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CONCEPTUAL DESIGN OF A PALLETIZING MACHINE FOR MICROBREWERIES

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Abstract. *To speed up the loading and unloading of goods during the transportation process, many companies use palletizing, which is a technique that uses platforms called pallets for loads and that allows them to be moved by forklifts or hydraulic cars. Large industries generally opt for palletizing systems that are fully automated and that require high investment for deployment, which may be infeasible for small company and discontinuous productions such as the productions of microbreweries. The manual palletizing of loads, however, can cause serious risks of musculoskeletal injuries. Thus, identifying the need, through the study of transport logistic of some microbreweries, the design of a pelletizing machine was developed specifically for this type of beer production. Based on an iterative methodology the geometry of the machine was developed by SolidWorks, which is computer-aided design software. In this way, this work presents the conceptual design of a semiautomatic palletizer to be used in microbreweries. The equipment uses mechanical, electrical and hydraulic systems manually operated.*

Keywords: *machine design, mechanical design, palletizer, microbrewery.*

1. INTRODUCTION

Although there is no doubt about the advantage of the palletizing system (unitization of loads on pallets) compared to manual handling of loads, both systems coexist simultaneously in Brazil due to the high cost of implementing the palletizing system (Sobral, 2006). When implemented the transport system with the use of pallets, to reduce the costs, some companies use the physical efforts of workers to manually palletize the loads. This can cause serious risks of musculoskeletal injuries that may have significant impact on the health of the employees. The act of lifting, carrying and pushing heavy loads are considered risk factors associated with manual palletizing (Iguti and Hoehne, 2003). On the other hand, the fully automated palletizing system used in large companies may be impracticable for small or medium-sized companies, such as microbreweries. Another characteristic of microbreweries makes the use of the fully automated palletizing system not adequate. In this type of production there is often a need for incomplete pallets, requiring an intervention by the operator. This work aims to present the conceptual design of a semiautomatic palletizer for handling loads by establishing its operation and its interaction with the operator with the intention of being an alternative for the microbreweries market.

2. DESIGN DEVELOPMENT METHODOLOGY

For the conception of the machine, its necessity was verified and then was defined one conceptual design. For this purpose, was studied the logistics of transportation in some Brazilians microbreweries.

Among the main design considerations listed by Juvinall and Marshek (2008), principally the cost and constructive facility were considered for the development of the machine, which was based on the simplicity of the mechanisms and the standardization of existing components in the market, allowing its maintainability. The design also sought measures to ensure the safety and health of the operator.

For the development of the conceptual design of the palletizing machine, we defined an iterative methodology, coming back to previous stages whenever an incompatibility was found, as expected in a mechanical design (Norton, 2010). Figure 1 shows the design flowchart.

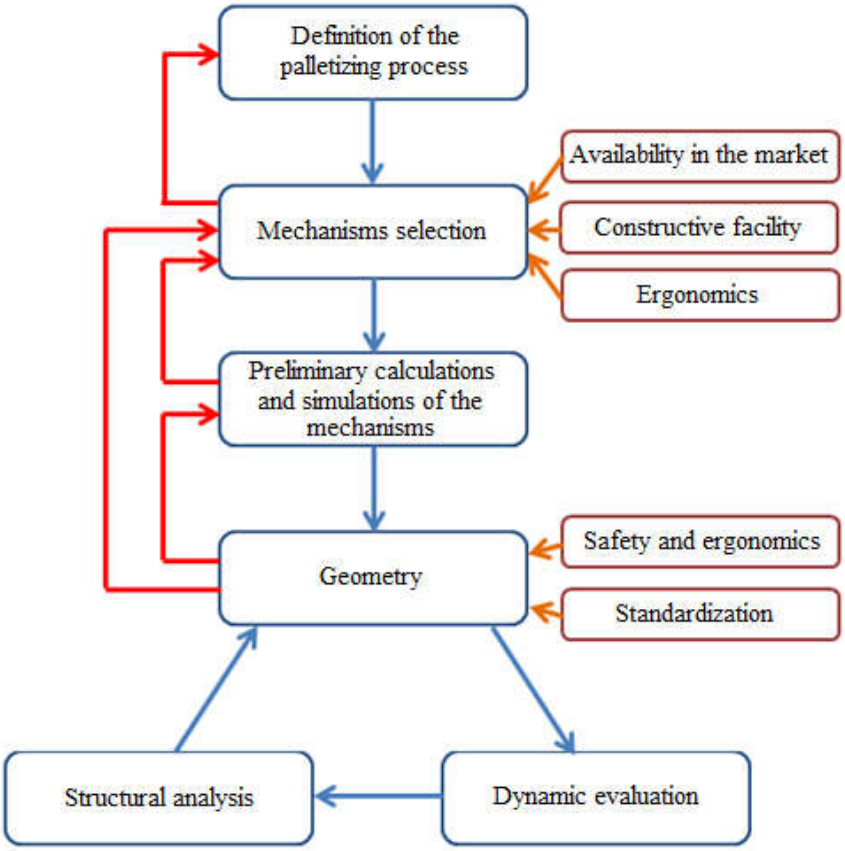

Figure 1. Flowchart of the design methodology.

