

Our specialty as industrial engineers is to optimize processes, increase efficiency and quality levels, standardize, increase productivity, manage, etc.

The specialty of biomedical engineers is to generate, implement and evaluate technological solutions that successfully meet the needs of the healthcare industry.

In order to answer the question of whether or not an industrial engineer can contribute knowledge to positively impact medicine, it is necessary to keep the following in mind:

The industrial engineer is trained to use simulators in computer modeling for; workflow simulation, plastics simulation, sustainability simulation, structural engineering simulation and structural design simulation.

The structural design simulation used by the industrial engineer proves to be the most appropriate to help a biomedical engineer. This simulation provides insight into the potential physical behavior of a product, detects early failures, inconsistencies and problems that may compromise the quality of the product.

Structural design simulation is also used by biomedical engineers to make products or human simulators relevant and feasible, complying with quality standards and safety policies.

Biomedical engineers rely heavily on electrical and electronic instrumentation, biomaterials development, as well as computational tools.

Industrial engineers can easily specialize in electronics and mechatronics.

The area of electronics in industrial engineering is essential for the modernization of processes and production chains that are developed in companies. It is a way to advance the professional career towards the digital world, since these professionals are trained to design, manufacture and maintain all types of electronic devices. It represents one of the specializations with the highest demand in the labor market, due to the growing evolution of the technology industry.

5. Conclusions

An electronic industrial engineer with a fundamental knowledge of medicine is fully capable of working in collaboration with medicine. Reciprocally, the doctor must be aware of the great contribution that our profession can give him. Whether in a project design, logistics, application of maintenance techniques, advice on procurement and purchase of material, equipment and services.

Conflict de interest: The authors declare that they have no conflict of interest.

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