DiFac: Digital Factory for Human-Oriented Production System

DiFac consortium[1]
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Abstract

This document supports the poster presentation of the DiFac consortium on Presence in the digital factory.

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DiFac (Digital Factory for Human-Oriented Production System) is an IST research project (FP6-2005-IST-5-035079) running from May 2006 – May 2009, funded by the European Commission within the 6th Framework Programme priority called "Collaborative Working Environments". The aim of the project is to develop an innovative, collaborative manufacturing environment (CME) for the next generation of digital factories to support the competitiveness of Small to Medium Enterprises (SMEs).

Within a digital factory, virtualised environments facilitate the sharing of factory resources, manufacturing information and knowledge, and help the simulation of collaborative design, planning, production, management and training among different participants and departments. DiFac will create a basic framework to support group work in an immersive and interactive way for these manufacturing activities, based on three main theoretical pillars: presence, collaboration and ergonomics. These were identified through liaison with the industrial partners of the consortium as key to the successful implementation of the digital factory approach within SMEs. The DiFac framework will be composed of both tools and methodologies which will support product development, factory layout and analysis, and training of workers, and will consider the pillar components throughout each phase of development. That is, the DiFac systems will provide solutions for factory tasks, the requirements for which are dictated by the industrial partners of the project and which will be developed and validated with respect to presence, collaboration and ergonomics.

Summary of the definition of sense of Presence is the sensation of "being there" without physically being in a precise physical place. In a VE the sensation of being inside the environment depends of different factors, which have been analyzed for different environments. The innovation of the project is the use of a psychological theory called "Flow" by Csikszentmihalyi (1996). Flow is a subjective state that people report when they are completely involved in something to the point of forgetting time, fatigue, and everything else but the activity itself.

The idea is to write a new concept of questionnaire merging questions from the Witmer & Singer Presence Questionnaire and the Flow Questionnaire applying to the Virtual Reality a methodology already consolidated for detecting experience in real world. This new methodology has just started its validation methodology. In next months a Questionnaire composed by 135 items will be validated with 500 subjects making different duties and experiences from practical ones (as reading) to virtual as navigating in an immersive videogame. The validation will continue with other two steps measuring also objective data as skin conductance, heart rate and the heart rate variability by the "bt2 exmovere watch". At the end we'll have a comprehensive questionnaire for rating the sense of Presence in VE.

DiFac will focus its efforts on the establishment of an innovative solution for collaborative product development using high-end synchronous collaboration methods and VR techniques (Chryssolouris *et al.* 2007, Pappas *et al.* 2006) aimed at the sensible reduction of a product's time-to-market, as well as production cost. The collaboration framework will provide among others users and role management, data security, user friendly environment, file sharing/browser, file/project

versioning, download synchronisation, public/private chat rooms for on-line communication among users and personal inbox/outbox for off-line communication.

The DiFac methodology for collaborative measurement is based on the Flow enhancing Hoffman and Novak's (1996) model in computer-mediated environments with new constructs, reflecting the collaborative aspects and their impact on experience of flow.

Taking proper account of people's needs and capabilities in design, implementation and operation is the province of Ergonomics. As a discipline it is concerned with the theory and practice of learning about human characteristics and capabilities, then using that understanding to improve people's interaction with the hardware, software and people with which they interact, and with the environments in which they do so (Lawson et al. 2006).

In DiFac, there is a distinction between the ergonomics of the various DiFac software tools and virtual reality/augmented reality (VR/AR) technologies, and the ergonomics of the factories, products and training, for which DiFac aims to improve the productivity and safety of people at work. That is, DiFac systems are being developed with a user-centered approach to ensure that end-users can achieve their goals effectively and efficiently, while remaining safe and healthy. Poor ergonomics (for example failure to account for the users' end needs; making systems excessively complicated; providing interfaces which do not support the user) has been cited as the reason for failure in many Information and Communications Technology (ICT) projects (Beynon-Davies 1999; UK National Audit Office 1999 and UK Public Accounts Committee 2000). In these cases, the abilities and needs of the people working within the systems or the equipment have not been understood and accounted for. Conversely, successful products or work systems typically demonstrate that the needs of their users have been addressed during conception, design, implementation and operation (Eason 1997 and Wastell and Cooper 1996).

Regarding factory design, product design and training, the DiFac technologies will provide the opportunity for a proactive approach to ergonomics - identifying and resolving ergonomics issues at an early stage in the design process, when changes are less costly to implement, rather than responding to complaints of ill-health in the workplace. This will be achieved by modeling the performance capabilities and behavior of employees to analyze digital representations of workplaces and factory procedures, thus reducing the risks of injury and improving employee safety and productivity (Chaffin 2001; Laughery 2005 and Lawson et al. 2006).

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