

Trayectorias Evolucionistas en la Dinámica Innovadora de la Empresa

“Evolutionary Effectiveness’s Dynamics of Enterprise Innovation”

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Industrial Engineering Msc. Thesis

Industrial Economy Emphasis

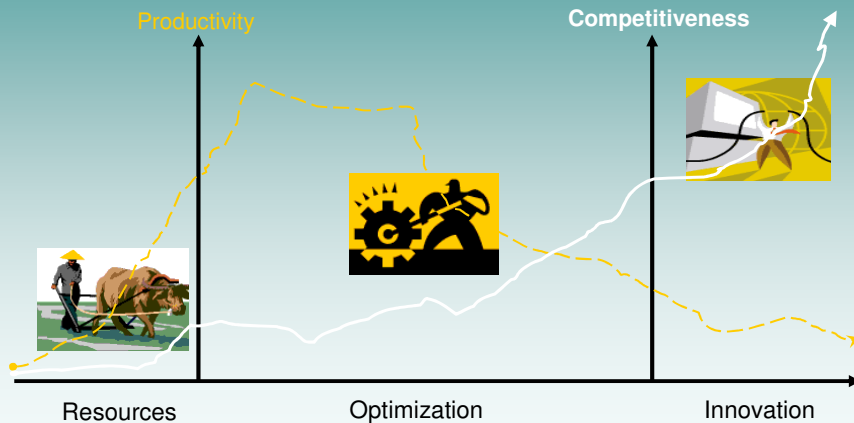
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A Description of Evolution in the Paradigm of Enterprise Development

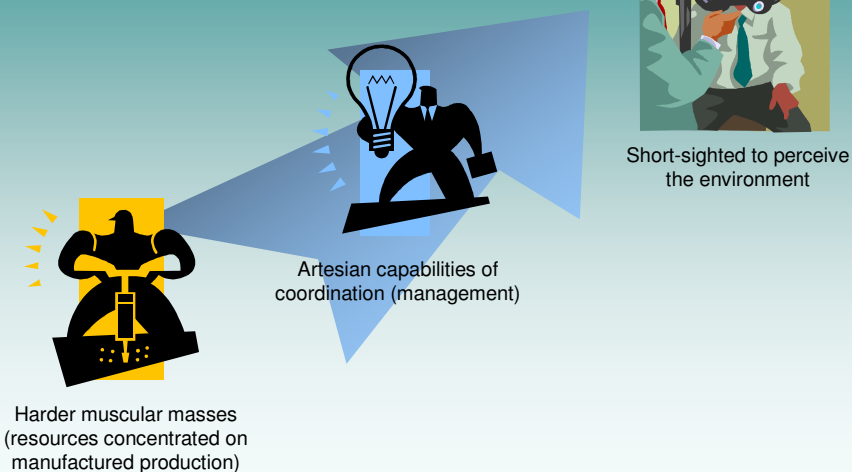


1. Contextual Antecedents in Colombian Enterprises

- *On Innovative Ambit*
 - enterprises are informally focused at problem solving not planned
 - changes are adopted (better, modifications) *on course*
 - strategic objective try to reduce both of risks and uncertainty
- *Organizational value chain discontinuous*
 - Sources of innovative ideas are exclusive domain of directives
 - activities are executed by “basic” production personal

(PDTIC, 2005)

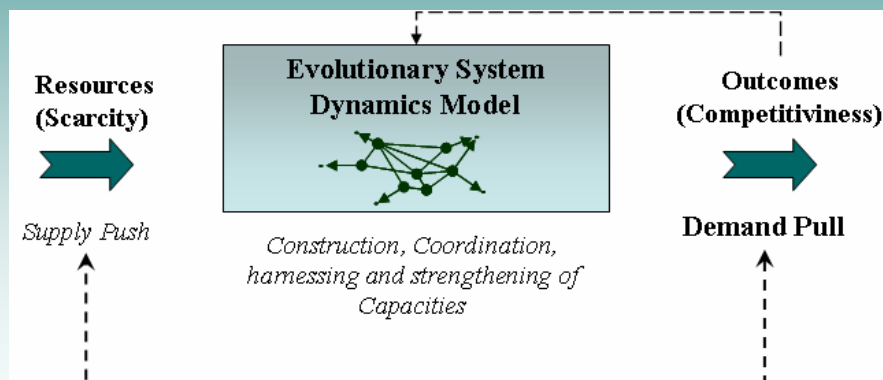
A Metaphorical Approach at Enterprise with Human Being



