

A MATHEMATICAL BASIS FOR INNOVATION

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ABSTRACT

This paper will present a mathematical model for thinking about innovation at various organizational levels.

To begin with a series of equations will be derived that will provide deeper insight into the nature of the system we live in. In particular the equations will provide some insight into the *inherent innovation bias* of our system, the *nature of each point* in the system, the broad *architectural forces* behind the development of organizations, the *inherent uniqueness* of each organization, the way to think about *varying cultures* or organizations, and the *inherent dynamism* of our system.

These equations will assist in putting ‘science’ into the ‘art’ of innovation. Three basic and ubiquitous states of organization – the physical, the vital the mental – will be built on to suggest six equations that provide insight into the fundamental organizational states of stagnation, stability, entropy, energy, sustainability, and fragmentation. These equations provide insight into the inherent bias of the system to always re-organize based on a more comprehensive possibility.

Equations for the characteristics or properties embedded in a single point will then be derived. The ‘point’ captures the inherent intelligence that appears to exist in the system, or in any smaller part of it. Hence, equations for the fundamental power, knowledge, presence, and nurturing hypothesized to exist in each point of our system will be derived. Following this, sets for each of the four characteristics embedded in a point will be derived, that in effect suggest the architectural forces that can create and develop any type of organization.

The hypothesis is that every organization, whether a person, team, corporation, market, or country is unique and that this uniqueness can be specified in terms of elements of the derived sets for power, knowledge, presence, and nurturing. Hence, an equation for the unique ‘signature’ of an organization will be derived. Further, the equation for uniqueness will itself be governed by an equation for the emergence of the uniqueness. Having defined an equation for the uniqueness of an organization it now becomes possible to also derive equations for the culture of an organization. Hence, two equations are derived – one for a monoculture and one for a diverse culture.

We now turn full circle and derive equations for the fundamental states of our system we had begun with: physical, vital, mental, and integral (from the family of nurturing). The derived equations

indicate the dynamism in-built into each of these states, and indicate too the conditions for the incarnation or interchange of the meta-levels with the observed states. Finally, we derive equations for Stagnation and for Dynamic Growth, based on the dynamism inherent in the four states.

These equations will provide a framework for thinking about and managing innovation at varying scales of organizational complexity.

Key words: Mathematics of Innovation, Equation for System Power, Equation for System Nurturing, Equation for System Knowledge, Equation for System Presence, Organizational Architectural Forces, Signature of an Organization, Equation for Dynamic Growth, Equation for Stagnation

INTRODUCTION AND RESEARCH METHOD

In *Connecting Inner Power with Global Change: The Fractal Ladder* (Malik, 2009) the case is made that there is a similar pattern that animates progress regardless of the type of organization. An organization, hence, could be an individual, a team, a business unit, a corporation, a market, a country, planet earth, or a system of thought, for example. This pattern is summarized as the movement from the 'physical' to the 'vital' to the 'mental', where the physical can be thought of as reality as characterized by what the eye can see. Necessarily the eye sees what has already been created: hence the physical can also be thought of as an orientation reinforcing the status quo. The vital can be thought of as reality as characterized by the play of energy. Such play often results in the strongest energy winning out, and hence the vital can be thought of as an orientation reinforcing experimentation even bordering on aggression. The mental can be thought of as reality as experienced by thought. Hence this orientation can be thought of as encompassing curiosity, idealism, and the future.

An organization can center itself in any of the three phases, and will perceive the world, interpret circumstances, and act consistently with the psychology that emanates from that orientation. As an organization progresses though, to thereby increase its degrees of freedom, it is observed that it essentially changes its orientation from the physical to the vital to the mental (Malik, 2009). This change in orientation is perceived as being the driver of innovation, and the hypothesis is that the orientations – the physical the vital, the mental – are embedded in the warp and woof of the system that we live in. Just as the bases of computer-technology is a binary representation and manipulation of zeros and ones, the hypothesis for a broad innovation-technology is a trinary representation and manipulation of the physical, the vital, and the mental.

Many different examples across the globe have been elaborated in *Connecting Inner Power with Global Change* (Malik, 2009), *An Integral Perspective on Current Economic Challenges: Making Sense of Market Crises* (Malik, 2013), and more recently in *The Flower Chronicles: A Radical Approach to System and Organizational Development* (Malik, 2014). In stepping back and asking why this similar pattern of progress exists ubiquitously, what this may point to is a reality of an implicit order that occurs in Time and Space:

- First, this progress happens regardless of area of the world, and regardless of industry. This points to a characteristic of an implicit-presence, whereby wherever there is the possibility of progress it will happen.
- Second, this progress happens in spite of tremendous opposition to it, again regardless of field and area. This points to a characteristic of implicit-power.

- Third, the right instrumentation and the right circumstances seem to be leveraged in order that the progress possible does happen. This points to a characteristic of implicit-knowledge that knows what to leverage and when. Implicit-knowledge implies prerequisite-state that contains a synthesis of contraries, and a consequent-state such that the right component is invoked at the right time. The notion of synthesis of contraries is pressing to the surface in many fields of life. Grand Unified Theories are being worked on in physics and mathematics. Even in very practical areas such as business similar efforts are underway. One such effort is that of the Vital Entrepreneurial Learning Organization [Platzek, Pretorius, Winzker (2014)], which suggests that changes in the business environment call for a rethink in mature organizations about management concepts and organization architecture required to grow and secure long-term vitality. Adaptability is needed to be simultaneously innovative towards exploring new opportunities while exploiting established businesses. To be such an ambidextrous organization, exploring the new while exploiting the old business concepts, balancing strategy, process, structure and skill issues are needed. Organizations with a more hierarchical structure and managerial perspective have to simultaneously adopt a more entrepreneurial perspective with complementary and networked structures. As a result, periods of incremental change marked by an increasing alignment among strategy, structure, people, and culture are punctuated by revolutionary change that needs a simultaneous shift.
- Fourth, the fact that this progress happens so that the degrees-of-freedom of the associated actors is continually increased points to an implicit-nurturing.

