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CA SYSTEMS IMPLEMENTATION IN TO THE DESIGN PROCESS OF ASSEMBLY CELLS

JAVOROVA, A[ngela] & VELISEK, K[arol]

Abstract: *Paper deals about methodology describing designing process of assembly cell with using of CA systems. Methodology solved in the paper is using CA tools, which will take great effect to the whole manufacturing cell design process. The methodology is divided in to the five project phases. Specifically the methodology is using phases such as: assembly product analysis, hardware specification, selection of proper control system, control system simulation and whole process simulation. Inputs needed for single phases are also defined. This way created methodology was used for design process and creation of real assembly cell and assembly product.*
Key words: *assembly cell, manufacturing systems flexibility, designing methods*

1. INTRODUCTION

Modern manufactures and manufacturing systems which are located in the manufacture places and manufacturing halls needs integration of various engineering works and actions. That why such manufacturing philosophy is needed which allows integration of control, organizing, monitoring, innovating and other actions in to the one piece. It is clear, that for such integration all partial element has to be prepared.

2. ASSEMBLY SYSTEMS DESIGN METHODOLOGY

Assembly systems in general consist of big number of building elements, single units or subsystems. All these are connected by number of connecting relations, links and properties. Using of systematic techniques in the design process leads to the its partition to the partial subsystems, units and elements. (Zvolensky et al., 2009) Elements are the smallest building units using for assembly system creation. Assembly systems are created by assembly machines, manipulating devices and by units using for input and output of products to the assembly device. All these subsystems are connected by material, information and functional links.

Design process of assembly processes includes complex activities. Basic principles usually used in the design process are:

- **modular principle** - leads to the reduction of number of elements, mechanisms or devices.
- **systematic principle** - its high degree of abstraction allows various simulating and optimizing principles.

Effective design process in actual conditions is not possible to realize without computer support. (Javorova et al., 2009).

Computer support brings effective help in following fields:

- presentation of designed components or whole assembles,
- compatibility check of single design components or parts,
- display of technical actions,
- kinematic investigation of designed mechanisms,
- calculations supported by finite elements method,
- optimalization of device parameters,
- preparation of manufacturing documentation,
- information basis of the designer.

Evolution and realization of 3D models for automated engineering systems, which are oriented to the design of assembly systems, are a part of supporting IT systems.

Simulation allows rapid and single understanding of process. Simulation has a huge potential in the field of finding reserves in the manufacturing or assembly processes. Praxis need really rapid tools which allows outputs on high quality level.

Today many such tools can be used for such goals. These tools are able to realize complex outputs in fields such as:

- parametric dimension design,
- rigidity calculations,
- manufacturing costs calculation,
- simulation of kinematic joints,
- simulation of control networks,
- processes simulations,
- and so on.

3. ASSEMBLY CELL DESIGN METHODOLOGY

Assembly cell design methodology was designed following to the support of design softwares, which are basic used for design and creation of modular structures as well as simulation of designed solutions. Whole design process was divided in to the several single levels, which are connected one to the other. Normally we are talking about these phases showed in Tab.1:

- assembly product analysis,
- hardware specification,
- control system choice and its simulation,
- process simulation and optimization.

Input	Design process phases	Výstup
Parts, final product	***Assembly product analysis***	*Assembly movements, forces, torques*
Assembly movements, forces, torques	***Hardware specification***	*Choice of actuators, sensors, storage devices, clamping devices, and so on*
Available kinds of energy supply, available actuators, sensors, storage devices, clamping devices d	***Control system choice***	*Control scheme design*
Control system scheme	***Control system simulation***	*Checked part of control system algorithm*
Process model	***Process simulation***	*Optimized process*

Tab. 1. Assembly cell design methodology (Ruzarovsky et al., 2010)