2. Description of Problem Situation

- Colombian enterprises are reactive and inertial
 - Resources scarcity
 - Strategic aims, lost!
 - ¿Why do the businessmen retrospectively define their successful as intelligence, but the failures as an exclusive exogenous impact?
- Exploration of underlying structure
 - Understand the evolution of innovative enterprises
 - Find leverage and intervention points of their strategic behaviour

Evolving Limitations as Opportunities From Black Box Focus...at endogenous leveraging!



3. Methodological Strategy: Evolutionism and System Dynamics

- On theory, understand the systemic determinants of organizational structure for evolving innovation
- On practice, this empiric analysis enable the identification of both weaknesses and limitations
- Implementation of focus areas to stimulate connections and synergies

4. Evolutionary Paradigm

- Lamarck holds that the natural selection intrinsically is “intentioned”
 - develop properties for mutataion and adaptation (Harris, 1991)
 - change sources aren't exclusives at environment
- Strategic and structural identity for selection and diffusion
 - living systems are informational and operationally “closed systems” (Maturana & Varela, 1994)
 - social systems selection their environment from their own function - strategic and structural possibilities (Luhmann, 1994)
 - different structures can explain a same functional identity, dynamically stable (Etkin & Schvoastein, 1992)

Axioms

- *Selection* eliminates diversity
 - Internal (tactical and adaptative)
 - Reactive
 - Structures and capabilities historically developed and learned.
 - Positivist: the environment is an object.
 - External (evolutionary)
 - Proactive
 - Structures of strategic future selection
 - Deliberated efforts: construct their environment
- The *mutation* processes increase diversity
- The *adaptation* process may be competitive (equilibrated -static)

5. Evolutionary Economy

- Endogenous Behaviour (Dosi & Nelson, 1994)
- Evolution as an accumulative process of information with selective retention (Winter, 1991)
- Variety is consequence of differentiation and diversification (innovation strategies)
- Diffusion, absorption and selection are according to strategic nature of firm (knowledge and internal structure)

Characteristics of economies (Arthur, Durlauf & Lane, 1991)

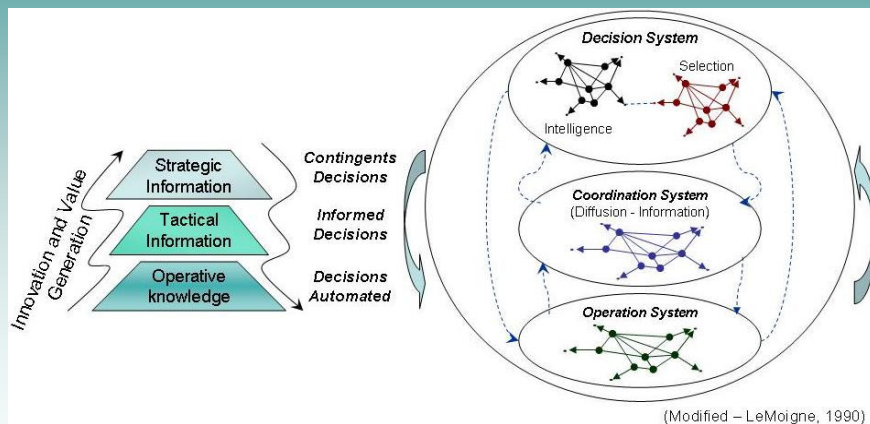
- “*Dispersed Interaction*”, heterogeneous and parallel
- “*No Global Controller or Cause*”, coevolution of interactions
- “*Many Levels of Organization*”, lower levels create contexts at higher levels
- “*Continual Adaptation*”, revise their adaptive behavior continually
- “*Perpetual Novelty*”, by changing in ways that allow them to depend on new resources, coevolve with resource changes to occupy new habitats
- “*Out-of-Equilibrium Dynamics*”, are induced by the pressure of trade imbalances: individual to individual, firm to firm