Hence, one can say that implicit in Space, there are four overarching characteristics – that of implicit-presence, implicit-power, implicit-knowledge, and implicit-nurturing (Malik, 2009). If then there is an implicit order in Time and an implicit order in Space, then our notion of organizational causality needs to be re-examined, since the very matrix in which any organizational play can arise is bounded differently than we may have so far imagined it to be.

Given such implicit order in Time and Space, and the nature of it, this paper will suggest a mathematical representation by which to think about the conditions giving rise to innovation.

The research method followed is essentially exploratory at this stage, as this is often found useful in the initial stages of research to set out a conceptual analytic framework such as the one that will be presented in this research. Furthermore the process of deductive logic is followed in this research paper to develop the essential mathematical equations for the organizational dynamics required to innovate.

BASIC FUNCTIONS REFLECTING INNOVATION BIAS IN SYSTEM

At a very basic level, keeping in mind the three ubiquitous states – physical, vital, mental - we first suggest six equations that provide approximations to situations such as Stagnation, Stability, Entropy, Energy, Sustainability, and Fragmentation. These equations are derived from the possibility and the obstacle provided by the three ubiquitous states.

Hence, if the physical orientation exists in its capacity as an obstacle, then we can say that while the physical is leading (represented by the subscript 'L' for leading), it is doing so as an obstacle

(represented by the superscript, '-') and hence the status quo will always remain as it, and this will result in stagnation. This can be represented by the function:

$$\text{Stagnation} = fn (P_L^-)$$

On the flip-side, if the physical is leading in a progressive capacity this results in stability of established structure, and is a great foundation for other things to be built. Stability can be represented as:

$$\text{Stability} = fn (P_L^+)$$

If the vital is leading in its rapacious capacity, this will result in entropy. Hence:

$$\text{Entropy} = fn (V_L^-)$$

In other words, with the random play of energy as captured by the Second law of Thermodynamics, the sum of the entropies of the participating thermodynamic systems increases (Van Wylen & Sonntag, 1985). Rather than existing as a universal state, the Second Law of Thermodynamics is true where the negative-vital is leading.

If the vital is leading in a balanced capacity, this will result in energy where and when it is needed. Hence:

$$\text{Energy} = fn (V_L^+)$$

If the mental is leading so that an idea is pitted against another idea, then fragmentation will result. Hence:

$$\text{Fragmentation} = fn (M_L^-)$$

If the mental is leading so that ideas are combined around the greatest idea, this will result in sustainability. Hence:

$$\text{Sustainability} = fn (M_L^+)$$

Creating macro-environments that are sustainable require an integrated and holistic technology management approach indicative of a mental-positive-leading paradigm. A case in point is that of biodiesel development typically entailing complex interactions of actors such as the technology developers, government at different levels, communities, as well as the natural environment, where different actions or responses in the greater system might hinder or undermine the positive effects of such a development. Given such complexity, an integrated and holistic technology assessment approach is indispensable to determine the potential effects of biodiesel development on sustainability in general, which can then inform and enhance proper planning and management. One such model that has been demonstrated and evaluated in the context of the Eastern Cape Province of South Africa is the Bioenergy Technology Sustainability Assessment (BIOTSA) model that has been developed, based on a system dynamics approach (Musango et al, 2011).

Given these we can also approximate that the outcome of any circumstance is going to be a function of which one of these six states is the strongest. Hence:

$$\text{Outcome}_{\text{circumstance}} = \text{Strongest} (P_L^-, P_L^+, V_L^-, V_L^+, M_L^-, M_L^+)$$

In general we tend to observe conditions of stability, energy, and sustainability as opposed to stagnation, entropy, and fragmentation, and hence can hypothesize that our system prefers these states and reinforces them.

NATURE OF A POINT

The 'point' captures the inherent intelligence that appears to exist in the system. This inherent intelligence is approximated by the four observations we previously arrived at that appear true of the space we live in.

Starting with observation #1: 'Progress happens regardless of area of the world, and regardless of industry. This points to a characteristic of an implicit-presence, whereby wherever there is the possibility of progress it will happen.' This is consistent with the suggestion that many innovative firms have shifted to an 'open innovation' model (Chesbrough, 2003a, 2003b), using a wide range of external actors and sources to help them achieve and sustain innovation. This model suggests that the advantages that firms gain from internal R&D expenditure have declined. Accordingly, many innovative firms now spend little on R&D and yet they are able to successfully innovate by drawing in knowledge and expertise from a wide range of external sources.

We can refer to this implicit-presence as system-presence. Translating this into an equation, we first give the notation $System_{pr}$ to system-presence. This system-presence is true across any considered Time-Space continuum starting from a time-space boundary '0' to a time-space boundary 'n'. This notion is characterized by the notation $TS_{0 \rightarrow N}$. Within that boundary from 0 to 'n', the 'presence' is such that it will always seize an opportunity to cause a shift from the physical-leading to the vital-leading, and from the vital-leading to the mental-leading. Research in evolutionary economics also suggests that a firm's openness to its external environment can improve its ability to innovate. Evolutionary economists highlight the role of search in helping organizations to find sources of variety, allowing them to create new combinations of technologies and knowledge (Nelson and Winter, 1982).

