Work 41 (2012) 2651-2655
DOI: 10.3233/WOR-2012-1031-2651
IOS Press

Macroergonomic aspects in the design of development programs in IDCs

Denis A. Coelho[a,*], Patricia R. Ferrara[b,c], Ana F. Couvinhas[b], Tânia M. Lima[a] and Jake K. Walter[b]
[a] *Human Technology Group, Dept. of Electromechanical Engineering, University of Beira Interior, Calçada da Fonte do Lameiro, 6201-001 Covilhã, Portugal*
[b] *TechnoServe Mozambique, Av. Zedequias Manganhela, 267, 5.º andar, Flat 6, Prédio JAT IV, Maputo, Mozambique*
[c] *Dept. of Industrial and Systems Engineering, University of Wisconsin-Madison, 3270A Mechanical Engineering Building, 1513 University Avenue, Madison, WI 53706-1572, United States of America*

Abstract. This paper revisits three reports on ergonomic aspects of development initiatives taking place in Industrially Developing Countries (IDCs). These include a macro-ergonomics intervention in a habitation community in Cape Verde (aimed at designing solutions contributing to sustainable development), the evolution of poultry growers' control strategies as an integrative broiler operation is introduced in Mozambique, and a set of macro-ergonomic considerations related to the Agro Forestry Village Project in Mozambique. The paper seeks to set the reviewed development endeavors against the backdrop of the goals of ergonomics interventions. This reflection may inform development agents in future processes of design and implementation of integrated community and work systems transformation.

Keywords: Industrially developing countries, sustainability, systems approach, community centered design, ergonomic goals

1. Introduction

Development initiatives necessitate deploying a multi-dimensional approach in order to increase the chances of successfully tackling the wide range of challenges that development agents encounter in the field. This paper revisits three previously published cases, placing emphasis on their underlying goals and positioning them against the backdrop of the goals of ergonomics interventions.

2. Cases

The three case studies cover a wide scope of development initiatives, including a community intervention (case A), a work system change (case B) and a prospective habitation and work system combined transformation (case C).

2.1. Case A - Macroergonomics intervention in a social community

This case was reported by Couvinhas et al. [1], and embedded a systems design approach for sustainable development in an IDC context, based on an analysis developed from an ethnographic study carried out during four months. The intervention that was designed and implemented was two-fold. On the one hand, the development project aimed at the transformation of the qualifications and motivational climate of an economically challenged community and the pursuit of an upward spiral for this community. On the other hand, the project sought the design and provision of objects and containers for water use within the home and the systemic management of water, its treatment and its possible uses. The intervention hence tackled ergonomic and systemic goals simultaneously; combining the satisfaction of fundamental needs (access to water for domestic consumption and

* Corresponding author. Tel.: +351 275 329943; Fax: +351 275 329972; E-mail: denis@ubi.pt.

irrigation of prospective vegetable gardens) with support and development of education and communal engagement (Figure 1). High-technology was not deployed in order to give local people the possibility to implement their own water purifying systems without depending on Non-Governmental Organizations (NGOs) and, or, resources from other countries, thus contributing to achieving a self-sustaining system. Maintaining technology intensity low increases the chances of resilience and self-reproduction of the solutions, enabling more people to increase their well-being. In the past, many projects in IDCs failed because high-technology solutions were implemented, while the use on a large scale and, or, the maintenance of those advanced technology products or services was impracticable.

Overall, the project sought to improve the quality of life of the people in the community focused, while adopting a sustainable approach. In order to achieve this overarching aim, a set of activities were fostered and supported, which are expected to contribute to achieve results that meet human needs at several levels (subsistence, self-improvement and self-esteem). By improving water management and contributing to mitigate water shortages, the project contributes to meet both subsistence and self-esteem needs, with a solution that fosters its dissemination given its low technology intensity. The support provided to education and training activities in a community setting, while improving job prospects for young people and hence increasing overall sense of safety in the community (meeting safety needs, by reducing the propensity for violence and crime among youngsters), also contributes to the satisfaction of individual self-actualization needs and added comfort and communal engagement.

