20th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2016, Mediterranean Sea Cruising, 24th September - 1st October, 2016

PERFORMANCE LAYER OF VIRTUAL AUTONOMOUS WORK SYSTEMS

Elvis Hozdić
University of Ljubljana,
Faculty of Mechanical Engineering
Slovenia

Zoran Jurković
University of Rijeka,
Faculty of Engineering
Croatia

ABSTRACT
Autonomous socio-cyber-physical work systems (ASCPWS) are a continuation of the development of production systems capable to respond to the increasingly complex demands of today's market. Such systems are a product of cybernetics autonomous operating system. The introduction of contemporary information and communication technologies (ICT) in the field of production enabled the timely and effective monitoring, control and management of production systems. Such systems enable functional layer developed in the virtual autonomous work system (VAWS). Performance layer of VAWS allows evaluation of the success ASCPWS and possible corrections to improve functionality ASCPWS, and prediction of the future state of the production system.
Keywords: Autonomous socio-cyber-physical work system, performance indicators, RapidMiner

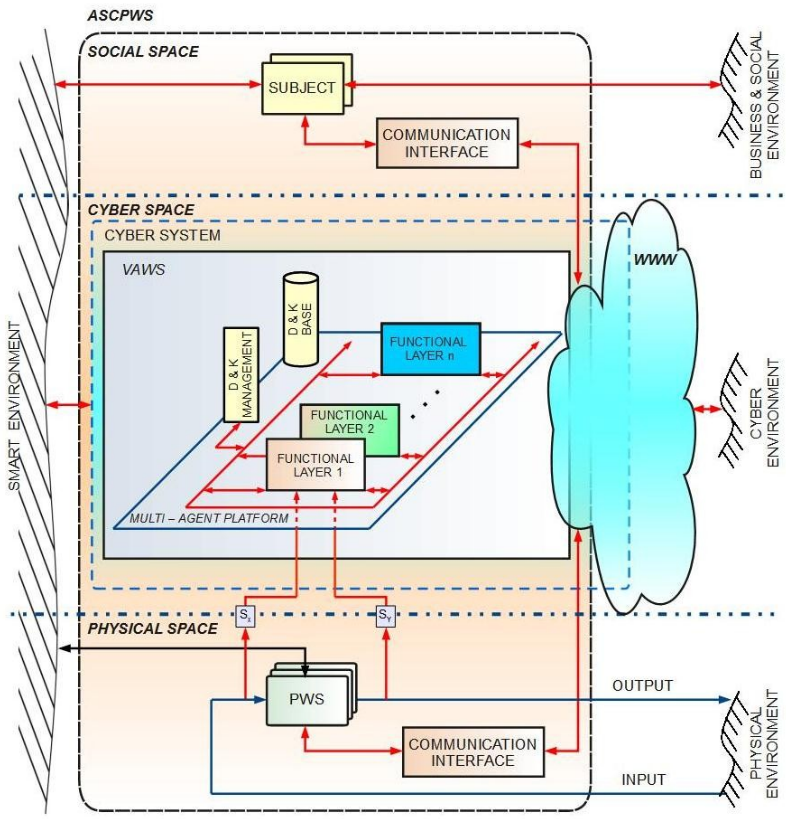
1. INTRODUCTION
The complex requirements of the market, global competition, more demanding customers, and rapid development of ICT has led to the structuring of new advanced production system in the form of ASCPWS [1][2][3]. Advanced manufacturing systems enable the raising of production capacity and the rapid growth of income [4].
The main problem of contemporary production, as from a wide variety of inputs determine steady, determined input in turbulent environment and the nature of internal and external sources of interference (machine failures, delays in supply, undisciplined payment, etc.). It is necessary to master demanding working structure that is structured in order to adequately respond to the demands of the global market [5].
The answers to the increasingly demanding market manufacturing companies seeking to develop new structures, methods and tools with which to better, better and more effectively manage advanced manufacturing systems in a dynamic environment [6],[7]. The companies that are using modern tools and management techniques can achieve and maintain the required quality of their business and gain a competitive edge in managing business relationships affected by rapid technological change, with complex interrelations between different economic sectors and market factors [8].
In order to effectively and successfully managing and operating ASCPWS developed the virtual autonomous work system with associated functional layer.
In this paper, it is shown a powered functional layer VAWS supported by a software tool *RapidMiner*.

2. AUTONOMOUS SOCIO-CYBER-PHYSICAL WORK SYSTEMS
Development ASCPS represents the continued evolution of the organizational structure of production of complex and adaptive distributed production system [9]. The starting point for structuring

ASCPWS arising from autonomous work system (AWS) [4]. AWS is a system with a relatively simple structure with autonomous behaviour and is able to perform the assigned functions and at the same time able to act autonomously in the network.

