4.2.4.5 Multi-Level *Nesting*: Product-Organizational Architecture Mapping

An overarching research question in this intellectual domain has been: "We know that organizations design products, but do products design organizations?" Recent research has observed that products do not design organizations, but knowledge does (Brusoni, 2006).[619]

> *"**Modular products can lead to modular organizations**, as product design rules define both the technological and organizational architecture of the firm (e.g. Sanchez and Mahoney, 1996; Shilling, 2000; Sturgeon, 2002; Langlois, 2003). Empirical studies questioned such findings: **non-modular organizations that produce modular products** were observed in the aircraft engine (Prencipe, 1997), hard disk drive (Chesbrough and Kusunoki, 2001) and automotive industries (Takeishi, 2002). These studies illustrated that firms consist of different **domains**, e.g. organizational structures, technological architectures, etc. that may obey different design rules. The evolution of the firm's **knowledge** bases also plays a fundamental role in mediating the relationship between product and organization design (Brusoni et al. 2001)."*[620]

While researchers like Fine (1998, 2005) have demonstrated that high firm performance results when product and organizational (i.e. supply chain) architectures are aligned, other researchers have demonstrated that *integral* organizations can indeed produce *modular* products (Prencipe, 1997; Chesbrough and Kusunoki, 2001; Takeishi, 2002 and Piepenbrock, 2004).

In fact, examples of *modular* organizations successfully producing *integral* products are not common. This research dissertation will attempt to show that in the commercial airplane industry, *Boeing* is evolving toward a more modular enterprise architecture, while its products are relatively more integral. Conversely, *Airbus* has a more integral enterprise architecture, while its products are more modular.

> *"Conventional aircraft comprising separate wings and fuselages accomplish the functions of providing lift and housing passengers using separate portions of the aircraft. Typically wings and fuselages are designed by different engineers and made within different factories. The **Airbus** consortium was **structured to take advantage of this architecture**. Wings are made in the UK, fuselage barrel sections in Germany, tail sections in Spain, and final assembly and integration take place in France."*[621]

Many researchers have observed the coincident relationship between product architecture and higher level organizational and even supply chain architectures (Sanchez and Mahoney, 1996; Fine, 1998; Schilling, 2000; Sturgeon, 2002; Langlois, 2003; Helper and Khambete, 2006) as shown in Figure 181 below.

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[619] I am indebted to Prof. Nightingale for helping me to clarify these concepts.
[620] Brusoni and Prencipe (2006).
[621] Whitney et al. (2004), pg. 10.

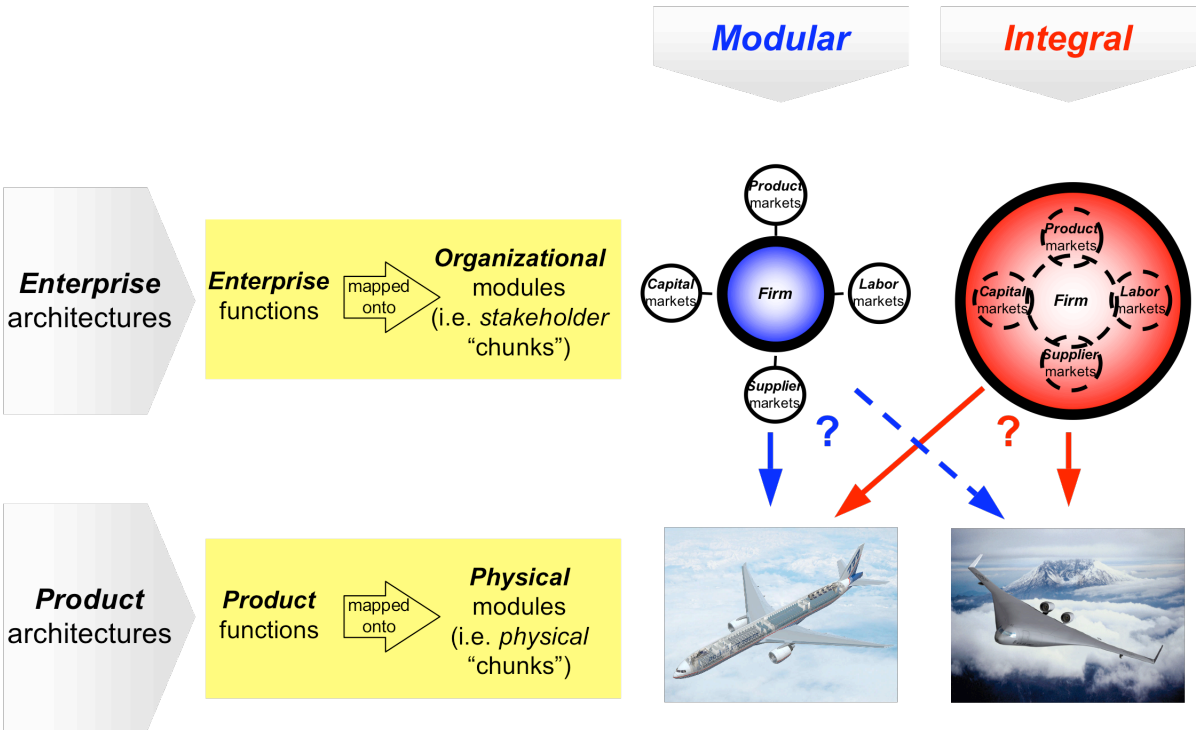

Figure 181: Deterministic Mapping of *Product* and *Enterprise* Architectures

The observation that successful product architecture drives (or is driven by) coincident supply chain architecture, does not necessarily imply that these in turn drive (or are driven by) coincident enterprise architectures (Prencipe, 1997; Chesbrough and Kusunoki, 2001, Takeishi, 2002; Sako, 2003; Brusoni and Prencipe, 2006). The potential reasons are hypothesized to be:

- The relatively narrow nature of the technologically-oriented interface information that drives the relationship between firm (product) and supply chain, compared to the more pluralistic information relating to investor and labor issues.

- Enterprise architecture does not necessarily drive product architecture, but product *system (or platform)* architecture. For example, it is much easier and more likely for an integral enterprise architecture (like that of *Airbus*) to produce a family or system of products which share more commonality, than it is for a modular enterprise architecture (like that of *Boeing*). In a sense, it is not *Airbus'* integral product's, but their integral product *strategy*, that is produced by the integral enterprise architecture.