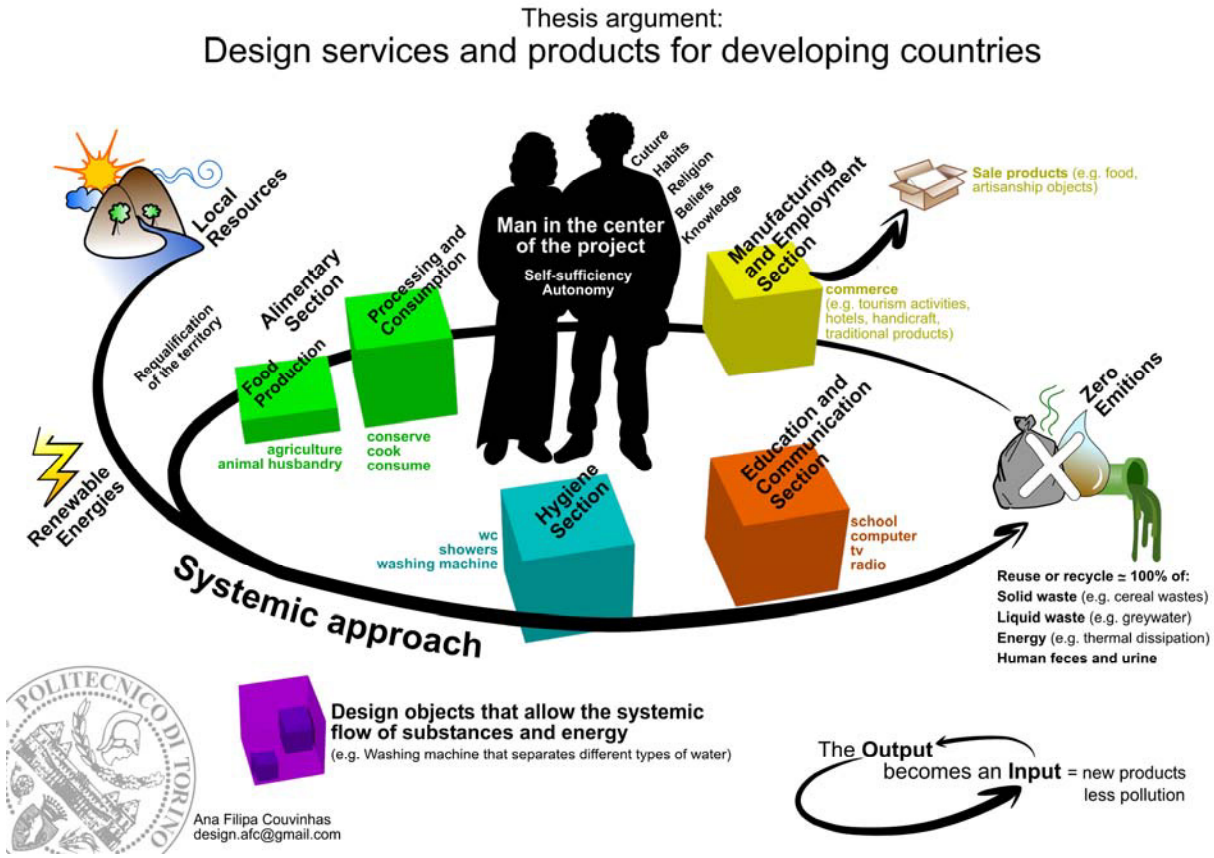

Fig. 1. Schematic depiction of the approach deployed in case A [2] (permission to reproduce this figure was granted by the copyright holder)