Criteria

- *Productive function isn't generic* (Schumpeter, 1961)
 - Differences through learning process (from innovation)
 - Externalities break static equilibrium (Schumpeter, 1978)
- *Learning processes dependence* (Cohen & Levinthal, 1990)
 - Actual knowledge level
 - Intensity of efforts to create a dynamic offer (Robinson & Siles, 2001).
- *Technologic and social co-evolution* (Lundvall, 2004)
 - Asymmetric generation, diffusion and application of knowledge (Coombs & Rod 2001; Jacoby, 2005; Lazaric & Raybaut, 2004)
 - Synchronism between offer and demand adaptability (De Fraja, 2004)

6. Focusing Elements for Modelization

Enterprise as Complex System Integrating Strategy and Evolutionary Focuses



Innovation on the Endogenous Evolutionary Frame of Enterprise

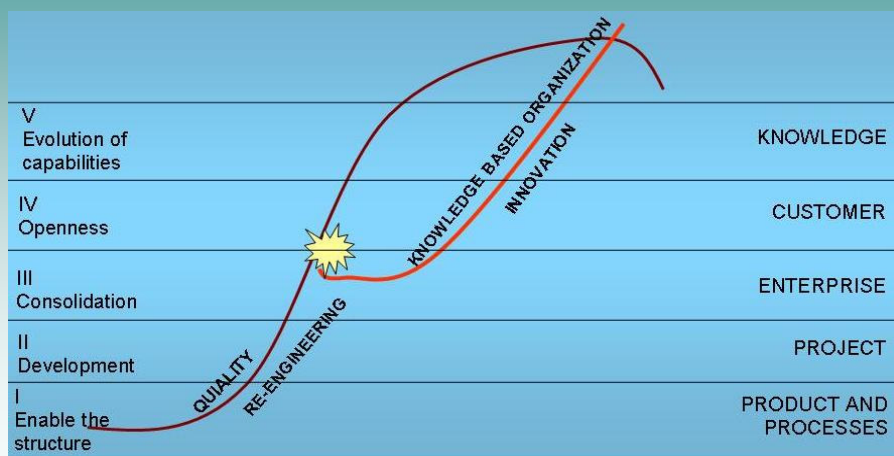
- According to Nelson & Winter (1977):
 - Production as combination of factors
 - Innovation as change on combinations

$$\text{Outcome} = \frac{\text{Outputs}^*}{\text{Inputs}^{**}} \begin{matrix} \longleftrightarrow & \text{Innovation (Focus by demand)} \\ \longleftrightarrow & \text{Efficiency (Focus by ofert)} \end{matrix}$$

* Product

** Factors

Transition from Optimization at Innovation Points of Emphasis in Endogenous Development

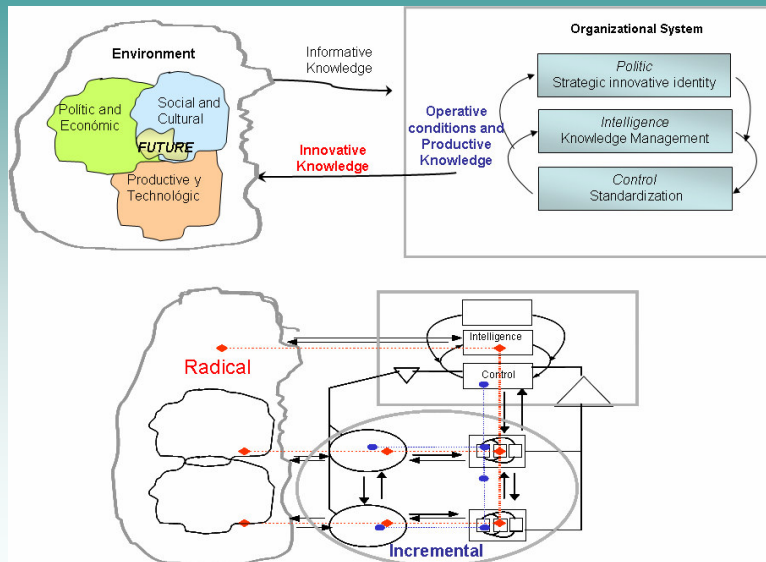


(Modified - Handy, 89)

