

The spiritual antecedent of C-K Theory: how one might explain high-impact engineering-design innovation and fast-paced economic growth in the Silicon Valley.

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Introduction

In the June 2012 edition of the weekly magazine, the Economists, the authors wrote: "Europe not only has a euro crisis, it also has a growth crisis. That is because of its chronic failure to encourage ambitious entrepreneurs." They then went on to show that based on an analysis of the world's 500 biggest publicly listed firms that Europe gave birth to just 12 new big companies between 1950 and 2007, while America produced 52 in the same period. Ordinarily the article may not have merited much attention, except that Europe has a long tradition of research and researchers working in the field of innovation, and if as implied by the authors, this body of research has failed to influence the practice of innovation, then a lot is being called into question about our models and theories of innovation. It is now eleven years since the first presentation of C-K theory at the International Conference on Engineering Design. Since that time, and indeed slightly before that time the field of design has been rapidly evolving and the domain of application of human centered design thinking has grown from product design (1), to service design (2), to business design (3), to market design (4) and indeed to the design of whole regions in what is sometimes called ecosystem design (5).

C-K Theory

C-K theory in brief is a theory that mathematically and socially explains the source and growth of new ideas in terms of activities in two distinct spaces (6); the concept space or C-space where the ideas do not have logical statuses; and the knowledge space K-space where ideas are either true or false, and thus have logical status. Socially, C could stand in for designers and generalists and K for engineers and specialists. Having a theory and knowing a theory is one thing, translating it into practice is another, and the argument we will make in this paper is that C-K theory despite its enormous power of explanation, would fail to influence the practice of design and innovation without the support of its spiritual antecedent. Unfortunately, the realization of its power cannot occur in a vacuum, and given the weak economy in Europe, it appears to be difficult to see very clearly the potential and limitations of C-K theory regarding innovation in Europe. An alternative strategy is to apply C-K theory to a different ecosystem, one with a strong economy such as the Silicon Valley. Before we explore the relationship between C-K theory and the Silicon Valley, it will be helpful to explain the term spiritual antecedent.

Spiritual Antecedent – A Definition

Law is one of the six¹ core disciplines of design necessary to create and grow innovation ecosystems such as the Silicon Valley. In the legal field a distinction is often made between the letter of the law and the spirit² of the law. The hypothesis of this paper is that a similar parallel exists in design theory. There is the letter or media of the theory, which includes its mathematical representation and physical embodiment practices, and there is the spirit of the theory. What came before, is and persists after the different activities that take place during the development of a product. We will use two examples to further support our argument 1) Stanford's d.school model of the "T-shaped" designer is the embodied form of C-K Theory. The d.school is one of the best examples of places where inter-disciplinary teams work together. T-shaped design teams have deep knowledge in one or two fields, and also have broad knowledge across several other fields critical to solving complex problems. These design teams blend technical, management, and psychological skills. 2) The second example is both historical and controversial. Recalling Max Weber's 1904 paper titled "Die protestantische Ethik und der 'Geist' des Kapitalismus," (The protestant ethic, and the spirit of

¹ Engineering, Law, Economics, Psychology, Anthropology, Art.

² This could be described in one or more narratives consisting of the historical context, the belief system, including the mindset (see Carol Dweck (8)), and the intention, including notions of self and group efficacy (see Albert Bandura (9)), and intelligence as a form of energy for adaptation (10).

capitalism (7)), it appears that the personification of the "T-shaped" designer serves parallel functions with the person of God's Spirit often referenced in the Judeo-Christian tradition. This should come as no surprise to most people in the Silicon Valley where discussions of the practice of entrepreneurship are laden with terms like collaboration (unity), mentorship (counseling), and role models (personification) to list a few examples. As a consequence of exploring this hypothesis and examples from a modern scientific perspective, we were compelled to ask two further questions: 1) Is the concept of a "spirit" still useful in modern times? 2) How might C-K theory be modified, if at all, in order to account for the difficulty of forming "T-Shaped" teams for innovation eco-system designs³?

Rainforest Theory

In 2012, two venture capitalists V. W Hwang and G. Horowitz wrote a book titled "The Rainforest: The Secret to Building the next Silicon Valley" (5). In it they set up the Rainforest theory. They argued that innovations appear in specific and conducive ecosystems such as cities that are made of two essential parts: The hardware, which is measurable, countable and visible, examples of which are Universities, Industrial Parks, Number of Patents, etc., and the software, which is invisible but remains essential. The secret, according to them, was to be found in the implicit behavioral rules that people observe in their day-to-day interactions. The Silicon Valley is an archetype of an innovation ecosystem they metaphorically refer to as "rainforests." They contrast the implicit rules of the rainforest with those of other environments they metaphorically refer to as "plantations."