2.2. Case B – Evolution of worker strategies in the control of poultry growing

This case was concerned with the introduction of an integrative broiler operation and the understanding of the consequent evolution of poultry growers' control strategies. Observing and understanding the transformation of work in terms of changes in the control strategies, Ferrara and Lee [8] reported that these transformations were a radical change in a rural industrially underdeveloped setting. Change in poultry growing required a shift from free-running foraging poultry to housed poultry in contracted work. Growers having access to previously unavailable resources had to act within new constraints and as such had to engage many new strategies to succeed. This case of work-system transformation, where work requirements changed substantially from those of previous situations (e.g. constructing a family owned chicken house, providing adequate supplies of resources, and acting to avert disease and to protect the poultry) required the adoption of new tools, technologies, and work aids in order to keep workload manageable and prevent system failure. Growers had to keep track of the feed provided and to maintain a safe environment. The poultry integrator acted as a source of knowledge, technology and access to resources through financing. This minimized loss by improving bird health within the vicinity of the chicken house. The researchers in this case aimed to develop, as a continuation to the case, organizational arrangements, tools and information technologies that would promote self regulation.

The changes introduced with the shift in the work requirements brought about by a reorganization of the model for poultry growing are expected to have positive impacts at individual (worker), family and community levels. By improving yields in poultry growing, the economic impact on individual and family life contributes to satisfy in more reliable manner, subsistence, individual and family comfort and safety needs. Increased community engagement may occur as a result of increased need for labor resources that the village may provide or the transfer of knowledge to the village for improving the health of their foraging chickens.

2.3. Case C – Habitation and Work System Transformation

Some of the macroergonomic [4] considerations related to the Agro-Forestry Village project in northern Mozambique were reported by Walter et al. [6]. This project provides technical and strategic support to firms and entrepreneurs in five communities where large investments in forest plantations are taking place with expected resulting transformation of related industries. Transformations in interrelated work domains are underway with the intention of applying knowledge and technology to change habitation and food systems as well. These activities depend on the The project was designed and planned (Figure 2) with combined and integrated interventions in several domains of activity (forestry, farming, poultry and tourism). This was developed in combination between habitation-related and external work activities, mediated by knowledge transfer and the introduction of technology.

The transformations sought self-regulating and self-sustaining systems that could self-reproduce and improve, expanding into new habitation and external work activities for individual and communal benefit. At the beginning of the project, stakeholders met for a week and created scenarios to come to a common understanding of the proposed development objectives for the five communities. One specifically noted point of agreement was that the development efforts must have the improvement of life satisfaction and hopes of the people as the central objective. The stakeholders also realized that their own epistemic transformation, from a techno-centric perspective to a socio-centric perspective, would be central to the transformation of the 'well-being' of the people.

This case represents a very pervasive transformation of habitation and work systems in rural northern Mozambique. Such transformations in several domains are expected to reverberate positively into the increased satisfaction, in a resilient continuity, of human needs. People interact with technology in performing work activities that transform resources, creating economic value and producing results that contribute to the satisfaction of a myriad of human needs, considering the very wide scope of the intervention in this project. This ranges from a restructuring of habitation systems integrated with worksystems transformation in several domains. These are expected to impact very positively on the satisfaction of human needs at various levels, including subsistence needs, self-improvement and actualization and

self-esteem, considering the overarching aim of improved quality of life and increased well-being.