The notion that the presence seizes on opportunity as characterized by the notation:

$$\begin{array}{c} Presence \\ \downarrow \\ Opportunity \end{array}$$

The shift from physical-leading to vital-leading and vital-leading to mental-leading is characterized by:

$$\begin{array}{l} P_L \rightarrow V_L \\ V_L \rightarrow M_L \end{array}$$

Hence in this approach it can be inferred that:

$$System_{pr} \equiv TS_{0 \rightarrow N} \left[\begin{array}{c} Presence \\ \downarrow \\ Opportunity \end{array} \left[\begin{array}{l} P_L \rightarrow V_L \\ V_L \rightarrow M_L \end{array} \right] \right]$$

But there is something else about this presence as well. All other developments take place in it. That is, it provides a container of sorts in which the plays of implicit-power or system-power, implicit-knowledge or system-knowledge, and implicit-nurturing or system-nurturing can take place. This notion is summarized by the notation:

$$\text{Container} \begin{bmatrix} \text{System}_P \\ \text{System}_K \\ \text{System}_N \end{bmatrix}$$

Hence, combining these various components, an equation for 'system-presence' arises:

$$\text{System}_{Pr} \equiv TS_{0 \rightarrow N} \left[\begin{array}{c} \text{Presence} \\ \downarrow \\ \text{Opportunity} \end{array} \begin{bmatrix} P_L \rightarrow V_L \\ V_L \rightarrow M_L \end{bmatrix} \right] \& \text{Container} \begin{bmatrix} \text{System}_P \\ \text{System}_K \\ \text{System}_N \end{bmatrix}$$

Moving to observation #2: 'This progress happens in spite of tremendous opposition to it, again regardless of field and area. This points to a characteristic of implicit-power.'

We can refer to this implicit-power as system-power. Constructing an equation for system-power, we first give the notation System_p to system-power. Any endeavor will always be met with resistances of various kinds. We characterize resistance that arises along the physical dimension as P_R . We characterize resistance that arises along the vital dimension as V_R . We characterize resistances that arise along the mental dimension as M_R . In the fruition of any endeavor one or all of these types of resistances may arise. Further, resistance of one kind often feeds on resistance of another kind, and to generalize we may characterize the resistance encountered in an endeavor as the product of the three types of resistance:

$$P_R * V_R * M_R$$

These resistances arise across any considered Time-Space boundary from 0 to 'n', and therefore we may say that the power of the system is such that:

$$\text{power} > \sum_{TS=0}^N P_R * V_R * M_R$$

An equation for 'system-power' hence, is the following:

$$\text{System}_p \equiv \text{power} > \sum_{TS=0}^N P_R * V_R * M_R$$

Moving to the third observation: 'The right instrumentation and the right circumstances seem to be leveraged in order that the progress possible does happen. This points to a characteristic of implicit-knowledge that knows what to leverage and when.' This idea is consistent with the work of Cohen and Levinthal, who argue that the ability to exploit external knowledge is a critical component of innovative performance (Cohen and Levinthal, 1990). It is further reinforced by the work of Laursen and Salter, who investigate the influence of search strategies for external knowledge (Laursen and Salter, 2006). They have proposed the concepts of breadth and depth as two components of the openness of individual firms' external search strategies as critical in increasing innovation.

We can refer to implicit-knowledge as system-knowledge. Translating this into an equation, we begin with the notation of System_k for system-knowledge. This System_k is such that it leverages the right instrumentation and circumstance to bring about the progress that is possible. We notate this concept of 'instrumentation' by the subscript 'I'. We notate the concept of 'circumstance' by the subscript 'C'. Both instrumentation and circumstance can be of a physical, vital, or mental type and we notate this possibility by:

$$\begin{bmatrix} P_{I,c} \\ V_{I,c} \\ M_{I,c} \end{bmatrix}$$

Further, we depict the notion that the ‘knowledge’ is such that it ‘leverages’ the right instrumentation and circumstance by:

$$\begin{array}{c} \textit{Knowledge} \\ \downarrow \\ \textit{Leverage} \end{array}$$

This act of leveraging results in a fundamental shift so that the physical-leading yields to the vital-leading, and the vital-leading yields to the mental-leading. Hence:

$$\begin{array}{c} \textit{Knowledge} \\ \downarrow \\ \textit{Leverage} \end{array} \begin{bmatrix} P_{I,c} \\ V_{I,c} \\ M_{I,c} \end{bmatrix} \rightarrow \begin{bmatrix} P_L & \rightarrow & V_L \\ V_L & \rightarrow & M_L \end{bmatrix}$$

Since this behavior appears to be true across any Time-Space continuum we hence arrive at an equation for system-knowledge:

$$\textit{System}_K \equiv TS_{0 \rightarrow N} \left[\begin{array}{c} \textit{Knowledge} \\ \downarrow \\ \textit{Leverage} \end{array} \begin{bmatrix} P_{I,c} \\ V_{I,c} \\ M_{I,c} \end{bmatrix} \rightarrow \begin{bmatrix} P_L & \rightarrow & V_L \\ V_L & \rightarrow & M_L \end{bmatrix} \right]$$

Moving to the fourth observation: ‘The fact that this progress happens so that the degrees-of-freedom of the associated actors is continually increased points to an implicit-nurturing’.

