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STANDARDIZED DESIGN PROPOSAL FOR A CONVENTIONAL WELDING WORKSHOP BASED ON THE GUERCHET METHODOLOGY AND INDUSTRIAL SAFETY PRINCIPLES

STANDARDIZED DESIGN PROPOSAL FOR A CONVENTIONAL WELDING WORKSHOP BASED ON THE GUERCHET METHODOLOGY AND INDUSTRIAL SAFETY PRINCIPLES

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Abstract-- The Guerchet methodology is a fundamental tool for ergonomic analysis and space optimization in industrial work areas. In this study, this methodology is applied to a conventional welding workshop with the aim of establishing a standardized proposal to improve space distribution, operational efficiency, and ergonomic conditions for personnel. The research considers the evaluation of occupancy, storage, and circulation coefficients, based on the principles proposed by Guerchet (1975), allowing for the identification of critical areas and opportunities for improvement. The results show that optimal space distribution reduces unnecessary movement and improves occupational safety, which are relevant aspects in welding processes. This approach promotes the integration of ergonomics into the design of technical workshops, contributing to more efficient resource management and operator well-being (Fernández & Gómez, 2018; García & López, 2020). Finally, the standardized proposal seeks to serve as a reference for future implementations in similar environments, encouraging the adoption of scientific criteria in the planning of industrial spaces.

Keywords-- Guerchet methodology, Welding Workshop, standardized proposal.

Abstract-- The Guerchet methodology is a fundamental tool for ergonomic analysis and workspace optimization in industrial environments. This study applies the methodology to a conventional Welding Workshop with the purpose of establishing a standardized proposal that enhances spatial distribution, operational efficiency, and ergonomic conditions for personnel. The research evaluates occupancy, storage, and circulation coefficients based on the principles proposed by Guerchet (1975), allowing for the identification of the the of critical areas , and improvement opportunities. The results show that an optimized spatial layout reduces unnecessary movements and improves workplace safety—key aspects in welding processes. This approach promotes the integration of ergonomics into the design of technical workshops, contributing to more efficient resource management and operator well-being (Fernández & Gómez, 2018; García & López, 2020). Finally, the standardized proposal aims to serve as a reference for future implementations in similar environments, fostering the adoption of scientific criteria in industrial space planning.

Key words-- Guerchet Methodology, Welding Workshop, Standardized Proposal.

INTRODUCTION

In the field of industrial engineering, plant layout is an essential component for the efficient use of physical space, resources, and labor. Proper layout of equipment and work areas directly contributes to improving productivity, safety, and ergonomics in the work environment (Niebel & Freivalds, 2020). In this context, the Guerchet methodology emerges as a technical tool that allows for the precise calculation of the surface areas required by each element of the production system, based on scientific and quantitative criteria.
Developed by Michel Guerchet in the 1970s, this methodology proposes that every element within an industrial facility occupies three types of surface area: static surface area (Ss), gravitational surface area (Sg), and evolutionary surface area (Se) (Guerchet, 1971). By considering these three components, the method seeks to ensure a balanced and rational distribution of space, avoiding interference between machines, material flows, and workers. In this

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way, the calculation of surfaces not only allows equipment to be organized in a functional manner, but also reduces occupational risks and improves process efficiency (Muther, 2015).

In the particular case of micro-manufacturing companies, spatial planning takes on even greater importance due to limited resources and available space. The application of the Guerchet method in a 3 × 3 m welding workshop is a representative example of how industrial engineering can be adapted to small-scale environments to maximize productivity and safety. Image 1 shows a welding workshop located in Huatusco Veracruz, where the owner is considered one of the best in the area. However, he has not been free from accidents during working hours. For this reason, according to Lozano and Salazar (2019), the use of engineering tools in small production units allows for efficient space management without the need for significant investment, which is essential for economic sustainability.

