**LABORATORY WORKPLACE OF AUTOMATED ASSEMBLY – CONTRIBUTION TO THE EDUCATION QUALITY EMPROVEMENT**

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## Abstract

*Creation of conditions for work with real technical device contributes to the increasing of the education quality and to the raising of students interest about the special objects too. The article presents starting points and present stage of laboratory workplace that is built at the Department of Automation and Production Systems of University of Žilina.*



## Key words

*robot, automated assembly, control system*


## Introduction

Department of Automation and Production Systems is oriented to the problem of computer aid and automation in engineering industry with emphasis on NC/CNC production machines and robots programming, work with CAx systems and microelectronics and microcomputers application in engineering practice too. The department guarantees the study programme "Automated production Systems". There a few of specialized laboratory workplaces are built for the education improvement. They are in a different stage of their realisation. One of them is the laboratory workplace of automated assembly. The one is before a final stage of its realisation.

## Design and realisation of automated workplace

The laboratory workplace is designed for the assembly product consists of 4 assembly components of different geometrical types as: base part ***(1)***, inner component ***(2)***, distance ring ***(3)*** and cover ***(4)*** – see Figure 1. The product main dimensions are ***45*** *x* ***60*** *x* ***25*** mm (***w*** *x* ***l*** *x* ***h***) and its weight is $m_c = 0{,}115\ kg$. Two methods are chosen for components grasping:

- Mechanical method – the parallel gripper with two shaped fingers is used for grasping of components ***1, 2*** a ***3***.
- Vacuum method for the component ***4*** one-side grasping with suction cup of diameter ***ød*** *= 8 mm.*

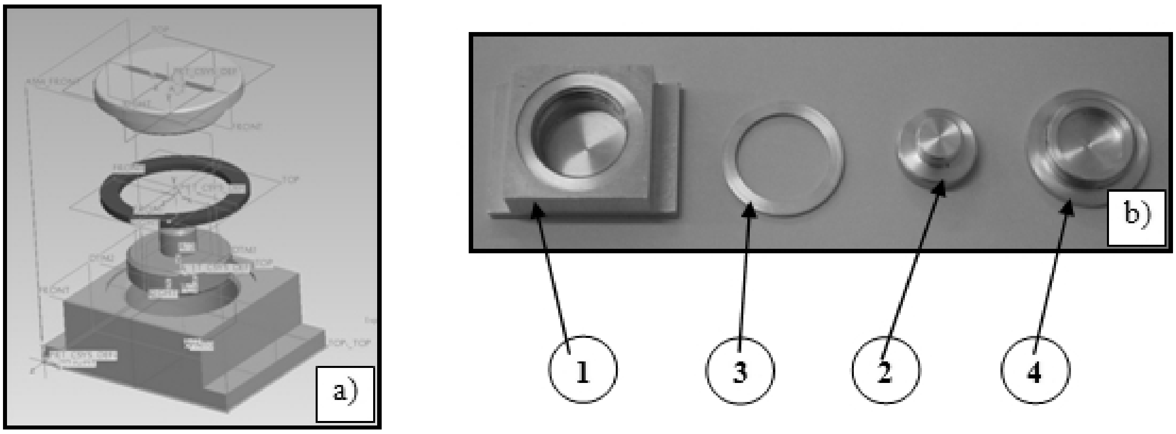


*Fig. 1.* *Assembly product*
*a) 3D model – exploded assembly, Pro/Engineer WF v.4*
*b) Manufactured assembly parts*

***The workplace structure and disposition***

The two assembly methods are under consideration for the product assembling. The components ***2, 3*** and ***4*** are input into the base part ***1*** from top to down in sequences. The product assembling is finished by screw of the component ***4*** into the base part.