We may refer to the characteristic of implicit-nurturing as ‘system-nurturing’. Like the other characteristics it appears to be true across a Time-Space continuum. This is depicted by:

$$TS_{0 \rightarrow N}$$

There is an action of nurturing such that any state is always advanced to a higher level. This is depicted by:

$$\prod_{\textit{Nurturing}} \begin{pmatrix} P_- & M_+ \\ V_- & V_+ \\ M_- & P_+ \end{pmatrix}$$

Hence, there is a ‘union’, depicted by ‘U’ that ‘nurtures’ the negatives towards their positives.

Further, there is an increasing action of nurturing such that the possibility of integration is always increased to form a larger and larger basis. This increasing basis is depicted as being modulated by the polar coordinates ‘r’ and ‘θ’, where r is the radius which increases from an initial value of ‘0’, and ‘θ’ is an angle from ‘0’ to ‘360’.

This notion of an increasing of ‘r’ and ‘θ’ is reinforced by the relatively recent phenomena of ‘Swift Trust’ as a form of trust occurring in temporary organizational structures, which can include quick starting groups or teams. It was first explored by Debra Meyerson and colleagues in 1996 (Meyerson and colleagues, 1996). In swift trust theory, a group or team assumes trust initially, and later verifies and adjusts trust beliefs accordingly. Traditionally, trust has been examined in the context of long-term relationships. The establishment of trust has been thought to rely largely on the history of a group and the interactions between members. This traditional view of trust generally assumes that

trust builds over time. However, this view is becoming problematic with the increase in globalization, change in technologies, and an increased reliance on temporary teams by organizations. Meyerson et al. propose that swift trust provides the necessary, initial, cognitive confidence for a temporary team to interact as if trust were present. However, swift trust requires an individual to verify that a team can manage vulnerabilities and expectations.

Hence, the equation of system-nurturing is depicted as:

$$System_N \equiv TS_{0 \rightarrow N} \left(\prod_{Nurturing} \begin{pmatrix} P_- & M_+ \\ V_- & V_+ \\ M_- & P_+ \end{pmatrix} \text{mod} (r, \theta) \right)$$

These four characteristics are true of the system we live in, and to denote this we generalize that every point in our system is embedded with this four-fold intelligence. This four-fold intelligence stands behind the play we exist in and is resident in every instant-spot of the system. To be able to leverage or activate this four-fold intelligence at will is the ultimate act of innovation since then these properties can incarnate in every endeavor.

ARCHITECTURAL FORCES

The characteristics embedded in a point suggest a level of innovation that is hard to fathom. One can only glimpse the extraordinary nature embedded in a point. And yet we can hypothesize that this extraordinary nature that is barely visible unless we set up the analytical lens of the sort suggested in Connecting Inner Power with Global Change, is responsible for a broader set of architectural forces that exist behind the visible face of things.

Hence, system-presence, system-power, system-knowledge, and system-nurturing that defines the nature of every point in our system, becomes more tangible as a broader set of architectural forces that emanate from each of them.

Considering system-presence, here is a characteristic that appears to be everywhere (Malik, 2009) at the service of all the constructs that develop within it. There is a diligence and perseverance by which any opportunity for progress is seized. Further, if one considers the extraordinary detail that appears in any construct, whether an atom, a body, a planet, or a galaxy, one is struck by the high degree of perfection that surfaces in this presence.

So if one contemplates the nature of this system-presence there is a set of forces that surface. Depicting such a set as $S_{System_{Pr}}$, one can arrive at elements such as Service, Perfection, Diligence, Perseverance, amongst others, that are part of this set. Hence, the set can be described as:

$$S_{System_{Pr}} \ni [Service, Perfection, Diligence, Perseverance, \dots]$$

Similarly, considering the characteristic of system-power, one can hypothesize that there is a family of forces that emanates from it. The kinds of forces may be thought of as Power, Courage, Adventure, Justice, amongst others. The set for system-power can hence be depicted as:

$$S_{System_P} \ni [Power, Courage, Adventure, Justice, \dots]$$

Similarly, considering the system-knowledge as the root of various powers that emanate from it, one may characterize the set for system-knowledge as:

$$S_{System_K} \ni [Knowledge, Wisdom, Law Making, Spread of Knowledge \dots]$$

The set for system-nurturing is:

$$S_{System_N} \ni [Love, Compassion, Harmony, Relationship \dots]$$

UNIQUENESS OF ORGANIZATIONS

The system we exist in is highly innovative. We have looked at four properties that define the source of the innovation. From this source emanate 4 sets of forces that help us understand the boundaries of the innovation. We also observe that no two organizations, regardless of scale, are alike. This uniqueness can be thought of as a further mechanism of the system we live in to ensure innovation.

In fact, a working hypothesis is that every organization, whether a person, team, corporation, market, or country is unique and that this uniqueness can be specified in terms of elements of the derived sets for system-presence, system-power, system-knowledge, and system-nurturing. Specifically, we may say that an organization's fount of uniqueness derives from one of the four properties.

Assuming then that the fount of uniqueness is system-presence, we can derive a general equation for organizations that belong to the family of system-presence. Let us refer to such uniqueness as Sig_x where the subscript 'x' refers to the source family, and 'Sig' or signature to 'uniqueness'. Hence the uniqueness of an organization in the family of system-presence would be notated by $Sig_{System_{Pr}}$.

Let us assume that there is a primary factor X that drives the uniqueness, and that this factor belongs to the set $S_{System_{Pr}}$. Let us assume that the uniqueness is further qualified by a number of secondary factors Y that may belong to any of the 4 sets - $S_{System_{Pr}}, S_{System_P}, S_{System_K}, S_{System_N}$. The primary factor X would have a greater weightage than any of the secondary factors Y. The weightage of X hence could be depicted by the number 'a', and the weightage of Y a number 'b_{0-n}', such that a > b. Further, the secondary element can repeat from '0 - n' times, and is hence depicted as $\overline{Yb_{0-n}}$.