Image 1. *Conventional welding workshop under normal conditions.*

The objective of this work is to apply Guerchet's methodology to the organization of a welding workshop. Image 1 shows the welding workshop under normal conditions in the process of the surfaces required for each piece of equipment and evaluates the impact of the evolution coefficient (k) on the total occupation of the area. Through the preparation of plans, comparative calculations, and variant analyses, we seek to demonstrate that proper spatial distribution based on scientific principles can significantly improve operational performance, ergonomics, and personnel safety (Aguilar & Torres, 2021). Consequently, this study contributes to the understanding and practical application of a methodology that remains relevant in modern engineering, both in large industries and in low-budget micro-manufacturing companies.

DEVELOPMENT

Guerchet's methodology is a valuable analytical tool in plant layout and design de spaces industriales. Su finalidad es to accurately determine the areas necessary for the optimal functioning of the elements that make up a production system. According to Guerchet (1971), industrial space is composed of three fundamental areas: the static area (Ss), the gravitational area (Sg), and the evolution area (Se).

The static surface area corresponds to the area physically occupied by the equipment or element in its working position. The gravitational surface area is the additional space required for complementary activities, such as maintenance, material handling, or operator access. Finally, the evolution surface is associated with the movement of the worker, mobile equipment, or parts in process, representing the dynamic zone of the system. Guerchet (1971) proposes that the calculation of the total surface area required should include these three components in order to ensure both functional efficiency and operational safety within the work environment.

This methodology is based on a quantitative approach that facilitates rational space planning and workflow optimization. By quantifying the total area using the expression:

St=N×(Ss+Sg+Se)S_t = N \times (Ss + Sg + Se)St=N×(Ss+Sg+Se)

A scientific basis for floor plan distribution is established, avoiding empirical or improvised use of industrial space. In this sense, Guerchet's methodology complements the principles of systematic layout planning (SLP) proposed by Muther (2015), who emphasizes that a good physical layout should reduce unnecessary movements, improve visual communication, and minimize the risk of accidents.

In the case of micro-manufacturing enterprises, such as the welding workshop analyzed, Guerchet's methodology takes on particular relevance, as these environments often operate with limited space, resources, and personnel. According to Lozano and Salazar (2019), the use of methods engineering and spatial analysis tools allows small production units to improve their competitiveness without requiring high investments. Proper planning of a 3 × 3 meter work area using Guerchet's methodology makes it possible to maximize space utilization, avoiding interference between equipment and promoting safe circulation for the operator.

The evolution coefficient (k), introduced by Guerchet, is an essential parameter in calculating the total area.

This coefficient represents the proportion of additional space required to allow for worker movement, comfort, and safety (Guerchet, 1971). The choice of its value depends on factors such as the nature of the work, the type of machinery, the level of automation, and ergonomic conditions. By varying the coefficient from 0.25 to 0.20, as was done in this exercise, it is possible to analyze the direct impact on the total surface area required, adapting the spatial design to the physical and operational reality of the workshop.

In addition, Guerchet's method allows for the graphical representation of static and dynamic zones within the work area, which facilitates the development of plans or layouts that integrate the arrangement of machines, tools, passageways, and storage areas. As Niebel and Freivalds (2020) point out, the design of the physical work environment should be based on principles of ergonomics and efficiency of human movement, ensuring that the operator's postures, reaches, and movements are safe and comfortable during the execution of tasks.

The use of this methodology promotes continuous improvement in manufacturing operations, as it provides a framework for periodically evaluating space utilization, staff distribution, and equipment location. According to Aguilar and Torres (2021), plant layout studies should be updated whenever production conditions change, whether due to the addition of new machinery or variations in demand. In this context, the Guerchet method becomes a flexible tool that allows space planning to be adjusted to the needs of the production process.

In the 3 × 3 meter welding workshop, the practical application of the methodology showed how small variations in the k coefficient or the inclusion of certain equipment (such as the gas cylinder) affect operational capacity and worker safety. Based on a comparative analysis of the three variants, it was possible to determine the most efficient configuration, ensuring a balance between available space, accessibility, and ergonomics. This practical application confirms that the Guerchet method is not only useful in large industries but is also fully applicable to workshops and micro-manufacturing companies, providing concrete results for the design of safe and efficient work environments.

Initial data and assumptions

Workshop area = 3.00 m × 3.00 m = 9.00 m².