Stages of design methodology:

- Initially, the tasks were defined to arrange the packages on the pallet;
- The mechanisms necessary to carry out the tasks of the process were subsequently selected. This step considered the mechanisms available in the market, constructive ease and ergonomics issues of the operators;
- Preliminary calculations and kinematic and dynamic simulations were performed at third step with the aim of preliminary verify, according to suppliers' catalogs, whether parameters such as speed, required effort, mechanism displacement and force exerted by the operator meet the design requirements;
- Geometry was developed with CAD (Computer-Aided Design) tools by considering standardization of materials, ergonomics and the safety requirements compliance;
- Based on the initial geometry and external loads, the requests of the structure and mechanisms of the equipment were performed through dynamic evaluations of the model from CAE (Computer-Aided Engineering) platform;
- The structural analysis was carried out after the requests in the structure were defined.
- Based on the results of structural analysis, the geometry was changed whenever it was necessary to withstand the applied load.

3. MACHINE DEVELOPMENT

The systematic engineering design methodology developed and proposed by Pahl and Beitz (1996) is divided into four phases: product planning and clarifying the task, conceptual design (purpose of this article), embodiment design and detail design. Thus, although the methodology shown in Figure 1 includes more than one of these phases, the purpose of this article is to present only the conceptual design of the machine.

The equipment was designed for beverages bottled in OW 600 bottles (which is one of the most used bottles in Brazilian microbreweries), conditioned in cardboard boxes containing 12 bottles each. The dimensions of the packages considered for the project were 250 mm x 240 mm x 320 mm, even though other variations can be found on the market. The packages are arranged in 4 layers superimposed on a pallet, that has 1000 mm of the width by 1200 mm of length. In Figure 2 is shown the dimensions considered for the packages, the pallet with its dimensions and the arrangement of the packages on the pallet.

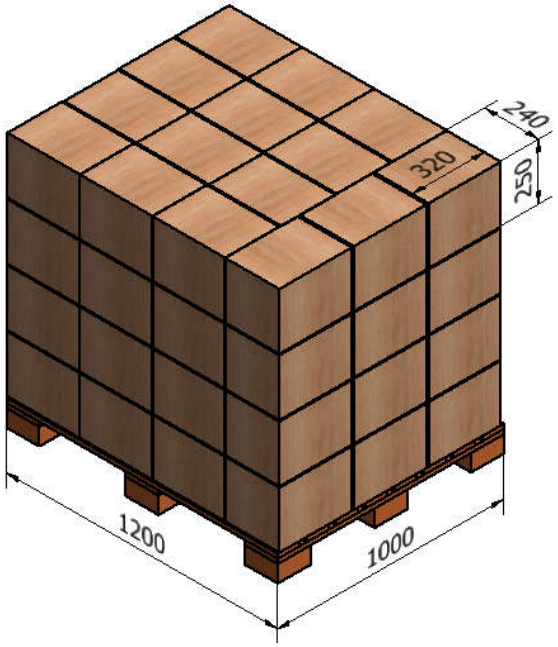

Figure 2. Arrangement of the packages on the pallet.

The tasks for palletization were defined as illustrated in Figure 3:

1. The wooden pallet is positioned below a movable platform on a table;
2. A layer of packages is arranged on the platform by the operator;
3. The movable platform is moved to leave the packages on the pallet;
4. The table that supports the pallet gets down to allow the return of the movable platform;
5. The platform is placed back on the pallet and the process continues until the formation of 4 layers and the pallet is withdrawn with the help of a forklift or a pallet truck.