The laboratory workplace structure consists of the next subsystems (Fig. 2):

- Two – arm assembly unit (***I***) has a kinematic structure of the type „***TT***“ and consists of two working tools – mechanical and vacuum grippers. This one realises required pose of grasped objects in frame of the planar rectangular. Maximum working area is ***360*** *x* ***20*** mm.
- 4 vertical gravity storages (***II-1, II-2, II-3*** a ***II-4***) equipped with the mechanisms of the components ejecting.
- Two-position linear unit (***III***) provides for assembly positions ***P1***, ***P2*** and movement of assembling subgroup from ***P1*** to ***P2*** too.
- Robot (***IV***) has a kinematic structure of type „RRR(RRR)“. This one will perform the finish assembly operation - the cover screw and then it will input the assembly product into the shelf storage (***V***).

The all mechanical subsystems, except the robot, are placed at the working table plate to execute a single required operation in logical sequences. The table is assembled from aluminium sections of MTS, s.r.o. Krivá na Orave (Bosch Rexroth Group) and its main dimensions are: ***1000*** *x* ***1000*** *x* ***750*** mm. The capacity of the vertical gravity storages and the shelf storage is 20 pieces (components / assembly products). The all active components of mechanical subsystems work on the base of pneumatics. They are pneumatic actuators of „*SMC, Industrial Automation*”. The all frameworks are assembled from components of modular system of *MTS, s.r.o. Krivá na Orave*. The other passive parts as shaped fingers, connecting plates and flanges, components of storages etc. were manufactured in *Minitec, s.r.o.* on the base of the drawing documentation.

