



COBOTS – FUTURE IN PRODUCTION

Malgorzata Olender, Wacław Banas

Silesian University of Technology, Faculty of Mechanical Engineering, Institute of Engineering Processes Automation and Integrated Manufacturing Systems, Konarskiego 18A, 44-100 Gliwice

Corresponding author: Malgorzata Olender, malgorzata.olender@polsl.pl

Abstract: Develop of technology has contributed in creation of new solutions in production systems, automation and robotization. The article focuses on considerations regarding cooperation of robots with humans (collaborative robots - cobots), which is a new solution for manufacturers; especially from the SME sector (small, medium enterprises). A solution which has a chance of implementation, because of older society and a problem with employees. Cobots as a theme of research are already available in literature but first of all, attention is paid to the way of cobots function capabilities. However, there are no specific solutions for ergonomic planning of these workstation or description of existing barriers for these solutions. In article indicates, what buyers should consider when want to buy a cobot and how to model an ergonomic workplace. In article pointed also problems with teaching people new techniques, behaviors and existing barriers by implementation new solutions.

Key words: collaboration robots, cobots, automation, safety, ergonomics, technology.

1. INTRODUCTION

Develop of technology which is visible, causes that manufacturer implementing solutions that were only just a dream years ago. Currently, this development is also very visible in the areas of automation and robotics. However, the implementation of proper available solutions in individual manufacturers is becoming a problem. Especially use of collaborative robots (cobots) is becoming more and more popular. This is an opportunity for SMEs, which have problems with employees and application of costs, which are not huge as traditional solutions, and also of possibility installing the robot in small spaces, because cobots don't need protective barriers. However, it is a solution that still requires a lot of work, because there are no strictly developed standards, procedures and steps of implementation cobots in the enterprise. The use of cobots has many advantages, but a lot of work is still to do, for example in terms of security or programming [1-5]. In article indicates the advantages and disadvantages of implementing cobots on the production line. It was pointed out, what to look for, when is designed a workplace, what to look for, when is choosing a

cobot and what type of barriers and indications are in implementing this solution. Solutions that require attention because of close cooperation with people in a workplace, which must be ergonomic and safe. These issues still need to be modified and improved, because without the certainty of safe human-robot collaboration, the solution will have no chance of implementation, even at lower costs than traditional robots.

2. DEVELOP OF PRODUCTION SYSTEMS

Develop of technology is important, because it is an opportunity for customers, who are constantly looking for solutions to improve processes occurring in the enterprise, not only in the production area, but also in the area of production management and planning [6-12]. There are many articles in literature connected with assessment of technological progress. Examples of tools may include [13-15]:

- Technology assessment;
- Technological foresight;
- Technological interview.

It should be remember that, the progress of technology is associated with the advantages of using new solutions, but it can also have many negative effects thru awareness of existing defects also gives the opportunity to minimize the anticipated effects of introduced changes, that are felt by the working society. Of course develop of technology allow to do some tasks faster thru introduced automation on the line, integrated management systems, or implemented robots in places, where work was dangerous or monotonous for a people. However, currently develop of technology, especially in the area of manufacturing, is increasingly associated with digitization, intelligent systems or human-robot integration - cobots. It should be check, how these solutions affect to society, human work and their qualifications. And also important is ergonomics of the workplace, barriers to overcome and the readiness of producers to implement new solutions.

3. MODELING OF A WORKPLACE

Planning the production process, many variables must be considered. At first designing a specific workplace, the designer must have information about [16- 19]:

- Production volume and type;
- Available machines;
- Transport paths;
- Transport vehicles;
- Equipment and another materials;
- Robotized workcell;
- Automated workplace;
- Moving products between workplace;
- Number of warehouses;
- Arrangement of warehouses and social rooms;
- Restrictions of production hall.

When designer knows all the above data, he can start designing the layout of the production hall. In Figure 1 is presented a general scheme of planning workplace in the hall.

Of course production planning does not end at this stage. In next step, during production planning should be included also volume of production and schedule.

While designing a concrete workplace, all data about work (times, tools, positions etc.) should be considered too. Of course while designed of a robotized workcell, important are appropriate barriers, covers and working space for the robot and a human. In Figure 2 is showed an example of a conventional robotized workcell.

