ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume X (XX), 2011, NR2

METHODOLOGICAL FRAMEWORK FOR DESIGNING THE PALLETIZATION OF SMALL PARTS.

Michal Lipčak[1], Marek Vagaš[1]
[1] Technical university in Košice, Faculty of Mechanical Engineering, Department of Production Systems and Robotics, michal.lipcak@tuke.sk, marek.vagas@tuke.sk

Keywords: palletizing, assembly, cell.

Abstract: The paper deals with a methodology for designing modular palletization - assembly cells. It describes the structure and principles of cell storage system for a variety of components entering the palletization - assembly process. The paper describes the methodological framework of designing palletization - assembly cells, whose main technological core is an industrial robot.

INTRODUCTION

Products currently have very short life against the life of the production line, therefore, the men must count with frequent exchanges of manufacturing or assembly process, and consequently to be reckoned with frequent adjustments in the production line. In addition to the operational units is an essential part of every line the conveyor system, which automatically ensures the movement of assembly units between workstations. A variation of the products respectively their modifications place on mounting systems and conveyor lines new requirements, which include: fast and high-value objects transport, automation of transport system with high adaptability to assembly streams change, providing the necessary positions and orientation of assembly object in assembly workstations. One of the important parameters is to achieve the shortest possible time, while maintaining the highest quality. Products are becoming more complex, the production of many variants and modifications expand with the aim to meet individual customer requirements. It is necessary to continuously optimize assembly processes and systems to increase the flexibility.

1. PALLETIZING - ASSEMBLY CELL

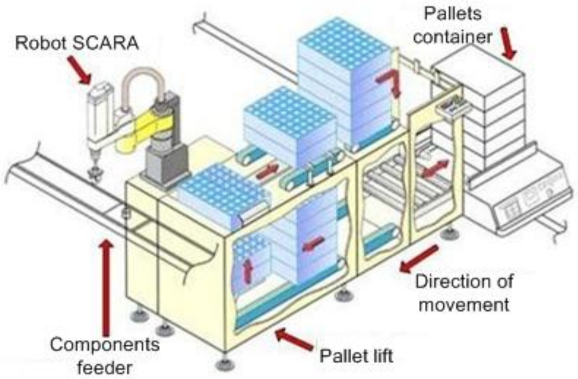

Figure 1. Palletization – assembly cell

In the structure of palletization – assembly systems the palletization – assembly cells separates like a separate groups, Fig. 1. Generally the centre is the system that meets following criteria:

- implements several types of assembly and handling operations,
- contains a digital control system providing flexible management,
- is equipped with an automatic exchange of assembly tools,

- is equipped with an automated supply system of basic and construction components.

2. METHODOLOGICAL FRAMEWORK FOR DESIGNING THE STRUCTURES OF PALLETIZATION – ASSEMBLY ROBOTIC CELLS

Block diagram of a methodology of appropriate structure of palletization - assembly cell is shown on Fig. 2.