Functional Structuralist Analysis

- Was identified 3 recurrent levels of relation and intervention:
 - Structural
 - Internal coherences (*productive* parts and relationships)
 - *Viability* of organization on environment
 - Functional dynamics (*informative, productive, or innovative*)
- From this, was found 3 capital levels on organization:
 - *Intellectual (strategic)*, quality of Human resource
 - *Structural (operational)*, common property
 - *Relational (systemic)*, complements

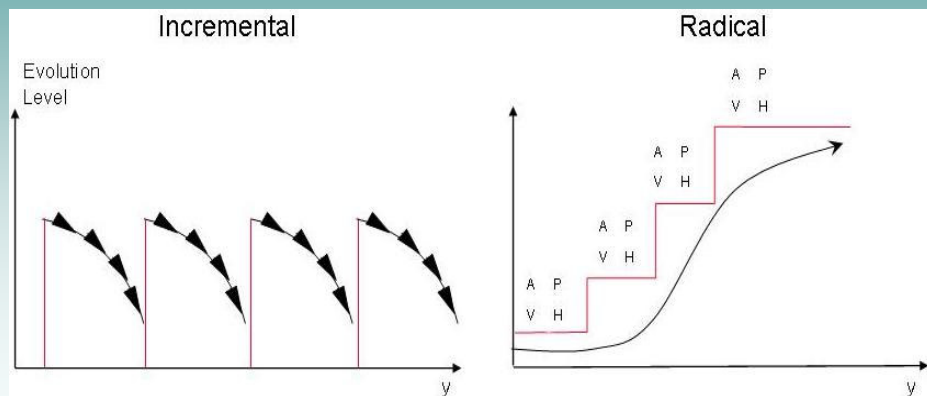
Innovative Scenarios as Structural Control Based on Knowledge



Characterization of Reference Modes of Enterprise's Endogenous Development

- *Incremental*
 - Stationary equilibrium
 - *Order and structuration* (Gomulka, 1960)
 - Repetitive trajectories, only changed by exogenous objects
- *Radical*
 - “unbalanced control”, but not uncontrolled (i.e. strategic and consciousness)
 - Dynamic equilibrium (advantages on short time)

Reference Modes of Evolutionary Trajectories



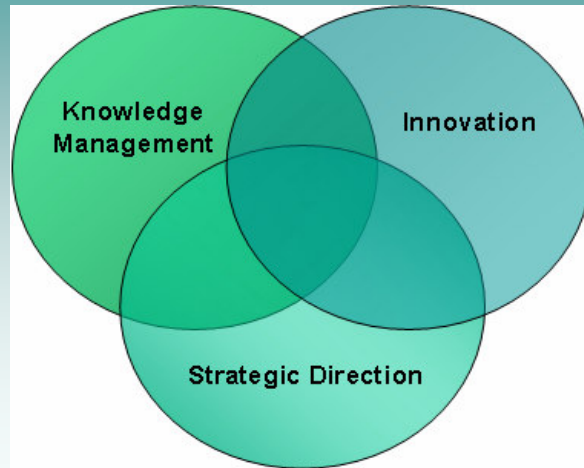
Characterization of Scenarios Identified From Endogenous Development

Organization	Incremental (inertial)	Radical (dynamic)
Market signals	Stables	Dynamics
Living cycle	Large	Short
Politic	Specialization	Integration
Strategy	Quality (imitation)	Creativity (innovation)
Structure	Homogeneous (vertical integration)	Heterogeneous (diverse through externalization)

Dynamic Hypothesis of Strategic (*evolutionary*) Behaviour

- Lazonick and Sullivan (2000)
 - *Sustained strategic agreement (resources)*
 - *Organizational compromise (incentives)*
 - *Strategic integration (Intra and Extra organizational)*