Table 1: The Rules of the Plantation (Industrial Production System), contrasted with the Rules of the Rainforest (Innovation Ecosystem). Observe the similarity with Knowledge (K) and Concept (C).

Rules of the Plantation	Rules of the Rainforest
Excel at your job	Break rules and dream
Be loyal to your team	Open doors and listen
Work with those you can depend on	Trust and be trusted
Seek a competitive edge	Seek fairness, not advantage
Do the job right the first time	Experiment and iterate together
Strive for perfection	Err, fail, and persist
Return favors	Pay it forward

While one might be tempted to map the plantation to the Knowledge space in C-K theory, and the Rainforest to the Concept space, there is an important difference between the two frameworks. In C-K theory, it is assumed that there exists a corpus of knowledge. In the Rainforest theory, it is assumed that there exists a corpus of behaviors. Our preferred diagrammatic depictions of the two frameworks are shown below side by side in Figure 1.

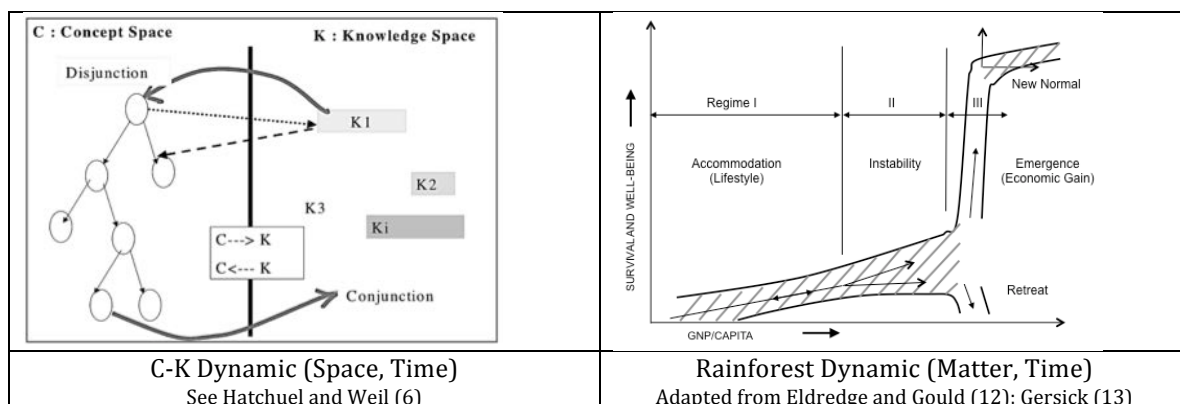


Figure 1: In C-K theory, the world is divided into two spaces, C-space and K-space and the dynamic consists of a set of operators that give rise to movement between the two spaces. In the Rainforest Theory, we can distinguish between two gradients of activity, one of low gradient corresponding to a lifestyle in equilibrium, and a very high gradient one corresponding to a lifestyle in disequilibrium and rapid economic gain leading to the emergence of a new set of norms.

³ See experiments by Nass and Moon (11) to explore the principle of similarity-attraction. This principle asserts that individuals are attracted to other people who are similar to them.

The Probe

We want to return to our earlier questions in light of the foregoing descriptions. 1) Is the concept of a spirit still useful in modern times? 2) How might C-K theory be modified, if at all, in order to account for the difficulty of forming "T-Shaped" teams for innovation eco-system designs? The two questions appear to be intertwined. If one were to compare the two dynamics, it will be clear that in practice there is a third space - the unknown. In this space the operators are unknown and the space itself is ill-defined and ambiguous. Some have described this space as that of the unknown-unknown. In this situation, it appears human emotion regulation plays a greater role than human justification, calculation and rationalization, in determining the next action. To explore the emotional dimension of human response further, we along with some collaborators conducted a short probe to see the range of emotions that a group of 22 students would experience when subjected to the same stimulus (14). Figure 2 shows that surprise-startle was the most common emotion expressed, followed by distress-anguish and anger-rage and more importantly the probe showed that students experienced a very wide range of emotions, 23 in all, which have been grouped into a set of seven basic emotions and one miscellaneous one (15, 16). Thus, it appears to us that without any constraining device, adhering to the rules of the rainforest, which appear counter-instinctual, would be difficult, and most teams would break up.