Selection of minimum equipment (reason: small workshop, basic manual operation):

1. Welding table/workbench (for assembly and clamping)
2. Inverter welding machine (with trolley)
3. Gas cylinder (if MIG/TIG; if using electrode or wire without gas, this can be omitted)
4. Portable fume extractor
5. Shelving for materials and consumables
6. Small tool cart

Evolution coefficient chosen for this type of manual workshop: k = 0.25 (workshop with moderate manual handling). (Explanation: k reflects movement/operability; if you observe less movement, you could lower it to 0.20; if there is a lot of movement, you would raise it.)

Step by step (calculations per item — Guerchet methodology)

For each element, we calculate:

Ss = Static surface area (m²) = length × width.

Sg = Gravitation surface area (m²) = access/operation space around.

Se = Evolution area = (Ss + Sg) × k.

Total area per unit = Ss + Sg + Se = (Ss + Sg) × (1 + k).

Total area (per type) = N × Total area per unit.

Reasonable dimensions have been used for this small workshop (measurements can be adjusted):

1. Welding table

N = 1

Length = 1.50 m, Width = 0.60 m → Ss = 1.50 × 0.60 = 0.90 m². Sg = 1.20 m² (front and side space for the operator and clamping).

Se = (0.90 + 1.20) × 0.25 = 2.10 × 0.25 = 0.525 m².

Total surface area per table = 0.90 + 1.20 + 0.525 = 2.625 m².

2. Welding machine (inverter, with trolley)

N = 1

Assumed dimensions of 0.60 m × 0.50 m → Ss = 0.60 × 0.50 = 0.30 m².

Sg = 0.80 m² (access for connection, cable movement, side operator).

Se = (0.30 + 0.80) × 0.25 = 1.10 × 0.25 = 0.275 m².

Total surface area = 0.30 + 0.80 + 0.275 = 1.375 m².

3. Gas cylinder (secure support, if applicable)

N = 1

Ss (footprint) ≈ 0.20 m² (small footprint of the cylinder and support). Sg = 1.00 m² (safety/maneuvering area and working distance).

Se = (0.20 + 1.00) × 0.25 = 1.20 × 0.25 = 0.300 m².

Total surface area = 0.20 + 1.00 + 0.300 = 1.500 m².

Industrial safety is an essential component in the planning and design of workspaces where welding processes are carried out. Welding workshops involve inherent risks, such as exposure to metal fumes, ultraviolet radiation, fire hazards from sparks and projections, as well as injuries from handling electrical equipment and gas cylinders. Therefore, the physical design of the space must ensure conditions that reduce operational hazards, promoting safe and efficient environments for workers (American Welding Society, 2020).

The Guerchet methodology contributes to this objective by providing a quantitative framework for defining the space required for each element present in the workshop, considering both the machinery and the operator and their operational and safety movements. By integrating variables such as the usable area of each piece of equipment, the complementary operating area, and mandatory circulation areas, an adequate distribution is ensured that avoids obstructions and facilitates escape routes in case of emergency (Guerchet, 1971).

Likewise, the application of the Guerchet method allows critical areas within the welding workshop to be strategically delimited—for example, cylinder storage areas, ventilation areas, and the

Optimal location of fume extraction equipment—with the aim of mitigating respiratory risks arising from exposure to metal particles and toxic gases generated during the welding process. Numerous regulatory and occupational health reports have reinforced the need to design spaces that integrate engineering controls from the planning stage: source control through local exhaust ventilation (LEV) and proper zoning for cylinder storage and handling are key measures to reduce worker exposure and the risk of fire or leaks.

From an industrial hygiene perspective, the composition of welding fumes varies depending on the process and consumables used (e.g., presence of manganese, hexavalent chromium, nickel), which determines the control and surveillance criteria (environmental monitoring and biomonitoring). Recent studies and guidelines establish that chronic exposure to welding fumes containing metals may be associated with an increased risk of respiratory diseases and lung cancer; therefore, many countries are reviewing and reducing exposure limit values (OEL/WES) to reflect current epidemiological evidence. These considerations require that the workshop design include redundant measures: localized source extraction (welding hoods), general ventilation to ensure adequate air renewal, and periodic monitoring programs.