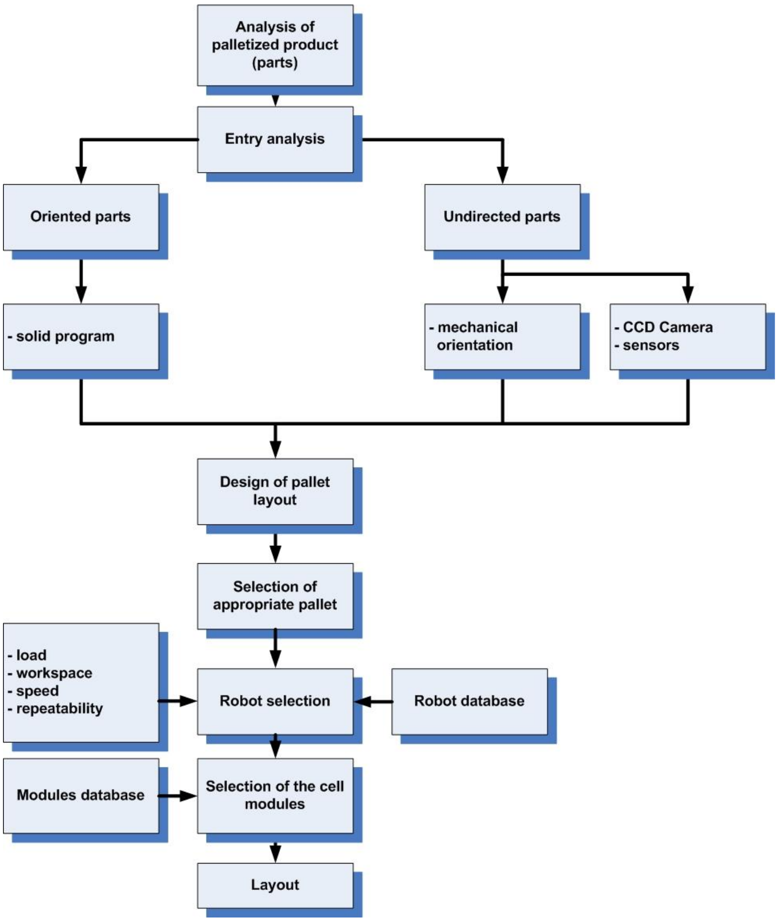

Figure 2. Block diagram of a methodology of appropriate structure of palletization - assembly cell

2.1 DESIGN OF PALLET LAYOUT

The most important design data that must be analyzed to create parts base are: geometric shape, dimensions, weight, material, intermediate form and under. From technical data for analyzing the parts base are frequently analyzed the types of technology operations and labor intensive. By palletizing operations there go primarily about the choice of surface arrangement of objects on the pallet. This is mainly dependent on: shape, dimensions and object weight, dimensions and load of pallet, handling and control capabilities of palletizing robot, on effect how to grip the objects, and on palletizing direction and sequence. When selecting an arrangement it is advantageous to use a network method. The size of the window is determined by the ground plan projection of the outline shape of the object increased by a certain value, taking into account the uncertainty and handling conflict of effectors states with objects stored on a pallet. Fig. 3 shows the different types of networks for the regular arrangement of objects on the pallet.

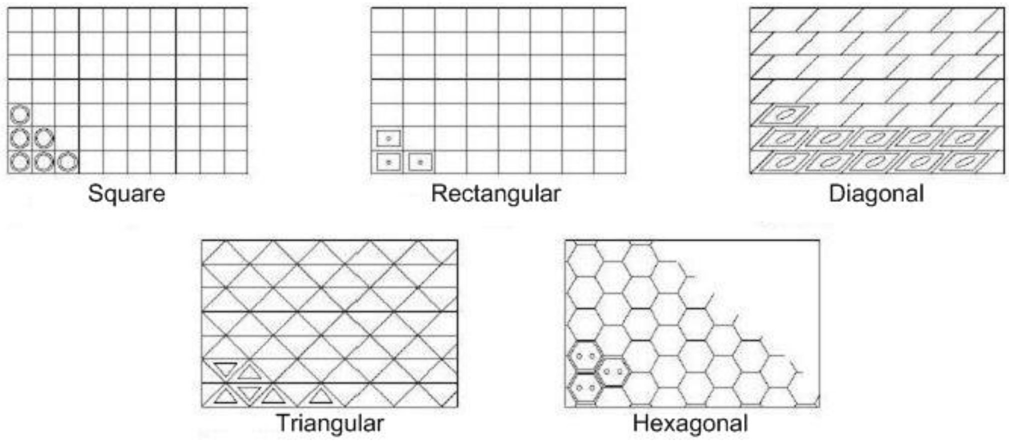

Figure 3. Network types

2.2 COMPONENTS INPUT

Components may enter into palletizing - the assembly process in two ways, either oriented or undirected. Complicated situation occurs when parts are entering the cell undirected. Components can be oriented:

- mechanically,
- with robot (manipulator) equipped with sensor system.

To give a component in the desired orientation in the time of entry into the cell, it is necessary to navigate it using the dedicated devices (guide elements), placed in the storage device paths. Fig. 4 illustrates inputs and outputs of palletizing - assembly cell parts and the active and passive indicative elements.

