

“EPIMEMETICS”: AGENT-BASED MODELING OF DISTRIBUTED COGNITION AND PERFORMANCE IN ORGANIZATIONS

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1. INTRODUCTION

Improving performance has been an almost universal, yet all too often elusive, goal of most organizations. In its basic form, performance can be thought of as the optimum creation of value through transformation of a substrate. The assumption is often made that this transformation is essentially linear: the more or better the substrate, the better will be the resulting value of transformation. This linear understanding is sometimes, but not always true. While individual talent is predictive in baseball, it is not in basketball or soccer [Swaab et al 2014]. It may be true in sales, but not in financial analysts on Wall Street [Groysberg 2010]. Surgical volume is predictive of performance of individual surgeons [Maruthappu et al 2014], but process proxy indicators are not predictive of larger organizational outcomes [Werner and McNutt 2009]. What separates these examples is the varying interdependence among the members of the group and the importance of emergent order.

2. CREATIVITY, COMPLEXITY AND PERFORMANCE

Logan and coauthors found that the most important determinant in organizational performance was the “organizational culture” of component “tribes” in the organization [Logan et al 2008]. While culture can have a variety of meanings, the definition used here is “the pattern and capacity for adaptation based upon shared history, value, purpose and future”. The “tribe” is the functional group of 20-120 people responsible for actual work elements, and conforms to Dunbar’s number of individuals with whom a close cooperative relationship can be maintained [Dunbar 1992]. Organizational culture is dynamic, emergent and coevolving with the agents and the system and is shared primarily through language [Zaffron and Logan 2009]. It shares many of the same attributes of “creativity”, characterized as a group action [Sawyer 2007] shared primarily through conversation [Csikszentmihaly 1996]. Both organizational culture and creativity transform an underlying substrate into something of value. We believe an understanding of the scaling of performance can be obtained from the fundamental allometric scaling equation.

3. ALLOMETRIC SCALING

To better understand scaling of biologic variables, West and coauthors developed a theory of a fundamental allometric scaling equation [West and Brown 2005]:

$$y = kx^{\alpha}$$

In the original equation, y is the biologic variable being measured, k is a species-specific constant, x is the mass of the organism and α is 0.75 or another multiple of the fourth root. Similar but superlinear allometric scaling is seen in cities [Bettencourt 2013]. The sublinear scaling seen in biologic entities seems to hold true with corporations, however. Both are thus “mortal”. We reasoned that intellectual capital, comprised of the distributed cognition of the workforce, could be the analog in an organization of mass in an organism. Therefore “ y ” is organizational performance, “ k ” is a complex constant made

up of organizational culture, and cognitive diversity, variance of core values, purpose, “x” is intellectual capital (organizational knowledge x variance of organizational knowledge) and “α” is .75.

4. THE AGENT-BASED MODEL

To investigate the utility of using agent-based models to study performance, we first developed a NetLogo™ [Wilensky ____] model to show that culture spread as a meme through an organization [Gonnering 2012]. In this model, a hypothetical organization consisting of 2 executives, 4 managers and 25 workers exchanges culture (positively or negatively, depending upon the relative differences in individual agent’s culture and organizational hierarchy) as the agents moved through time and space. We confirmed that organizational culture did indeed spread as a meme and that its spread was influenced by starting point, internal and external pressures and other path dependent elements. We then amplified upon that model to investigate the interrelationships of organizational culture, organizational values, intellectual capital (depth and breadth of knowledge) and organizational performance [Gonnering and Logan in press]. In the version of the model reported here, we added a variable for cognitive diversity to approximate innovation capability and investigated the effects of “compliance” and “engagement” as described by Pink [Pink 2009].

5. RESULTS

We found that the model mirrored real-world findings [Logan, et al 2008]: Without intervention, organizational culture stabilized at a Stage 3 level and organizational performance advanced very slowly and with linear dynamics. By introducing “triading”, structural holes in the network framework were closed and clustering was increased. In effect, a Small World Network resulted. The probability the organizational culture could advance beyond Stage 3 to Stage 4 was also thereby increased. At that point, a phase-transition was seen with a marked increase in organizational performance. Sensitive dependence on initial conditions was seen, as small differences in starting point had large differences in outcome. Absent triading, there was no significant effect of the compliance/engagement ratio. However, when structural holes were closed an appreciable gain in performance was noted with increasing engagement:

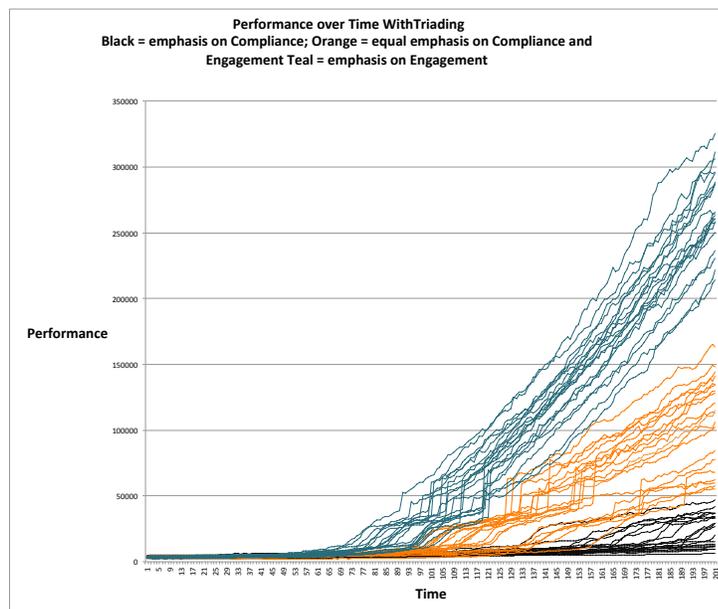


Fig. 1 Performance vs. Time for various configuration of the model.

6. “EPIMIMETIC LANDSCAPE”

Distributed cognition, the collective intellectual capital of an organization, is the ultimate source of performance. This is the substrate transformed through organizational culture. We believe that additional influences, such as triading and the balance between compliance and engagement, modify that organizational culture very similarly to epigenetic modifications on genotype producing phenotypical variation [Paaby and Rockman 2014]. We propose the term “epimemetic” to characterize these modifiers of organizational culture resulting in the production of an “epimemetic landscape” of performance:

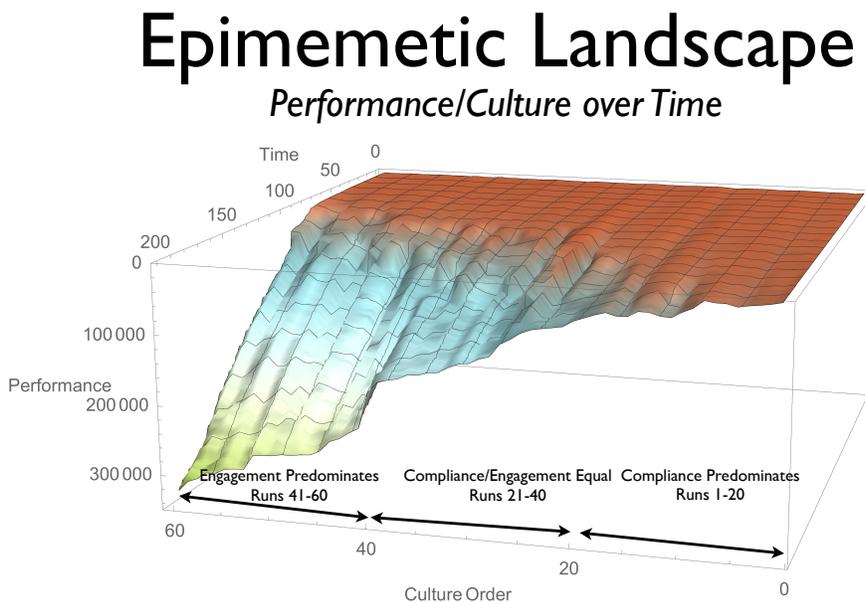


Fig. 2 “Epimemetic” landscape of performance. Organizational culture modified by compliance/engagement ratio influences path-dependency of organizational performance.

7. IMPLICATIONS

All models are wrong....but some are useful [Box 1976].

Undoubtedly, this model is wrong, but it *could* still be useful. It can explain observations on performance, but all our assumptions may not be correct. While further real world validation would be necessary for it to be “predictive”, it still has utility [Epstein 2008]. For the organization wishing to maximize performance, this model allows visualization of some of the findings in *Tribal Leadership* [Logan et al 2008] and *The Three Laws of Performance* [Zaffron and Logan 2009]:

- Performance is the result of various factors acting upon a substrate.
- The intellectual capital of collective intelligence can provide the same substrate in the generalized allometric scaling equation as does mass for the organism.
- Modifiers of organizational culture, such as closing structural holes and the compliance/engagement ratio, seem to function in a way analogous to epigenetic modifiers of genotype to produce phenotypic variation.
- Once other epimemetic factors advance the organizational culture beyond a critical threshold, increasing compliance at the expense of engagement could act as a significant anchor on performance. Conversely, increasing engagement may encourage a marked increase in performance.

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