- If/when product architectural changes are required, it will take successively longer times to evolve/adapt the architectures of the supply chain, and even longer to evolve/adapt the architectures of the enterprise. The greater the scope of the system in space and time, the greater the degree of architectural inertia.

Heuristic 1g:

The nested architectures of product, supply chain and extended enterprise, will tend to be aligned along the integrality-modularity spectrum, as an indication of optimized performance. It is noted however that structural inertia increases with increasing extent of the architectures, making alignment changes slower.

> *"To a significant degree, product and supply chain architectures tend to be **aligned** along the integrality-modularity spectrum…in essence, product and supply chain architectures tend to be **mutually reinforcing**."*[622]

[622] Fine, C.H. (1998), pg. 140.

4.3 Enterprise Architecture *3D-Constitutive Model*

> *"A company is its **chain of continually evolving capabilities** – that is, its own capabilities plus the capabilities of **everyone it does business with**."*[623]

> *"To extend a **systemic approach to strategy**, I suggest that a company be viewed not as a member of a single industry, but as part of a **business ecosystem** that crosses a variety of industries."*[624]

4.3.1 *Stakeholder "Chunks"* (functional decomposition)

The stakeholders are defined in "chunks" along three orthogonal axes: the axis defining the customer-supplier relationships of the value chain, the axis defining the factors of production, and the axis defining the nature of competition. Each will be briefly discussed in the following subsections.

4.3.1.1 *Value Chain* Axis

As shown in Figure 182 below, this pair of stakeholders comprise the customer and supplier "chunk" taken from Porter's 1985 classic.

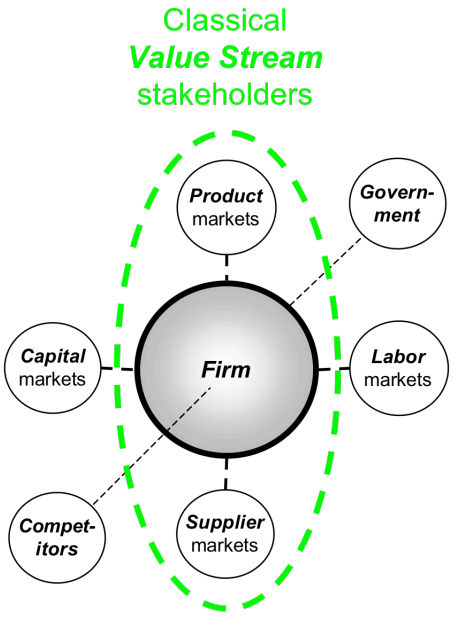

Figure 182: Enterprise Architecture: *Value Chain* Axis

[623] Fine, C.H. (1998), pg. 71.
[624] Moore, J.F. (1993).

4.3.1.1.1 ***Product / Service*** **markets** (customers)

4.3.1.1.2 ***Supplier*** **markets** (suppliers)

Firm boundaries (Sako, 2006). Make-Buy. Vertical Integration. Outsourcing. Offshoring (Helper and Khambete, 2006).

4.3.1.1.3 Supplier "Push" vs. Customer "Pull"

*"You can have **any color** you'd like… as long as it's **black**."*[625]

When markets are growing rapidly, the industry is generally capacity-constrained and the producer tends to be in control in a "push" mode. Conversely, when markets begin to mature, the industry is generally demand-constrained and the customer tends to be in control in a "pull" mode as shown in Figure 183 below.

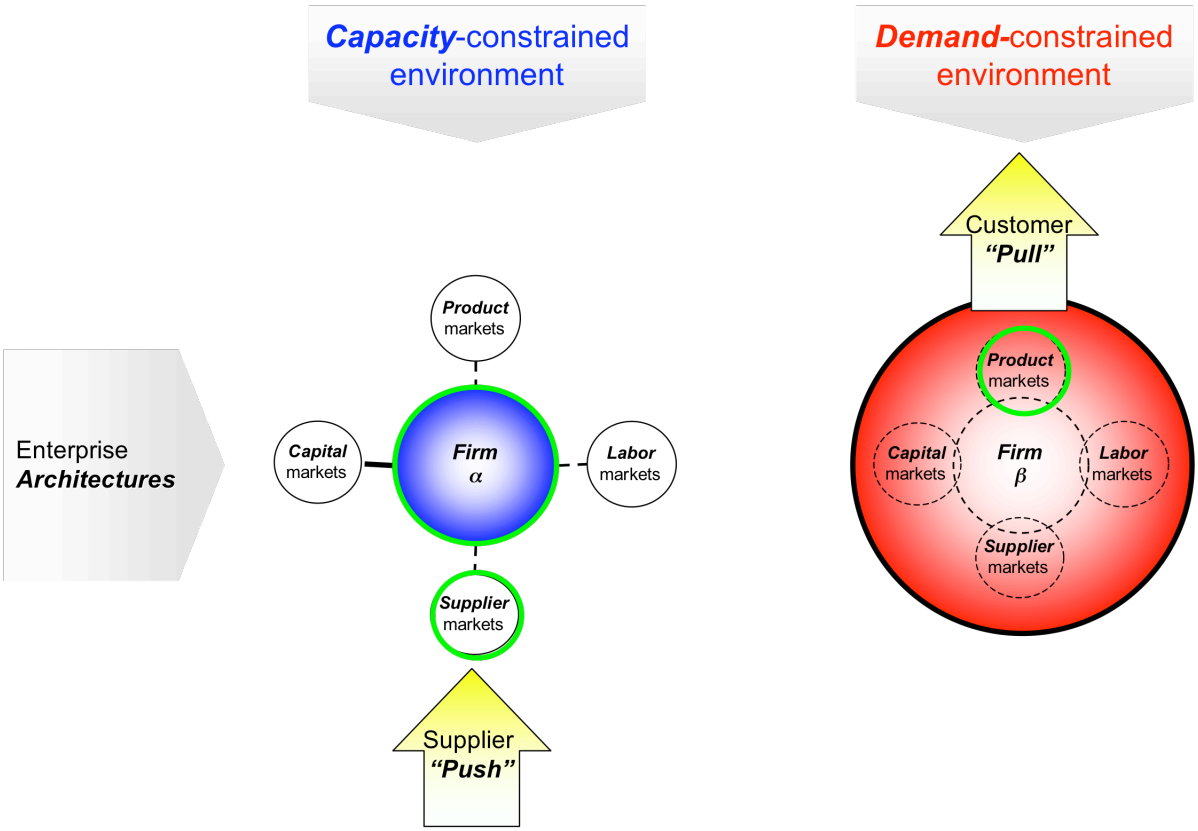

Figure 183: *Supplier* "Push" vs. *Customer* "Pull"

[625] Henry Ford's famous "push" tactics in the early automobile industry.