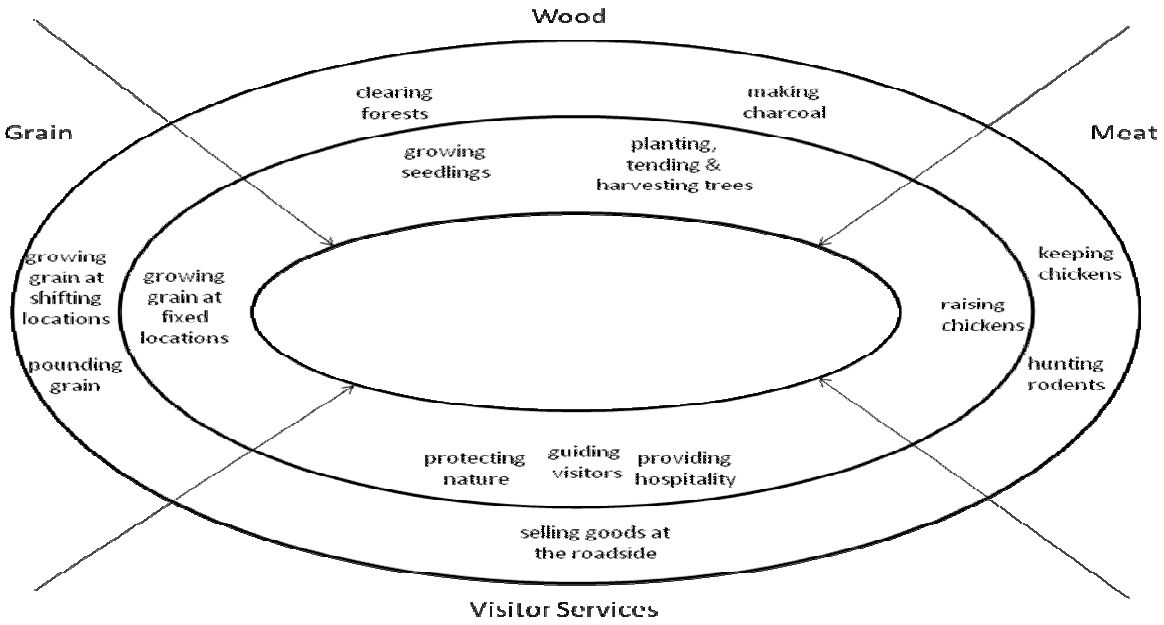

Fig. 2. Schematic depiction of the proposed evolution of work systems designed in case C [6] (permission to reproduce this figure was granted by the copyright holder.)

3. Human factors engineering approaches to design for development

A systemic design approach, embedding a systems view, was explicitly deployed in cases A and C, whereas the systems approach in case B assumed a cognitive engineering framework. In the systemic approach, problem solving is based on exploration of the possible mechanisms that may be deployed to meet a set of problem requirements and selecting a design that satisfies the requirements. This assists in considering sustainability, communal and ergonomic goals in the design of initiatives aimed at achieving human development. Problem solving for the actor in the cognitive engineering approach evolves over time [7].

Community ergonomics [5] has been recognized as a tool to identify and implement a community-environment interface to bridge the gap between the disadvantaged residents of a community and the resources driving the social environment within which they function. The community ergonomics approach is comprised of seven activities that lead to the identification and design of effective community-environment interfaces, with learning and self-regulatory mechanisms built-in at each stage. The activities include an action-oriented approach, participation by everyone, diversity and conflict management, encouraging learning, building self-regulation, embedding a feedback triad and continuous improvement and innovation.

In these human factors engineering or sociotechnical approaches to development initiatives in IDCs, in seeking development of a community-environment interface that may expedite access to existing resources and infra-structure, the aim is to empower an economically disadvantaged and resource challenged community with self-sustaining solutions that embrace a wide set of actors and activities, contributing to increased well-being and better quality of life. Community ergonomics is deemed as a solid basis, to promote added resilience to development initiatives in social communities in IDCs, given the pro-activity embedded in the approach and its successful track.

As the three cases discussed in the previous section demonstrate, development initiatives are tied to communities and to transformation of work and habitation systems. The cases illustrate three characteristics, i.e. community engagement (water), the effects

of changing work requirements (poultry growing) and the interactions between intended changes to produce synergies (agro forestry villages). In ergonomic approaches to development initiatives in industrially developing regions, the aim is often to empower an economically disadvantaged and resource challenged community with self-sustaining solutions that embrace a wide set of actors and activities, reverberating positively on a wide set of dimensions and contributing to an increased and more resilient and self-sustaining satisfaction of human needs.