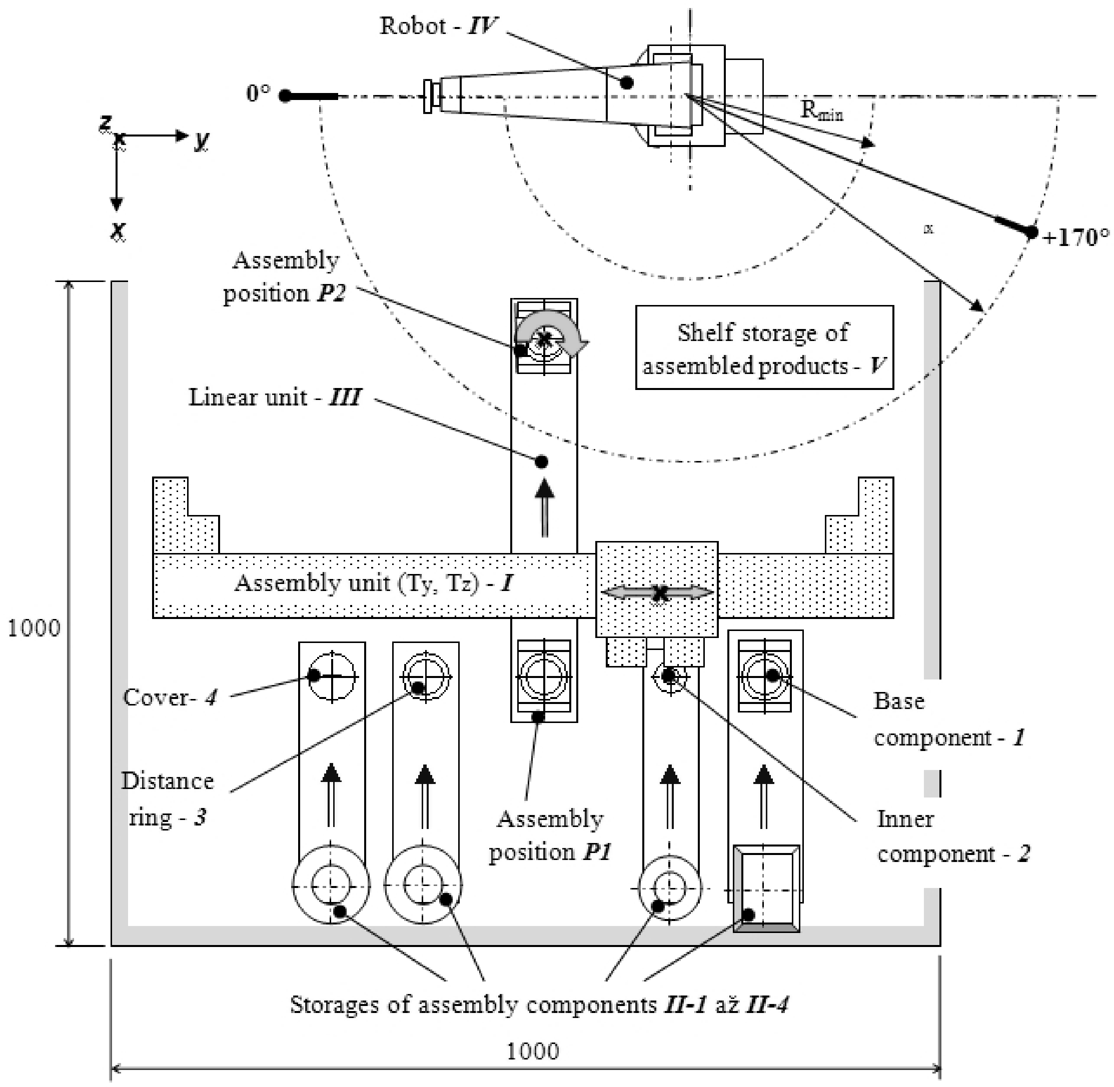


***Fig. 2.** Describe of the laboratory workplace structure and disposition*

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Robot FANUC LR Mate 200iC will be placed at the own working table so near the assembly workplace to reach both the assembly position ***P2*** and all twenty positions in the shelf storage. Robot FANUC will substitute two single units that were initially considered – screw unit and unit operating the shelf storage. The Figure 3 shows the laboratory workplace of automated assembly in the stage before starting of the control system solution.

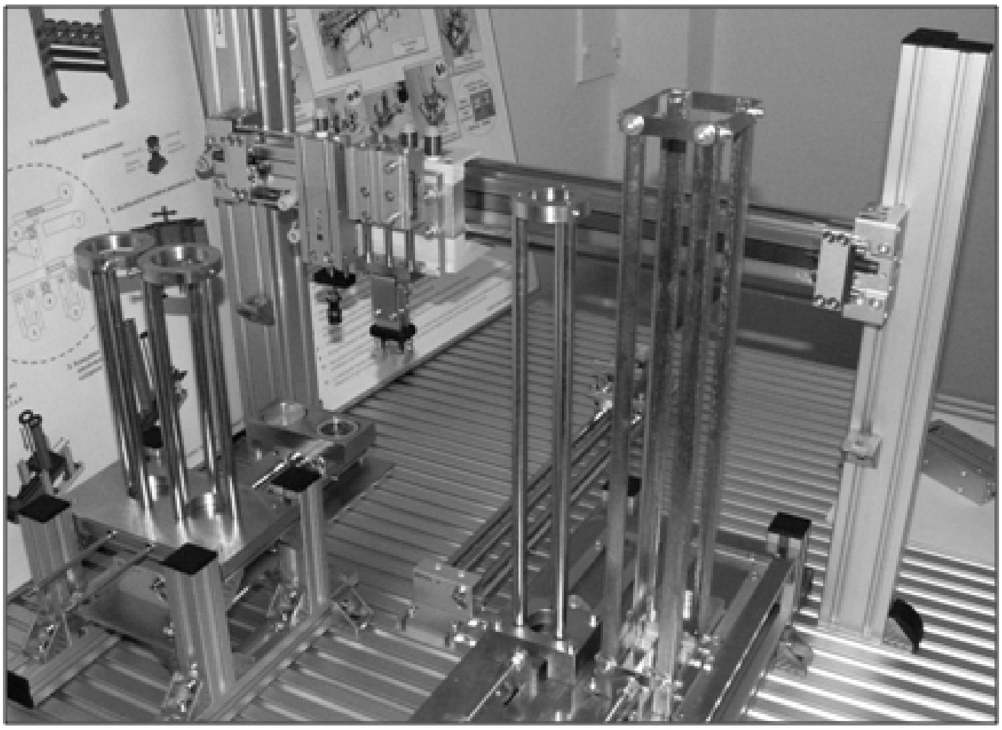

***Fig. 3.*** *Laboratory workplace - stage before starting of control system solving*

***Workplace active components control system***

For the control of automated assembly workspace was used *Vision 280* system (Figure 4) from Unitronics Company. Vision 280 control system is named *OPLC* (**O**perator panel and **P**rogrammable **L**ogic **C**ontroller).

