DATABASE AND WEB INTERFACE FOR SOFTWARE APPLICATION FOR ASSIGNMENT OF PROCESS TASKS IN TECHNOLOGICAL OPERATIONS

CIOCAN Cristian-Florin, CATANĂ Mădălin-Gabriel
Faculty of Industrial Engineering and Robotics, Informatics applied in Industrial Engineering,
4th Study Year, e-mail: ciocam20@gmail.com

ABSTRACT: The article "Database and web interface for software application for assignment of process tasks in technological operations" focuses on developing a computer application that utilizes a Microsoft Access database implemented according to the ANSI ISA-95 standard, along with a web interface created using HTML, CSS, JavaScript, SQL, and PHP programming languages. The application aims to optimize an assembly line and will also handle the grouping of phases in operations without duration restrictions or maximum execution time (in which case it will allocate as many phases as possible together to the machine intended for the operation). The purpose of the paper is to present the current state of the web interface and the database, as well as to introduce algorithms that can be used for optimizing phases in technological operations. This application could be beneficial for companies engaged in industrial activities that require an efficient solution for allocating technological phases in their operations.

KEYWORDS : data base, web interface, algorithm, software application, technological operations

1. Introduction

In the digital era we live in, the use of information technologies is a necessity in any business. Information systems are designed to provide quick and efficient solutions regarding data management and processes within a company. For optimizing the phases of technological operations, algorithms from the "Assembly line balancing" category are used, which are applied to an assembly line that needs to perform a set of consecutive operations on a workpiece. The workpiece is then transferred from one workstation to another until it reaches the end of the production line. Each workstation can perform a finite number of different operations, and the connection between workstations is established through precedence relationships. In other words, some operations can only begin after other operations have been completed. If each workstation on the line has the same processing time for operations on the workpiece, then the workpieces will move smoothly from one workstation to another without the need for waiting by the workpiece or the operator. Through this optimization, balancing the process of an assembly line can help reduce operator downtime and significantly decrease the time required to complete a workpiece.

2. General considerations

2.1. Assembly line balancing – concept and exemples

Assembly line balancing (ALB) represents an active research area in optimizing operations management. The concept of an assembly line (AL) emerged when the finished product leaned towards the perception of product modularity. Typically, the interchangeable parts of the final product are assembled in a sequence using the most well-designed logistics in an AL. The initial stage of configuring and designing an AL was focused on mass production with cost-efficient manufacturing of standardized products. This led to a high degree of labor specialization and the corresponding effects of learning. However, the recent trend has brought forth the idea of producing low-volume customized products, known as mass customization. This strategic shift has been prompted by the diverse needs of customers along with product individualization. It has triggered research on balancing and sequencing ALs for customized products on the same line in an intermix scenario, characterized as mixed-model assembly line balancing and sequencing (MMALB). Planning the configuration of these has become a significant concern as the initial high investment is coupled with the design, installation, and redesign of an AL [1].

The classical definition of the line balancing problem, also known as the simple assembly line balancing problem, is as follows: given a set of tasks with different durations, a set of precedence constraints between tasks, and a set of workstations, allocate each task to a workstation such that no precedence constraint is violated, and the allocation is optimal. The precedence relationship specifies the order in which assembly tasks must be performed according to the assembly process. The optimization criterion gives rise to two variants of the problem: either the cycle time is given and cannot be exceeded by the sum of the durations of all tasks allocated to any workstation, and the number of workstations is minimized, or the number of workstations is fixed, and the cycle time equal to the largest sum of durations of tasks allocated to a workstation must be minimized [2].

Grouping phases in operations without duration restrictions or maximum execution rate is a technique used in production planning and scheduling. This technique involves grouping as many phases as possible together and allocating them to the machine designated for that operation. This can be achieved through the following steps:

1. Identifying the phases that can be grouped together on the machine assigned to that operation [3].
2. Evaluating the total time required to complete the group of phases. This total time must be less than or equal to the available cycle time on the respective machine [3].
3. In case the total time exceeds the available cycle time, options such as adding additional machines or dividing the group of phases into smaller subgroups that can be processed separately can be considered [3].

