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1. Angela JAVOROVÁ, 2. František PECHÁČEK

ASSEMBLY SYSTEM DESIGN WITH MODULARITY AND CA SUPPORT USING

1-2. SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA, FACULTY OF MATERIALS SCIENCE AND TECHNOLOGY IN TRNAVA, INSTITUTE OF PRODUCTION SYSTEMS AND APPLIED MECHANICS, DEPARTMENT OF TECHNOLOGICAL DEVICES AND SYSTEMS
RAZUSOVA 2, 917 24 TRNAVA, SLOVAKIA

ABSTRACT: This paper deals about designing process of assembly system with using of modularity and CA systems. Paper describes the benefits of using the principle of modularity in the design process of assembly system. The methodology is divided in to the five project phases. There are: assembly product analysis, hardware specification, selection of proper control system, control system simulation and whole process simulation.
KEYWORDS: CA system, modularity, design, assembly system, FluidSim, simulation

❖ INTRODUCTION

Modern manufacturing is currently located in production areas and production areas require the integration of different types of engineering and manufacturing operations. Therefore production philosophy allowing the integration of control, organizational, monitoring and other innovative type of activities into one unit is needed. Due to the relatively high variability of real production technologies, dominant technologies, production volumes, production flows, production use funds and many others, further consideration and analysis of the problem are focused on area of modern automated, especially robotized production. Creation and design of automated assembly system is a complex problem, which includes design problematic of automated device. Of course automated system design problematic is consequently adjusted following to the requirements of assembly devices design problematic. Such designing process, which is designing automated assembly device, needs some guide. This guide will carry designer over the all problems which are connected with assembly process and also its automation. After using of such guide, some automated assembly device will be designed. Such guide, or better say such tool is and methodology of automated assembly devices design. Each automated device consists of several building units such as suspension frame, manipulating equipment, working equipment, helping equipment, or control equipment.

❖ MODULARITY PRINCIPLE IN ASSEMBLY SYSTEM DESIGN

Design on a modular principle is an essential means for achieving particular long-term flexibility. Long-term flexibility reflects the system's ability to adapt to changes that do not occur at the time of its design and installation. Typical issues to be addressed are the removal, exchange and additions machins and workplaces, information system changes and the like. Modularity reduces secondary investments and the cost of rebuilding assembly systems. Using the modularity principles in the design of assembly systems is one of effective ways for their development. The new systems developments have to solve some specific terms and criteria. In the modular assembly systems designing process are important technical and economic requirements.

Other important considerations are the following:

- □ Project considerations, leading to a computerized optimization of the assembly systems configuration as basic modular items controlled by computer integrated manufacturing (CIM).
- □ Production and technology considerations, leading to minimizing the cost to implement the assembly systems, allow optimizing economic efficiency.
- □ Operational and service considerations, leading to minimization of costs operation, assembly systems maintenance and service.
- □ Reliability considerations, leading to increased reliability over the life of the system.

Modular principle has several advantages. There are:

- □ Creation of purpose-oriented assembly systems. They have the best technical economic parameters with regard to specific applications.

- Getting of new configurations of assembly systems integration of appropriate units and modules.
- Simpler and more flexible transition to the new handling and assembly tasks.
- Greater economic efficiency.
- Use of already developed and tested modules assembly systems.
- Reducing the requirements for development and project tasks.
- Increase reliability, provided that the modules are sufficiently verified.
- Reducing the cost of production, maintenance and service due to a reduction general nomenclature of elements and components and increase the serial production.

Functional modules of assembly systems designing require the application of the following principles:

- Uniformity of technical and design principles and characteristics of functional modules designed to implement the same kind of handling and assembly operations.
- Implementation of functional modules in a series of dimensional types.
- Maximum independence of functional modules from the kind of energy and motion control method.
- Compatibility and interoperability of functional modules with the possibility of flexible modification or configuration of assembly systems.
- High internal unification of elements of functional modules.

❖ ASSEMBLY PROCESS DESIGN

Assembly systems generally consist of a large set of modular elements, units and subsystems, which are linked by a complex set of functional relationships and properties. Application of systemic approaches in designing assembly systems leads to their partial decomposition of subsystems, units and elements that can analyze in terms of their properties, relations and functional behavior of the assembly process. Analysis of the proposed construction of assembly system and its designing is based on the analysis of input data obtained by analysis of assembly cycle and appropriate means of automation. The individual components are selected using software tools – Propneu, awarded on the basis of the requirements (Figure 1).