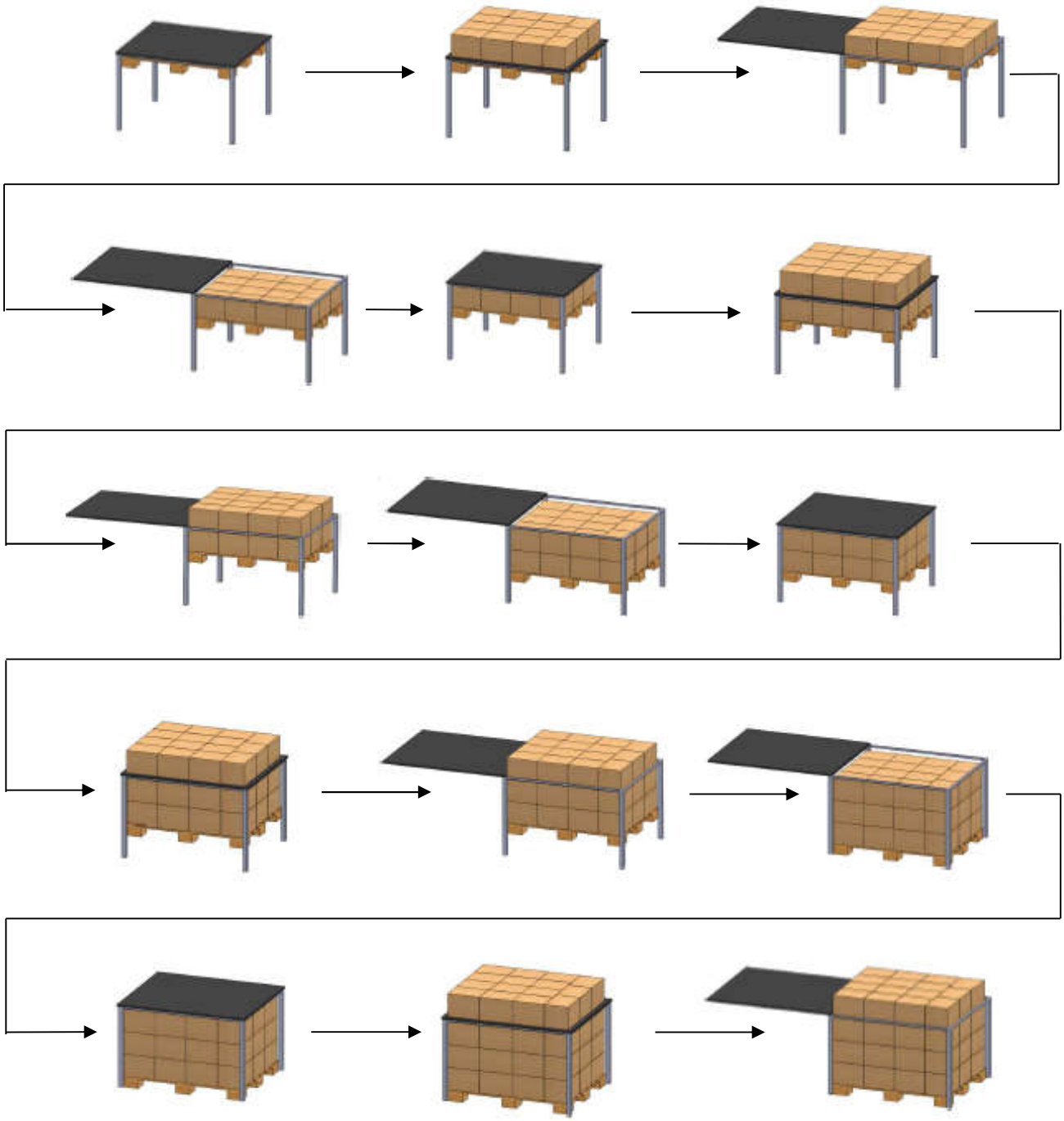

Figure 3. Schematic drawing of the unitized charge formation.

The mechanisms and geometry of the equipment can be seen in Figure 4. To facilitate the arrangement of the layers on the platform, ball transfers were used to allow the sliding of the packages with minimum effort exerted by the operator. For the translation movement of the movable platform, a rack-and-pinion system driven by electric motor for electronic gates was used. Side guides were used so that the platform of ball transfers, which moves on casters, could be maintained in a linear trajectory. Stoppers were used so that the packages were left on the pallet when the platform of ball transfers is translated. A pantographic mechanism was used for the vertical movement of the table that supports the pallet.