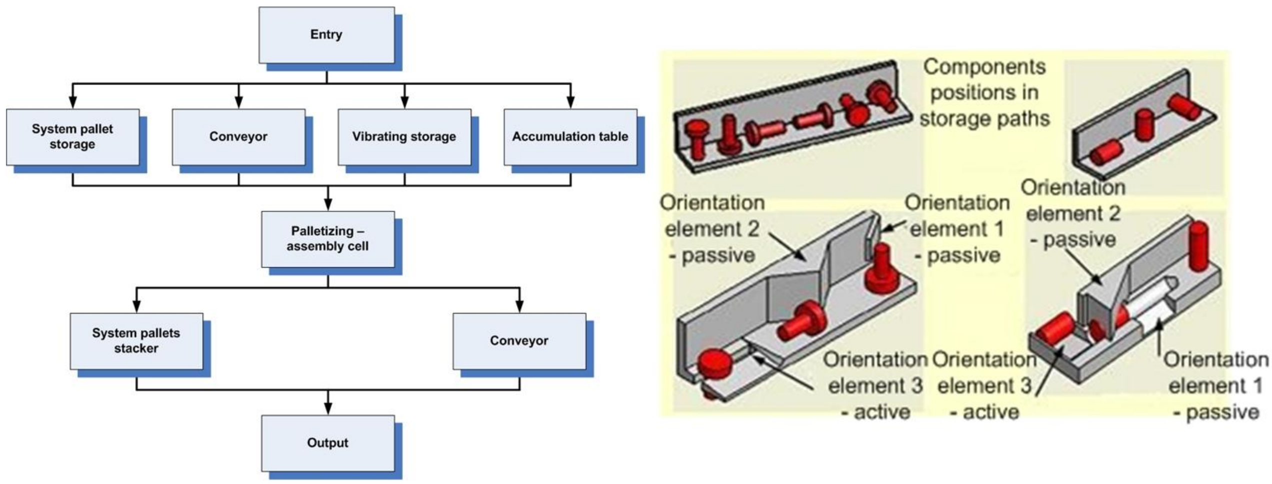

Figure 4. Inputs and outputs of parts and active and passive elements

2.3 SELECTION OF INDUSTRIAL ROBOT

Selection of industrial robot plays an important role in the design process of palletizing -

assembly cells. Fig. 5 illustrates a methodology for selection of industrial robots.

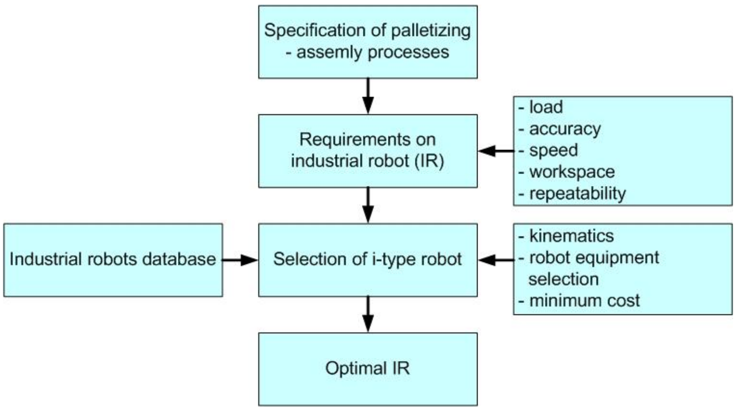

Figure 5. Industrial robot selection methodology

For applications in the palletizing - assembly process as the most suitable types of robots seem to be SCARA robots and linear (Cartesian) types of robots. On Fig. 6 is a comparison of the suitability of particular types of robots.

Applications	SCARA robot	Linear (cartesian) robot
Palletizing	X	X
Assembly	X	X
Constant acceleration in circular motion	X	
Structural rigidity		X
Accuracy	X	X
Load		X
Rotation ability	X	
Workspace usability	X	

Figure 6. Comparison of the suitability of different types of robots for specific applications

2.4 GRIPPER SELECTION

The most widespread effect of a robot gripper is grasping and manipulation with object to ensure the maintenance of a stable position in the movement and release on the follow-up manufacturing operation. On the robot gripper are placed several requirements, while most important of them are: optimal adaptation to functions of handling operations, shape and dimensional adaptivity of handling objects, high precision of gripping the objects, ensure the stability of orientation and position of the manipulated object, bound and synchronized movement of active elements, simple, robust and rigid structure, low weight and compact dimensions, minimize the number of structural elements, high reliability, easy maintenance and easy replacement of damaged and worn elements based on the operating principle we know these types of grippers: on a mechanical principle, on a vacuum principle and a magnetic principle.

Fig. 7 shown the dependence between the shape of the object and manner of contact with the gripper and on fig. 8 is shown the action of grip strength Fu. Also fig. 9

shows the table of „k" coefficient and fig. 10 shows friction coefficient μ for the most used materials (combinations of materials).