4.3.1.2 *Factors of Production* Axis

As shown in Figure 184 below, this pair of stakeholders comprise the capital and labor (K, l) "chunk" taken from classical economics. As will be discussed later, these stakeholders often provide the "teleological pull" or objective functions for the enterprise.

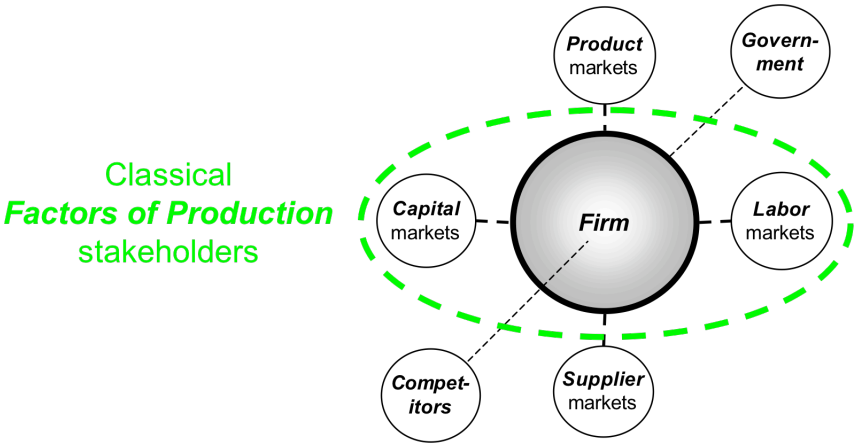

Figure 184: Enterprise Architecture: *Factors of Production* Axis

As we will discuss later in chapter 6, the relative dominance of capital vs. labor is contingent upon the state of the industrial evolution.

4.3.1.2.1 *Capital* markets (investors)

For the purposes of the framework, "capital" markets refers both to debt and equity markets, having fixed and variable (or residual) claims on the enterprise's cash flows. Each will be discussed in turn.

4.3.1.2.1.1 Capital Structure: *Debt* vs. *Equity*

Modigliani and Miller won the nobel prize for demonstrating (under certain circumstances) the irrelevance of capital structure.

> *"When a company earns more on borrowed money than it pays in interest, returns on equity will rise, and vice versa.* ***Leverage thus improves financial performance when things are going well, but worsens performance when things are going poorly****. It is a classic fair-weather friend."*[626]

Higgins (2004) notes that leverage can both help and hurt ROE, depending on certainty of ROIC. In fact, based on empirical research (McConnell and Servaes, 19995), Higgins (2004) notes that debt levels should vary with firm growth.

> *"For* ***'high-growth'*** *firms corporate* ***value is negatively correlated with leverage****, whereas for* ***'low-growth'*** *firms corporate* ***value is positively correlated with leverage****."*[627]

> "[In] *rapidly growing businesses…****high growth and high debt are a dangerous combination****."*[628]

> *"****Slow-growth*** *companies have a much easier time with financing decisions. Face the reality that the business has few attractive investment opportunities, and seek to create value for owners through* ***aggressive use of debt financing****. Use the company's health operating cash flow as the magnet for borrowing as much money as is feasible, and use the proceeds to* ***repurchase shares****."*[629]

4.3.1.2.1.2 *Debt* markets

[626] Higgins, R.C. (2004), pg. 194.
[627] Higgins, R.C. (2004), pg. 215.
[628] Higgins, R.C. (2004), pg. 215.
[629] Higgins, R.C. (2004), pg. 217.

4.3.1.2.1.3 *Equity* markets

Equity markets can be divided into *public* and *private* equity. Within this classification, equity investors can be characterized on the dimensions of *patience* as well as *activism*.

4.3.1.2.1.3.1 *Quality* of Equity Investors

4.3.1.2.1.3.1.1 *Public* vs. *Private* Equity

4.3.1.2.1.3.1.2 "Patient" vs. "Impatient" capital

Within the Varieties of Capitalism framework, Goyer (2006) examines the varieties of institutional investors (ranging from the "patient" capital of pension funds, to the "impatient" capital of mutual/hedge funds) in France and Germany. He concludes that firm-level institutional arrangements of workplace organization account for the most significant variable in ascribing why French firms attract more short-term impatient capital (e.g. mutual/hedge funds) particularly from Anglo-Saxon investors, while German firms attract more long-term patient capital (e.g. pension funds).

> *"The concentration of power in the CEO of **French** companies is valued by **mutual and hedge funds**, since it makes it easier to reorganize the strategy of the firm quickly – a key aspect of the preferences of this type of investors given their **short-time horizon**. By contrast the relative absence of mutual and hedge funds, coupled with the growing strength of **pension funds** with their demands for financial transparency and **long-term horizon**, constitutes a **stabilizing** factor for the institutional arrangements of **workplace organization** of **German** companies."*[630]

Conflicting accounts of pension funds exist however:

> *"Everyone who has worked with American managements can testify that the need to satisfy the **pension fund** manager's quest for **higher earnings next quarter**, together with the panicky fear of the raider, constantly pushes top management towards decisions they know to be costly, if not suicidal, mistakes. The damage is greatest where we can least afford it: in the fast growing, middle-sized, high-tech or **high-engineering firm** that needs to **put every available penny into tomorrow** – research, product development, market development, people development, services – lest it lose leadership for itself and for the U.S. economy."*[631]

A recent example of patient capital comes from *Airbus'* parent company, *EADS*.