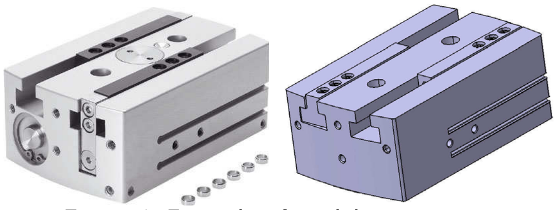

Figure 1. Example of modularity systems component – parallel gripper and gripper CA model

Selected components were created in the Catia environment 3D model of assembly system. The main part of assembly system is 3-axis Cartesian kinematics. Another part of the assembly system is a workspace with features providing an operational process of assembly handling and storage of individual assembly parts (Figure 2).

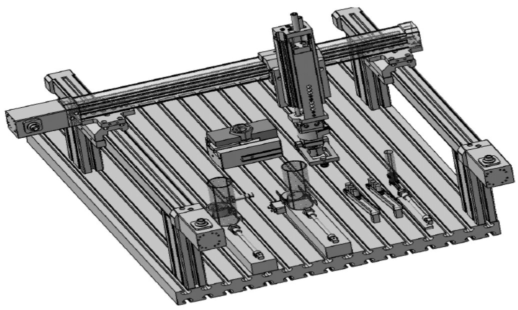

Figure 2. The layout of the proposed assembly system

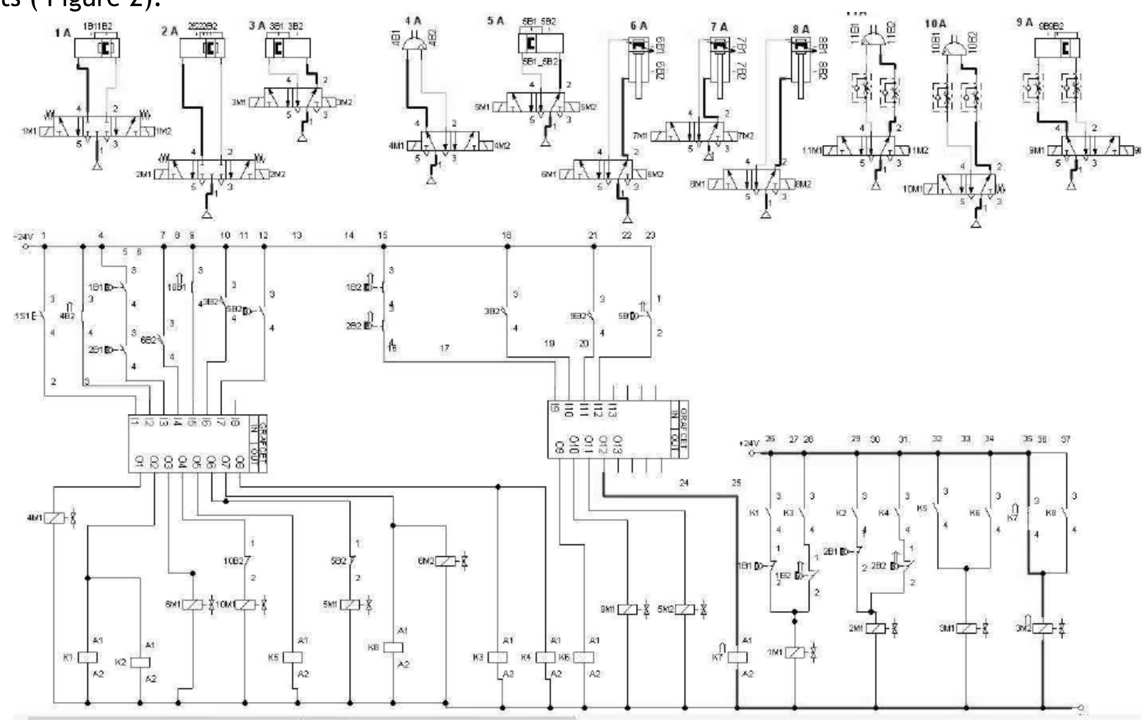

Figure 3. Control circuit and its simulation by FluidSIM

❖ CONTROL SYSTEM SIMULATION

Simulation of manufacturing systems is used by optimization tools. Simulation is used for scheduling of manufacturing operations and production in all industries. Simulation allows you to quickly and easily understand the process and provides an enormous potential for finding reserves in the design process.

As a tool for scheduling processes is advantageous in cases, predictive planning and decision-making is an alternative. Practice requires rapid tools to provide quality results. Software FluidSIM was used as a simulation tool. FluidSIM 4 is comprehensive software for creation, simulation, instruction and study of electropneumatic, electrohydraulic and digital circuits.