The equation, hence for a unique organization derived from the family of system-presence is:

$$Sig_P. = Xa + \overline{Yb_{0-n}} \text{ where } \left[\begin{array}{l} X \in [S_{System_{Pr}}] \\ Y \in [S_{System_{Pr}}, S_{System_P}, S_{System_K}, S_{System_N}] \\ a, b \text{ are integers; } a > b \end{array} \right]$$

Similarly, an equation for a unique organization derived from the family of system-power is:

$$Sig_V. = Xa + \overline{Yb_{0-n}} \text{ where } \left[\begin{array}{l} X \in [S_{System_P}] \\ Y \in [S_{System_{Pr}}, S_{System_P}, S_{System_K}, S_{System_N}] \\ a, b \text{ are integers; } a > b \end{array} \right]$$

An equation for a unique organization derived from the family of system-knowledge is:

$$Sig_M. = Xa + \overline{Yb_{0-n}} \text{ where } \left[\begin{array}{l} X \in [S_{System_K}] \\ Y \in [S_{System_{Pr}}, S_{System_P}, S_{System_K}, S_{System_N}] \\ a, b \text{ are integers; } a > b \end{array} \right]$$

An equation for a unique organization derived from the family of system-nurturing is:

$$Sig_{1.} = Xa + \overline{Yb_{0-n}} \text{ where } \left[\begin{array}{l} X \in [S_{System_N}] \\ Y \in [S_{System_{Pr}}, S_{System_P}, S_{System_K}, S_{System_N}] \\ a, b \text{ are integers; } a > b \end{array} \right]$$

The four preceding equations can be generalized as:

$$Sig = Xa + \overline{Yb_{0-n}} \text{ where } \left[\begin{array}{l} X \in [S_{System_{Pr}}, S_{System_P}, S_{System_K}, S_{System_N}] \\ Y \in [S_{System_{Pr}}, S_{System_P}, S_{System_K}, S_{System_N}] \\ a, b \text{ are integers; } a > b \end{array} \right]$$

EMEREGENCE OF UNIQUENESS

While the uniqueness or organizations as represented by the Signature is a seed, like any seed there is a process for its emergence, and the uniqueness will often be hidden or very much behind the scene until certain conditions are fulfilled.

The implicit nature of Time and Space suggest a universal developmental model that gives us a cue as to the process for emergence (Malik, Deep Order Youtube). In this model the four sets of architectural forces already described form a pool in space, as it were, from which possibility arises. Possibility itself is unique from point to point and is governed by the Equation for Uniqueness described in the previous section. The emergence of this uniqueness is governed by the process we identified when discussing the implicit order in Time.

Hence we may observe that initially the uniqueness takes a 'physical' form, moving on to a 'vital' form, and then onto a 'mental' form. Once the orientations implicit in each of these phases are assimilated, then the uniqueness takes on an 'integral' form. The integral form is a threshold phase, and allows the uniqueness suggested by the Signature to emerge in fuller force or in its 'force' form. The final phase is the 'contextual form' that allows the signature to act with impunity within a considered context.

Mathematically, if an organization exists at the physical phase, we may hypothesize that its signature or uniqueness is modulated by the constant ' π '. π is the seed of a circle or sphere and can be thought of as defining behavior that is tightly bound. Within such a tightly bound volume it will likely not even be apparent what the uniqueness of an organization necessarily is. Assuming the uniqueness to be defined by the derived question *Sig*, the physical-level (P) behavior can be described by the following equation-segment where 'mod' signifies modulated-by:

$$P: Sig * mod(\pi)$$

If an organization exists at the vital level, we may hypothesize that its uniqueness is modulated by the Euler-constant 'e'. e is at the root of exponential behavior. The vital by definition is about assertive and aggressive growth the symbol of which, I would hypothesize' is 'e'. Hence vital-level (V) modulation (represented by 'mod') can be described by the following equation-segment:

$$V: Sig * mod(e)$$

If an organization exists at the mental level, we may hypothesize that its uniqueness is modulated by the Gaussian Distribution 'G'. G summarizes rational behavior with a key direction followed by most, and directions more and more on the edge followed by outliers. Mental-level dynamics are arguably quite similar, and I will hypothesize are best modeled by such a distribution. Mental-level (M) modulation (mod) can hence be described by the following equation-segment:

$$M: Sig * mod (G)$$

The physical, the vital, and the mental levels are orientations in which patterns of perceiving, being, behaving are set in their ways. Each pattern has its purpose and its limitation and it can be argued that being able to learn from each orientation and yet being able to move beyond that, is the next logical step in any developmental model. The integral level hence, is about being able to leverage each of the patterns that naturally arise at the three preceding levels at will, and about further, being able to integrate these and arrive at new ways of perceiving and being.