> *"Lagardere recently reported a 57% drop in 2006 profit, due largely to the poor performance of its 7.5% stake in EADS. Chief executive Arnauld Lagardère, who also co-chairs EADS, also ruled out the sale of the company's stake in EADS when announcing his annual results. **'I will play my role and I want to carry on being part o EADS's growth**,' he told Le Monde. He added that he saw no need for a capital increase at EADS, presumably in lieu of politicians who wish to take a bigger role in Airbus. **So concerned was Lagardère about EADS' future the he vowed to return any upcoming dividend back to the company. 'The Airbus situation has affected everyone, the employees above all, but also the shareholders and notably the small investors who have suffered from the drop in shares**,' he said."*[632]

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[630] Goyer, M. (2006), pg. 423.
[631] Drucker, P. (1986), pg. 32, as quoted in Hansen and Hill (1991), pg. 1.
[632] Olson, P. (2007), "Lagardere Won't Cut and Run from Airbus," *Forbes* magazine, March 14, 2007.

4.3.1.2.1.3.1.3 *Institutional* vs. *Individual* Investors

Hansen and Hill (1991) determined empirically that contrary to popular belief, *institutional* owners are not necessarily myopic and that greater institutional ownership may be associated with greater R&D expenditures.[633] They show that it is *individual* investors who exhibit more short-term orientation.

> *"American firms are **myopic**… in the sense that **time horizons are short**.* [This] *partly has to do with the **high cost of capital** in the United States."*[634]

Goyer (2006) compares the varieties of institutional investors in France and Germany.

> *"I distinguish primarily between **pension** and **mutual/hedge funds**. Pension funds constitute **long-term** investors that acquire an equity stake in corporations primarily for **diversification** purposes; mutual/hedge funds seek to maximize assets under their management as they possess a **shorter term** horizon and operate under competitive pressures to beat market benchmarks. The importance of this distinction between different types of investors is primarily driven by its implications for the mode of coordination of firms. As Hall and Soskice (2001) have argued, access to **patient capital** constitutes a key feature of **coordinated market economics**, as opposed to **liberal market economics** that rely on **short-term, risk capital**. The investment strategies and **time horizons** of mutual/hedge and pension funds have different consequences for the sustainability of national models. Mutual and hedge funds posess short-term investment strategies and time horizons. They also exhibit **firm-specific preferences** since the performance of their portfolio is shaped by the behavior of a **smaller number of companies** than is the case for pension funds."*[635]

4.3.1.2.1.3.1.4 *Insider* vs. *Outsider* Investors

4.3.1.2.1.3.2 *Quantity* of Equity Investors: ownership diffusion

[633] This research applied to time-series studies of four technology-driven industries: pharmaceuticals, chemicals, computers, and aerospace. It should be noted that while in R&D investment in most technology-driven industries was positively correlated with degree of institutional holdings, this relationship was reversed in the aerospace industry – it appears that institutional investors are myopic in aerospace stocks.
[634] Nelson, R. (1991), pg. 62.
[635] Goyer, M. (2006), pp. 400-401.

4.3.1.2.1.3.3 *Managerial* capitalism

A variety of forms of "capitalism" have emerged, the most advanced of which is known as "managerial capitalism" which is the result of the separation of ownership from management.

The capital markets or equity investors are traditionally seen as the "owners" of the firm. They claim any residual profits from the operations of the firm. Recently, researchers (e.g. Ghoshal, 2005) have begun to call into question this theory.

4.3.1.2.1.3.3.1 Principal-Agent problem: *Agency* vs. *Stewardship*

In an effort to increase efficiency through specialization (Smith, 1776), the functions of firm ownership and management were separated, resulting in a modular link in this portion of the factors of production axis. This however created a misalignment of incentives resulting in unintended inefficiencies, known as the 'principal-agent' problem (Jensen & Meckling, 1976; Fama, 1980).

Note however as shown in Figure 185 below, that an integral enterprise architecture (by definition) is one in which is designed to minimize or mitigate the misaligned incentives of the principal-agent problem which is known as "stewardship" (Donaldson and Davis, 1989 and 1991).

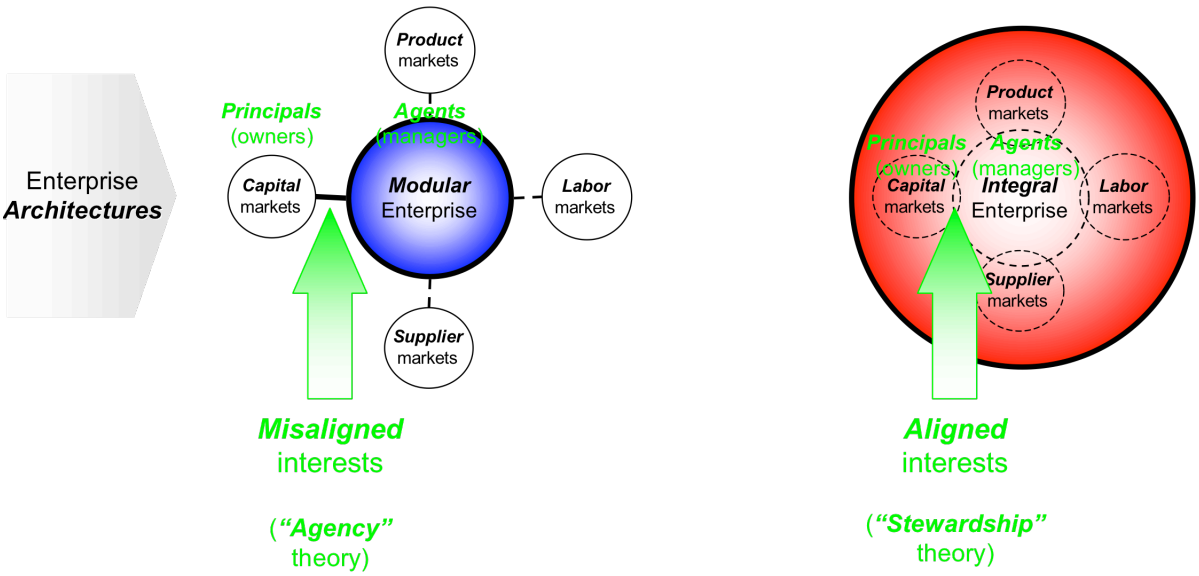

Figure 185: Principal-Agent problem: *Agency* vs. *Stewardship* Theories

Davis, Schoorman and Donaldson (1997) summarize the key characteristics of each form as is shown in Table 14 below.