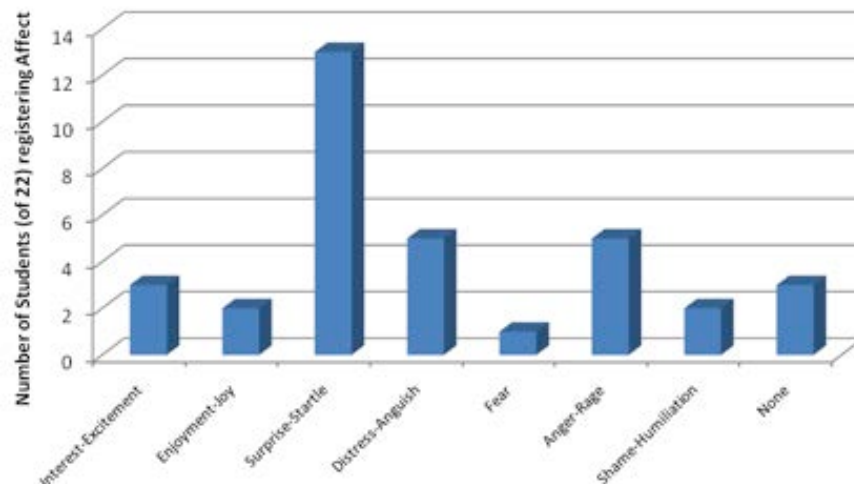


Figure 2: The wide range of natural response of participant to the same stimulus. They were allowed to mention more than one emotion.

C-K-U Theory: A broadening of C-K theory into the predictive domain

Recent findings on creative people show that they perceive the world differently. Specifically, they are more visual and more tactile. In addition, they have been shown to have a low fear response to novelty (17). In fact, it makes sense that evolution would select for a high fear response to novelty, as this would increase survival rate. There is a saying "curiosity kills the cat," and consequently the fear of novelty is nurtured. Thus to be complete in the sense of being able to function as a predictive theory, C-K theory would need to be extended to C-K-U theory, where U stands for the space of the unknowns.

C-K-U Practice: A deepening to handle situations involving unknown unknowns

Is the concept of the Spirit relevant today? It was mentioned in the Bible that the Jews used the concept during their exodus from Egypt. They were going into the unknown and it was important to maintain group cohesion hence the Spirit of God and his commandments emphasized the concept of love. The same was true of the early Christians, in their quest to go into unknown territories to fulfill what has been called "the great commission," they required the Spirit to empower them and to keep them united. Military campaigns attempt to generate the same type of morale in their troops, and indeed Hwang and Horowitz have argued that today's Silicon Valley has inherited a frontier spirit that combines individual ruggedness, independence, and openness to strangers with local community interdependence, contingent rule creation, and enforcement (5). A brief survey of leading knowledge management frameworks shows some recognition of this notion of a spirit.

Whether it is the "Fog" in Eddy Obeng's framework for project management (18), or the idea of "tacit" a term in the Nonaka and Takechi's SECI model (19) borrowed from Michael Polanyi's work (20), or the idea of "disorder" in David Snowden's Cynefin framework (21), or the "diffused" in Max Boisot's I-Space model (22), See Figure 3.