Unfolding Strategy Based on Innovative Knowledge



7. General Description of Strategic and Structural Influences on Evolutionary Dynamics Framework

Causal Variables Definition (Setting up)

- *Diversity of Strategic sources of Innovation*
- *Absorption (diffusion) of environment by organization. Synergies*
- *Evolution. Intensity of qualified work*
- *Strategic integration (integral). Cognitive asymmetries*
- *Cognitive mobilization. Disconcentration of production, and mobilization of qualified agents to soft strategic areas*

Diffusion, Absorption and Strategic Selection (Heuristics of “coevolutionary causal dynamics”)

- On historic sense, radical innovations annul the efficiency of ancestral routines of information
- This imply an inertial response in front of radical changes, to maintain stables the “technical coefficients” (Nelson & Rosenberg, 1998)
- The incremental specialization reduces the probability to find diversity of trajectories (EDT, 1996)
- Initial knowledge facilitates the learning of new relational knowledge as an accumulative process (Simon, 1961; March, 1963)
- As consequence, the local knowledge bounds the selection and diffusion on a common and inertial horizon

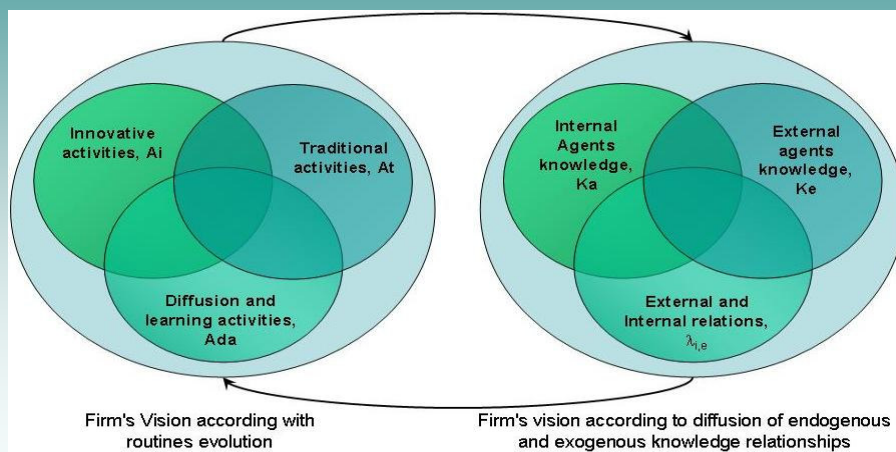
- Cooperation with other varied agents enable both of channels and sources of innovation.
- Not concentrated structures (more complexes, flexible and diversified) mobilize agents on quantity and quality to soft areas (division of work) with better outcomes (EDT, 1996).
- Firms with more qualified agents and innovative activities are more diversely articulated (PDTIC, 2005).
- Radical innovations have sources and influences more diverse.
- Effective learning is produced by conversion of explicit and tacit knowledge on an strategic pointed frame (Kim, 1998; 2001; Nonaka y Takeuchi, 1995).

- Influences of learning process:
 - Base of being knowledge (Cohen & Levinthal, 1990)
 - Intensity of the strategic effort (Kim, 2001)
- If the knowledge's density increases, the intensity of innovative activities increases too, and decrease both of differentiation and specialization (Saviotti, 1994)
- More relative efficiency of strategy in last period take more life-size or intensity on present time (Schumpeter, 1978)
- Innovation don't increase indefinitely, as cause of other agents pressure (*innovation mechanism*, Downie, 1958).
- The efficiency mean permanently growths. Only is deadened if strategy decline or is restrictively practiced

Articulation of the Model

- Organizational System typifying
 - n agents (a , Internal; e , External)
 - Different knowledge, k_a (tacit or articulated), specific and asymmetric structurally.
- Integration on organizational strategy, through 3 practices (Nelson, 2004):
 - Innovative activities, A_i
 - Traditional Activities, A_t
 - Diffusion activities (learning, strategic adaptation), A_{da} .

