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DEPARTMENT OF ENGINEERING PROCESSES AUTOMATION AND INTEGRATED MANUFACTURING SYSTEMS

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MAKE A SIMULATION, SAVE TIME AND YOUR MONEY

Abstract: Planning and implementation of automated processes can be improved by means of a previously prepared simulation. The article presents an example of simulation of the welding process of car body parts made in the Process Simulate program. Performing earlier planning allows you to verify the concept, solve technical problems and prepare programs at the stage of project creation.

1. Introduction

Designing automated technological processes is a multistep operation. Issues related to spatial planning, mechanics, electrics and programming are discussed. Thanks to the simulation and technical documentation, it is possible to plan the work and solve problems before installing the devices. In the era of increasing demand in the electronics, automotive and household goods industry as well as reduced professional activity of manual workers, the automation of production processes is firmly developed. Robotisation affects the increase of product quality, reduction of labour costs and motivates people to improve their professional qualifications.

The beginnings of robotics applied in the industry date back to 1962 in the United States. In the 90's, the most robots were used in Japan, and now the most robots are being used in China.

Currently, all large production automation projects are supported by advanced computer programs that are designed to help engineers make decisions. The main processes that are automated in the automotive industry include gluing, welding, cutting, bolting, riveting, handing, casting, assembly and quality control.

2. Selection of tools

A well-made analysis is based on the proper selection of robots for the process and proper modelling of the mechanisms in the station, where parts of the body will be folded.

Choosing the type of robot and the weight of the tool it is needed to perform the operation, the speed of movement of the robot's links and the market price of the manipulators.

The choice of the tool is significantly influenced by various parameters. In the case of spot welding, the pressure, welding time and space availability on the vehicle body are important to the tool. Having a properly selected tool, we know its geometry. This is one of the most important information, because in the next step we are able to verify the robot's reach.

a) *b*)

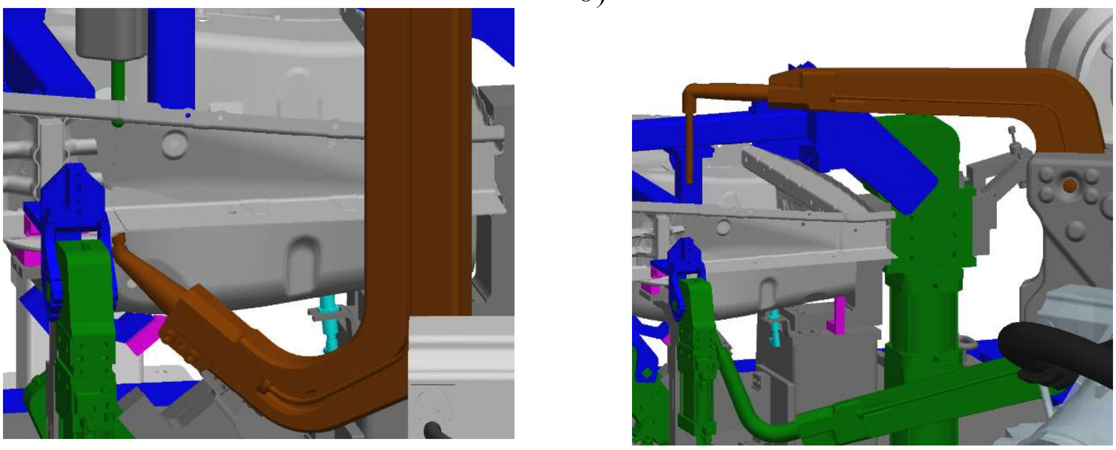

Fig. 1. Two guns compared: a) wrong, b) correct

On the pictures above (Fig. 1) we can see wrong and correct selected gun. The first one is wrong, because space between two electrods is too small even when the gun is open to the maximum value. The second one is correct, because the gun has enough space to perform the operation.

With such an analysis, the risk of making a mistake is very small and eliminates the costs of incorrect selection of devices, possible returns / exchanges and a prolonged process of production implementation.

Cycle time: 65s				
Robot / Station	Description	Start [s]	Duration [s]	End [s]
50RB_100	Robot unload big part from statiion	0.0	**10.0**	10.0
50RB_100	Ride on 7th axis (1m = 1s)	10.0	**5.0**	15.0
50RB_100	Robot load the big part on station	15.0	**10.0**	25.0
50RB_100	Ride on 7th axis (1m = 1s)	25.0	**5.0**	30.0
80RB_100	Robot unloading big part from station	25.0	**10.0**	35.0
70RB_100	Robot unloading middle part from station	10.0	**8.0**	18.0
70RB_100	Robot unloading middle part from station	18.0	**8.0**	26.0
70RB_100	Robots load the middle part on station	26.0	**8.0**	34.0
70RB_100	Robots load the middle part on station	34.0	**8.0**	42.0
80RB_100	Robot unloading big part from station	0.0	**10.0**	10.0
80RB_100	Robot reorient	10.0	**2.0**	12.0
80RB_100	Glue (150mm/s)	12.0	**30.0**	42.0
80RB_100	Robot reorient	42.0	**11.0**	53.0
80RB_100	Robot reorient	53.0	**2.0**	55.0
80RB_100	Robot load the big part on station	55.0	**10.0**	65.0

