

Chapter 12

Cognition and Complexity: An Agent-Based Model of Cognitive Capital under Stress

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ABSTRACT

Contemporary knowledge work places create tremendous challenges for employees and managers. High levels of “cognitive capital” are required to cope with the rapidly evolving complexity of work. This chapter presents an agent-based model of the dynamics of cognitive capital in a simulated workplace. Factors such as stress, sleep insufficiency, and excessive work function to reduce the cognitive capital among workers. The cognitive capital in this microworld is tracked among agents suffering from stress, sleep insufficiency and excessive work. The authors also explore how cognitive capital changes under varying cognitive enrichment scenarios. Simulation results reveal a range of behaviors typical of complex systems, showing evidence of periods of both stability and instability. The authors also see symmetry breaking behavior as the dynamics of cognitive capital create drastic change.

INTRODUCTION

Management scholarship examining complex systems has focused predominantly on large scale human socio-organizational systems (Gharajedaghi, 2011). These systems create particular analytical challenges due to the intimate, and often difficult to assess, linkages between dynamic variables. These flows of relationships, oscillating at various frequencies and amplitudes, create a mosaic of

interactions that embed uncertainty and produce the inevitable unanticipated consequences that typify human action in complex realms. We live in a world in which humanity’s best efforts result in outcomes at odds with our best intentions. The implied hope of the study of complex systems is that such investigation will result in institutional and management systems that both accommodate and appreciate the challenges of evolving socio-economic-organizational complexity.

The fundamental coping mechanism of humans is the often referred to ultimate complex system,

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the human brain. The brain is clearly a complex system as evidenced by the multiple spatial and temporal scales that too operate at varying frequencies and amplitudes. These varying signals moving across and within this three pound mass result in autonomic responses, intentional behaviors, thoughts and the holy grail of the mind. The brain that produces the mind however presents a fundamental conundrum for analysts. The evolution of the human brain results in macro level complex systems that defy the brain's capacity to cope with the complexity of its own invention. The gift of complexity in which the creations of many minds from human culture to human organization also serves as a bane as individual level responses face the challenge of coping, understanding and thriving.

The nexus between management and the brain is the human workplace. This workplace is a complex system comprised of individual level brains responding to a multitude of stimuli and bounded by constraints such as group dynamics, the task environment and organizational missions. This multitude of interacting variables explains the difficulty of making sense of human performance given the hierarchy of systems and subsystems involved. Management scholarship devotes considerable attention to these challenges of performance by focusing on system level variables such as organizational culture to micro levels of analysis such as employee stress. What, however, is lacking from management scholarship is an appreciation for the cognitive performance of individual employees. In particular, the advance of new communication technologies combined with the increasing pace and expectations in an era of hyper competition places an array of stressors on human cognition in the workplace. Cognition involves the abilities to reason, think, and solve problems and represents skills critical to success in knowledge work.

Recent advances in fields ranging from cognitive science, to human factors to the neurosciences now provide a means to better understand the

implications of work on both human cognition and human performance. These advances have also resulted in the creation of new fields of study such as neuroergonomics (Parasuraman & Rizzo, 2007). This new field seeks to understand the intimate connection between cognitive performance and the dynamics of the workplace. The applied scientific agenda of neuroergonomics is to create work environments with supportive human factors that enhance the cognitive functioning of people at work.

These emergent scientific advances also coincide with a consistent research finding that many elements of contemporary knowledge work serve to diminish cognitive performance (Jackson, 2008; Klingberg, 2009). For example, the contemporary knowledge based workplace engenders multitasking, a set of behaviors, that clearly reduces effective cognition and work performance. The numerous interruptions that typify contemporary knowledge work further serve to diminish the very cognition that is considered the core of knowledge work. In short, the complexity that is loaded on to contemporary work often functions in opposition to the principle that knowledge work requires effective cognitive functioning.

These detrimental work realities of multitasking and interruptions, or as may better be labeled the distracted workplace, are exacerbated by other individual level responses to work and life. Individual level responses to stress, for example, also serve to diminish cognition and work performance (McEwen, 2007). Stress also influences sleep behavior. A very large body of literature validates the negative effects on human cognition and performance that accrues from sleep insufficiency (Durmer & Dinges, 2005). Couple factors such as stress and sleep insufficiency with excessive work hours and a toxic mix of elements accrues that diminishes cognitive performance.

This chapter presents and explores a simulated work environment using an agent-based model. Agent-based modeling is a widely used simulation method for exploring complex systems and

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