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ScienceDirect

Procedia Manufacturing 23 (2018) 261–266

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

8th Conference on Learning Factories 2018 - Advanced Engineering Education & Training for Manufacturing Innovation

Integration of digital learning in industry 4.0

Nina Tvenge[a], Kristian Martinsen[a]*

[a]NTNU Department of Manufacturing and Cicil Eningeering, Teknologivn 21, 2815 Gjøvik, Norway

Abstract

The emerging advances in sensor systems, automation and Information and Communication Technology (ICT) for manufacturing opens new possibilities for lifelong learning utilizing data from production. The data can be source for on-the-job practical learning as well as serve as cases for more formal learning situations. This paper proposes a model for company's implementation of learning, and discusses how this implies a closer integration with the learning activities to the cyber-physical manufacturing system as a seamless, integrated ICT learning and a hybrid human/machine intelligence model where data analysis, simulations and communication are sources for not only decision support, but also continuous learning and knowledge enhancement.

Peer-review under responsibility of the scientific committee of the 8th Conference on Learning Factories 2018 - Advanced Engineering Education & Training for Manufacturing Innovation.

Keywords: Industry 4.0; Learing factories, social learing

1. Introduction

Future manufacturing systems are becoming intelligent, constantly learning and improving, with high adaptability to changing environments, increasing resource efficiency, and smart integrations of humans and technology. The emerging technological advances in sensor systems, automation and ICT for manufacturing plays a major role in this evolution. Some call this trend as the fourth industrial revolution, and "Industry 4.0" is a buzzword frequently used to describe this. The basis are technologies such as; Flexible Automation, Wireless Sensor Systems, Cyber-Physical Systems, Artificial Intelligence, (Big) Data Analysis and Internet of Things. Cyber Physical Manufacturing Systems (CPMS) will be a combination of computational elements, physical elements, software and humans. This trend implies

* Corresponding author. Tel.: 47 99521849.
E-mail address: kristian.martinsen@ntnu.no

2351-9789
Peer-review under responsibility of the scientific committee of the 8th Conference on Learning Factories 2018 - Advanced Engineering Education & Training for Manufacturing Innovation.
10.1016/j.promfg.2018.04.027

changes in manufacturing workplaces towards less manual work and more "brain"-work. Future manufacturing workers need ability to analyse, abstract and innovate and the knowledge levels in general are rising.

1.1. A need for novel workplace learning paradigms in Industry 4.0

The increasing need for a competent workforce leads to an acceleration of the need for lifelong learning. On the other hand, are traditional social/practice based learning paradigms challenged by the current trends. The increasing digitalisation will change how we communicate and how we learn *[1]*. In traditional social learning systems in manufacturing, the individuals are working and learning together in teams or Apprentice-Systems. Lave and Wenger [2] described this as Communities of Practice (COP) which provides *"a sense of belonging, commitment, and shared identity*" [2]-[6] and a method for employees to learn from each other. In Industry 4.0, this way of learning seems to be challenged due to more specialized work and fewer employees doing the same type of work. Fewer people and more physical distance between each person results in new work organizations. This implies the need for novel learning systems i.e. in the form of supervision, guidance and collaborative learning; synchronous and/or asynchronous, mediated through ICT tools. ICT tools make it possible to develop new learning methodologies, throughout the spectrum from lifelong learning to campus students. The use of modern ICT opens new potentials for on-the-job, individual workplace learning, from more or less primitive e-learning schemes to advanced serious games [7].

1.2. ICT supported workplace learning

ICT has a natural place in Industry 4.0 education and knowledge creation, and there are versatile expectations to the effects on ICT supported lifelong learning [8] ;

- increased learning as an effect of access to more data and knowledge
- more efficient learning
- learner focused learning activities
- new learning environments with higher degree of collaboration/cooperation
- more opportunities for critical thinking and analytical approaches

Current implementations of ICT aided learning paradigms have, however not always been satisfactory for the involved participants [9]. One reason might be the gap between the formal ICT-supported learning and the practice based learning at the workplace. Formal learning plays currently only a minor part in workplace learning, a norm is that about 80% of workplace learning is informal [10]. Research shows that ICT supported learning will not make the teacher obsolete. ICT can boost more effective and efficient learning processes, but not without support. Learning activities as social interactions guided by a teacher, has had the greatest impact on learning outcome, significantly bigger than other methods [11].

More and more authors point to the fact that ICT-based learning has gone from being closed off and centred around the individuals to being social and where sharing is essential: The learner's needs are at the centre, not the technology itself [12]. There is, however, still a need for social and practical training and technology is not a substitute for this, but a range of different tools that can enhance learning and increase students' learning space [13]. The ability to collaborate is highly acknowledged and wanted by employers, therefore teamwork and communication must be facilitated in forthcoming work place learning paradigms. A growing number of social networks and other web 2.0 and web 3.0 services can be used for flexible and informal learning and provide access to experts and peers. This is also called semantic web and make it possible to share infinite amounts of multi-medial learning resources in future Industry 4.0 learning. Workers can set up their personal learning environments (PLEs) according to their interests, learning styles and ambitions. This is both an opportunity and a challenge for the individual learner. Large enterprises have the power to develop internal personal learning environments; SME's have to utilize more or less ready-made solutions [14]. Open educational resources (OER) are freely accessible documents and media resources for teaching, learning, education, assessment and research purposes.