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ROBOTIZED PRODUCTION CELLS FOR ARC WELDING
ROBOTIZOVANÁ TECHNOLOGICKÁ PRACOVIŠTĚ OBLOUKOVÉHO SVAŘOVÁNÍ

Abstract
The article deals with progress in robotization in arc welding technology. It is based on knowledges and experiences acquired from realized or upcoming robotized production cells (RPC) and gives informations about essential components of RPC and about possible future development in this field. It also includes demonstrative pictures of possible solutions from few companies that operate on our market.

Abstrakt
Příspěvek se zabývá rozvojem robotizace v technologii obloukového svařování. Vychází z poznatků a zkušeností z realizovaných nebo připravovaných RTP a předkládá technické veřejnosti informace o nezbytném obsahu RTP a o možném budoucím vývoji v této oblasti. Jsou v něm také názorné obrázkové přílohy možných řešení od některých firem, které působí na našem trhu.

1 INTRODUCTION

Robotized production cells (RPC) for arc welding used to be created according to specific conceptions of customers and supplier companies made the solutions individually for each customer and his demands. Such robotized production cells are however more expensive.

Individual solutions share some common variants and setups and that forced the companies to come with a new approach – the idea of modules, which can be combined into different RPC assemblies. As even these assemblies are similar in many aspects, most of the companies engaged in robotics in technology of arc welding in shielding gas atmosphere offer already also complete modular systems, built using their own components.

There also already exists very powerful specialised software which is able to quickly design and make up the whole workplaces and to easily create their projects and programs for robots.

2 COMPONENTS OF RTC FOR ARC WELDING

The complete RTC for arc welding in shielding gas atmosphere consists of many basic and necessary components, including the following:

- welding robot,
- positioning device,
- sources of shielding gas, compressed air,
- source of electric energy,
- workplace delimited by enclosures or fences, entrance provided by doors which block the operation of the robot and thus provide safety for operation crew,
- control panel (a console for programming and starting of robot actions and other devices),
- wire bin with electrically driven wire feeder which conveys the wire to the welding torch through feed tube (location and size of the welding wire bin is based on customer's demands and capabilities of the particular cell's disposition),
- safety welding torch holder,
- device for torch exchange and accuracy check,
- welding cell built on a steel frame.

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The positioning device is usually designed as rotary table with two working areas, whose two working positions are secured on place by a pneumatic-mechanical lock. A robot suitable for arc welding equipped with necessary accessories has typically the following parameters:

- payload usually from 6 to 16 kg on the end interface,
- kinematics structure mostly angular, with 5 to 6 degrees of freedom,
- repeated accuracy typically ±0,1 mm (this value is sufficient for most applications),
- in most cases it's appropriate to use an adaptive robot, which is equipped with all necessary sensors needed to verify the actual welding torch position and to monitor the ongoing welding process,
- integral part is also the corresponding control unit,
- air-cooled welding torch

The actual process of welding takes place in a closed cell equipped with suction system which eliminates the exhausts and remaining used shielding gas during welding. A scheme of such a cell is show on Figure 1.

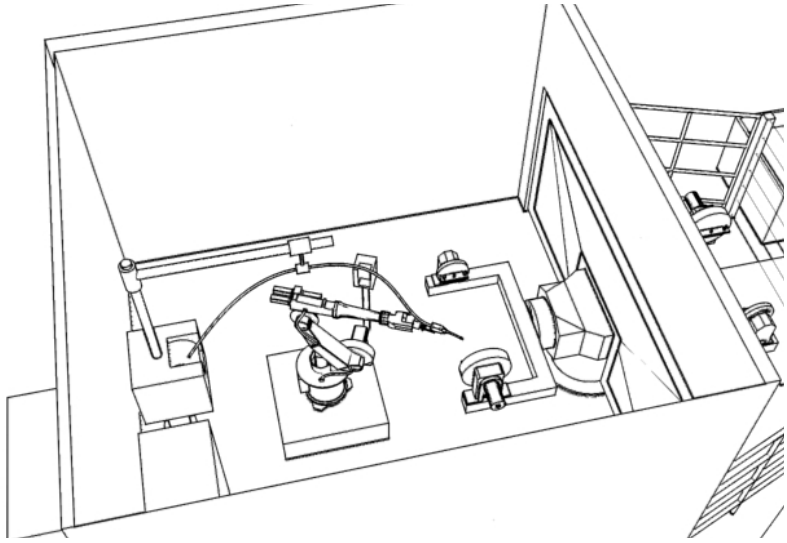

Figure 1: Draft of a robotized production cell for arc welding

3 EXAMPLES OF SOME AVAILABLE MODULAR CELLS

Panasonic Industrial Company offers three types of robotized arc welding cells. **PerformArc ET** (Electronic Turntable) is a cell with electrically driven turning table, **PerformArc TT** is a cell of a table-table type and **PerformArc MT** (Manual Turntable) has a manually operated 2-station table with inter-lock function and 2 worktables. All three types meet demands on modularity and are fully equipped, including welding robots Panasonic. Maximal payload of one worktable position is 250 kg, overall weight of the cell is 2700 kg and dimensions 3.8 x 2.2 x 2.3 m.