Mathematically I represent such behavior as being an integrative function ($\int x$) where 'x' is the ability to move between the patterns emanating from G, e, π , at will, represented by $\overline{G, e, \pi}$. Integral-level (I) modulation (mod) of uniqueness (Sig) can hence be represented by the following equation-segment:

$$I: Sig * mod \left(\int \overline{G, e, \pi} \right)$$

The condition of overcoming any fixed and limiting patterns is the prerequisite for the emergence of 'Force' or for entering into the force-level. At this level the uniqueness behind the particular development being considered can emerge in its purity and become a truly creative dynamic. I represent this aspect of creativity that is in a sense not bound by circumstance, by the constant 'c', the speed of light. Force-level (F) modulation (mod) of uniqueness (Sig) can hence be represented by the following equation-segment:

$$F: Sig * mod (c)$$

Once the signature of an organization arises and continues to exercise itself in its purity, it achieves contextual-mastery (C) and is able to exercise itself as though the context it is acting in, that can vary in scale and complexity, were all of the same substance as itself. This equality is represented by the integrative function ' $\int = 1$ '. The equation-segment that notates this contextual-level (C) modulation (mod) applied to organizational uniqueness (Sig) is hence:

$$C: Sig * mod \left(\int = 1 \right)$$

Piecing all the equation-segments together the equation for the emergence of uniqueness (Sig_E), where 'X' can be any of the discussed modulations at the respective development-model levels (P, V, M, I, F, C), is hence summarized as:

$$Sig_E = X \left[\begin{array}{l} C: Sig * mod \left(\int = 1 \right) \\ F: Sig * mod (c) \\ I: Sig * mod \left(\int \overline{G, e, \pi} \right) \\ M: Sig * mod (G) \\ V: Sig * mod (e) \\ P: Sig * mod (\pi) \end{array} \right]$$

VARYING CULTURE OF ORGANIZATIONS

Having defined an equation for the uniqueness of an organization it now becomes possible to also derive equations for the culture of an organization. The essential variables in the equation for

uniqueness are the X and Y elements, where X is the primary element that defines that organization's uniqueness and Y are the secondary elements that support or nuance the primary element. X is an element of the X_{Set} , which is the set comprised of elements from $S_{System_{Pr}}$, S_{System_P} , S_{System_K} , and S_{System_N} . The Y elements are derived from the Y_{Set} which is also a set comprised of elements from $S_{System_{Pr}}$, S_{System_P} , S_{System_K} , and S_{System_N} .

In thinking about variation in culture derived from the same primary element, the variable factor is hence the number of elements in the Y_{Set} . The hypothesis is that the more the number of secondary elements, the more diverse and hence the more stable and innovative the organization will be. If we think of an organization as having multiple levels, then an equation that will define a monoculture is hence the following:

$$\text{Monoculture: } elements_{Y_{set(n)}} = elements_{Y_{set(1)}}$$

What this equation is basically stating is that at some level 'n' the number and make-up of elements are exactly the same as the initial seed-state from which the organization culture emerged. Such an organization may do well in a very specific circumstance, and probably the one it was created for. However the reality is that change is the only constant and therefore when faced with a different set of circumstances this organization will not have the source of innovation to allow it to respond differently. It will likely destabilize and go extinct.

By contrast, the equation for a diverse culture is:

$$\text{Diverse Culture: } elements_{Y_{set(n)}} \propto (1 + g)^n$$

In this equation the number and make-up of elements at some level 'n' in the organization is different than any level that precedes it. The difference is related to an exponential function where 'g' is a growth factor that will increase, likely linearly, as the organization gets more and more complex, and 'n' is the level down in the organization starting from level '1' which is the executive level. The diverse culture will have many more sources of innovation when faced with change because of the plethora of secondary elements that support the primary element.

INHERENT DYNAMICS OF OUR SYSTEM

So far we have considered the inherent innovation that exists at the system level, summarized by the nature of a point. We have considered how this deep fount of innovation is present everywhere, and further have explored sets that make more practical the range of creative forces available in each of the four components of a point. These architectural forces further define the possibility inherent in our system available to us. Leveraging these sets of forces we were able to arrive at an equation for the uniqueness of an organization, regardless of scale. We were further able to consider what made for an innovative versus a stagnant culture.

In some sense we have traced the precipitation of innovation from the barely perceptible nature of the ubiquitous point, to how this reveals itself to us a play of forces, to how organizations take their seed and grow from that.

We now turn full-circle to return to the initial orientations that allowed us to hypothesize so much about the nature of innovation in the first place. Now we look deeper into the nature of the

physical, the vital, the mental, and the integral, and derive equations that in effect give us further insight into the dynamics of innovation inherent in these orientations.

We glimpsed the negative and positive sides of the physical, the vital, and the mental in the first set of equations that approximated the conditions of Stagnation, Stability, Entropy, Energy, Fragmentation, and Sustainability.

Here we take a deeper look at the dynamics inherent in each of these orientations that can allow the shift from the negative to positive, or in other words, that reveal the process of innovation in these fundamental orientations.

Such shifts will increase the spread in taxonomies of novelty of innovation to span from radical and truly revolutionary, such as the microchip, to the incremental, such as changing packaging on existing products (Henderson and Clark, 1990). The shift to the positive will allow birthing of radical innovations that seem to offer the greatest opportunity for performance differences (Marsili and Salter, 2005). Tushman and Anderson classify radical innovation in terms of ‘competence enhancing’ (positive) or ‘competence-destroying’ (negative, reflecting the different ways novel innovations alter patterns of industrial competition among firms working within the industry (Tushman and Anderson, 1986; Anderson and Tushman, 1990).

Hence, starting with the physical, we arrive at an equation summarized as:

Physical

$$= \begin{bmatrix} M_3 \rightarrow System_{pr} \\ (\uparrow F \rightarrow I) \\ M_2 \rightarrow S_{System_{pr}} \\ (\uparrow Sig \rightarrow F) \\ M_1 \rightarrow Sig_P \\ (\uparrow > P_P) \\ U \rightarrow Physical_U \end{bmatrix} TC \rightarrow Physical_T, \text{ where } \left[\begin{array}{l} Physical_U \ni [inertia, lethargy, status quo, \dots] \\ Physical_T \ni [adaptability, durability, strength, \dots] \end{array} \right]$$

Essentially this equation is laying out the conditions of moving from the untransformed or negative physical state represented by *Physical_U* to the transformed or positive physical state represented by *Physical_T*.