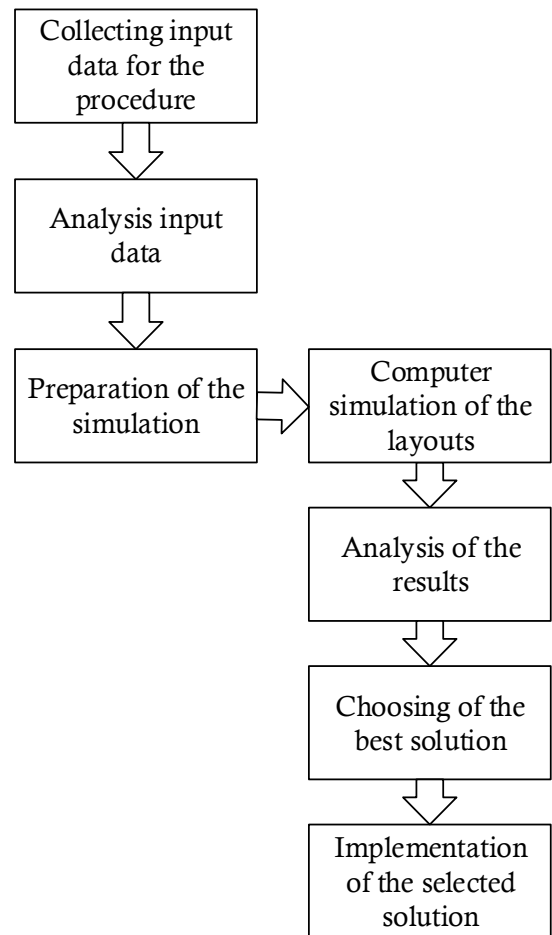


Fig. 1. Schema of planning production layout, own based on [16]

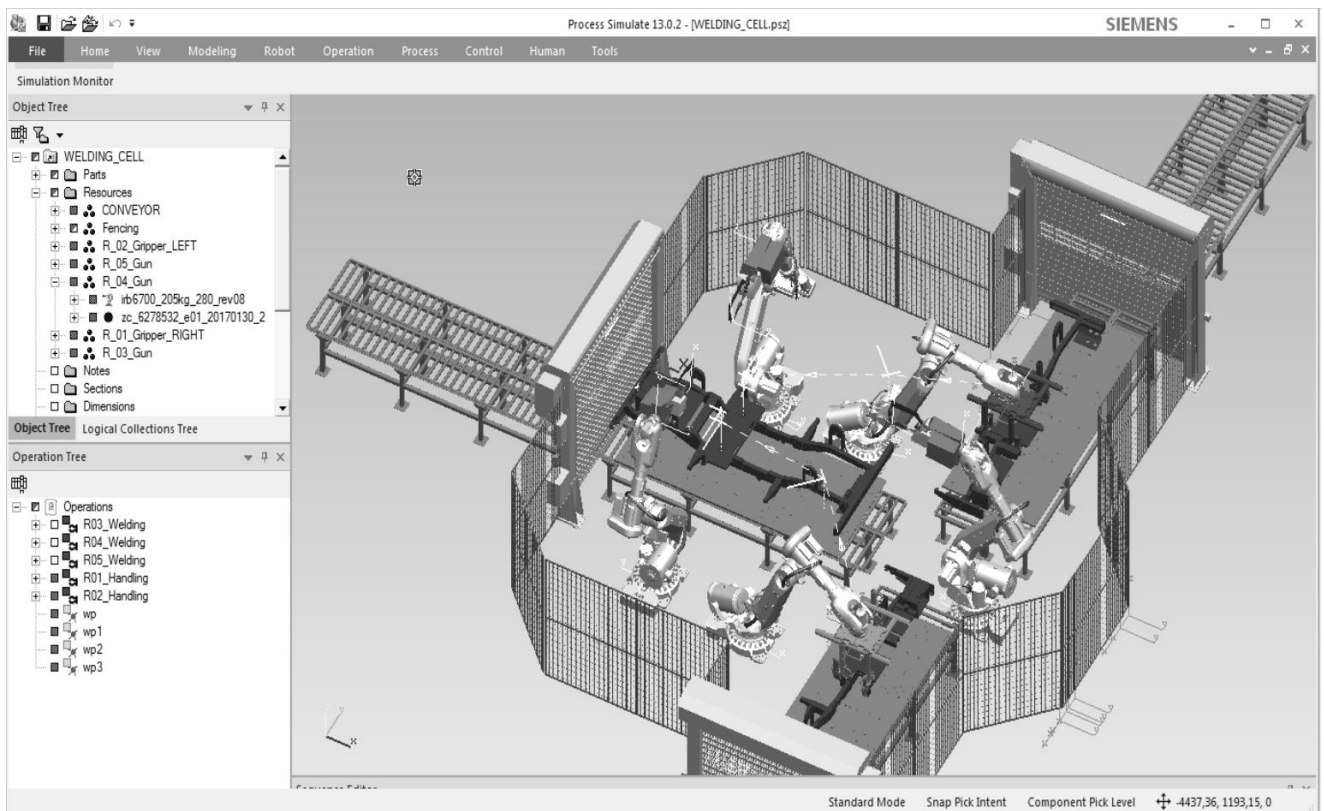


Fig. 2. Robotized production workcell [20]