Compact, reasonably priced and flexible robotized cell is offered by **Valk Welding** Company, under the name **Minicell**. This cell meets the demand for simple, easy to operate and affordable robot concepts. The cell disposes of a torsion free steel frame, two doors for the operator and a door to change the drum with welding wire. Due to its compact design with two workstations, the Minicell is extremely suitable for fully continuous welding of small workpieces. If desired, the Minicell can be enhanced with a mechanic welding torch cleaning unit, the Program Protection System (PPS) and/or automatic sliding doors.

Figure 2: Welding cells Panasonic PerformArc ET and PerformArc TT

Figure 3: Minicell RPC

Standard Cell is a simple and flexible solution for minimum investment costs. Because of the two workstations, the robot is able to produce at one side, while the operator feeds and discharges the products on the other side. The unit can be enhanced with various safety devices and various types of welding tables. The standard cells can be provided with two clamping places and can be delivered with manually or automatically controlled dividing table. The basis is formed by a torsion free support, upon which the welding robot, power source and clamping table are being placed. The cells comply with the CE-marking, and fit as a whole in a lorry; they can be taken into use directly after installation without major adjustments. Since the separate frames are 100% identical, programmes can rapidly and easily be copied from one cell to the others.

The third type of RPC for arc welding offered by Valk Welding Company is **Flex Cell**, which is very compact and capable of handling welding of products from a wide range of shapes and dimensions.

Due to accent on modularity of the mentioned cells, it is possible to create various modifications. This primarily includes a choice of welding robot and source of welding current from the given range or a choice of various accessories, for example exhausters, welding torch cleaning devices or the welding torch itself.

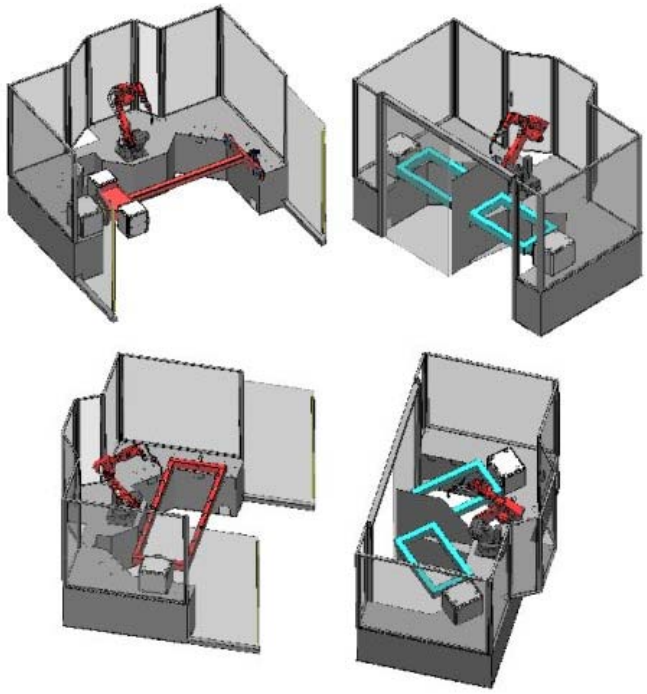

Figure 4: Flex Cell RPC in various configurations

Another company involved in development of arc welding cells is **ABB**. Their **FlexArc** robotic welding cells are complete robot systems available in several flexible and versatile, standard modular packages. A notable advantage of ABB cells is that they are available also in virtual format which can be opened in their powerful software called Robot-Studio and can be programmed offline on a personal computer with ease.