The first matrix should be read from the bottom to the top:

$$\begin{bmatrix} M_3 \rightarrow System_{pr} \\ (\uparrow F \rightarrow I) \\ M_2 \rightarrow S_{System_{pr}} \\ (\uparrow Sig \rightarrow F) \\ M_1 \rightarrow Sig_P \\ (\uparrow > P_P) \\ U \rightarrow Physical_U \end{bmatrix}$$

Hence, at the bottom we have the starting point ‘*U → Physical_U*’ which identifies the default or untransformed (U) level of the physical. The next row up, (*↑ > P_P*), states that when we have overcome (>) the patterns of the untransformed physical (*P_P*), then we move to the next level (↑). Breaking through to the next level, *M₁ → Sig_P*, allows its dynamics to become active. Hence, the signature or uniqueness of the physical (*Sig_P*) becomes active at meta-level 1 (*M₁*). As this signature becomes more like a Force (*Sig → F*), the conditions for breakthrough (↑) to the next level

are achieved. This next level is referred to as meta-level 2 (M_2), and indicates that the architectural forces represented by the set of system-presence (S_{System_p}) have become more consciously active. When this Force becomes Integral ($F \rightarrow I$) then the conditions for breakthrough (\uparrow) to the next level are achieved. The next level is notated as M_3 for meta-level 3, and the dynamics here indicate that the equation for system-presence becomes active. Becoming active basically means that the respective meta-level dynamic begins to act at the once 'untransformed' level (U) further modifying it. Modification or transformation began when M_1 became active. Transformation is accelerated when M_2 becomes active, and even further accelerated when M_3 becomes active.

The rate of the transformation can be better envisioned when considering action of the Transformation Circle, or TC. The TC can be thought of as 4 concentric circles, with M_3 at the center. M_3 is surrounded by M_2 , which is surrounded by M_1 . The outer circle is U. If we consider the TC to be a clock, than at time 't = 0', the physical' can be thought of as being entirely in U. The clock starts ticking only when some initial patterns P_p are overcome ($>P_p$). From this point on as time proceeds the conditions for breakthrough become riper, and a sinusoidal wave begins to integrate more of the concentric circles together. The sinusoid wave (sin) is itself modulated by an euler function, e^x , where 'x' is determined by the strength to overcome patterns (\uparrow) which will likely vary over time but net-net will be positive once the clock has started ticking because of the joy experienced with progressive movement. Being that the limit is the outer boundary of the concentric circles, there is further modulation by π until the 4 concentric circles have been integrated. TC, hence, may be represented by:

$$TC \equiv (> P_p) \rightarrow \text{mod}(\sin, e^x, \pi)$$

Hence, the initial nature of the physical that may be characterized by the set comprising of elements such as inertia, lethargy, acceptance of the status quo, amongst other such elements ($Physical_U \ni [inertia, lethargy, status quo, \dots]$), transforms into a physical more characterized by elements such as adaptability, durability, strength, and so on ($Physical_U \ni [inertia, lethargy, status quo, \dots]$). This transformation represents the inherent innovation-dynamic within the Physical.

Similarly, the equation for the 'Vital' also shows the built-in transformation that represents the innovation-dynamic within the vital:

Vital

$$= \begin{bmatrix} M_3 \rightarrow System_p \\ (\uparrow F \rightarrow I) \\ M_2 \rightarrow S_{System_p} \\ (\uparrow Sig \rightarrow F) \\ M_1 \rightarrow Sig_V \\ (\uparrow > P_V) \\ U \rightarrow Vital_U \end{bmatrix} TC \rightarrow Vital_T, \text{ where } \begin{bmatrix} Vital_U \ni [aggression, self centeredness, exploitation, \dots] \\ Vital_T \ni [energy, support, adventure, enthusiasm, \dots] \end{bmatrix}$$

The equation for the 'Mental' is similarly summarized as:

Mental

$$= \begin{bmatrix} M_3 \rightarrow System_S \\ (\uparrow F \rightarrow I) \\ M_2 \rightarrow S_{System_S} \\ (\uparrow Sig \rightarrow F) \\ M_1 \rightarrow Sig_M \\ (\uparrow > P_M) \\ U \rightarrow Mental_U \end{bmatrix} TC \rightarrow Mental_T, \text{ where } \begin{bmatrix} Mental_U \ni [fixation, fundamentalism, fragmentation, \dots] \\ Mental_T \ni [understanding, imagination, inspiration, \dots] \end{bmatrix}$$

The equation for the 'Integral' is similarly summarized as:

Integral

$$= \begin{bmatrix} M_3 \rightarrow System_N \\ (\uparrow F \rightarrow I) \\ M_2 \rightarrow S_{System_N} \\ (\uparrow Sig \rightarrow F) \\ M_1 \rightarrow Sig_I \\ (\uparrow > P_I) \\ U \rightarrow Integral_U \end{bmatrix} TC \rightarrow Integral_T, \text{ where } \begin{bmatrix} Integral_U \ni [possession, usurpation, hidden agendas, \dots] \\ Integral_T \ni [appreciation, shift POV, MPV, synthesis, \dots] \end{bmatrix}$$

Equations for Stagnation and Dynamic Growth

Considering the equations for the Physical, the Vital, the Mental, and the Integral, we see the implicit reality of innovation present within them. This sense of innovation is embedded within these fundamental orientations. But as the Transformation Circle, TC, indicates, each of the respective untransformed sets transforms to each of the respective transformed sets only if TC becomes active.