Enterprise Architecture	***Modular***	***Integral***
Governance Theory	***Agency*** theory	***Stewardship*** theory
Model of Man	*Economic* man	*Self-actualizing* man
Behavior	*Self*-serving	*Collective*-serving
***Psychological* Mechanisms**		
Motivation	*Lower* order / economic needs (psychological, security, economic)	*Higher* order needs (growth, achievement, self-actualization)
	Extrinsic	*Intrinsic*
Social Comparison	*Other managers*	*Principal*
Identification	*Low* value commitment	*High* value commitment
Power	*Institutional* (legitimate, coercive, control)	*Personal* (expert, referent)
***Situational M*echanisms**		
Management Philosophy	*Control* oriented	*Involvement* oriented
Risk orientation	*Control mechanisms*	*Trust*
Time orientation	*Short*-term	*Long*-term
Objective	*Cost control*	*Performance enhancement*
Cultural Differences	*Individualism*	*Collectivism*
	High power distance	*Low* power distance

Table 14: Comparing *Agency* and *Stewardship* Theories

As will be discussed in Chapter 5, ownership and managerial functioning are driven by different objectives of profit and growth.

4.3.1.2.1.3.3.2 Board of Directors: "Architectural" Gatekeeper

The shareholders, via the board of directors, have an important power: selecting, evaluating and rewarding the chief architect.

Many researchers have recently begun to question why the shareholders are the stakeholders that get to select the leadership, most recently Ghoshal (2005). Ghoshal argues that the primacy of shareholders interests was based on the (now) outdated notion that they were the risk-takers of the enterprise. Instead he argues, the employees are the true risk-takers of the enterprise:

> *"In every substantive sense, **employees carry more risks than do the shareholders**. Also, their contributions of knowledge, skills and entrepreneurship are typically more important than the contributions of capital by shareholders, a **pure commodity** that is perhaps in **excess supply**."*[636]

This point of view is what was earlier described as "human capitalism", or "labor-managed firms".

[636] Ghoshal, S. (2005), pg. 80.

4.3.1.2.2 *Labor* markets

The discussion of labor (or human capital) markets proceeds along the dimensions classically associated with other capital markets – i.e. in the make vs. buy analysis (Miles and Snow, 1984) of determining the boundaries of the firm, meaning is labor internalized or externalized?

Additionally the discussion of labor markets will include the quality of the interfaces between the firm and its human capital stakeholders, specifically along the short-term arm's length and long-term trust-based dimension.

4.3.1.2.2.1 ***Boundaries*** (make vs. buy)

Lepak and Snell (1999); Sako (2006).

4.3.1.2.2.2 ***Interfaces*** (arm's length vs. trust-based)

The integral EA form of the labor stakeholder sees long-term trust-based employment. Although this does not preclude the existence of labor unions (as *Southwest Airlines* demonstrated) it does tend to minimize their formal *raison d'etre*.

Although such integrality clearly exists in some enterprises (e.g. in the form of life-time employment), it is debatable as to the degree of complete foresight about its long-term effects. Evolutionary economists (Nelson, 1991) question the rationality of the origins of such practices:

> *"Thus, as I understand it, large Japanese firms adapted **'lifetime employment'** for their skilled workers in the early post war era to try to deal with a problem of **skill shortages and labor unrest**. It is quite unclear how many Japanese managers **foresaw advantages** associated with worker loyalty."*[637]

Like other stakeholder architectures, the effects of integrality in the labor stakeholder group involve temporal tradeoffs.

> *"**Guaranteeing job security** intensifies the **tradeoff between short and long term effects**. In the **short run performance is worse**."*[638]

[637] Nelson (1991).
[638] Sterman, Repenning and Kofman (1997), pp. 515-516.

In Table 15 below, Arthur (1992) defines two systems of workplace industrial relations.

Industrial Relations Functions	**Type of System**	
	Cost Reduction	**Commitment Maximizing**
Organization of Work	Job tasks narrowly defined	Broadly defined jobs
Employee Relations	Very little employee influence over "management" decisions; No formal employee complaint/grievance mechanisms; Little communication/socialization efforts	High level of employee participation/involvement; Formal dispute resolution procedures (nonunion firms); Regularly share business/economic information with employees
Staffing/Supervision	Low skill requirements; Intense supervision/control	High percent of skilled workers; Self-managing teams
Training	Limited training efforts	More extensive, general skills training
Compensation	Limited benefits; Relatively low wages; Incentive-based	More extensive benefits; Relatively high wages; All salaried/stock ownership

Table 15: Two Systems of Workplace Industrial Relations

In Table 16 below, Delery and Doty (1996) show the following rankings of human resource practices from a survey study using Likert rankings of the banking industry.

Ideal Strategic Profiles Variables	**Market-type** (Prospector)	**Middle-of-the-Road** (Analyzer)	**Internal** (Defender)
Results-oriented appraisals	**4.44**	3.41	2.38
Profit sharing	**6.33**	4.26	2.19
Job descriptions	3.38	4.49	**5.60**
Employment security	2.79	3.90	**5.01**
Internal career opportunities	3.86	4.67	**5.48**
Training	3.08	4.24	**5.40**
Participation/voice	4.60	5.36	**6.12**

Table 16: HR Practices in Configurations

Lepak and Snell (1999).

4.3.1.2.3 Dominant Factor of Production (*capital* vs. *labor*)

In certain situations, capital is relatively the more dominant factor of production, while in other situations, labor is relatively the more dominant factor of production. In the following subsections, we will explore important contingencies; and in essay #3, we will integrate these contingencies into a coherent environmental assessment in order to determine which combinations of contingencies (i.e. *traditional* capitalism or *human* capitalism) are expected to dominate during the life-cycle of an industry's (or more accurately, a business ecosystem's) evolution.

