

The laboratory of the flexible manufacturing systems with robotized operation for environment of drawing-free production

The changes realized in an assembly workspace of an iCIM 3000 system

[Radovan Holubek, Nina Vetríková, Michala Šimúnová, Karol Velišek]

Abstract— This contribution focuses on the laboratory of flexible manufacturing systems with robotized operation for environment of drawing-free production, which is located at the Institute of production technologies. The practical education of drawing-free documentation using the software Catia and Autocad is special focused on the mentioned laboratories. Students create 3D models of parts and whole machine units according the required tasks using the programs of modeling/design and then it is subsequently generated to 2D drawing and NC program. It is possible to realize the production of specified machine parts, units and also their subsequent assembly on the final workplace with using the CNC machines. All of these laboratory facilities are intended not only to help the educational process and motivate students but also to use them in the bachelor and diploma thesis which are supposed to allow students to virtually create the new conceptual designs realized in the each manufacturing and assembly workplace/station of the system. Conceptual designs are realized on the base of the new base parts suggestions produced in the laboratories.

Keywords—component, system, iCIM, desk set, assembly, turning machine, milling machine, assembly workplace

I. Introduction

The situation in the economy, development of engineering, electrotechnical, automotive industry require to educate professionals from the students also in the field of construction and work with CAD systems. Nowadays, everyone should try to increase the efficiency, integration and diversification of the educational process with the key orientations to the needs and requirements of the practice. As part of the integration of more objects, we are moving through the creation of drawingless documentation which is considered as an incoming reality of the present modern engineering industry. The drawings have begun to emerge in the electronic form by the incoming of the information technologies and it has been necessary to change the administration and the control of the drawing documentation.

Radovan Holubek, Nina Vetríkova, Michala Šimúnova, Karol Velišek

Slovak University of Technology
Slovak republic

I dare say that nowadays the meaning of the drawing is degraded only to the holder of the information and it is defined not only for highly specialized departments, where another obligatory regulation specifies the administration of the documentation. Several reports conversion of drawings can be seen in many industrial enterprises that already don't have their own archive collecting the drawings but they already have in most cases a sophisticated data management in an electronic form for the transmission of information about the shape, sizes, dimensions and production parameters. From the above it follows that the drawing is only the production information holder, which is in the most cases already managed/controlled only in its electronic form. [1, 4]. In the present, our faculty is equipped by the laboratory of flexible manufacturing systems with robotized operation for environment of drawing-free production, where students have the opportunity within the practical exercises to realize the production of the designed parts and machine units according to the specified tasks. By the implementation of teaching and practical exercises in the laboratory we increase the competitiveness of our graduates in the current labor market in Slovakia and also in the context of globalization in the pan-European labor market.

II. The characteristic of the manufacturing - assembly system iCIM 3000

A flexible manufacturing system shown in Figure 1, which is located in the mentioned laboratory is used as a modular, open, flexible, manufacturing and assembly system.



Figure 1. Flexible manufacturing system

The central part of the system is a pallet conveyor system (which works as a connection between the individual workstations of the system).

This system consists of the five workplaces such as:

- milling workplace,
- turning workplace,
- automatic storage workplace,
- control workplace,
- assembly workplace.

A. The automatic storage workplace

The automatic storage workplace is the main storage for all material used in the iCIM production, raw and semifinished parts as well as the end products. All workpieces are stored on the standard pallets, equipped with the fixtures for each specific workpiece. This storage workplace shown in Figure 2 also provides the intelligent evidence of the production by the superior control system.



Figure 2. Automatic storage workplace

B. The workplace of turning and milling

The production is provided by two CNC machines shown in Figure 3 and Figure 4 (concept turn and concept mill) on the base of the production procedures, which are automatic sent to the production devices from the superior control system. The manipulation with the raw, semifinished parts and end products of the whole system is provided by a few angular industrial robots [2].



Figure 3. Concept turn Emcoturn 105



Figure 4. Concept mill Emcomill 105

C. Assembly workplace with the camera control

One of the most important elements/parts of the system is robotized assembly workplace shown in Figure 5, which provides the final mounting. The part of this workplace is an intelligent camera system, which races about the right assembly procedures. [3]



Figure 5. Assembly workplace with the camera control

D. Desk set to be initially produced by system iCIM 3000

The produced desk set shown in Figure 6a,b., which is produced and mounted in this system consists of five parts such as: baseplate, penholder, pen, thermometer – device used for temperature measurement, hygrometer – device used for humidity measurement.



Figure 6a. The desk set mounted in the iCIM system

After the production of the required penholder and base plate - produced in milling and turning workplace, the parts of the desk set are transported by the pallets to the workplace for the final assembly. Directly in the workplace for the final assembly, there are other parts of the mounted desk set - pens, hygrometers and thermometers. After inserting the pen holder to the baseplate, thermometer and hygrometer are further inserted to the hole. Assembled final desk set is subsequently transported via conveyor to the storage system [8].