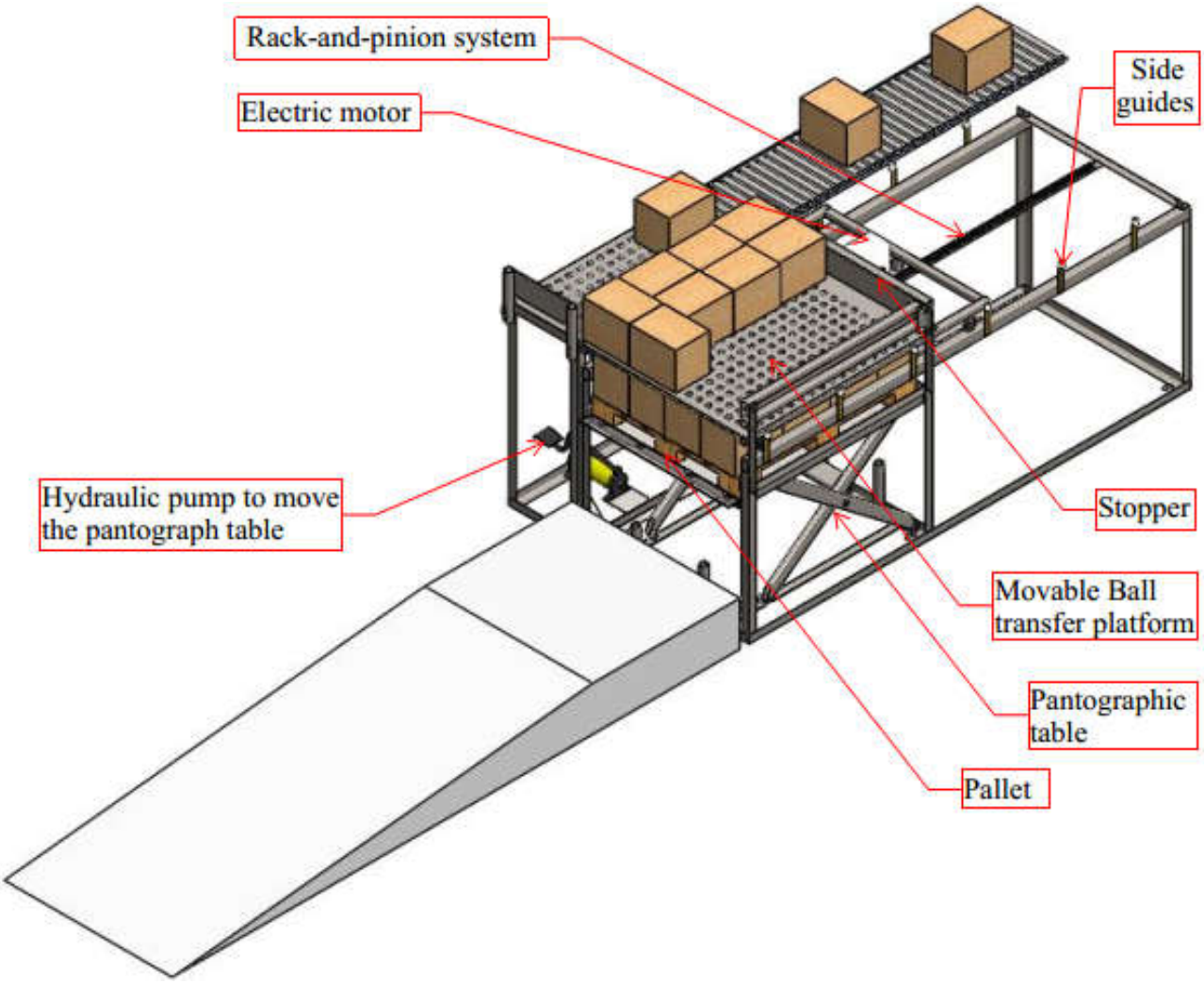

Figure 4. Conceptual design.

In Figure 5 is shown the top view of the palletizing machine. In this way it is possible to visualize its main dimensions (in mm) and to predict the area occupied by the equipment.

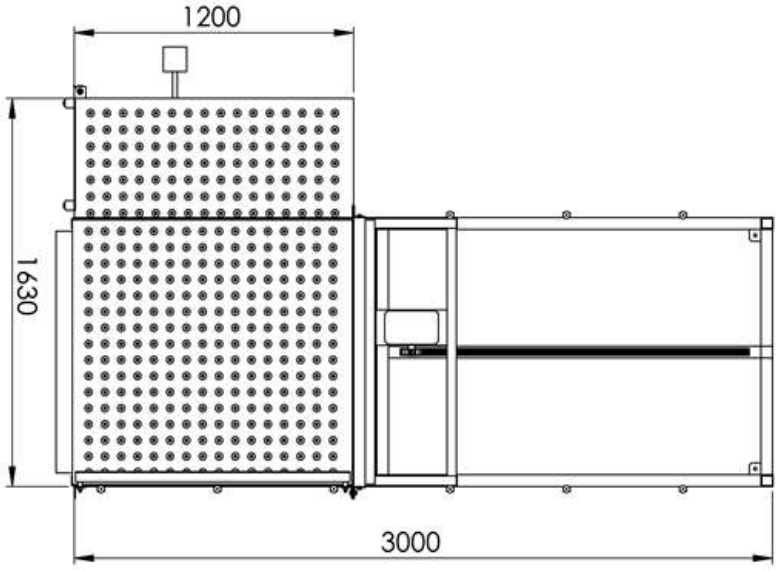

Figure 5. Top view of the palletizing machine.

4. CONCLUSIONS

The conceptual design of the semiautomatic palletizer aims to attend, in a viable way, a specific market where there is no continuous flow of production and the palletizing is not realized during the entire factory operation time. There is also, in the microbreweries, the constant need for changes in the arrangement of packages, such as incomplete pallets and different types of beer on the same pallet, for attend the clients' orders.

5. REFERENCES

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