Preface to the Special Issue: Cybernetic Manufacturing Systems Project—Ergonomics Solutions for Flexible Production Systems
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This special issue includes articles on research performed during the Cybernetic Manufacturing Systems (CyberManS) project, which was funded in part under the European Commission’s Sixth Framework Programme for Research and Technological Development. The project was in response to a joint call under Information Society Technologies (IST) and Nanotechnologies and nanoscience, knowledge-based Multifunctional materials and new Production processes and devices (NMP). The joint call between IST and NMP was in recognition of the need for integrating technologies for a fast and flexible manufacturing industry.

The manufacturing industry has changed considerably over the last 100 years, from Tayloristic rigid, fast, repetitive manufacturing through the Toyota Lean engineering approach to mass customization. Never has the importance of flexible production processes been so obvious than in today’s manufacturing climate. For example, it is now a common requirement for production systems to accommodate several platforms of vehicles on one production line. In European and other developed economics, innovation has focused on the development of higher value-added products, resulting in low-volume, high-variety product mixes on production lines. These production areas need to be able to configure, reconfigure, and adapt quickly to new and changing products. Flexible manufacturing is highly dependent on the skill repertoire of humans and their ability to learn new skills fast. In addition, humans also excel in fast, intelligent decision making, a particular weakness of computers. So, despite the advances in robotic automation during the last 30 years, the human component in manufacturing processes remains of paramount importance. Optimization of work processes involving humans, however, dictates a need for optimization of the human factor (ergonomics science).

This special issue presents seven research articles addressing different facets of the challenge in optimizing the human factor in modern manufacturing. The article by Gazzoni discusses the benefits and limitations of using array electrodes with multichannel surface electromyography (EMG) in industrial ergonomics research and in field trials. By using this approach, detailed data can be recorded on muscle activation patterns. Gazzoni demonstrates that this approach can be used successfully in the study of muscle force and fatigue during dynamic tasks under laboratory conditions. Three EMG case studies are presented on typical industrial scenarios using the system.

Collins and O’Sullivan present data on psychosocial risk exposure and rates of self-reported musculoskeletal disorders across different age groups of men and women. The results indicate a trend of increasing frequency of musculoskeletal symptoms with age, especially for the lower back, neck, and shoulders. It is worrisome that their data indicated high rates of presentism for older-age workers.

The article by Fritzsche compared the accuracy of ergonomics risk assessments using digital computer human models to evaluate real tasks on the shop floor. The conclusions were that computer simulations remain helpful in performing preproduction ergonomics evaluations. The predictions of posture related loads achieved good accuracy, but estimation of forces was more difficult. Embedding
ergonomics evaluation techniques within digital human-modeling software is proposed to improve efficiency and accuracy in preproduction ergonomics.

Detailed high-end digital human models are expensive and not commonplace in small- and medium-size businesses. Hallbeck and colleagues present details of a solution to this problem. Ergomix is a mixed-reality system that superimposes people on design drawings of tasks. The interactive system embraces the participatory ergonomics approach, using real workers in the design of workstations. Five case studies are presented that show that the computer solution can be used for ergonomics evaluation and in a price range accessible to small- and medium-size enterprises. Demonstrating clear-cut benefits because of ergonomics interventions helps to achieve buy-in from stakeholders in organizations. Some managers and engineers have a narrow view of what ergonomics is about. De Looze and colleagues describe an intervention case study where significant productivity and quality improvements were achieved through the application of ergonomics approaches. They also provide an online decision tool that can be used to secure commitment and resources from company managers by estimating the economic benefits due to ergonomics interventions.

Finneran and O'Sullivan also studied aspects of ergonomics and productivity. In a laboratory study, they had participants perform self-paced, repetitive exertions at various levels of force and exertion duration. Their results demonstrate that, by manipulating ergonomics risk factors to more acceptable levels, productivity can be changed. A model is presented with profiles of duty time illustrating the effects. Levizziari and colleagues describe a technical solution to the ergonomics of manipulator control using haptic technologies. Some suspended industrial equipment, such as welding devices, remains a challenge in modern manufacturing. Automation of these tasks reduces flexibility considerably, while worker manipulation involves the exertion of high forces in deviated body postures. The proposed system detects the movement of the device via a stereovision system and then guides the direction of movement through the servomotors on the suspension arm. Visual feedback is simultaneously presented on a small monitor and haptic feedback is provided via the control handles. These articles illustrate that considerable achievements have been made in understanding the science behind ergonomics risks and musculoskeletal disorders. They also illustrate that the intelligence has been well-incorporated in practical approaches for exploitation in industry through the use of information systems.

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