Grouping phases in operations without duration restrictions can help improve production efficiency by reducing set-up times and increasing machine utilization. However, this technique can be more challenging to implement compared to operations with duration restrictions or maximum execution rates, as there are more variables to consider, such as the total time required for phase grouping and the number of machines available for that operation [3].

Algorithms and Efficient Methods for Assembly Line Balancing :

• The Largest Candidate Rule (LCR): This method aims to achieve a balance in the processing lines as evenly as possible, although it is impossible to achieve a perfect balance between workstations. The efficiency of the line is related to the differences in minimum processing times and precedence constraints between tasks. The LCR method considers the tasks to be arranged in descending order of execution time to be allocated to a workstation [4, 5].

• The Kilbridge and Wester Method (K&W) is a heuristic procedure that selects the tasks to be assigned to workstations based on their positions in the precedence diagram. This method is known for its reliability in overcoming difficulties encountered in the LCR method, where a certain task may be selected based on processing time. However, it does not respect the order relationship between tasks in the precedence diagram [4].

• RPW (Ranked Positional Weight): RPW was introduced by Helgeson and Birnie in 1961. It is a combination of the LCR and K&W methods. RPW takes into account both the processing time of the task and its position in the precedence diagram. Therefore, tasks are assigned to workstations based on their RPW weight [5].

2.2. ANSI ISA-95 standard

ANSI ISA-95 is a standard that addresses the integration of manufacturing systems from the level of production cells to the enterprise level. The standard defines a reference model for the interoperability of manufacturing systems and provides a set of communication standards, data management, and messages that can be used to develop interoperable solutions for manufacturing operations [6].

Regarding the implementation of a database according to the ANSI ISA-95 standard, it defines a reference model for structuring data within manufacturing systems, called the Manufacturing Reference

Model (MRM). This model defines a layered architecture, with levels representing the processes and functions of the manufacturing system [6, 7].

The Manufacturing Reference Model includes four main levels:

• Level 0 (device level) - This represents the lowest level in the hierarchy of the manufacturing system and includes all devices and sensors involved in the production process [6, 7].

• Level 1 (production cell level) - This level includes all production cells and focuses on controlling the processes that take place within them [6, 7].

• Level 2 (production unit level) - This level is responsible for planning and controlling production at the production unit level [6, 7].

• Level 3 (enterprise level) - This level represents the highest level in the hierarchy of the manufacturing system and is responsible for coordinating and managing the entire production process [6, 7].

Regarding the database structure according to the ANSI ISA-95 standard, it should adhere to the reference model and provide relevant information for each level in the manufacturing system hierarchy. Thus, the database should include information about the devices used in the production process, their status and performance, production orders, production performed at the cell and unit levels, as well as resources used in the production process [8].

Furthermore, the ANSI ISA-95 standard also includes a set of communication standards and messages that can be used to facilitate the transfer of information between different levels in the manufacturing system hierarchy and ensure interoperability among manufacturing systems [6, 7, 8].

2.3. Database – Microsoft Access

Microsoft Access is a relational database management system (RDBMS) developed by Microsoft Corporation. It is a powerful tool for storing and managing data, allowing users to create, edit, and save data in a structured format. Additionally, Microsoft Access provides functionality for creating user-friendly interfaces, reports, and forms for data presentation [9].

Microsoft Access is a widely popular solution for database management due to its user-friendly nature, integration with other Microsoft products, and the flexibility it offers [9, 10]. Moreover, Microsoft Access is a scalable tool, meaning it can be used for both small and large databases. With Microsoft Access, users can create and manage relationships between different data sets. This enables users to create complex reports that combine data from multiple tables. Additionally, users can use SQL to query the database and retrieve data based on search criteria [9, 10, 11].

Overall, implementing an Access database in a web application can be an efficient and convenient solution for creating and managing real-time data and improving business process efficiency. However, it is important to consider performance, security, and data integrity to ensure an adequate and secure user experience [9, 10, 11].

2.4. Programming Languages and Technologies Used in Web Development and Web Application Creation

To create a web interface, we can use various programming languages, among which we find:

• HTML (HyperText Markup Language) is a markup language used to create web pages. Using HTML, you can create elements such as text, images, hyperlinks, and web forms [12, 13].

• PHP (Hypertext Preprocessor) is an interpreted web programming language used to generate dynamic content for web pages [12, 13].