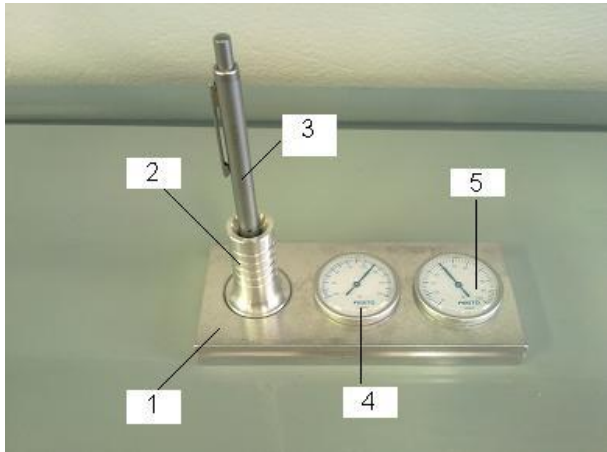


Figure 6b. Desk set to be initially produced in the system iCIM

III. The proposal of the changes realized in the assembly workplace of the flexible manufacturing system

Currently, there are some diploma and bachelor thesis realized in this iCIM system, where the new base parts are proposed, designed and also modeled in Catia software. The proposed base part is made in turning and milling workplace. The other workplaces of the system has to be adapted to the new base part (assembled desk sets).

The main role of our students during the exercises is to propose the implementation of changes in the individual workplaces based on a new base part. As an example there is one of the proposals for the change realization of the assembly workplace based on the proposed new base part in the paper [6, 7, 8].

New proposal of the mounted desk set consists of:

- metal support plate,
- baseplate: metal – black color, plastic - white color,
- penholder: plastic – black color, red color, metal – silver color,
- cylinders: plastic – black color, red color.

In the flexible manufacturing-assembly system iCIM, the product can be produced in different six variations depending on the customer's order as is shown in Figure 7.



Figure 7. Different variants of the mounted desk set

It is possible to produce plastic penholder as well as metal in turning workplace, baseplates are produced in milling workplace. For the right mounting of the desk set in the assembly workplace, it is necessary to preprogram the flexible system according specified requirements.

In the operating area of the assembly workplace it has been necessary to propose slip buffers within the realization of the new mounted desk set. In this buffers shown in Figure 8. There are two different mounted cylinders located.

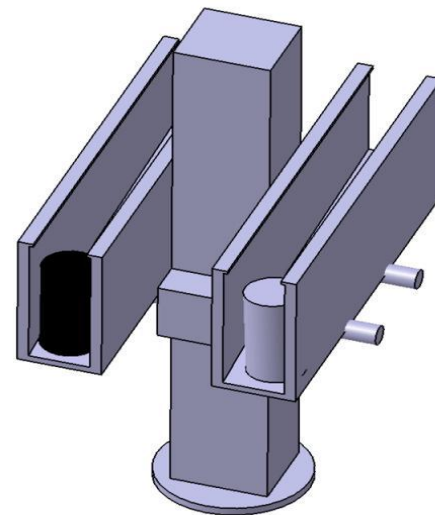


Figure 8. New slip buffers proposed within the new realization

Within the new mounted desk set realization it is necessary to differentiate the material: plastic or metal components and

also their colors. This is the reason why the operating area should be extended about the next sensory equipment.

On the base of requirements, the assembly workspace has been extended about the innovative sensor of colors, which is shown in Figure 9.



Figure 9. Proposed sensor of the colors

This sensor is able to distinguish four colors in high resolution, it can shoot length to 35mm, it will provide scan the color of penholders. Another sensor that is already in the workplace is an optical sensor SOEG-L-Q30-P-A-S-2L.

This sensor is used for the identification of the baseplates. The sensor identifies the presence of a base plate in the operating area of the assembly workplace [3, 4].

In order to identify the metal and plastic base plate it is necessary to supplement the operating area by inductive sensor ISPD 112 S 01 shown in Figure 10.



Figure 10. Proposed inductive sensor

The assembly workspace of the mentioned system is ultimately supplemented by two new sensors such as the inductive sensor and sensor of color. Sliding buffers are higher than the original ones because the proposed cylinders, which are controlled by industrial camera [7].

Detail of the operating area with all the proposed sensors can be seen in Figure 11 and Figure 12, where it is the complete assembly workplace with implemented changes.