Dialogic Causality and Synergies on Evolutionary Process



Dynamic Structures Modelization

- Different structures along the F_y time determinate different functional forms of knowledge (K) and activities (A)

$$F_y \geq \sum_0^y \{A_i \cap A_t \cap A_{da}\}$$

where, $A_{da} \geq \sum_{a=1}^n K_a, \forall agents$

, on time y

- Therefore, evolutionary dynamics not only depend of knowledge level...
- Effectiveness on organizational development as system (*i*nternal and *e*xternal integration), diversifying the organizational management.
- This criterion enable the existence of intersections as learning diffusion (l_i, l_e).

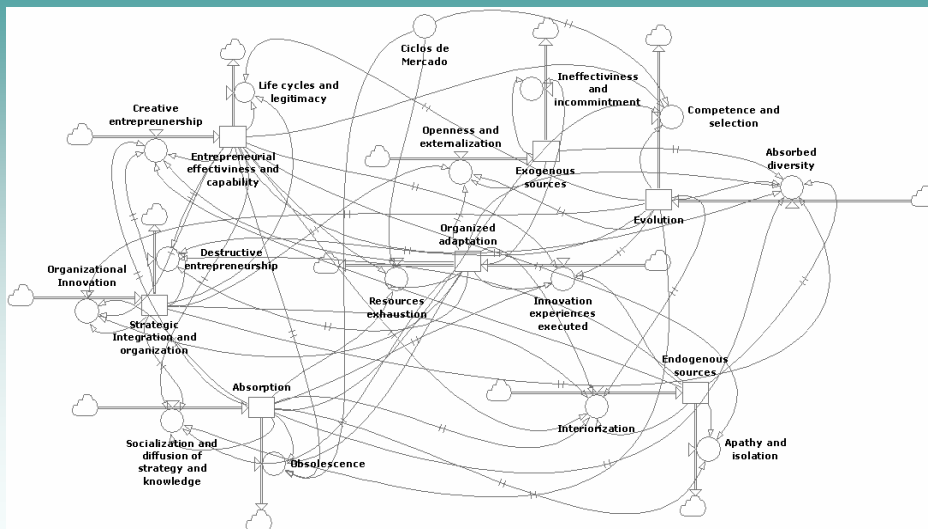
$$E_T = \{ \lambda_e (A_i)^{K_e} + \lambda_i (A_t)^{K_a} + \lambda (A_{da})^{(K_e + K_a)/2} \} / 3$$

where $K_e, K_a \in (0,1] \wedge \lambda_i, \lambda_e, \lambda \in [0,1]$

- The evolutionary condition suggested, implies that the expansion of innovative activities must be bigger than traditional, inertial for organization on environment reference.

$$\left(\frac{[\partial A_i / \partial y]}{A_i} \right) > \left(\frac{[\partial A_t / \partial y]}{A_t} \right)$$

System Dynamics Model



Analysis of the Model

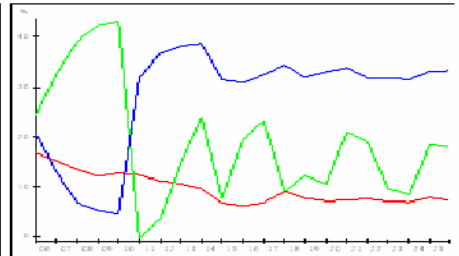
- Intervention variables: Strategic Integration, *Organizational Innovation*
- Normal Conditions: Low Levels (not innovative, inertial)
- Stimulation through pulses in the 3rd year on control variables on different ranges from 4% to 20%.
- Control Variables:
 - Organizational absorption of knowledge, *red line*
 - Enterpriser's Capacity and effectiveness, *blue line*
 - **Evolution level, *green line****

Obtained Trajectories

Action on the model	Obtained scenario
<p><i>Original scenario (Inertial, 0)</i></p> <p>Structure within stimulus. Trajectory that radically decreases and disappear.</p>	
<p><i>Reactive scenario (Inertial, 1)</i></p> <p>Stimulus at 4%. Behaviour of which attempt to reaction jumping, hasn't inefficacy.</p>	

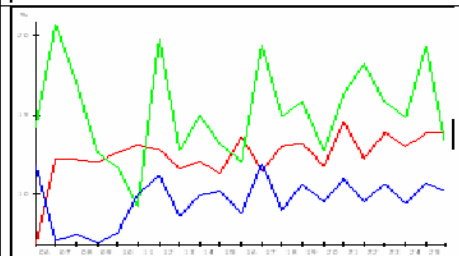
Transition at Incremental (2)

Stimulus on 8%.
Behaviour with periodic and constant adjusts.