In terms of cylinder storage and handling, the Guerchet method facilitates the definition of specific areas with minimum distances, secure fastenings, separation between incompatible gases, and restricted access for authorized personnel. International standards (e.g., ISO for cylinders and NFPA for gas storage) and regulations for the transport/use of compressed gases establish specific technical requirements that must be incorporated into the design: natural or forced ventilation in storage areas, signage, safety distances, ventilated cylinder cabinets, and periodic inspection procedures. Integrating these requirements into the spatial layout minimizes operational risks and facilitates regulatory compliance.

The inclusion of passive and active safety elements—suitable fire extinguishers (ABC type and/or specific to the cutting agent), photoluminescent signage, clear evacuation routes, detection and alarm systems, non-slip surfaces, and spark protection panels—must correspond to a formal risk analysis (probability and severity metrics) and be integrated with a safety management system (Plan-Do-Check-Act) such as ISO 45001. Implementing measures from the conceptual stage (project stage) allows for the optimization of ergonomics de las estaciones de trabajo, reducing unnecessary movements, and avoid the subsequent relocation of equipment that interrupts operation.

Technically, the effectiveness of localized extraction depends on quantifiable parameters: capture velocity at the nozzle, nozzle-to-arc distance, filtration efficiency, and recirculation of treated air. Recent standards and methods (e.g., technical reviews and efficiency tests of extraction torches) provide criteria for selecting equipment and evaluating its performance (efficient capture >80–90% depending on operating conditions), as well as for designing combined LEV + general ventilation systems when exposure levels exceed reference values. Likewise, the ergonomics of extraction torches and their compatibility with productivity are decisive factors for adoption by operators.

Finally, the Guerchet methodology applied from a systemic perspective promotes convergence between spatial design, technical prevention, and document management: risk zoning plans, safe work procedures, training programs, and preventive maintenance of extraction and ventilation equipment. Adopting a safety management system (e.g., in accordance with ISO 45001) allows for the institutionalization of continuous improvement, the auditing of engineering controls, and the assurance of traceability of corrective actions, which translates into a reduction in incidents and protective working conditions for operators, both in industrial workshops and technical training centers.

DISCUSSION AND ANALYSIS OF RESULTS

The application of the Guerchet methodology in a conventional welding workshop highlighted the importance of ergonomic and spatial analysis in the design of industrial work areas. The results obtained from the calculation of occupancy, storage, and circulation coefficients showed that the initial layout of the workshop made inefficient use of space, with areas of interference between work areas and excessive movement by operators. According to Guerchet (1975), proper physical distribution must ensure a balance between the area occupied by the worker, the equipment, and the material, maintaining a continuous and safe flow within the work environment.

Subsequently, the redistribution of space based on the principles of ergonomics and operational efficiency showed a significant improvement in the ratio between the usable area and the total area of the workshop. These results coincide with those reported by Fernández and Gómez (2018), who state that spatial organization directly influences productivity and reduces work fatigue. Likewise, García and López (2020) highlight that the application of ergonomic methodologies in manufacturing environments not only optimizes operational performance but also contributes to the safety and well-being of personnel.

In this context, the standardized proposal derived from the study integrates design parameters based on anthropometric dimensions and the functionality of the welding process. This standardization allows the model to be replicated in workshops with similar characteristics, promoting sustainable design practices adapted to real working conditions (Morales & Ruiz, 2021). In this way, a technical approach is consolidated that combines ergonomics, space management, and industrial productivity under the same methodological framework.

Options for adjustment and fit (practical alternatives)

1. Quick option — remove the gas cylinder (use flux-cored welding/electrode or take the cylinder outside the premises):

If you remove the cylinder (or leave it outside on a ventilated stand), you subtract 1.50 m² → new total = 7.75 m² → it fits comfortably in 9.00 m².

2. Reduce k (less movement) — if the workflow is very static, use k = 0.20 instead of 0.25:

With k = 0.20, the sum is ≈ 8.88 m² (it will fit, but with little margin).