4.3.1.2.3.1 *Traditional* vs. *Human* capitalism

4.3.1.2.3.1.1 *Traditional* capitalism (*capital* dominance)

Traditional capitalism is characterized by the relatively rapid building of physical capacity (e.g. property, plant and equipment), often for economies of scale. For this to happen rapidly, capital markets are required which demand high rates of growth. The main attributes of *traditional* capitalism are:

- Capital (not labor) markets are the focus of the objective function: "profit maximization".
- Capital (not labor) is the risk-bearing factor of production (Ghohal, 2005)
- Capital (not labor) supply is the system constraint (Ghoshal, 2005)
- Capital (not labor) is the source of competitive advantage

4.3.1.2.3.1.2 *Human* capitalism (*labor* dominance)

Human capitalism on the other hand is characterized by the relatively slow growing of knowledge-based capability, often for economies of scope. For this to happen, stability is often required for the labor markets. The main attributes of *human* capitalism are:

- Labor (not capital) markets are the focus of the objective function: "labor-management".
- Labor (not capital) is the risk-bearing factor of production (Ghoshal, 2005)
- Labor (not capital) supply is the system constraint (Ghosahl, 2005)
- Labor (not capital) is the source of competitive advantage

4.3.1.2.3.2 *Enterprise Architectural* tendencies

While it is theoretically not impossible for both enterprise architectural forms to focus on traditional vs. human capitalism, this framework asserts that by definition, modular enterprise architectures tend to focus on physical capital as a means to ramp up physical *capacity* expansion, while integral enterprise architectures tend to focus on the *capability* of human assets as the source in innovation (whether product or process) and therefore competitive advantage. Figure 186 below summarizes the diametrically-opposed postures of each of the extremes of enterprise architectures.

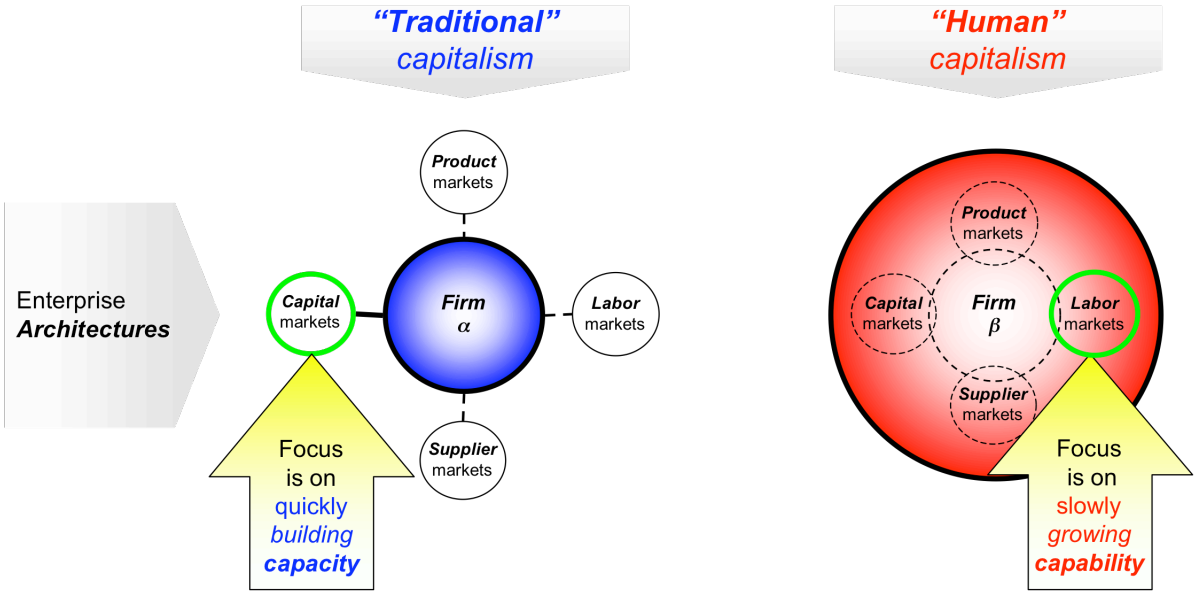

Figure 186: *Traditional* capitalism vs. *Human* capitalism

4.3.1.2.3.3 *Cultural / National* tendencies

While Anglo-Saxon capitalism has tended to focus on the providers of *capital,* the German-Japanese capitalism has tended to focus on the providers of *labor* (Thurow, 1992). Such stakeholders tended to integrate in order to achieve scale and therefore market power in the forms of unions. This would suggest that Anglo-Saxon traditions have a greater tendency towards modular enterprise architectural forms, while the German-Japanese capitalism has a tendency towards integral enterprise architectural forms.

4.3.1.3 Competitive *Enablers* and *Constraints* Axis

As shown in Figure 187 below, this pair of stakeholders comprise the competitor and government "chunk". "Government" is meant in the generic sense, covering local, state, federal and "meta-" levels like its participation in the World Trade Organization.

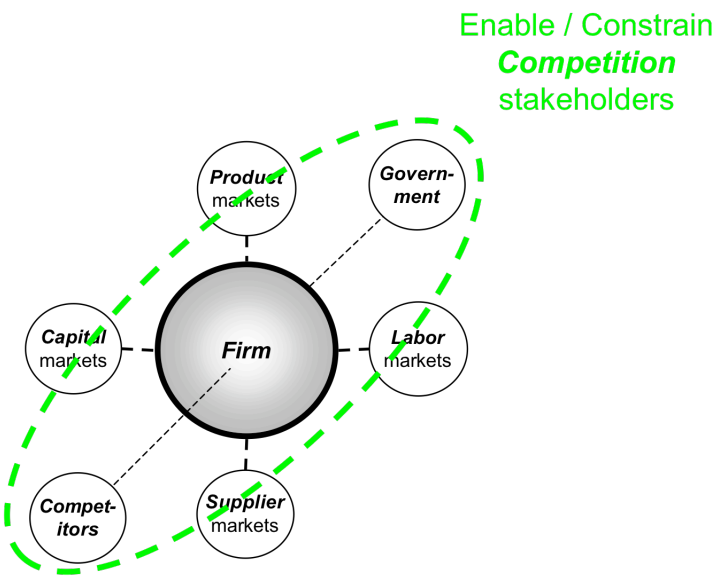

Figure 187: Enterprise Architecture: *Competition* Axis

4.3.1.3.1 *Regulatory* markets (governments)

> [In the U.S.] *"**business and government** seldom work together and **often are at odds**."*[639]
>
> *"Many of the organizations which play an important role in resource allocation, including **governmental organizations**, are **not profit-maximizers**."*[640]

The role of governments both in regulating national industries and promoting international interests is important (Krugman, 1987; Brahm, 1995).

