Towards Human-Profile Based Operations in Advanced Factory Governance Systems: Contemporary Challenges for Socio-Technical Systems Design?

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Keywords
Design methodology, human behavior analysis, human directed manufacturing system, information equipment, information storage, man-machine interaction, support system, user friendliness

Extended Abstract
Socio-Technical Systems Design (STSD) is a dominant human-factors design approach to develop a human-centered, technology enabled, team-based, manufacturing system (Van Eijnen, 1993). STSD asserts that the human factor is of vital importance for the successful functioning of intelligent manufacturing systems (Vink et al., 2002). Recently, STSD was successfully used in the European Union 5th Framework IST project ‘PSIM’ (Participative Simulation environment for Integral Manufacturing enterprise renewal) that was part of the global Human-Machine Coexisting Systems (HUMACS) project. HUMACS was aimed at developing a ‘Human-Factors Centered Manufacturing
Enterprise’ in which people give full play to their capabilities from every perspective with full sense of fulfillment and satisfaction (Yamada, 2002).

In PSIM project (Van Eijnatten, Ed., 2002) both a procedure and dedicated software were developed and tested in five companies in Europe, Japan and the US. The PSIM participative simulation prototype (Little et al., 2001) supports companies in developing new organizational structures in which humans can perform healthier and better. In the PSIM project ‘participative simulation’ was used as a method (Van Eijnatten & Vink, 2002). Participative simulation is both a dialogue environment for the exchange of tacit and explicit knowledge about the design and control of production systems, and an ICT environment that supports dialogue between workers of different levels in the organization to stimulate thought processes about renewal. PSIM articulated the growing role of domain models and information systems in participative decision-making in factories. The participating companies evaluated PSIM positively as a ‘breakthrough’ innovation in the field of business and work.

Enterprise modeling is on the increase (Goossenaerts & Pelletier, 2002). A virtual plant environment (Goossenaerts et al., 2002; Matsuo & Matsuoka 2004; Shin et al., 2004)) is an advanced information environment that supports operations, decision-making and transformations in the factory. The criteria that constrain these activities stem from different disciplines. These disciplines focus on physical-, human-, and economic factors. The integral effect of these factors on the factory is mediated by principles of governance and characterized by a growing range of concerns such as quality, safety and health, environment friendliness, security, etc. For the latter concerns, the drivers often stem from the public domain, and the response in the factory is considered overhead from the economic viewpoint. For this reason, the public domain should facilitate the responses, seen in the context of the remediation (Virkkunen & Kuutti, 2000) – by introducing information society instruments – of the activity systems involving humans, businesses and the public domain (socio-industrial eco-system), see Table 1.

Table 1: Agents and Their Instruments in the Information Society (taken from Goossenaerts, 2004)

<table>
<thead>
<tr>
<th>Nr Scale</th>
<th>Agent/System</th>
<th>Environment</th>
<th>Components</th>
<th>Principles guiding design and evaluation</th>
<th>Methodologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Micro</td>
<td>human</td>
<td>natural &amp; socio-industrial eco-system</td>
<td>limbs, senses, body parts</td>
<td>personal development</td>
<td>learning, training</td>
</tr>
<tr>
<td></td>
<td>personal IS</td>
<td>its owner keyboard, memory, display, speaker, …</td>
<td>user-friendliness, ergonomy, calmness, …</td>
<td>user centered engineering</td>
<td></td>
</tr>
<tr>
<td>(ii) Meso</td>
<td>Company, public body, university socio-industrial eco-system (market)</td>
<td>employees, facilities, students, products, etc</td>
<td>productivity, market share, competition, customer satisfaction</td>
<td>strategic/ tactical/ operations management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>enterprise information system</td>
<td>the organization &amp; its processes databases, systems, documents, plans &amp; schedules, etc</td>
<td>functionality, usability, non-functional requirements</td>
<td>Information system implementation; model driven architecture (MDA)</td>
<td></td>
</tr>
<tr>
<td>(ii) Macro</td>
<td>socio-industrial eco-system</td>
<td>the natural environment roads, harbours, airports, facilities, courts, enforcement authorities, customs</td>
<td>sustainability, growth, legal security, social security, equal rights, privacy</td>
<td>industrial policy development, policy making, society oriented design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>information infrastructure (public, social) socio-industrial eco-system &amp; its natural environment telecom. networks, public databases &amp; registries, middleware,...</td>
<td>requirements, e.g. reversing fragmentation in research, privacy</td>
<td>society aware 4+1 view (software intensive eco-systems, MDA)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Factory Governance requires an intensive collaboration among agents at the scales of human, business and the public domain, where each pair of agent and instrument is a ‘software/ data/ knowledge-intensive system’ for which IEEE 1471-2000 defines the architecture. Table 1 lists these systems and describes their aspects using the terms of the standard. A comprehensive methodology to align human-profile based operations with shifting objectives in advanced factory governance systems draws on three bodies of knowledge (Goossenaerts, 2004):

1) The Cultural Historical Activity Theory is an elaboration that is due to Engeström (1995), following original work by Vygotsky (1962) on the micro-agent, and Leont’ev (1989) on the meso-agent,
2) The model-driven architecture, in which we use the OMG terms, and elaborate profiles of humans,
3) The decisional reference model that originates from the GRAI methodology (Doumeingts).

Assuming a management entity that derives new objectives for governing activity systems (in the factory) that it can influence by choices for certain decision variables. Assuming furthermore that the activity system has the availability of a so-called IST instrument that is model driven (in the OMG/ MDA sense), the operations of which are traceable (via mappings) to CIM layer models, see Figure 1.

Figure 1  Roadmap and the Acquisition of Capabilities - New Scenarios (taken from Goossenaerts, 2004)

The proposed approach can be applied, as is illustrated by a strategy implementation case, and by a human change case. Impacts in terms of implementation cost and
acceptance are described. Although an Activity Theory perspective was used here, we would like to reflect on the use of STSD as an alternative framework for specifying human profile based operations in advanced factory governance systems.

References


Full Reference of Submitted Abstract for ICMA 2004


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