The basic functionality ASCPWS the transformation of inputs into output. Elements ASCPWS the physical elements (machinery, tools, measuring instruments, etc.), a cybernetic functionality of AWS and the subject. These elements allow functional competence ASCPWS required to perform the process.

ASCPWS, shown in Figure 1, is build by three basic building blocks, namely: social element that integrates the subject, cyber element which represents VAWS as a virtual element AWS and physical element which includes physical work systems (PWS).



Legend:

ASCPWS	–	Autonomous Socio-Cyber-Physical Work System
D&K BASE	–	Data & knowledge base
D&K MANAGEMENT	–	Data & knowledge management
PWS	–	Physical Work System
S_X, S_Y	–	Sensors
WWW	–	Internet
→	–	Material flow
→	–	Information flow

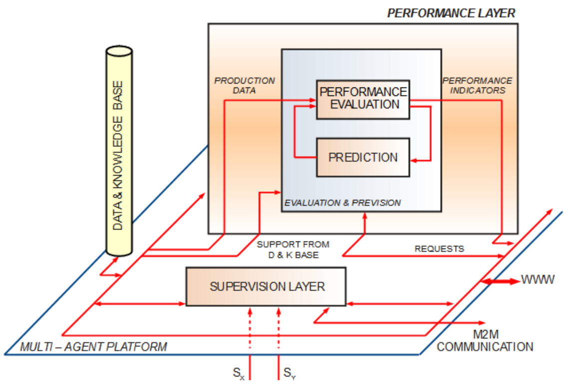
Figure 1. Autonomous socio-cyber-physical work system [2]

VAWS is the cyber component ASCPWS integrated cyber system. VAWS is a system that allows the establishment of a multi-agent platform for the flow of information between the social system and the system in which they existing PWS, and other elements contained in the cyber system. The crucial task is VAWS cybernetics production ASCPWS functionality, integrated in the multi-agent platform, which allows an adequate flow of information, to manage ASCPWS in real time. Cybernetics AWS possible that some elements of its functionality, as defined in [4], transferred into the virtual world.

For each individual functionality ASCPWS assigned to the functional layer. Structure VAWS consists of several layers that communicate with each other and allow production functionality ASCPWS.
This paper introduces a performance layer of autonomous socio-cyber-physical work systems.

3. PERFORMANCE LAYER OF AUTONOMOUS SOCIO-CYBER-PHYSICAL WORK SYSTEMS

Performances of a layer is a layer VAWS that allows the evaluation of the performance ASCPWS and possible corrections to improve functionality ASCPWS, Figure 2.
Evaluation of the effectiveness ASCPWS is based on the calculation of key performance indicators, through which it is possible to assess the performance of action ASCPWS from different perspectives observation. The objective of this evaluation is to inform decision-makers about the current state of the system and thereby enable successful functioning. In the process of evaluating the performance of the system functionality layer of performance benefits to the inputs of the current production data, such as the duration of the operation, operating, processing, production quantity, quality and so on.
Based on these data, calculates the specific indicator of success, such as productivity, efficiency, cycle, system availability, level of quality, capability index machines, process capability index, etc.



Legend:

S_X, S_Y	–	Sensors
WWW	–	Internet
→	–	Information flow

Figure 2. Performance layer of virtual autonomous work system

Knowing such indicators entity and a functional layer of control have better information about the state of the system, and in decision-making and the execution process.
Element forecasting functionality in the structure layer of performance provides insight into the future performance of the system, the predictions of his condition. Based on these forecasts, which are based on the assessment of deviation or degradation of the system under normal operating conditions, it is possible to predict the future state of the system. The existence of corrective loops in functionality layer of performance enables correction process of certain parameters with a view to improving the state of the system initiated by the operator. Data correction process is saved in a database. Performance layer is able to retrieve current data directly from the supervision layer and thereby provide insight into system status in real time.