*OPLC Vision 280* is compact system fitted with 4,7" touch-screen, alphanumeric and function keys directly on OPLC panel. This components form the HMI control system interface. System is fitted with real time clock, backup battery for the real time clock and system data. *OPLC* supports 158 In/Out connections. This can be connected to system via *snap-in* module or via input-output plug-ins - Figure 5.

*Fig. 4.* *OPLC Vision V280.*

***Fig. 5.*** *Snap-in and IO plug-ins and communication modules*

It is possible to configure various types of analog and digital inputs and outputs according to needs using the plug-ins, as well as various types of com modules among them GSM communication. *OPLC* communicates with outer environment via two RS232 / RS485 or CANbus com ports. It contains 12 independent PID regulation loops and 64kB data memory.

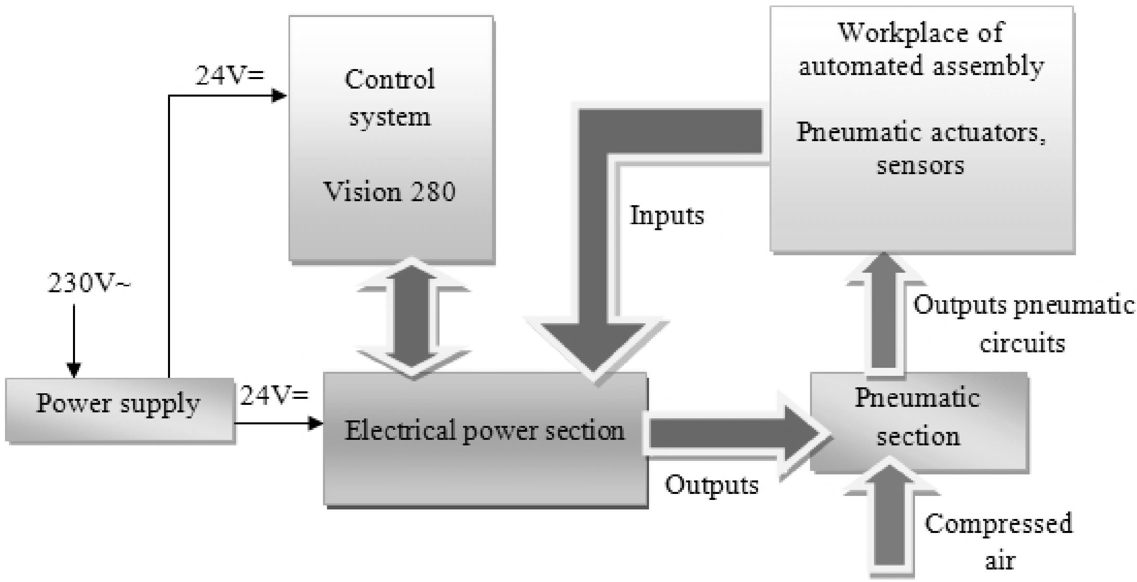


***Fig. 6.*** *Electro-pneumatic block diagram*

Electro-pneumatic block diagram (Figure 6) was designed for the automated assembly workstation control application that was the starting-point for the realization of the control system.

*OPLC Vision 280* is programmed using the *VisiLogic* program that contains applications for PLC as well as HMI. *VisiLogic* uses "*Ladder Diagram*" (LD) programming language. Control program was created on the base of contact diagrams. It is possible to use various types of logical, mathematical, HMI, database and function blocks in the program creation. Control algorithms were designed according to requirements for workstation control and assembly course. Flow-chart on Figure 7 shows the work program base cycle.