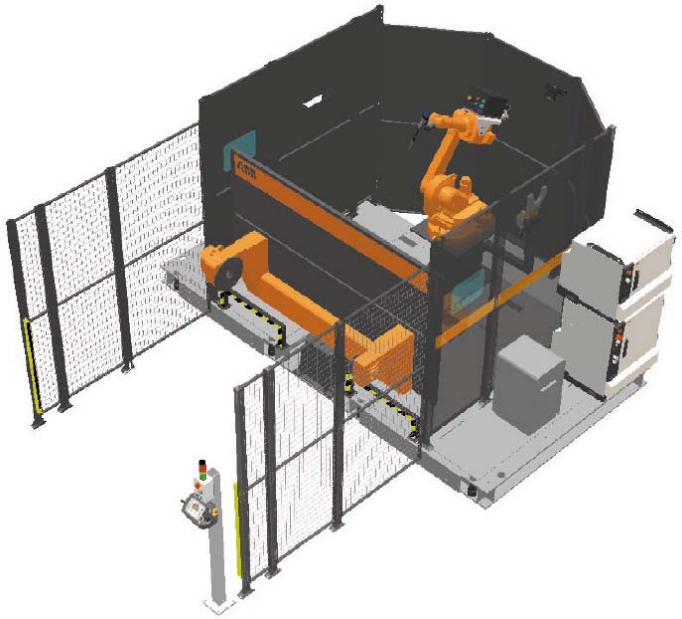

Figure 5: ABB FlexArc cell - virtual model of the actual system rendered in Robot-Studio

4 NEW TRENDS IN ARC WELDING ROBOTS PROGRAMMING

No robotized production cell for arc welding works still on the same product or set of products. There is a need to reprogram the robot sometimes and this used to mean that the cell and also all other production systems dependent on the welding cell had to be stopped for the time while the new program was created and tested directly on the robot. As robot systems are very expensive, the goal is to keep them in operation for as long as possible and thus so called *off-line programming* is very profitable.

ABB RobotStudio is a powerful software system that allows both on-line and a full off-line programming of any industrial robots. When there is a new product coming into production, programs for all robots and their accessories can be completely built and also tested and verified on a personal computer and afterwards copied directly to the robots' control systems in a while. There are also other advantages of this approach, as this SW allows to easily perform some tasks which were very difficult or even dangerous with on-line programming – this includes for example checking of colliding configurations and positions, optimization of robot movements and position of the welded parts, accessibility of all points along the welding path or simultaneous operation of the robot and positioning device during the welding process itself.

The four main benefits of off-line programming are:

- Risk reduction,
- quicker start-up,
- shorter change-over,
- increased productivity.

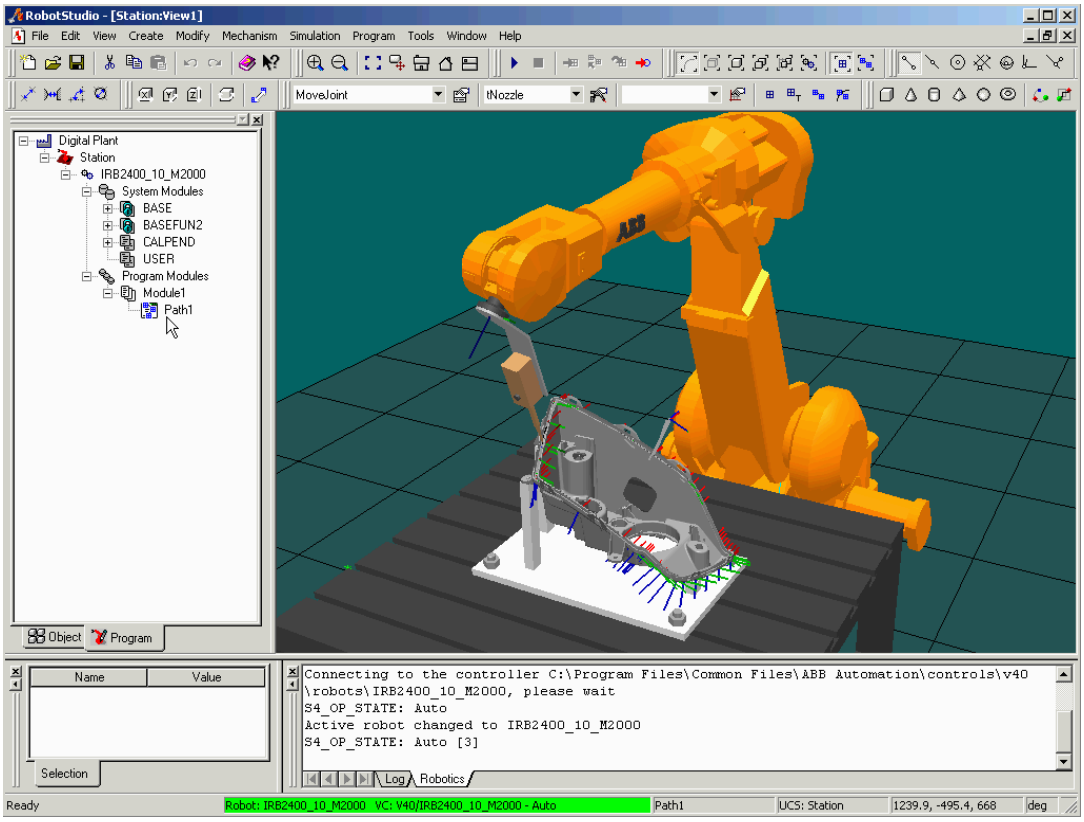

Figure 6: RobotStudio environment

Making a program for RPC for arc welding using RobotStudio requires coming through the following steps:

1. Use some CAD system to make model of the workpiece.
2. Import the model of the workpiece and models of robot, positioning devices and other important parts of the cell to the Robot-Studio environment.
3. Set up the cell – put all parts on right positions.
4. Pick paths on the workpiece that represent the welds and configure movement of the torch along these paths.
5. Test and optimize the program.
6. Copy the program to the robot's control system.

RobotStudio comes with models of all ABB robots, accessories and whole modular cells, so building a control system for them is very easy. It also includes an emulator of the real robot control system and it is used to control the virtual robot in the SW environment. This means that the real robot will behave exactly the same as his virtual representation when the program is copied into its control system and there is no need of any kind of translation.

Very important and useful is for example the feature that allows a quick check of any collisions of parts of the robot or torch with accessories or the workpiece. It reduces risks of damage the robot could take while testing the program on the physical robot and also it speeds up the whole process. Similar benefits comes from other features, like the ability to check whether the welding torch can reach all points along the patch without bringing the robot close to singular configurations.

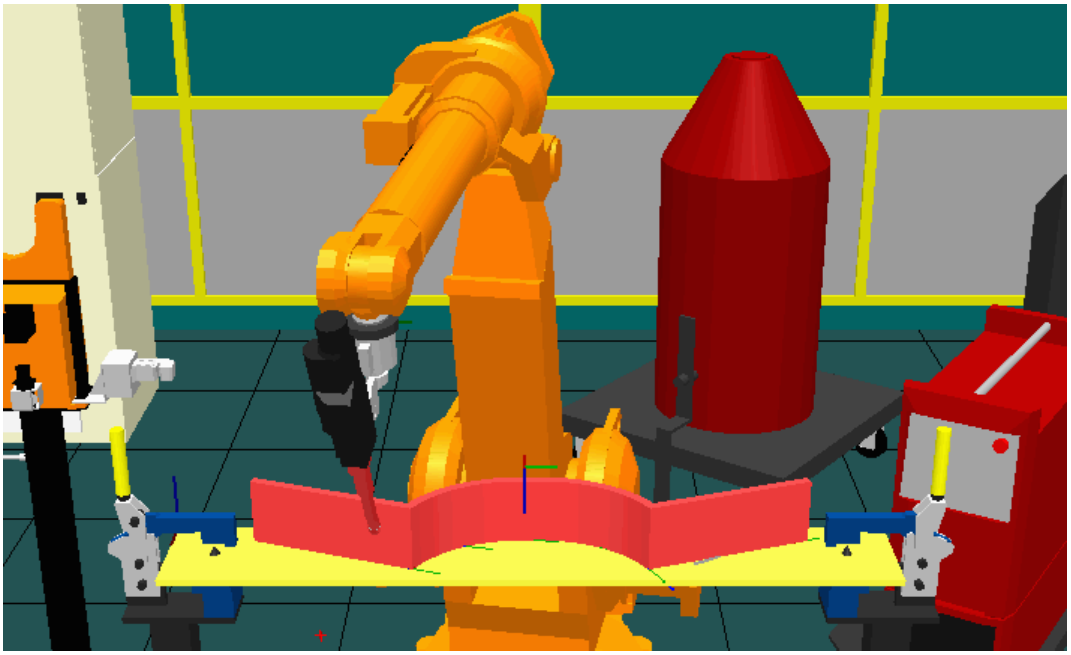

Figure 7: Collision detection in RobotStudio

5 CONCLUSION

Robotized arc welding is a very common operation in various industry branches and thus there is a big progress not only in the robots themselves, but also in the whole robotized cells and control systems. The current state-of-art is based on modular robotized production cells for arc welding. These cells are cheaper and the time needed to start them up is shorter in comparison with custom-built robotized workplaces.

Big progress has been made also in the matter of welding robots programming. The modern software offers a full off-line programming, which significantly increases the productivity of a robotized cell, because time needed for start-up and change-over is reduced and cycles of the robot are optimized.

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