4.3.1.3.2 *Profit* markets (competitors)

Game theory, mixed duopoly.

[639] Nelson, R. (1991), pg. 63.
[640] Stiglitz, J.E. (1991), pg. 15, quoted in Braham, R. (1995), pg. 76.

4.3.2 *Enterprise* Boundaries

The academic discussion around the "boundaries of the firm" has historically (Coase, 1937) embraced only its supplier markets in the traditional "make-buy" decision. More recently, it has embraced the firm's labor markets (Sako, 2006). This framework attempts to address a broader set of stakeholders which define the "boundaries of the firm", which include the complementary stakeholders to suppliers and employees, namely customers and investors as shown in Figure 188 below.

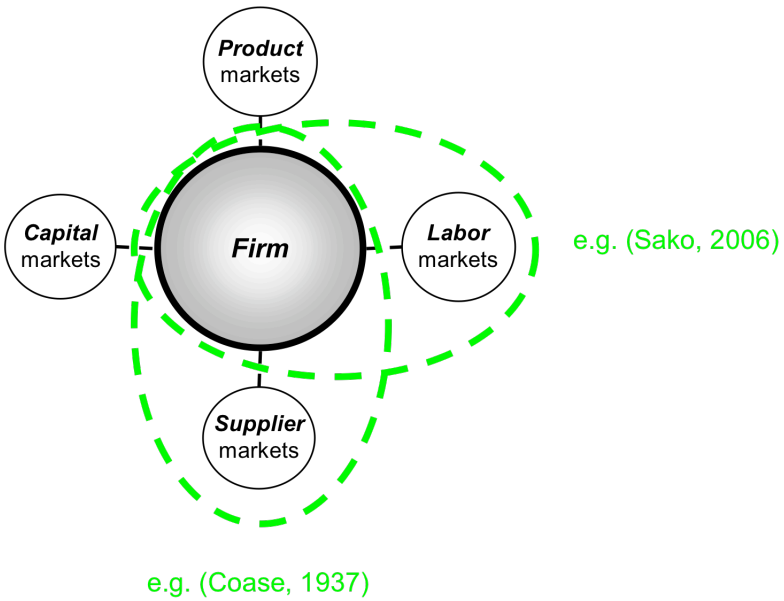

Figure 188: Classical discussions around the "Boundaries of the Firm"

As shown in Figure 189 below, the boundaries of the enterprise vary according to the objectives of the firm. These vary from local optimization of the firm, to more global optimization of the firm and its extended enterprise.

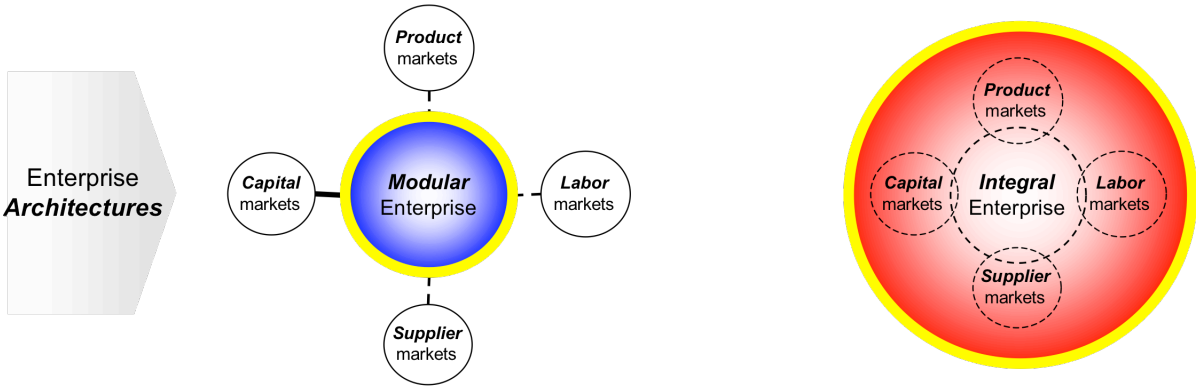

Figure 189: Enterprise Boundaries

Organizations have long been recognized as exchanging things with their environments, called "open" systems. The boundaries of the organization (both spatial and temporal) define the extent of the organization, and the degree of "openness". As will be shown below, the firm exchanges things with entities outside of its control, and in that sense, all firms are open systems with respect to their stakeholders. However, as we shall explore later, different enterprise architectures (modular and integral) vary in their *control* over these exchanges with their extended enterprises. Specifically in chapter 5, when we address the structural dynamics of enterprises, we will draw a distinction between open and closed systems and open and closed *causal* systems.

Rice (1958, 1963) focused on boundary management issues.

> [The primary task of leadership is] *"to **manage the relations between the enterprise and its environment** so as to permit optimal performance of the primary task of the enterprise* [which is] *the task that it must perform to **survive**."*[641]

[641] Rice, A. (1963), pp. 13-15.

4.3.2.1 Spatial

> *"Firms and their attributes are **parts of the environment** and are linked to it by exchanges of resources."*[642]

As noted by various researchers (Fine, 1998; Dyer and Singh, 1998), the spatial boundaries of the firm can be important in defining a firm's competitive advantage.

> *"**Key firm resources** may reside in a firm's **external network**".*[643]

4.3.2.1.1 *Vertical* Integration (boundaries)

The theory of the firm (Coase, 1937) provides insights into why firms exist vis a vis markets, and where the efficient boundary of the firm should be. Either the price mechanism coordinates economic activity in market transactions, or managerial authority coordinates economic activity in vertically-integrated firms.

Later Williamson's transaction cost economics (Williamson, 1975) extended this theory by positing logical firm boundaries based on the transaction as the unit of analysis. While Coase focused on costs as the discriminating criterion between firms and hierarchies, Williamson posited a set of factors which generated these transaction costs: asset specificity, uncertainty, frequency, opportunism and bounded rationality, with asset specificity being the most important.

The classic case study of vertical integration or the make-buy problem is *General Motors-Fisher Body*.