The simulator uses a range of symbolic and numerical procedures to solve linear, non-linear and differential-algebraic equation systems. Various integration processes are available to the simulator which are selected and controlled intelligently in relation to the operating time. Creation and simulation control circuit.

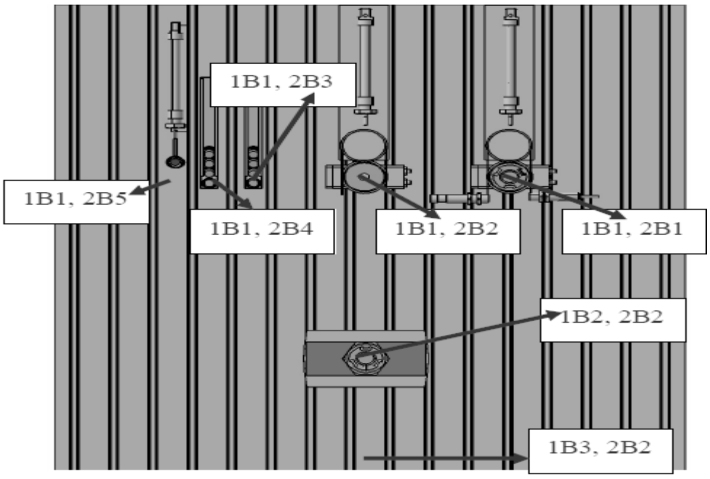

Figure 4. Sensing positions and his indicated signatures

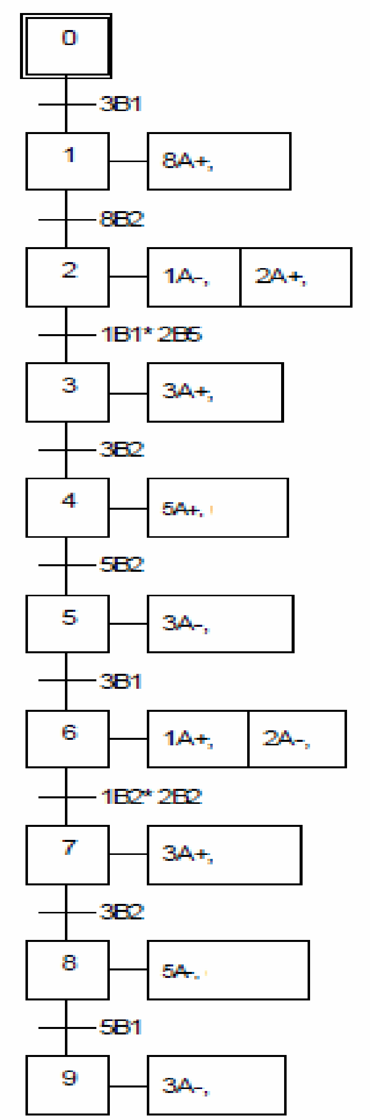

Figure 5. Makrostep Grafcet defined sequence of steps, required signals from sensors and individual actuators movement

Creation of control circuit is relatively simple and consists of:
- ☐ selection of individual components of hierarchical libraries,
- ☐ defining and setting the required values of individual components,
- ☐ logical link between different components

Graphics form control algorithm called Grafcet was used (Figure 5). Application helped to clarify the algorithm that was divided into individual macrosteps. Individual drives were marked as required by the rules for drawing air schemes, namely "A" as the actuator and serial number. The proposed assembly cell consists of actuators which are marked 1A to 11A. Each position of gripping head achieved in the assembly process was marked by a series of signals generated by the achieved to that position. Since this a location is planned, definition of two signals is sufficient. These signals are insured by x-axis and y-axis drives. The x-axis it is two positions at the level of storage, which are solved in one line and the clamping level. These positions are sensing by sensors placed on the x-axis, which is marked 1A. Thus signals are 1B1 and 1B2. Five positions are indicated on y-axis (2A). Thus are indicated 2B1, 2B2, 2B3, 2B4, 2B5 (Figure 4). The last steps are compiling control circuit and its simulation (Figure 3). This simulation is used to verify that the proposed control circuit is still in the design phase.

❖ CONCLUSIONS

Development and implementation of the 3D models for automated systems engineering, which are focuses on the assembly system design is an important part of support systems developing. Assembly system design is using CA tools to streamline the process and possible to realize change or layout of already complicated analysis or possibly even change in management in the design stage, save time and money. The present method combines pre-project, project, and also construction phase formation is accompanied by a selection of choice of individual sub-components, which is created model projected system. The methodology includes a control model and a control circuit simulation.

❖ ACKNOWLEDGEMENT

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