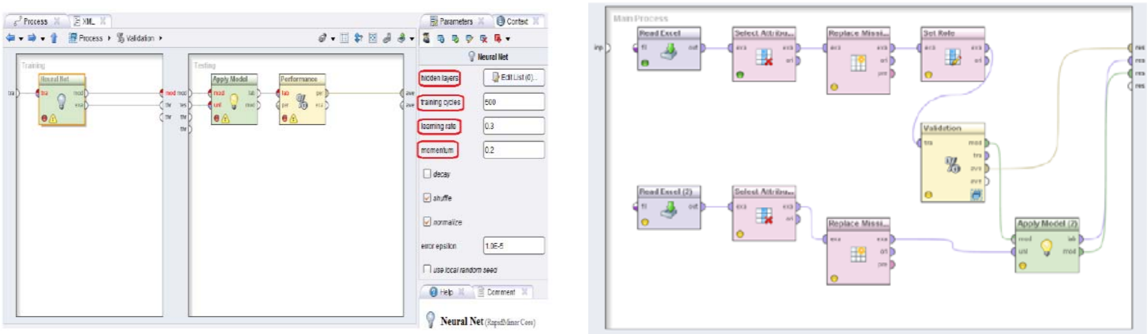
3.1. Software support to performance layer

Software-powered layer VAWS provide various software tools for data mining, such as *WEKA*, *KNIME, RapidMiner etc.*
WEKA is one of the most used free software tools for machine learning and data mining, and a reference for most other tools. *WEKA* contains tools for regression, classification, clustering, association rules, visualization and pre-processing of data.
Programming tool *KNIME* for presentation of graphs is used files, where each file is determined by the appropriate operator. Within each file is a special *XML* file with information on operators such as parameters and results stored in binary files.

RapidMiner is an advanced analytical tools for data mining, machine learning and predictive analysis. It offers support for text mining, Internet, images and data open connections, and visualize the results of data mining. *RapidMiner* is particularly interesting for the support of the developed-powered layer in terms of prediction. This software tool is capable of independently training and trained neural network which enables the prediction of the production system.

Neural networks (NN), such methods of artificial intelligence, in today's business are increasingly used in the context of the system for decision-making. The most common are realized in the form of a computer program that can identify patterns in the data and create models for these data. Since the program train and train network, if the user is not satisfied with the result, by adjusting the number of hidden layers, cycle training, the rate of learning and teaching moments. Depending on the difference between the results of the program and the desired result, the user adjusts the specified items until you get the desired result, that is, until the network is trained and to train, Figure 3a.

Creating the prediction in the programming tool *RapidMiner* is shown in Figure 3b.



a) *b)*

Figure 3. a) Coaching and training of the neural network
b) Creating the prediction in the programming tool RapidMiner

4. CONLUSIONS

In this paper, the concept of performing layer VAS is shown, and its role in the ASCPWS. It shows the software support with a focus on programming tool *RapidMiner*. Future work must be focused in the direction of the case studies to the specific example that shows functionality of developed preformatting layer simulating the program tool *RapidMiner.*

5. REFERENCES

[1] E. Hozdić, S. Žapčević, and P. Butala, “Kibernetsko-fizičke strukture za nove autonomne radne sisteme,” in 10th International Scientific Conference on Production Engineering Development And Modernization Of Production, RIM 2015, 2015.

[2] E. Hozdić, R. Vrabič, and P. Butala, “Conceptualization of socio-cyber-physical production systems (unpublished manuscript),” in Research work: Model of cyber-physical production system, 2016.

[3] E. Hozdić, “Manufacturing For Industry 4.0,” in 19th International Research/Expert Conference ”Trends in the Development of Machinery and Associated Technology” TMT 2015, 2015.

[4] P. Butala and A. Sluga, “Autonomous work systems in manufacturing networks,” CIRP Ann. - Manuf. Technol., vol. 55, no. 1, pp. 521–524, Jan. 2006.

[5] B. Rihtaršič, D. Husejnagić, P. Butala, and A. Sluga, “Informacijsko podprta inovativna proizvodnja,” in Industrijski forum IRT 2010, 2010, pp. 123–128.

[6] B. Rihtaršič, P. Butala, J. Jenkole, J. Ovsec, D. Husejnagić, and A. Sluga, “Nove proizvodne delovne strukture - prehod v novo proizvodno paradigmo,” in Zbornik referatov , dan raziskav Koper: CIMOS avtomobilska industrija d.d., 2005, pp. 83–86.

[7] O. Sauer, “Production monitoring linked to object identification and tracking - a step towards real time manufacturing in automotive plants,” in Proceedings of the 3rd CIRP Sponsored Conference, Setubal, Portugal, Digital enterprise technology, 2006.

[8] E. Katsanos and A. Bitos, “Methods of Industrial Production Management: A Critical Rewiew,” in Proceedings of the 1st International Conference on Manufacturing Engineering, Quality and Production Systems (MEWAPS 2009), 2009.

[9] J. Peklenik, “Complexity in Manufacturing Systems,” CIRP J. Manuf. Syst., vol. 24, pp. 17 –25, 1995.