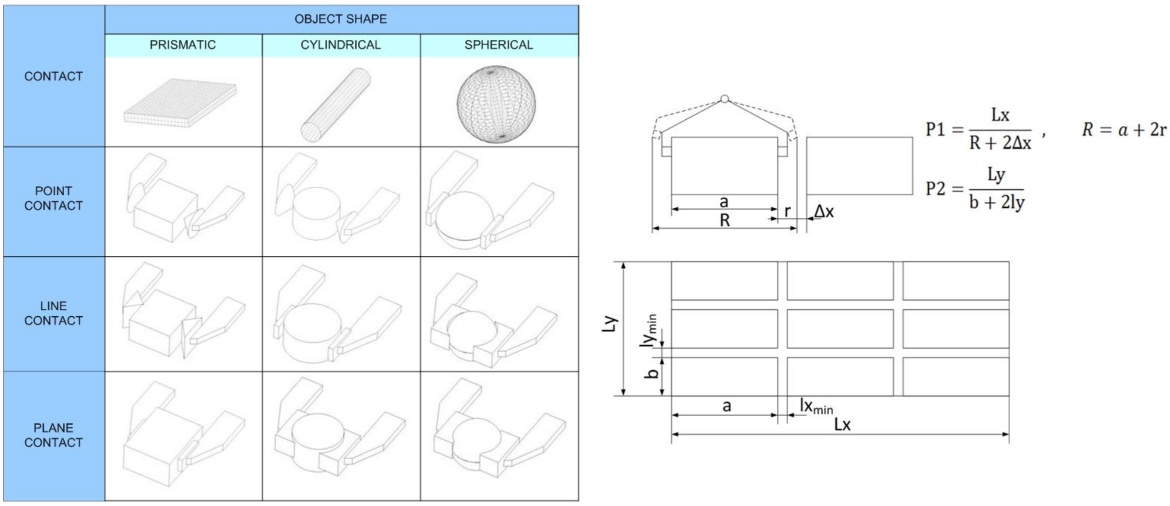

Figure 7. Dependence between the shape of the object and manner of contact with the gripper

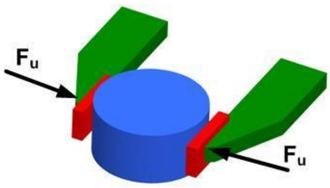

Figure 8. Grip strenght Fu

Between object and gripper operating friction, therefore we should consider with the factor k. Then we can calculate the grip strenght Fu, where:

$$Fu = k \times m \times g,$$

m – object weight, g – gravity.

Jaws number - i	μ = 0,1	μ = 0,2
2	20	10
3	13	7
4	10	5

Figure 9. Coefficient k

Contact materials	Friction coefficient	
	dry, clean	lubricated
steel - steel	0,12 – 0,17	0,05
steel - cast iron	0.2	0,05
steel - brass	0.2	0,05
steel - bronze	0.2	0,05
steel - rubber	0,3	0,15
steel - leather	0,6	0,25
steel - ferodo	0,6 – 0,7	x
steel - plastic	0,1	x

Figure 10. Friction coefficient μ for the most used materials (combinations of materials)

CONCLUSION

The aim of this paper was to develop a methodological framework to design a robotic palletizing - assembly cell. Enormous importance of palletizing is nowadays felt in every sphere of life and especially in industry. With increasing degree of automation also grow the demand for intelligence of palletizing - assembly workstations. Development is moving towards to creating ever smarter workstations where all modular components are integrated into a single cell.

References:

1. Mikuláš, Hajduk., Naqib, Daneshjo., Vladimír, Baláž., Ján, Semjon. Robotické bunky: TU SjF Košice, 2008. ISBN:978-553-0034-4.
2. Marián, Tolnay. Manipulačné a dopravné systémy : STU Bratislava, 2006. ISBN: 80-227-2379-7.
3. Rares, Pancu., Macedon, Ganea., Constantin, Bungau. Constructive solutions at the modular fixtute of the workingpart at the flexibile manufacturing cell TMA-AL-550: IMT Oradea, 2010. ISSN: 1583-0691.
4. Mikuláš, Hajduk., Vladimír, Baláž. Palletization with robot OTC Daihen : DNTU Doneck, 2009. ISBN: 966-7907-25-2.

This contribution is the result of the project implementation: Center for research of control of technical, environmental and human risks for permanent development of production and products in mechanical engineering (ITMS:26220120060) supported by the Research & Development Operational Programme funded by the ERDF.