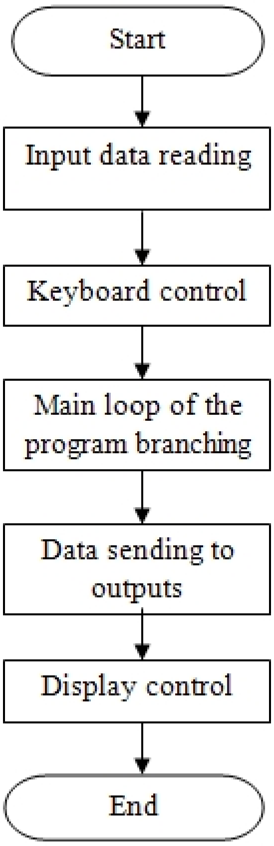


***Fig. 7.*** *Basic work cycle flow-chart*

These variable data types were used in the process of the workstation control system creating:
MI - integer values (registers) 0..96,
MB - memory bites 0..92,
SB - system bites 7 and 31.

Proposed control system was realized. All of its components are placed inside the work table structure under the top table - see Figure 8.

Concluding stage of the project of laboratory workplace building will be cover several tasks connected with verification of the complete laboratory workplace. The next partial working activities will be planned:

- An implementation of the robot FANUC to the laboratory workplace activities.
- A completing of control system with additional I/O modules.
- The storages minimum capacity monitoring in context with fluently control of the laboratory workplace processes.
- The testing of the complete laboratory workplace.

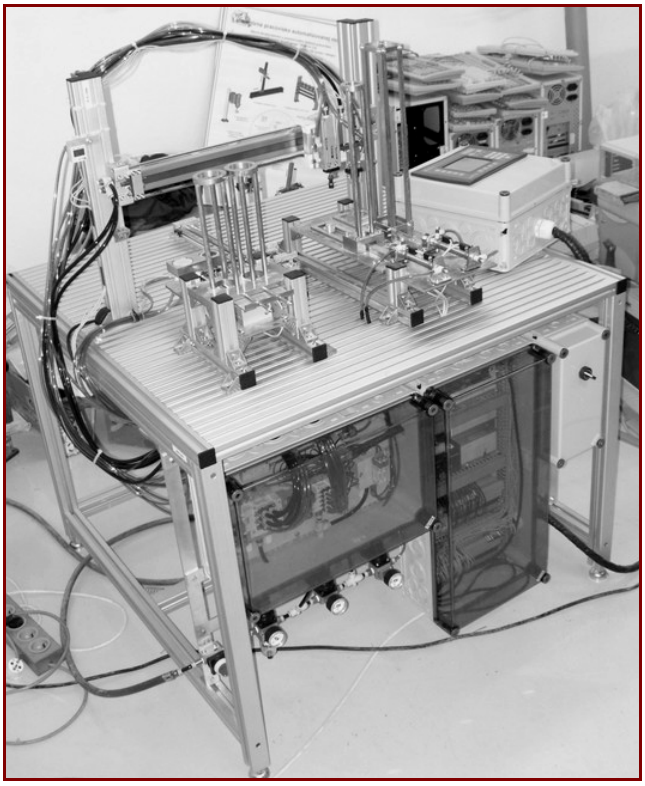

***Fig. 8.*** *Laboratory workplace of automated assembly – a realisation present stage*

## Conclusion

The first idea to design a laboratory workplace of automated assembly at our department appeared in 2004. The workplace requirements were specified stepwise up to the present. The students of both bachelor and engineering study form cooperated at the particular problems solution. The purchase of active and passive components and pneumatic circle components and production of other parts were endowed from the financial sources of several research projects, namely of projects as: V-046-06-00, V-07-016-00, A-06-004-00, A-004-05-00. The methodology of the automated choice of the suitable gripper of modular type on the base of similarity principles was elaborated and verified in conditions of the designed laboratory workplace.

Laboratory workplace of automated assembly will be utilized for educational purposes especially. We will plan to utilize this one as the integrating element for the teaching system of special objects that are focused to pre problem of production systems automation.

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