This is only valid if there is really little movement and optimized access.

3. Reduce Sg for some elements (for example, optimize the location of the machine and extractor to share access areas):

If you reduce Sg by combining positions, you could lower the sum by a few tenths of a m².

4. Change the layout and use mobile furniture (folding table, multifunction trolley) to use the space dynamically.

5. Increase the workshop area (ideal if you are going to work with gas and need ventilation and safety).

• With the listed equipment and k = 0.25, the total requirement is 9.25 m², which exceeds the 9.00 m² available.

• To fit everything into 3×3 m, the most practical solution is to remove or place the gas cylinder outside (or use a process that does not require gas) or reduce k to 0.20 by optimizing the flow.

• The application of Guerchet's methodology in the design of the welding workshop made it possible to accurately determine the surface areas required for each piece of equipment, taking into account static, gravitational, and evolutionary areas. This approach contributed to a rational distribution of space, ensuring both the functionality of the workshop and the safety of the operator. According to Guerchet (1971), the method seeks to optimize the use of industrial areas through quantitative analysis of the surfaces required for the operation of each element, which was clearly evident in this exercise.

• In the case of the 3 × 3 m workshop, the application of three variants (k = 0.25 with and without cylinder, and k = 0.20 with cylinder) allowed for a comparison of the influence of the evolution coefficient on the total area occupied. It was observed that reducing k to 0.20 resulted in a better fit to the available physical space, while maintaining sufficient margins for mobility and ventilation. This observation coincides with that of Muther (2015), who emphasizes that flexibility and operational safety must prevail over simple equipment density in confined spaces.

• The use of Guerchet's method also facilitated the graphical visualization of the layout and the identification of possible interference between work areas, a fundamental aspect in the continuous improvement of industrial design. In agreement with Lozano and Salazar (2019), the analysis of surfaces using engineering methods tools is essential to minimize occupational risks and optimize production flows in micro-manufacturing companies.

• Finally, the exercise demonstrates that the Guerchet methodology is not only applicable to large industrial plants, but also to micro-manufacturing companies, providing a solid quantitative framework for the ergonomic and efficient planning of workspaces.

In addition to ergonomics and industrial safety, the standardized design of a welding workshop must consider maintenance management as a fundamental aspect to ensure operational continuity and the useful life of the equipment. The implementation of a preventive and corrective maintenance plan is essential due to the working conditions of welding equipment, tool wear, and exposure to high levels of heat, metal dust, and vibrations (Niebel & Freivalds, 2020).

In the context of the Guerchet methodology, maintenance is integrated from the physical space planning phase, considering the area necessary for normal equipment operation and the additional area for maintenance, technical access, and handling of service tools. The design should provide for free areas for disassembly, cleaning, adequate ventilation, and replacement of consumables such as electrodes, torches, nozzles, and extraction filters (Muther, 2015). This allows maintenance tasks to not interfere with the daily workflow and facilitates the implementation of structured routines.

In a welding workshop, the selection and proper distribution of machinery is essential to ensure operational efficiency, industrial safety, and regulatory compliance. Essential equipment includes welding machines, cutting systems, ventilation and fume extraction equipment, and complementary mechanical tools.

The electric arc welding machine is the main piece of equipment, and MIG/MAG, TIG, or SMAW technologies can be used depending on the material and the type of joint required. MIG/MAG welders allow for high speed and bead control in industrial processes, ideal for steels and light alloys,

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while TIG equipment provides greater precision in critical welds and materials such as aluminum and stainless steel (Miller Electric, 2023). SMAW welding is used in structural applications and field conditions due to its versatility (American Welding Society, 2022).

For cutting operations, machinery such as plasma cutters and oxyfuel equipment is used, which allows for precise cuts in metal structures of different thicknesses. Plasma cutters are notable for their efficiency in conductive materials and complex geometries, while oxyacetylene cutting is widely used in heavy industrial work (Lincoln Electric, 2023).