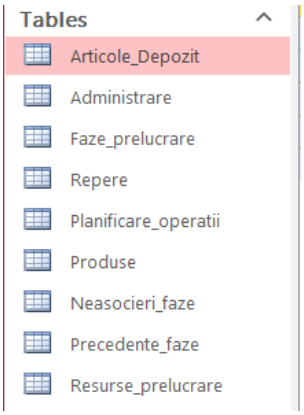
• PHP can be used to create web applications, forums, blogs, and much more [12, 13].

• JavaScript is a programming language primarily used to create interactivity in web pages. JavaScript can be used for form validation, creating special effects, modifying page elements, and much more [12, 13].

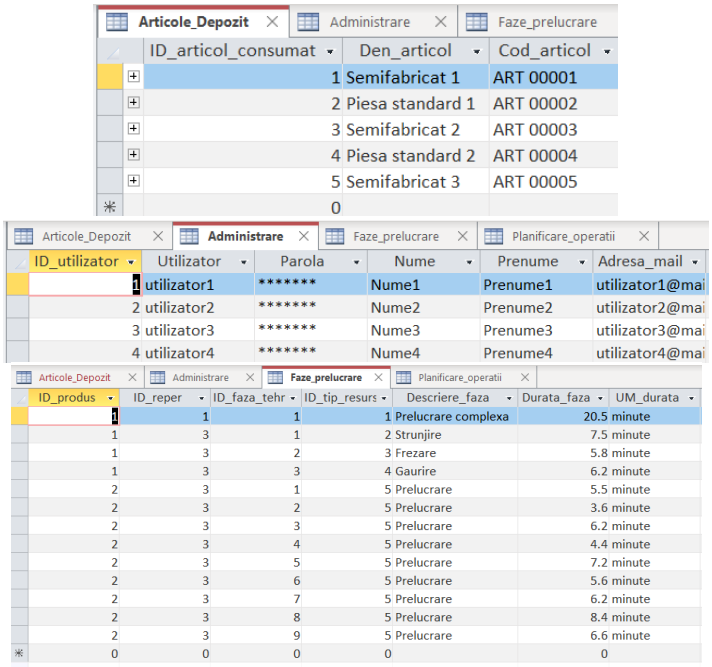
• CSS (Cascading Style Sheets) is a styling language used to define the appearance and style of elements on a web page. CSS can be used to change background colors, fonts, margins, and many other styling features of a web page [12, 13].

3. Current status

The application consists of two essential parts: the database and the web interface. The database was created using the Microsoft Access program [9, 10, 11, 14] and includes nine tables (Articole_Depozit, Administrare, Faze_prelucrare, Repere, Planificare_operații, Produse, Neasocieri_faze, Precdențe_faze, Resurse_prelucrare) that contain data used for testing the application. The tables are presented in Fig. 1.



(a) Tables from data base



(b) Table structure and components

Fig. 1. Structure of data base

In Fig. 2, we have the relationships between tables that allow users to access and manage information in a coherent and organized manner. The primary keys, which uniquely identify the records in the tables, are displayed [8].