Pneumatic kind of automation was chosen for design and specification of single building components. Because of big components availability and its word wide representation a system tool Festo ProPneu was chosen. ProPneu is and software tooling, which allows to design pneumatic systems. This action is made by generating of single components of designed system following to the input requirements and needed performances. To the ProPneu software functions also belongs the possibility of dynamic system behavior simulation. Following to the dynamic behavior of the system, is software able to optimize the parameters of every single building component. This tooling is able to design a pneumatic system by choice of single building parts following to the limited information about designed pneumatic device. ProPneu is a very strong tooling, which helps by choice, calculation and following optimalization of pneumatic systems. Is allows to specified all components in steps. Each component is taken from database which contains all needed information and technical specification about the component. All selection process is realized in following steps:

- definition of basic system parameters
- choice of supporting parameters and pneumatic scheme function simulation
- projection data display
- bill of material of designed pneumatic scheme

Supporting part of whole designed assembly cell is and three axis of Cartesian structure showed at the Fig. 1. Movements in single axes are generated by linear pneumatic actuators, which guides have needed precision. Axis precision is needed because of assembly process needs. Whole design is based on the modular structure, which is created by actuators choiced by mentioned software tooling. (Horvath et al., 2009) Model of whole designed assembly cell is showed at the Fig. 2. This was designed system allows:

- virtual objectification of all needs defined to the system,
- disposal placement solution of all subsystems,
- material flow simplification,
- possible collisions remove.

By using of such models, there is also possible to solve or delete all possible design issues in the phase of model creation. Such solution saves lot of finances, because issues solving is made without prototypes changes. (Matusova & Hruskova, 2008)

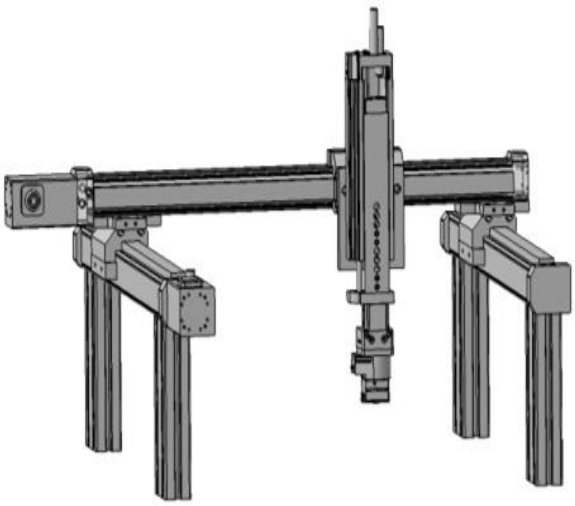

Fig. 1. Supporting pneumatic structure

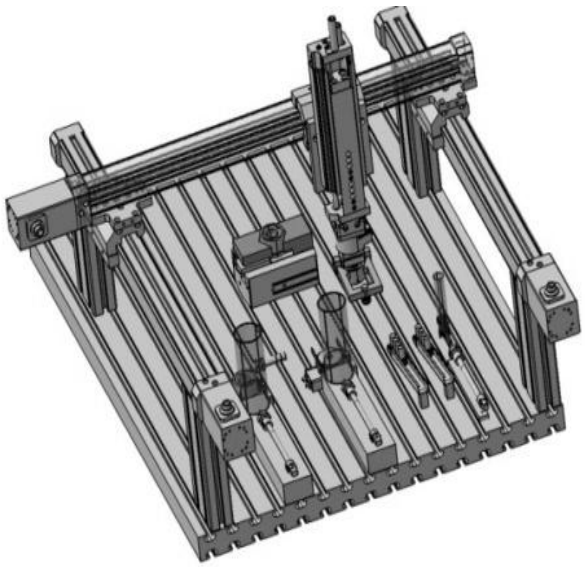

Fig. 2. Assembly cell design model

4. CONCLUSION

Presented methodology step by step analyzes single design levels, which realization is needed for complex solution of assembly cell. Single steps are by design process using well known analytical and design methods, which are modified following to the using CA tooling and systems. Presented methodology includes phases which can be done before as well as during the design process. Methodology is also filled up by sub actions which are used for selection of single building components. Methodology includes also model of control system.

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