For designed such a workcell, it is necessary to include [20-22]:

- Modeling of a robot;
- Arrangement of components in a workcell;
- Defining the kinematics of machines;
- Defining the paths of a robot;
- Testing of the created model;
- Verification of the created model.

Use of robots is very popular solution, especially in places, where work for humans is dangerous for example at painting or welding. However, new solutions for automation and robotization in industry are still required. Currently, increases concern the producers of implementation of cobots.

4. COBOTS

4.1 Implementation of cobots

According to the definition of PN-EN ISO 10218-2, point 3.2, a cooperating robot is a robot, designed for direct cooperation with a human, in a middle of a defined workspace, without barriers. Unlike a classic industrial robot, cobots have been built in way that is necessary to significantly limit the power and strength of their movements [23].

Implementation of the traditional robots, so far require a large of workspace, because are needed barriers or cages and have often been used in dangerous works for human. According to technological progress, cobots are used also for other works with humans. For example, a two-armed robot works with a human to assembling small parts [5]. Another solution can be a small robot designed for assembly small parts too, but this robot has also torque sensors in all seven axes. This solution allows doing most delicate assembly tasks [5]. An example of cobot is shown in Figure 3.



Fig. 3. Cobot, UR10 E-Series [24]

Next example can be a robot with two arms. This robot has sonar with a 360° scanning range and camera, which are used to detect various objects, including humans. In addition, each arm has 7 degrees of freedom [5]. Another company installed cobot for palletizing and labeling. This example has a lot of advantages. However these solutions would not be possible to introduce, without work of engineers, because area for working robots and especially human safety in these solutions are based for modeling workplace.

4.2 Choosing of cobot

For choosing the right cobot and for planning implementation in the workplace, it is necessary to pay attention for a lot of factors that will support decisions. According to [25, 26], authors pay attention to some issues like (Figure 4):

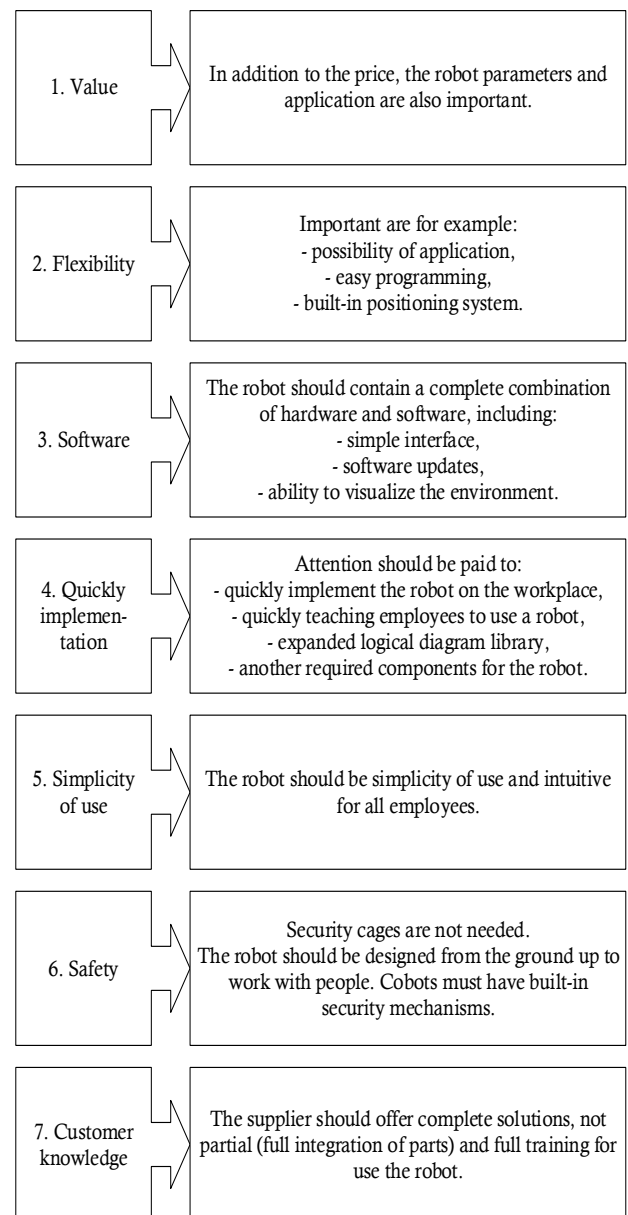


Fig. 4. Selected features connected with cobot selection, own based on [25]