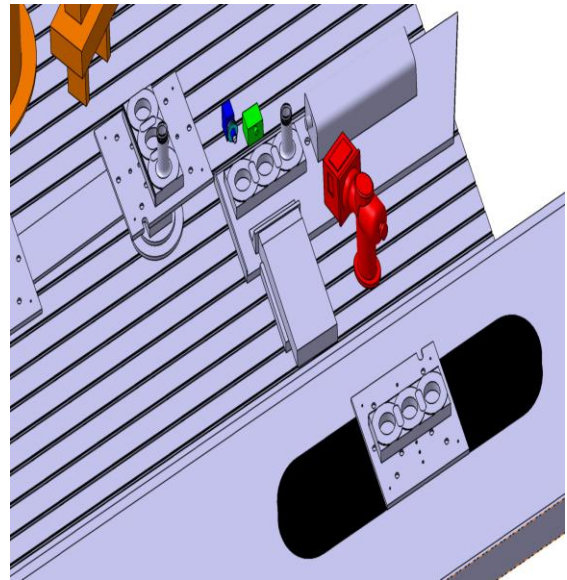


Figure 11. Detail of the assembly workspace with the proposed sensors

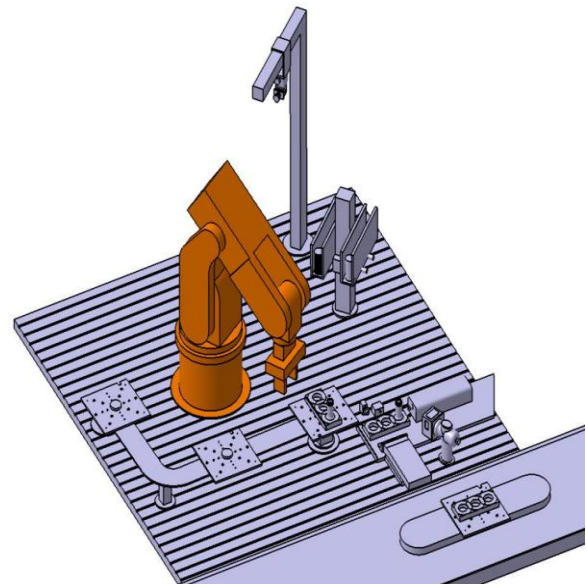


Figure 12. Complete assembly workplace with the proposed changes which have been realized

CONCLUSION

The development of the information technology has brought a phenomenon of the constructing in a virtual 3D environment to the area of mechanical engineering and this allows engineers to immediately obtain a much greater insight and detail level of the construction than is possible in 2D environments. The establishment and extension of that laboratory therefore respond to the ever increasing demands of the European labor market and rapidly growing engineering industry in Slovakia, which put the employers for graduates of technical universities. We expect increased interest in our students due to the increase of their value in the labor market. We try to adapt our education to the needs of future employers of our graduates. Work in this laboratory has a big influence on students and they greatly increase their practical skills such as:

- ability of the individual solutions of tasks occurring in practice,
- crisis management,
- communication,
- working with the different 3D modeling software,
- Understanding of the methodology of creative technical work.

Acknowledgment

This work was supported by KEGA 027STU-4/2014: Establishment virtual laboratory of robotics and manipulation techniques.

References

- [1] Danišová, N., Ružarovský, R., - Velišek, K.: Design of Camera System Location at the Station for Loading and Orientation. - CECOL 2012: III Central European Conference on Logistics. Trnava, SR, 28. - 30. 11. 2012. - Trnava : AlumniPress, 2012. - ISBN 978-80-8096-179-4. - [8]. - registered: Scopus.In: Applied Mechanics and Materials. - ISSN 1660-9336(PRINT). - ISSN 1662-7482(ONLINE). - Vol. 309 : 3rd Central European Conference on Logistics (CECOL 2012), November 28 -30, 2012, Trnava, Slovak Republic (2013). - ISBN 978-3-03785-636-9, s. 27-34
- [2] Kusiak, A., Salustri.: Computational Intelligence in Product Design Engineering, IEEE Transactions on Systems, Part C, Vol 37, NO5,2007. pp766-778 [online].[cit. 2013- 09-09]
- [3] Vetríková, Nina - Šimúnová, Michala. Algorithms and evolution diagrams application for determining the new assembly process sequences. In *Applied Mechanics and Materials*. Vol. 693 (2014), s. 16-21. ISSN 1660-9336.
- [4] T. Yamaguchi, S. Nakamura, R. Saegusa, and S. Hashimoto, "Image-based crack detection for real concrete surfaces," *IEEJ Transactions on Electrical and Electronic Engineering*, vol. 3, no.1, pp. 128–135, 2008.
- [5] Srivastava,S. Boyat, S. and Sadistap, S. „A Robust Machine Vision Algorithm Development for Quality Parameters Extraction of Circular Biscuits and Cookies Digital Images“ *Journal of Food Processing*, Volume 2014 (2014), Article ID 376360, 13 pages
- [6] Jiannan, CH. Lei L. Jiwei I. Zhaoxuan J, and Guosheng Z. „, Machine Vision-Based Automatic Detection Method Of Indicating Values of a Pointer Gauge“, *Mathematical Problems in Engineering*,
- [7] Mukesh Kumar Saini, Pradeep K. Atrey, and Abdulmotaleb El Saddik „From Smart Camera to SmartHub: Embracing Cloud for Video Surveillance“ Hindawi Publishing Corporation,International Journal of Distributed Sensor Networks ,Volume 2014, Article ID 757845, 10 pages.
- [8] Danišová, Nina. Digital image processing in the camera system of assembly systems ICIM. In *Applied Mechanics and Materials*. s. 173-178. ISSN 1660-9336. registered: WOS ; SCOPUS.
- [9] Sun Feng-Jie, Antian-Jiang, Fan Jie-Qing, Yang Chun-Ping, Xu Zheng. Study on the Recognition of Pointer Poistion of Electric Power Transformer Temperature Meter [J]. *Proceedings of CSEE*, 2007, 27(7): 470-475.