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Bio-Inspired Information Complexity Management: From Ant Colony to Construction Firm

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Abstract : Effective information management is crucial for any construction project and its success. Primary areas of information generation are either the construction site or the design office. There are different types of information required at different stages of construction involving various stakeholders creating complexity. There is a need for effective management of information flows to reduce uncertainty creating complexity. Nature provides a unique perspective in terms of dealing with complexity, in particular, information complexity. System dynamics methodology provides tools and techniques to address complexity. It involves modeling and simulation techniques that help address complexity. Nature has been dealing with complex systems since its creation 4.5 billion years ago. It has perfected its system by evolution, resilience towards sudden changes, and extinction of unadaptable and outdated species that are no longer fit for the environment. Nature has been accommodating the changing factors and handling complexity forever. Humans have started to look at their natural counterparts for inspiration and solutions for their problems. This brings forth the possibility of using a biomimetics approach to improve the management practices used in the construction sector. Ants inhabit different habitats. Cataglyphis and Pogonomyrmex live in deserts, Leafcutter ants reside in rainforests, and Pharaoh ants are native to urban developments of tropical areas. Detailed studies have been done on fifty species out of fourteen thousand discovered. They provide the opportunity to study the interactions in diverse environments to generate collective behavior. Animals evolve to better adapt to their environment. The collective behavior of ants emerges from feedback through interactions among individuals, based on a combination of three basic factors: The patchiness of resources in time and space, operating cost, environmental stability, and the threat of rupture. If resources appear in patches through time and space, the response is accelerating and non-linear, and if resources are scattered, the response follows a linear pattern. If the acquisition of energy through food is faster than energy spent to get it, the default is to continue with an activity unless it is halted for some reason. If the energy spent is rather higher than getting it, the default changes to stay put unless activated. Finally, if the environment is stable and the threat of rupture is low, the activation and amplification rate is slow but steady. Otherwise, it is fast and sporadic. To further study the effects and to eliminate the environmental bias, the behavior of four different ant species were studied, namely Red Harvester ants (Pogonomyrmex Barbatus), Argentine ants (Linepithema Humile), Turtle ants (Cephalotes Goniodontus), Leafcutter ants (Genus: Atta). This study aims to improve the information system in the construction sector by providing a guideline inspired by nature with a systems-thinking approach, using system dynamics as a tool. Identified factors and their interdependencies were analyzed in the form of a causal loop diagram (CLD), and construction industry professionals were interviewed based on the developed CLD, which was validated with significance response. These factors and interdependencies in the natural system corresponds with the man-made systems, providing a guideline for effective use and flow of information.

Keywords : biomimetics, complex systems, construction management, information management, system dynamics
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