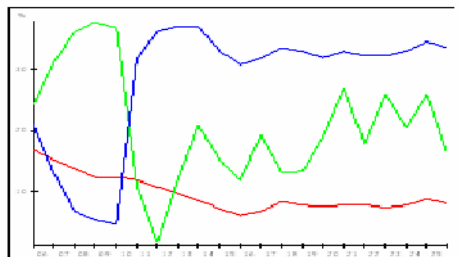
Incremental stabilization (3)

At 12% the behaviour has
incremental modified cycles
that slowly growth.



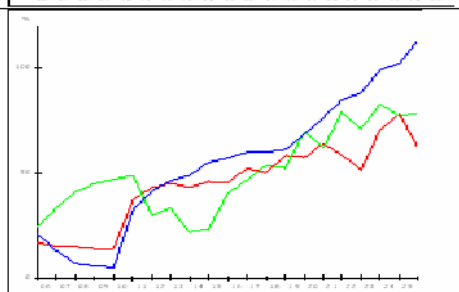
Transition to Radical

On 16% the model present
reaction with incrementally
scalable pardons, on a slow but
growing behaviour.



Radical stabilization

Leveraging at 20%, develops a
sigmoid behaviour through
steps from continuous jumps.



Leveraged Points (path dependencies)

- Adoption of specialized strategies (incremental) decreases diversity of evolutionary trajectories.
- Technologic and social co-evolution as structural imperative for sustained development.
- Differences on emphasis of firm's strategies are determinants to specific differences on trajectories.
- Structural restrictions and evolutionary requests demand an opening organizational system.
- For an Introjected innovative strategy as organizational identity, their management need a knowledge contract.
- Strategic value of innovative knowledge: it generates and replicate synergies and don't lose its value.

Synthesis

- Flexible organizations at exogenous influence of environment need a stable strategy (of innovation)... this is an integral dilemma of the firm...
- ... proposed as mean as aim, because:
 - *Mean*, enable (re) generation and (re) articulation of innovative knowledge
 - *Aim*, as diversified specialization from positive externalities.
- Emphasis on innovation as competitive possibility has as fundamental challenger the design of a flexible structure one to support 3 strategic objectives:
 - Differentiation (through diversity)
 - Efficiency (support structure)
 - (Development of) Process development (effectiveness of sustained strategy)
- A simple leverage point enable the structure for the innovative strategy.

Concluding... Tree's Diagram

- A metaphor from biology, as an evolving tree,
 - Root: Strategic nucleus of cultivated skills
 - Trunk: Incorporation of new processes and managing modes.
 - Fruits: Facilitation of innovation
- As consequence, it requests major:
 - Learning capacities: leveraging the construction of capacities that dynamists the endogenous and logistic growth
 - Strategic management: parallels and permanent generation of adequate social conditions



Future proposal key issues in organizational complex systems

- The model was aimed to improve and converge scientific justification logic from models aimed at practical usefulness...
 - Should they be of different construction?
 - Are there “simple rules” for agent modelers that might give guidance on the simple/complex dimension?
- Models, Proof, and Prediction?
- How to define minimum validation requirements? All agent rules based on stylized facts? Are agent models testing, or simply assuming order-creation theory?
- If agent models are about how structure emerges from the interactions of heterogeneous agents, and if it is about equilibrium processes, then how can the model shift from one regime to the other?

Recomended Referents

- Stanley Salthe (1985). *Evolving Hierarchical Systems*. p. 75.
- Salthe (1991). *Development and Evolution*.
- Van de Vijver, Salthe, and Delpos (1998). *Evolutionary Systems*.

Asking Questions...?

