Working With Sustainable Systems-of-Systems: Applying System Dynamics to Green Building Consulting

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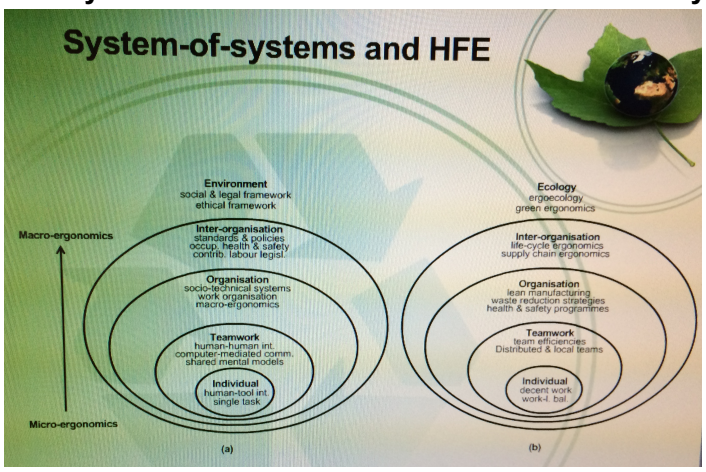
Background: Webinar directed to the necessity to move beyond “simple'” open-systems analysis to complex systems analysis. Webinar will introduce the principles of systems-of-systems, specifically how systems-of-systems thinking can help us understand the complex interrelationships between related HFE systems.

1) Requirements for Systems-of-systems Maier’s (1998)

- 5 requirements for a system-of-system

1. Operational independence of the components in the system
    - Systems can operate individually and independent of each other. (i.e. in Human/computer system both the human and computer can operate by themselves in a self-regulating function)
2. Actually operate independently in practice and will continue to operate in some form without the necessity for a system of systems.
    - Systems continue to act without interaction or input from the other system
3. Evolves with new purposes, functions and even components added, removed or modified.
    - Computer can be programmed to function in different/new manner; humans can learn and evolve internal properties
4. Emergent features and side effects that are not inherent or predictable
    - Systems operate and new things happen that were not anticipated/predicted showing faults and/or new benefits of the system interaction
5. Component systems should be geographically dispersed.
    - Increases diversity and asymmetric aspects to the system

2) System Dynamics and Interactions Within/Between Systems



Micro → Macro ergonomics

- Encompasses different levels of systems within systems

A) "Typical" System Layout

MICRO

- Individual - Human-tool interaction, single task
- Teamwork – Human-human interaction, computer-mediated communication, shared mental models
- Organization – Socio-technical systems, work organization, macro-ergonomics
- Inter-organization – Standards and policies, occupational health and safety, contributing labour legislation
- Environment – Social and legal framework, ethical framework

MACRO

B) Environmental System Layout

MICRO

- Individual – Decent work life balance
- Teamwork – Team efficiencies, distributed and local teams
- Organization – lean manufacturing, waster reduction strategies, health and safety programs
- Inter-organization – life-cycle ergonomics, supply chain ergonomics
- Environment – ergo-ecology, green ergonomics

MACRO

Child systems – system within a system (Individual level system would be considered "child system" to teamwork)
Parent systems – systems encompassing other systems (Organizational level system would be considered "parent system" to teamwork)
Sibling systems – systems within same level (human-tool interaction during single task)

Interaction between child/parent/sibling systems, effects efficiency and growth of systems. When interjecting at levels of systems need to consider the interactions of systems it encompasses and leads to (child and parent) and the work that is being done within the system. How are these people interacting with these systems and how is that related to the parent/child/sibling system?

When interacting/developing systems, systems with the most efficiency and adaptability to changes will show longevity and improved natural sustainability (ability to last or be maintained). If systems lack human efficiency they will typically be thrown out or used inappropriately.

3) Ergonomics and Green Buildings

- Green building defin: "The practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a buildings life-cycle"

(i.e including Living walls, grey water, waste management, zero net energy etc)

- "Green" building certifications/ratings vary based on location and demographics
  - LEED, BREEAM, GreenStar, NABERS

- Each rating system has a number of different tools with a range of "credits" to receive accreditation.

- GreenStar- Australia and South Africa- "Ergonomics Credit"
  - South Africa awards additional credit for an individual ergonomic workstation analysis -Credits for having ergonomics approved design according to ISO 9241-11: 1998 and ISO 11064-4:2004 etc
  - Credit for Workspace efficiency, >30 occupants a post occupancy survey/evaluation must be completed by a professional (including ergonomist)

- According to Attaianse and Duca (2012) and Attaianese (2012)- Human Factors and Ergonomic Considerations with Green Buildings:
  - Building construction (Health and safety, MMH, assembly)
  - Occupant wellbeing, comfort and efficiency (Environmental ergonomics)
  - Building operation and maintenance (usability ergonomics with building technology)
  - Workplace layout and design
  - Interior fitout (ergonomic furniture and finishings)
  - Occupant interaction with building for resource efficiency

4) Future Considerations for Ergonomics in Green Buildings

- Human behaviour in green buildings for resource efficiency
- Operation and maintenance interactions to ensure building performance
- Building design and placement for active behaviour
- Translation of building philosophy into other aspects of an occupant's life