STRENGTHENING AUDIOVISUAL AUTOMATION COURSES 
IN FOOD ENGINEERING CAREERS

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ABSTRACT
The automation courses established in the curricula of food engineering careers need to be strengthened and updated in order to improve student learning and new trends related to process automation such as IoT are covered. A review of the literature was carried out whose objective was to obtain an overview of the status of automation courses in food engineering careers and to share improvements to strengthen these in order to ensure that graduates acquire the necessary skills and competences to perform in today’s industry.

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1. Introduction

Since its inception, the food industry has sought to keep pace with other industries in the adoption of new technologies such as automation, which has allowed great changes in the industry, to such an extent that, due to rapid technological progress, consumer expectations and the search for safety, the food industry was forced to automate most of its manufacturing processes (Gunasekaran, 2009). On the other hand, due to the adoption of automation by the food industry, it became necessary for professionals in food engineering careers to integrate automation and control courses to their curricula, being currently mandatory courses for the career.

Over the last 10 years, industry worldwide has experienced a series of impressive technological advances, generated by the new industrial revolution known as Industry 4.0. A term that refers to innovation in production processes through the use of technologies and devices that communicate with each other during the activities of a value chain, with the aim of building partially or fully automated production environments (Karacay, 2018). Within the new technologies introduced with Industry 4.0; robotics, sensors, the Internet of Things (IoT), artificial intelligence (AI), big data, blockchain, among others, are being employed in order to generate greater productivity and efficiency during the production processes of the industry in general.

Although this technological development has generated great benefits to the food industry, on the other hand, it is affecting the labor market, creating the need for the already established levels of occupational structure to evolve according to the new skills required by the changes generated by the changes in the food industry. Evolution that is not reaching higher education for careers related to the food industry, since according to Ekren & Kumar (2020) there is currently a shortage of qualified professionals to carry out tasks involving Industry 4.0 due to the fact that universities continue to train students in the shadow of it.

This new technological era poses new challenges and these are not only limited to the complexity of implementing technologies in the food sector, but the main challenge lies with the people who work in this industry, especially food industry engineering professionals, who must acquire new skills, especially to lead and manage the digital transformation in their work environment. Authors such as Garcés et al. (2020) emphasize that the training of engineering professionals must currently adapt to the demands of new competencies in the face of increasingly dynamic and changing work and social environments.

Therefore, the main objective of this review is to inform about the status of automation courses for food engineering careers and to propose improvements to strengthen them in order to ensure that graduates acquire the necessary skills and competencies to perform in today’s industry.

2. Automation courses for food industry engineers

Automation courses taught in careers such as food industry engineering aim to raise awareness of industry advances in process automation, use of sensors, actuators, and controllers (Farrow & LeMaster, 2006). For students in engineering careers, automation and control courses are of great importance, to such an extent that nowadays virtually all engineering curricula have one (Rehg, 2020).

In the most developed countries, food engineering careers have automation or simulation laboratories to put the student in contact with the theory learned; however, in less developed countries, students have very limited possibilities to interact in automation laboratories, mainly because universities focus on investing in natural science laboratories, leaving aside those related to these technologies. On the other hand, Pereira et al. (2012) points out that these courses should seek to reduce the gap between these and real industrial practice, so that ensuring that students have contact with devices, systems and techniques similar to those of real industry should be a priority. Likewise, currently with the introduction of Industry 4.0, there are new technologies linked to automation such as the Internet of Things that are gaining strength in the food industry, so updating curricula taking into account the new emerging technologies in the sector should be a priority for universities with undergraduate programs related to food engineering.
3. Strengthening of automation courses in the food industry.

4.0 technologies such as IoT, blockchain, smart sensors and robotics, big data and AI, are currently the most employed within the food industry. It is well known that every industrial revolution has notably affected human labor and this new technological wave is no exception, as there is currently a large imbalance between the current capabilities of employees and the future needs of the industry (Rawboon et al., 2021). Hence, universities are required to update their curricula and prepare their students and teachers to inculcate new skills and meet the challenges of Industry 4.0 (Sandoval et al., 2022).

As mentioned in the previous section, automation courses are present in the curricula of food engineering careers, however, there are certain deficiencies in terms of the topics that are addressed in this, because they have not been updated taking into account the new technologies applied to automation, leaving them aside and making students not sufficiently prepared at the time of exercising their profession in relation to emerging technologies. Although for food engineering students, automation courses should not have a high demand because computer technologies are not their basic field, they should have the necessary breadth so that future professionals acquire the necessary skills to understand, evaluate and lead the implementation of automation projects related to the sector. To this end, it is essential to formulate efficient learning methodologies in these courses, emphasizing the use of automation laboratories and the teaching of technologies related to improve it, such as IoT, as well as to encourage formative research so that students can propose projects taking into account what they have learned in the automation courses.