An easy way, hence, to characterize stagnation (or the lack of innovation) and dynamic growth (the presence of innovation) is through the following generalized equations where 'x' can be thought as the Physical, the Vital, the Mental, or the Integral.

The generalized equation for Stagnation hence is:

$$\frac{d(TC_x)}{dt} \leq 0$$

The generalized equation for Dynamic Growth is:

$$\frac{d(TC_x)}{dt} > 0$$

The theory presented here suggests enhancements to the field of System Dynamics and Systems Thinking pioneered by such people Forrester, Sterman, Meadows, Checkland, amongst others. More systematic research would need to be conducted to understand the self-organizing characteristics of system-power, system-knowledge, system-presence, and system-nurturing.

CASES

The theoretical framework and equations presented in this paper are being concretely applied to increase the level of innovation in several leading organizations in different parts of the world. Presented here are some mini-cases of their application:

1. At a Silicon Valley hi-tech company the fundamental equation for dynamic growth, $\frac{d(TC_x)}{dt} > 0$, is being ingrained into the culture by bringing about a conscious four-fold shift from:

$$Physical_U \rightarrow Physical_T$$

$$Vital_U \rightarrow Vital_T$$

$$Mental_U \rightarrow Mental_T$$

$$Integral_U \rightarrow Integral_T$$

This is being achieved by building awareness at the individual and team operating levels through the use of specific Software-as-a-Service (SaaS) technologies designed to facilitate these shifts (Deep Order Technologies, Analytics).

2. At one of the world's leading Academic Centers based in Silicon Valley, the general issue of facilitating emergence of uniqueness was addressed through facilitating teams through the Sig_E journey summarized below. Specifically the use of the same SaaS technologies (re: Deep Order Technologies, Analytics) was used to accelerate the journey through the P, V, and M levels:

$$Sig_E = X \begin{bmatrix} C: Sig * mod \left(\int = 1 \right) \\ F: Sig mod (c) \\ I: Sig mod \left(\int \overline{G, e, \pi} \right) \\ M: Sig * mod (G) \\ V: Sig * mod (e) \\ P: Sig * mod (\pi) \end{bmatrix}$$

Some reporting of this journey appeared in Forbes (Skibola, 2011) in 2011. A similar journey was undergone by the Officer cadre of the Indian Armed Forces over a multi-year period, using a similar approach and technology.

3. At one of the world's leading eye hospitals the challenge of building sustainable, innovative culture as represented by the Sig equation was pursued:

$$Sig = Xa + \overline{Yb_{0-n}} \text{ where } \begin{bmatrix} X \in [S_{System_P}, S_{System_P}, S_{System_K}, S_{System_N}] \\ Y \in [S_{System_P}, S_{System_P}, S_{System_K}, S_{System_N}] \\ a, b \text{ are integers; } a > b \end{bmatrix}$$

The emphasis was on understanding the sets of architectural forces that a group of highly specialized physicians will ideally thrive in, and re-orienting the organization to that set of forces. Individual and Team DNA technologies (Deep Order Technologies, Organizational DNA Determination) were leveraged in achieving this.

CONCLUSION

We live in a deeply innovative system. Empirical observation, regardless of field, indicates the natural movement from the physical, to the vital, to mental orientations. This gives insight into the implicit nature of Time in our system. The question as to what the implicit order in Time tells us leads to the hypothesis of four macro-characteristics true regardless of location, and hence point to an implicit nature of Space in our system. The need to consider Time and Space differently must give rise to a different set of causal organizational and system models. The starting point for reconsidering any such causal model is the nature of each point in our system. We find that each point is embedded with system-presence, system-power, system-knowledge, and system-nurturing. This implicit nature is the fount of a large set of architectural forces that seek to seed themselves into any developmental effort. Hence any organization regardless of scale is unique, and its uniqueness is determined by the combination of architectural forces. While these three sets of conditions, meta-level 1 being the uniqueness of an organization, meta-level 2 being the set of architectural forces from which uniqueness is determined, and meta-level 3 being the implicit nature of a point, stand behind each practical orientation, each practical orientation (the physical, the vital, the mental, the integral) begins by being more untransformed, and through the action of the meta-levels gradually becomes more transformed. This movement from the untransformed to the transformed orientations reinforce the inherent innovation prevalent in our system. We hence see innovation precipitating from the barely visible level, meta-level 3, to the closely practical level, the untransformed. These observations and the equations derived suggest a vastly different way of mobilizing and managing innovation in general.

This paper also suggests several potential areas of further research. In particular:

1. The theory presented here suggests enhancements to the field of System Dynamics and Systems Thinking pioneered by such people Forrester, Sterman, Meadows, Checkland, amongst others. Research would need to be conducted to understand the self-organizing characteristics of system-power, system-knowledge, system-presence, and system-nurturing identified in this paper.
2. While equations have been derived for the physical, vital, mental, and integral, these suggest the need for additional research to systematically understand the process by which $X_U \rightarrow X_T$, that is, the process by which the untransformed set becomes the transformed set. Related to this research on the best way in which meta-levels precipitate into the untransformed levels would also need to be structured and conducted.
3. While stability in general is perceived as being enhanced by diversity, the equations for mono-culture and diverse-culture with their implications on stability need to be backed by research.
4. The equation for uniqueness and emergence of uniqueness need to be validated with additional research.
5. While several cases have been mentioned that leverage the innovation framework described here through the use of SaaS-based software, the lasting effects on innovation will also need to be researched.

6. Tertiary-based approach to innovation and research into the bases of a fractal representation needs to be elaborated.

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