Considering above features, the most important thing is that, selected cobot should works well on concrete workplace in manufacturers. First of all, important is to adjust robot to the place, where will be work, and then rest of features should be considered. After picking a cobot for work, also important is design a workplace, which should fulfill requirements of an ergonomic workplace. In literature are many articles that describe ergonomic issues [27-31]. They describe methods, programs, standards or tools. This is a very important issue, because it concerns about the work of humans and their safety in workplace. In combination with robot collaboration and human solutions, this issue becomes even more important.

4.3 Shaping the ergonomic workplace

In connection with the develop of ergonomics workplace, it is necessary to consider area like [27, 30]:

- Conditions of work;
- Load of work;
- Ensuring safety work.

It is necessary, to modeling of an ergonomic workplace be a continuous process. During the analysis, related to the ergonomics of the workplace, several areas are important, like (Figure 5).

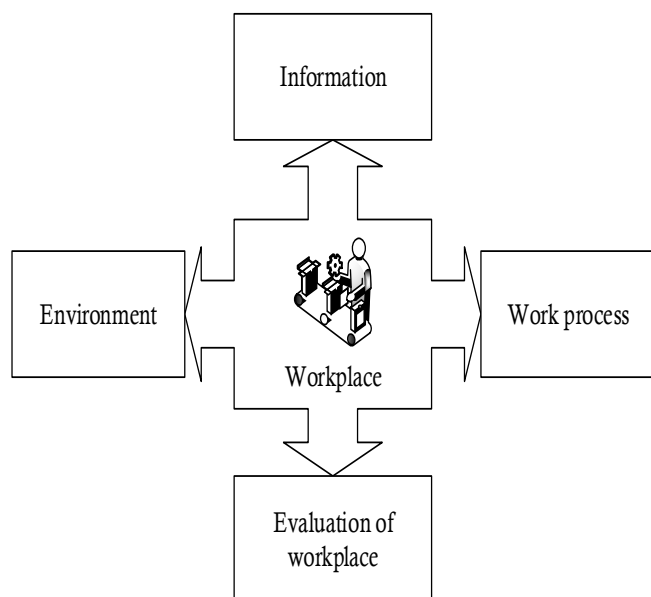


Fig. 5. Areas of shaping ergonomics workplace [30]

These areas should be constantly improved to develop an ergonomic workplace. It is possible only at the time of the adopted action plan, which indicates, what should be done in this moment in the workplace. In order to generalize and adopt standards of action to improve safety, EU countries have introduced directive 89/391/EWG. This directive obliges all employers to (Figure 6) [30]:

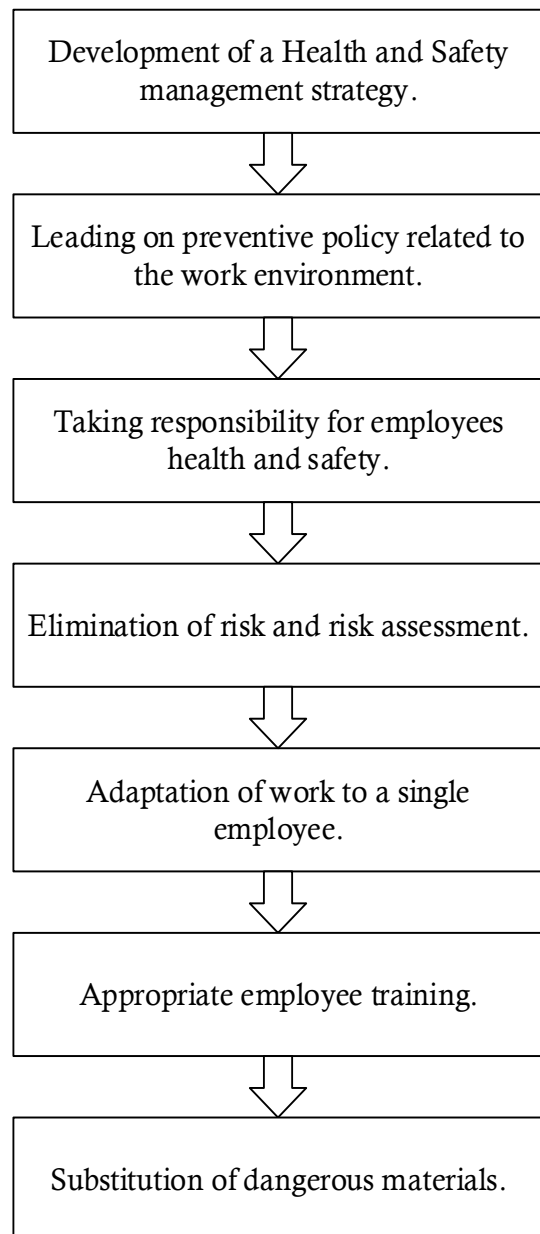


Fig. 6. Responsibilities for employers according to directive 89/391/EWG, own based on [32]

Safe working conditions and behaviors are tested by various methods. In literature, authors written about this topic, use methods like RULA, OWAS or computer modeling and simulations [33-37]. However Augmented Reality (AR) is becoming more popular for this type of issues. According to the authors Kregel and Poelman, in AR methods, localization systems can be placed [27, 38, 39]:

- Located on the head;
- With components located on the hands;
- Space interaction systems.

These solutions are very useful for ergonomic analysis at the workplace using cobots. The possibility of available solutions, allows for almost exact and quickly analysis or computer modeling, so workplace becomes safer for human. And more, because of working humans with cobots, there are no

barriers or other covers, which are always placed on standard solutions using industrial robots. Going forward, employees must be more aware of what may happen in the workplace and in case of problems, know how to behave and how to react. And also using of cobots brings another new problem to solve, for example training of new staff and further develop of applied solutions.

4.4 Staff training and further develop

Unfortunately, due to fact that develops of technology is visible, fears are being to, because no one know, how these solutions will affect on society. No one knows how much work will be done by the robots and machines. This is a very important issue to look out for. Currently, it can be seen, that population gets older and some people go abroad to work. Manufacturers are looking for solutions that will return money after some time and will ensure continuity of production. Employees are still needed and most of them with good qualifications. In future will be needed employees, who will be able to find themselves in new working conditions or will be able to quickly change qualifications, because work in the future will be related with IT technologies. According to authors [40, 41], in the future will be needed employees, who will be able to:

- Analyze big data sets;
- Manage IT systems;
- Implement Internet of Things at production workplace, especially with robots;
- Cooperate with international groups;
- Manage new technology.

These issues are related to issues connected with factory of the future. However, it can be already seen by the example of cobots, that knowledge of robotization, IT and programming are very required by manufacturers. And the implementation of cobots is just the beginning of this revolution. Revolution, which is also reflected in the education of employees, because it is necessary to develop the study plans for future students, or the training program. Changes in new solutions require necessary changes in education plans.

4.5 Barriers of new solution and further perspective

Cobots, as a solution for SME sector, may become a very popular solution in the future. Before this happens, working standards in area of cobots must be developed. However, production process and his limitations can be the barriers to introduce this solution. Currently, research is lead, in which area this solutions can be implemented. Another barrier of solution is also problem with human-robot communication. Now for this is used programming panel, but unfortunately appropriate communication

channels need to be more developed because of missed covers on workplace. Before making unplanned movements, robot must be properly secured, to safely cooperate with humans at one time. These solution can be, for example, voice commands, but this solution will not work in a place with high noise levels. Another solution can be also mechanical signals (by touch of cobot) or light signals. Another barrier is also human fear connected with cooperation with cobot, because if there is no cover, then subconsciously humans feel in danger. This is an area that has a huge impact on the implementation of robot on the line. Also often employees are afraid or do not want to participate in training. They don't want to change qualifications, which are also a huge challenge for current manufacturers. That is why it is so important to train employees properly or to organize study for young people, who will be in moment work active.

5. CONCLUSIONS

Manufacturers, because of small group of employees, get older society and the costs of implementing new solutions, are increasingly paying attention to the topic of cobots. There is still a lot to do in area of research with this solution. A solution that can be a cure for the current problems for producers from the SME sector. First of all, attention should be paid to safety of implementation cobots, ergonomic modeling of the workplace, but also to training of staff, who will be able to find themselves in new technologies.

This article is the result of continuous work on the subject of cobots in the Institute and will be further developed.

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