Engineering are professions of a practical nature, so it is necessary to put the student in contact with the reality that he/she will face as a professional in his/her work, in this way it is required that engineering programs present balance between theoretical classes and practice (Vazquez-Gonzalez et al., 2018). Generally, practical classes are usually carried out in laboratories, which are of utmost importance in engineering careers, because they seek the student to put into practice the theory and become familiar with it, hence authors like Pereira et al. (2012) y Jara et al. (2011) point out that the use of instructional laboratories from the early days of education should be essential and a priority in engineering programs. Understanding these courses, requires hands-on experience, as it is impossible for the student to identify the complexities of real systems without witnessing them, so a good laboratory is important for teaching (Pasik-Duncan & Verleger, 2009). Automation courses on the other hand are not exempt from the use of laboratories, although there are careers related to robotics, mechatronics or computer science that require these courses at an advanced level due to the specific skills of their work environment, it is also important that the use of automation laboratories is adopted by food engineering careers, since there is currently a high degree of automation in this industry, so that future graduates will be in constant presence of these devices and must be able to understand their use and operation.

IoT or Internet of Things is a technology that has been used in conjunction with automation in order to control or monitor processes through the use of the Internet, without the need to intervene directly in them. (Ramaswamy & Tripathi, 2015). Learning about this technology generates the opportunity to expand the possibilities of engineering careers, by generating experiences in aspects of it that go beyond the basic curriculum of the careers (Raikar et al., 2018). On the other hand, according to a World Bank study rescued in. Du et al. (2021) points out that in the next ten years approximately two million IoT-related jobs will be unfilled in the world because workers will not have the necessary skills or knowledge to meet the demand for jobs related to this technology.

With respect to food engineering curricula, this technology can be addressed in two ways, the first by including IoT within the automation and control courses found in current curricula, or a more comprehensive education program combining IoT and automation could also be considered, as proposed by Suila Kuaban et al. (2022) who proposed an education program based on IoT and automation to be implemented in undergraduate programs in food engineering and agriculture to prepare students, teachers and professionals to apply IoT solutions in industry. They also point out the need to combine courses from disciplines such as electrical engineering, electronics, automation, robotics and computer science with basic courses from food and agriculture careers. This program proposes seven academic semesters where students from their first year in the university career will have contact with the basic courses for the understanding of IoT, courses such as introduction to programming, introduction to IoT, digital and analog electronics, sensors and actuators for IoT,
microcontrollers and microprocessors for IoT, among others, are proposed in this research. In addition, they propose an approach for these courses based on lectures, laboratory practices, generation of study projects, workshops and collaborative research.

Formative research refers to the action of training in and for research, whose main objective is to become familiar with research; i.e., it has an educational purpose (Lapa-Asto et al., 2019). Several authors agree in pointing out that formative research is essential for professional training, since it allows to generate highly meaningful learning and to give the student a push for innovation (Prado Juscam, 2023).

Therefore, applying this methodology in the formulation of projects by the teacher in conjunction with the students, will allow the latter to assimilate what they have learned at a more specific level to the subject treated. Regarding automation as a course within the food engineering career, involving students in formative research projects allows them to give free rein to the application of what they have learned in the course, either for the construction of automated prototypes for processes that have not yet been applied, the improvement of existing equipment or the application of new technologies compatible with automation.

**Figure 1.** Prototype of a water quality control system to measure turbidity, pH, temperature and electrical conductivity parameters.

On the other hand, the course can be used to propose equipment for educational purposes benefiting other courses taught at the same universities, such as designing a prototype of a water quality control system to measure the parameters of turbidity, pH, temperature and electrical conductivity as shown in Figure 1, as a result of a formative research of semester 2022-1, in the course of Principles of Control and Automation of Agroindustrial Processes of the Professional School of Engineering of Food Industries of the National University of Frontera, to automate a certain process of long duration to reduce the time in the elaboration of process graphs, as well as to be able to supervise and control the processes remotely, since as we know the drying processes usually last several days exceeding the hours of class programmed for a specific topic. An example of this can be found in the work of Valov & Valova (2020) and Saavedra et al. (2008) who proposed in their respective articles the automation of hot air dryers for teaching purposes, streamlining the process of obtaining graphs and drying curves, as well as being able to evaluate the process remotely. In this way, other processes such as fermentation, osmotic dehydration, or any other long-term process, can be automated on a small scale for educational purposes, facilitating the understanding of the processes in a practical way.

4. Conclusions

Automation courses present in the curricula of food engineering careers should be updated following the new technological trends in the food industry. IoT is one of them and is presented as a tool to
improve process automation, so expanding the automation courses by including this technology in the learning process would be ideal, since its use in the industry is spreading rapidly. On the other hand, these automation courses should be strengthened through the use of laboratories to expose students to devices similar to those in real industry and strengthen their knowledge. It is also recommended the formative research applied to this course, so that the student uses all the knowledge acquired for the formulation of automation projects.
References