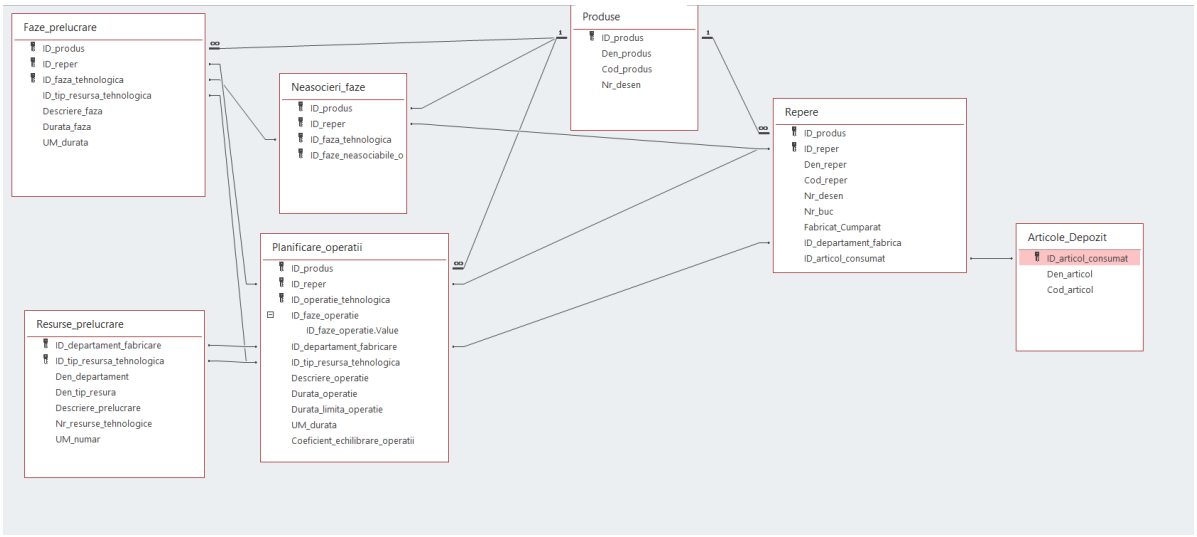


Fig. 2. Relationship table

In the web interface, we have the ability to access and edit the tables in the database. Figure 3 shows the main page of the interface from where we can access the tables in the database, and Figure 4 presents the page with the "Articole Depozit" table from the database.

On the main page, we have buttons that have been styled using CSS, and when a button is pressed, it will open a new page specific to the table from the database [13].

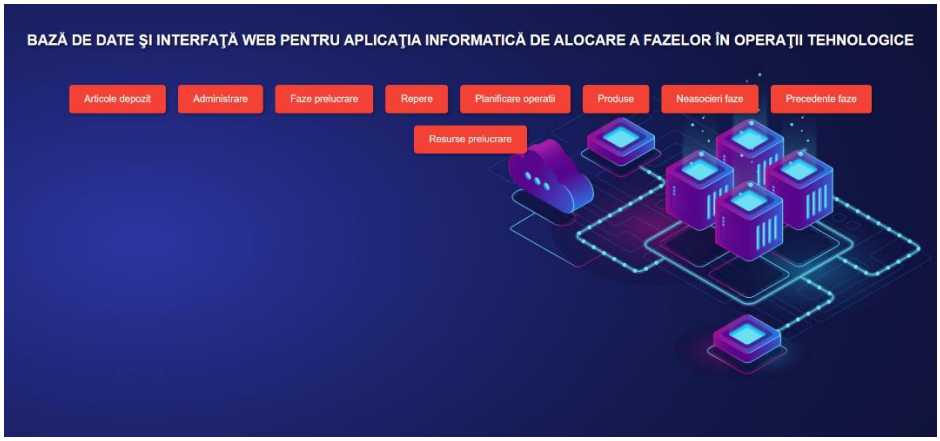


Fig. 3. Main page

In the "Articole depozit" page, we can observe the data from the database. Using the "Adauga rand" button, we can add a new row, and by positioning the cursor, we can select where we want to add new information. After adding the information, we will press the "Actualizeaza" button, and the information will be saved in the database. If we want to delete a row, we will press the "Sterge" button [13].

Fig. 4. Table from ,,Articole Depozit”

4. Conclusions

In the studied problem, we have observed the need to optimize processes as much as possible in order to increase productivity, and the implementation of an algorithm in industrial processes is becoming increasingly common. It is also essential to create a symbiosis between computer applications and a web page to make it accessible from anywhere, and an interface that allows various modifications to the database is highly efficient.

Microsoft Access is a powerful database management solution that allows users to easily create, access, and administer databases. With an intuitive interface and powerful organizing and searching features, Microsoft Access can be used to manage a wide range of information, from inventory stock to customer information and billing. Additionally, Microsoft Access can be integrated into a web interface to provide access to the database from anywhere and at any time, with an internet connection. The use of Assembly line balancing algorithms can also be extremely useful in optimizing production and assembly processes, ensuring that available resources are used with maximum efficiency and production yield is maximized. With the help of these algorithms, the best methods of arranging and distributing tasks among workstations can be identified, minimizing processing time and maximizing overall efficiency.

By combining these tools, a complex and powerful system for data management and optimization of production and assembly processes can be created, which can significantly improve companies' efficiency and productivity.

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