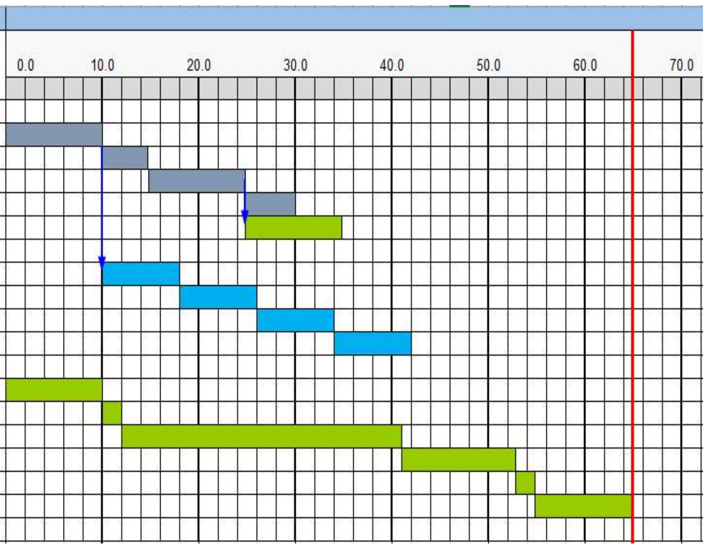

Fig. 2. Time diagram

Cycle time is one of the ways to optimise production. It provides information on how often one product leaves the production line. The length of this time varies and depends on the customer's demand for a certain number of products. In the process of determining the cycle time, the time diagram is usually helpful (Fig. 2).

"Collision Set" is a tool used to detect collisions between data structures. It performs well in creating paths for the robot in tight spaces. Thanks to it you can observe the dynamic course of the simulation with the update of the distance and immediately correct the incorrect path. In this way it is easier to verify and document a bad construction for the construction department.

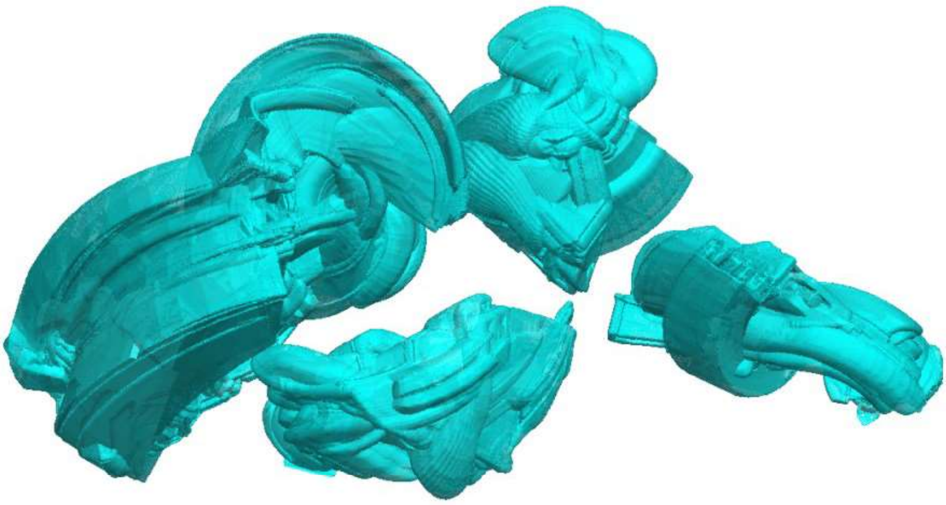

Fig. 3. Points cloud

In simulation programs, it is possible to generate a point cloud (Fig. 3). It is created based on the path of passage. This cloud determines the robot's field of work and then it is easy to estimate how many space in the cell remains to be used.

OLP is a short form of Off-Line Programming. In this phase, robots paths are created, the paths to the stations and paths to service positions. Then signals for the exchange of information between the robots and from a robot to a PLC are added. Signals controlling robot mechanisms and other mechanisms in its area have also been added.

Additionally in this phase all main positions and other points are named according to the client's standard.

3. Simulation of process for customer

MRS (Multi Resource Simulation) or SOP (Simulation of Process) is a movie showing the real time and flow of parts on the line. The process simulation aims to visualise the entire production process for the customer. Also it is a proof that it is possible to perform all operations at a given time.

The most attention when starting automated devices should be given to the safety of people who will work in their environment. For this purpose, we use curtains and safety switches. In the case of robots, tools based on generating work areas are applied. They use geometric limitations and speed. On the basis of signal exchange with the PLC, the robot is able to determine whether it enters the employee's work zone. The 3D environment creates solids and saving vertices in the form of points in the robot program. On this basis it is possible to determine when a given robot can work in a given sphere, or block it so that it never appears there (e.g. blocking cell boundaries from the fence).

The question arises whether we need robotics programmers implementing the process. Despite a well-prepared simulation, the position of Online Robotics Programmers is an integral part of the production launch. Below it is explained why.

One of the first tasks belonging to robotics on the line is the first commissioning of a given robot. This involves calibrating the axes, determining the load on the arms, weighing the tools, comparing the home position with the offline values, and even checking mounting the robot to the floor. The second task is to configure the network. Checking and adding devices that work in cooperation with the PLC and robot.

The next task is to verify the correctness of connecting devices with Eplan, e.g. sensors on the gripper (grip check), passing the loaded paths and checking their collision-free (with and without part) and teaching the process positions. The robots also check the exchange of signals between the PLC and the robot. This is included in the virtual start department (WINMOD) in which all irregularities should be captured.

The last tasks are matters related to the safety check in a given cell and eventually inclusion of dry run (production without parts at 100% speed), test production, support.

4. Conclusion

Thanks to all these components, it is possible to plan the integration of the new model on the current line, without having to stop production. This integration can take place on non-working days, weekends and holidays. Thanks to the simulation it is possible to design a collision-free path for all robots and to optimise the cycle time. This is a great convenience because one can design a workstation or more workstations on the factory even if there are not needed components. In simulation programs it is possible to compare different sizes of devices and stands, conveyors. One can adjust the clamp sizes and their positions.

Above all, however, offline simulation gives the opportunity to design the factory equipment while it is being built. And when the factory already exists, it is easy to reflect the location of the elements from the simulation on the real object.

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