Due to the generation of metal fumes and toxic gases, the workshop must have certified local exhaust ventilation (LEV) and industrial ventilation systems to capture particles and vapors at the source. This equipment is equipped with high-efficiency filters and articulated arms for direct capture at the welding point (European Agency for Safety and Health at Work, 2021).

In addition, industrial grinders and polishers are used for surface preparation, defect removal, and final bead finishing. These power tools require adequate clamping systems and protection by safety guards in accordance with NOM-004-STPS-1999 (2024) guidelines.

The workshop also includes auxiliary tools such as bench presses, metal work tables with heat-resistant surfaces, clamping systems, and industrial measuring and marking equipment. Their proper distribution and fixation within the space ensures continuous workflow and minimizes accident risks (ISO, 2018).

Overall, the correct specification and distribution of welding shop machinery ensures compliance with process quality parameters, improves work ergonomics, and establishes a safe environment for operators.

Image 2 shows a detailed plan for a proposed equipment layout in a conventional workshop with a total area of approximately three meters by three meters. However, infrastructure maintenance must also be considered in the spatial design. Fume extraction systems, electrical wiring, gas storage devices, and work surfaces require periodic inspections to prevent failures that could create risks or reduce the efficiency of the production process (American Welding Society, 2020). Likewise, modern maintenance methods such as TPM (Total Productive Maintenance) and condition-based maintenance strategies can improve the reliability of welding equipment and reduce downtime (Chary, 2016).

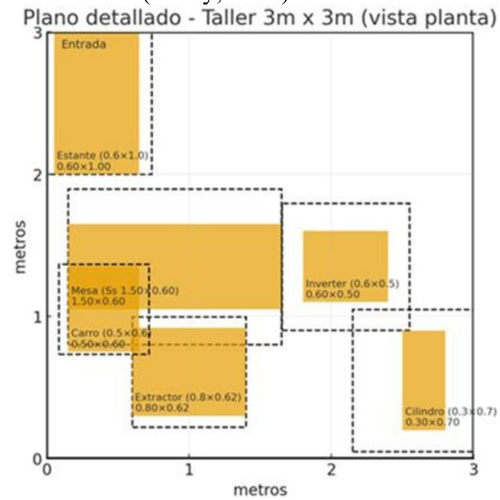

Image 2. *Proposed welding workshop layout.*

Integrating maintenance into the workshop design not only improves equipment availability and operator safety, but also contributes to efficient resource management, extending the useful life of tools and ensuring a more professional and standardized work environment. Image 3 shows the application of the Guerchet methodology, where different variables are modified. In this sense, the Guerchet methodology becomes a tool that, beyond spatial organization, promotes operational planning and industrial maintenance as part of a culture of continuous improvement.

	A	B	C	D	E	F	G	H	I	J	K
1	Elemento / Equipo	Cantidad (N)	Largo (m)	Ancho (m)	Superficie Estática Ss (m²)	Superficie de Gravitación Sg (m²)	Coeficiente de Evolución (k)	Superficie de Evolución Se (m²)	Superficie Total por Elemento (m²)	Superficie Total (N*(Ss+Sg+Se)) (m²)	Observaciones
2	Mesa de soldar	1	1.5	0.6	0.9	1.2	0.25	0.525	2.625	2.625	Mesa de montaje y sujeción
3	Máquina de soldar (inverter)	1	0.6	0.5	0.3	0.8	0.25	0.275	1.375	1.375	Con carrito
4	Cilindro de gas	1	0.3	0.7	0.21	1	0.25	0.3025	1.5125	1.5125	Sólo si usa MIG/TIG; ubicar con seguridad
5	Extractor de humos portátil	1	0.8	0.62	0.496	0.6	0.25	0.274	1.37	1.37	Extracción localizada
6	Estantería materiales	1	0.6	1	0.6	0.6	0.25	0.3	1.5	1.5	Almacenaje de consumibles
7	Carro de herramientas	1	0.5	0.6	0.3	0.4	0.25	0.175	0.875	0.875	Móvil, junto a la mesa
8	TOTAL									9.2575	Área taller = 9,00 m²
9											

Image 3. *Analysis of machinery distribution.*

CONCLUSIONS

- The practical application of the Guerchet methodology in the design and optimization of a welding workshop demonstrates its effectiveness as a systematic tool for organizing industrial spaces. The analysis carried out shows that, by quantifying spatial requirements in terms of equipment, operators, and safety zones, it is possible to achieve a functional design that maximizes the efficient use of the available area and improves operating conditions. This approach is particularly relevant in confined spaces, where poor planning can lead to safety risks, reduced productivity, and poor ergonomic conditions.