4. Conclusion

Three cases that reported on ergonomic aspects of development initiatives taking place in Industrially Developing Countries (IDCs) were revisited. This set of studies suggest that development projects aims are necessarily tied to the satisfaction of human needs, and as such, this translates directly into their goals, adapted to the context of the development intervention or initiative. As human needs are varied and multidimensional [3], so are development projects' goals interconnected and multi-layered, sharing a common aim, improving the quality of life and the well-being of the people involved in the transformations. These aims translate into the satisfaction of safety, comfort, self-actualization and added self-esteem needs as a result of the implementation of new activities or transformation of existing ones, in stark alignment, implicitly or explicitly, depending on the case, with goals for ergonomic interventions. Moreover, development programs are inherently socio-technical system development activities and, as such, a systems approach is a prerequisite for their successful design and implementation.

One of the salient themes springing from the analyses and discussions carried out between the authors, about the relationships between the three studies, is the uncertainty associated with the materialization of both the resources and the benefits envisaged by development initiatives. For instance, in case A, low-technology solutions were deployed as a means of increasing the potential for reproducibility of the solution and its widespread adoption. Uncertainty implies that thorough understanding of the environment, especially the consequences of lacking infrastructure and institutions, must be obtained in the planning of these kinds of projects, with the expectation that there are a myriad of dimensions and levels where potential benefits might accrue as well. Potential benefits and failures hence need to be viewed in perspective with strengths, weaknesses, opportunities and threats (SWOT) underlying the development problems in their context. Mechanisms for self-evaluation throughout the life cycle provide a metacognitive capability to address issues at various levels according to the effectiveness of activity at those levels. This self-regulation is necessary because without the adoption of appropriate technologies and increased knowledge that is created through experience and education, human development does not take place. Human factors engineering provides macro-ergonomic resources as well as micro-ergonomic resources and these can be used jointly at all levels of the needs satisfaction hierarchy.

Acknowledgements

The authors would like to express their gratitude to Juma H. Juma and Brad Paul for their role in the collaborative design, implementation and monitoring of the development projects mentioned in the paper that take place in Mozambique.

References

[1] A.F. Couvinhas, D.A. Coelho, P. Tamborrini, and L. Bistagnino, Systems design for sustainable development applied to an IDC context – A case study of a Mindelo periphery, São Vicente Island, Cape Verde. In Matthias Göbel et al. (Ed.), Human Factors in Organizational Design and Management – X. IEA – International Ergonomics Association, Santa Monica, California, USA (2011) (pp. I-55 to I-60).

[2] A.F. Couvinhas, Unpublished Masters thesis, Politecnico di Torino, Italy (2011).

[3] A.H. Maslow, A Theory of Human Motivation, Psychological Review 50(4) (1943):370-96.

[4] B. M. Kleiner, Macroergonomics: Work Systems Analysis and Design. Human Factors, 50(3), 2011, 461-467.

[5] J.H. Smith, W.J .Cohen, F.T. Conway, P. Carayon, A. Derjani-Bayeh and M.J. Smith, Community Ergonomics. In H.W. Hendrick and B.M. Kleiner (Eds.) Macroergonomics: Theory, Methods, and Applications, Mahwah, NJ: Lawrence Erlbaum Associates, Publishers, (2002) 289-309.

[6] J.K. Walter, P.R. Ferrara, J.H. Juma, B. Paul, D.A. Coelho and A.F. Couvinhas, Organization Development within a Context of Rapid industrialization – Agro Forestry Villages in Mozambique. In Matthias Göbel et al. (Ed.), Human Factors in Organizational Design and Management – X. IEA – International Ergonomics Association, Santa Monica, California, USA (2011) (pp. I- to I-).

[7] J. Rasmussen and A. Jensen, Information processing and human-Machine interaction: An approach to cognitive engineering. North Holland, New York (1986).

[8] P.R. Ferrara, and J.D. Lee, Poultry Growers' Control strategies and their Evolution. Proceedings of the Human Factors and Ergonomics Society 54th Annual Meeting, 2010, pp. 1468-1472.