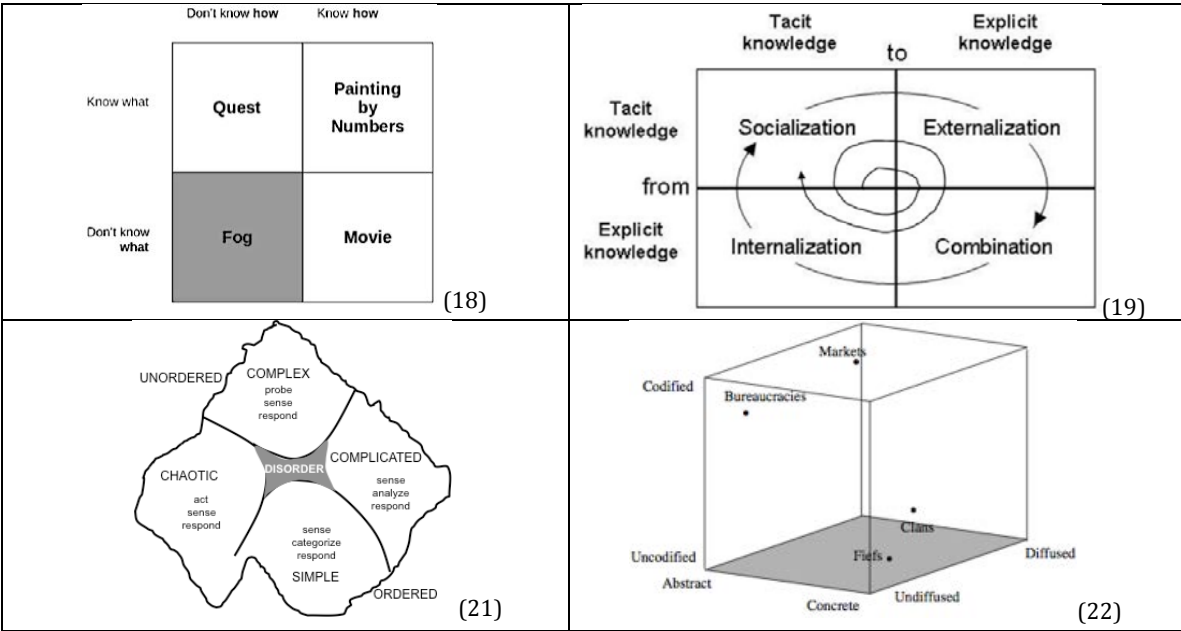


Figure 3: Several Leading Knowledge Management Frameworks show some recognition of the notion of a spirit but do not quite name it as such. Words such as fog (18), tacit (19), disorder (21), and diffused (22) are rather used.

It is however, not until we get to Nonaka, Toyama, & Konno's notion of "Ba" (23) that we find an idea similar to the one of the spirit used in Judeo-Christian tradition. While Nonaka et al's textual description of Ba is related to context and place, their visual depiction is more telling. Judging by the circles, concentric circles and spirals, the phenomenon seems more related to field forces such as the magnetic field around a live electrical wire, and the gravitational field between the Sun and its orbiting planets, see Figure 4.

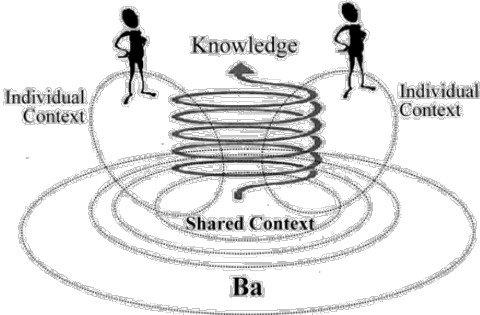


Figure 4: Knowledge needs a context to be created. The ba - space, time, and place - offers a shared context-specific knowledge-creating place where participants can interact with one another. (23).

In the Stanford d.school, the "T-shaped" teams are supported by an interior design of the space that helps to foster the kind of energy and attitude required to confront the unknown. This appears to be no different from the way the design of Cathedrals helped to foster a contemplative attitude of worship. In addition, the Greeks had a notion of muses, which entered individuals and enabled them to do creative things. Therefore, whether through buildings, muses, or the personification of certain ideals, it appears that the C-K-U theory would benefit from the active participation of an intermediary device that is not itself in the C-K space, but transcends it.

Summary

From all indications, we as humans are in the midst of the knowledge revolution. The pace of change is faster and the volume of information is greater. We have invented algorithms to handle big data and frameworks to help us better see through the deluge of information. However we seem to come short when it comes to our collective will and ability to act together. While our information handling devices have empowered the individual, they have also separated us further. The concept of the personified spirit is one that brings about a permanent sense of unity in diversity. It seems to us that when these two notions – the externally empowered individual, and the internalized personified spirit of unity – are combined with the proposed C-K-U theory, we will be in a better position to handle the complex and urgent challenges we face as scientists and innovators today. Before concluding, we would like to share a quotation from Herbert Simon, one of the early proponents of the need for a science of design.

Is it our Job to Forecast the Future or to Fashion it?

We must look ahead at today's radical changes in technology, not just as forecasters but as actors charged with designing and bringing about a sustainable and acceptable world. New knowledge gives us power for change: for good or ill, for knowledge is neutral. The problems we face go well beyond technology: problems of living in harmony with nature, and most important, living in harmony with each other. Information technology, so closely tied to the properties of the human mind, can give us, if we ask the right questions, the special insights we need to advance these goals.

In that spirit, it seems fitting to conclude with a series of questions that are thrown up for us. First, could C-K-U theory be applied to the domain of institutional design (24), including innovation ecosystem design, by extending the usual preoccupation with rules and enforcement mechanism, to include a conception of the Spirit? Second, is the Spirit antecedent to a collaborative effort of the Human Mind⁴ in pursuit of innovation, given the unknowingness of the innovative space and the tendency of most humans to avoid dangerous and risky situations? Third, would recreating the frontier situation artificially induce the creative collaborative spirit in other places outside of the Silicon Valley, and lead to high-impact engineering-design innovation and fast-paced economic growth?

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⁴ An alternative way of thinking about this question is by elimination. If we succeed in modeling the behaviors of the human body with the Robot, and the human mind with a computer, would there be a residual? (Intentional or Empathetic Energy, Field Forces, Time, Language, Belief).

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