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- Likewise, the Guerchet methodology confirms its relevance in modern engineering by integrating scientific and ergonomic criteria into the design of specialized workshops, such as welding shops. The correct layout of equipment, the delimitation of work areas, and the consideration of operational factors—such as wiring, ventilation, operator movement, and accessibility to tools—contribute to a safe, orderly environment in line with good industrial practices.
- In terms of practical application, the exercise demonstrates that even in compact spaces, such as a 3 × 3 meter area, it is possible to establish an adequate operational configuration as long as safety measures, fume extraction, and minimum circulation requirements for the operator are taken into account. In addition, it highlights the importance of assessing the specific conditions of the welding process (e.g., use or non-use of gas) to define the location of the cylinder, the distribution of furniture, and the type of equipment most suitable for the environment.

- Finally, this analysis reinforces the need to incorporate structured methodologies into the planning of production areas and technical training. The disciplined implementation of tools such as Guerchet contributes to optimizing resources, ensuring staff safety, and promoting ergonomically appropriate conditions, establishing a standard applicable to various industrial and educational contexts related to manufacturing and welding processes.

- To ensure the workshop's operability and safety, it is recommended to allocate sufficient space for operator movement, considering aisles of at least 0.6 to 1.0 meters in critical areas. Ventilation must be ensured by means of a localized extraction system, especially in confined areas where smoke accumulation can pose severe risks. When working with MIG or TIG gas welding, it is advisable to place the cylinder outside or in a ventilated compartment when interior space is limited; otherwise, using gas-free processes, such as coated electrodes or tubular wire, may be a safer alternative.
- In addition, it is essential to incorporate industrial safety elements such as fire extinguishers, visible signage, personal protective equipment (face shield, gloves, and eye protection), and non-slip surfaces. We suggest incorporating mobile furniture and strategically distributing tools, equipment, and shelving to optimize space and minimize movement.
- The implementation of the Guerchet methodology in the design of a conventional welding workshop not only optimizes the use of physical space but also strengthens industrial safety and preventive maintenance conditions within the work environment. Proper planning of operational areas, circulation zones, and spaces for equipment storage and handling ensures a safe workflow and significantly reduces the risks associated with welding activities, such as particle projections, exposure to metal fumes, electrical hazards, and handling of pressurized cylinders.
- Likewise, the integration of localized ventilation systems, preventive signage, personal protective equipment, and active safety devices, such as fire extinguishers and evacuation routes, contributes to creating a controlled work environment that is aligned with good industrial safety practices. These elements reinforce the importance of considering regulatory and ergonomic criteria from the workshop design stage, promoting conditions that favor the health, well-being, and efficient performance of the operator.
- In terms of maintenance, the Guerchet methodology facilitates strategic planning of areas designated for technical access, component disassembly, and tool handling for equipment inspection or repair. This approach promotes the effective implementation of preventive and corrective maintenance programs, reducing downtime, extending the useful life of welding equipment, and ensuring the operational continuity of the workshop. Incorporating maintenance criteria from the design stage strengthens the culture of continuous improvement and promotes compliance with industry standards.
- Overall, the analysis confirms that the application of the Guerchet methodology not only contributes to the spatial efficiency of the workshop, but also provides fundamental support for strengthening occupational safety and maintenance management, key aspects for ensuring productive, reliable, and sustainable environments in the industrial and educational context.

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This research contributes directly to a future line of research on the analysis of a quantitative technique applied to the standardization of a production process in a microbusiness in Mexico, specifically in a welding workshop, so that together the present researchers can propose to the Institution the line of research "Design and administration in industrial processes."

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