4.3.2.1.2 *Virtual* Integration (interfaces)

> *"**General Motors** and **Toyota** are helpful for illustrating why the categories in '**make versus buy**' or '**vertical integration versus outsourcing**' are inadequate: they do not account precisely for the **complexity of relationships** we observe in practice. Rather than using the categorization of vertically integrated or disintegrated, supply chain relationships can be categorized on a scale running **from the highly integral to the highly modular**, depending on the degree of proximity of the members in the chain along four dimensions: **geographic, organizational, cultural and electronic**."*[644]

More recently other researchers, while acknowledging power and clarity of transaction cost economics, have questioned the complexity that it captures. Instead of focusing on asset ownership, Fine (1998) posits four dimensions of "proximity": geographic, organizational (including ownership), cultural and electronic.

In this sense, Fine (1998) is less interested in who owns the assets (i.e. legal *boundaries*), but in how the assets are managed (i.e. *interfaces*). The *quality* of the relationships between stakeholders (often called "relational coordination" or "relational contracting" is very

[642] Farjoun, M. (2002), pp. 577.
[643] Farjoun, M. (2002), pp. 577.
[644] Fine, C. (1998), pg. 158.

important in determining an enterprise's architecture and will be discussed in the following sections.

4.3.2.2 Temporal

> *"**Time horizon** is a temporal yardstick for evaluating **success or failure** that reflects the **dynamics of a firm and its context**."*[645]

4.3.2.3 Effect of *Spatio-Temporal* Boundaries on *Strategy*

Those enterprise architectures which are managed to a narrow spatial and temporal boundaries (i.e. modular), have great tactical advantages, while those which are managed to broader spatial and temporal boundaries (i.e. integral) have greater strategic advantages. As shown in Figure 190 below, the analogy is to a game of chess, where the integral enterprise architecture, by optimizing more globally has a greater vision both of the board as well as of many moves in advance. It is "built" to deal with greater dynamic complexity, where cause and effect are distant in (stakeholder) space and time, even though such extra vision has added costs.

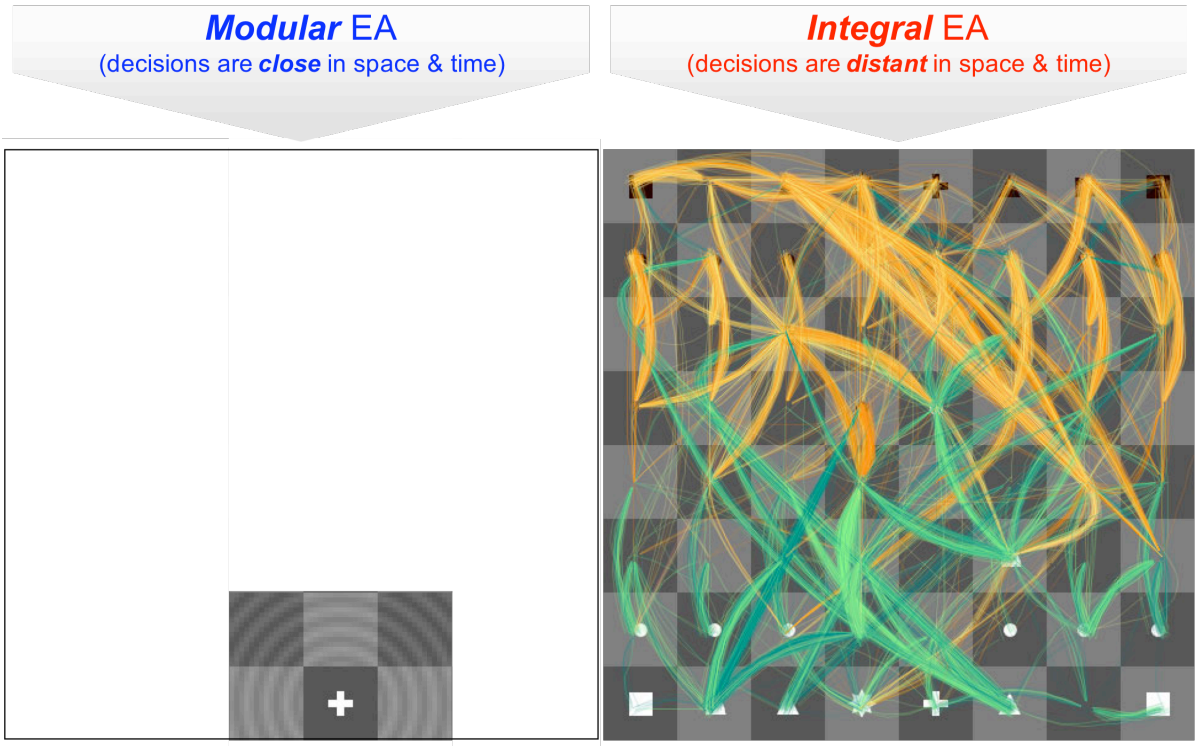

Figure 190: Effect of *Spatio-Temporal* Boundaries on *Strategy*

[645] Lengnick-Hall and Wolff (1999), pg. 1119.

4.3.3 *Enterprise* Interfaces

4.3.3.1 *Quantity* of Stakeholders

The first obvious descriptor of the architecture is the quantity of stakeholders within a specific chunk.

4.3.3.2 *Quality* of Stakeholder Relationships

The quantity-quality dimensions are not orthogonal. They are interrelated, with quality ultimately driving the quantity.

Fine (1998) defines the supply chain integrality along four dimensions: geographic, organizational, cultural and electronic.[646]

Within the context of off-shoring, Helper and Khambete (2006) define three types of organizational interfaces: information (e.g. degree of tacitness), incentive alignment (e.g. asset ownership, employment stability), and proximity (e.g. geographic and cultural).

Ghemawat (2001) defines proximity in terms of four distances: cultural, administrative, geographic and economic.

Trust is an important construct in defining the quality of stakeholder relationships, and recently, researchers have posited that trust is multi-dimensional, and differs between the firm and different stakeholders (Pirson and Malhorta, 2008).

4.3.3.2.1 Two Relationship Archetypes

Two different types of relationships are discussed. The qualitative properties of each can be extracted approximately via such classic games as the "ultimatum game".

4.3.3.2.1.1 *Managing Contracts*: Short-term, Arm's Length

Based on an ideology-based "gloomy-vision" (Ghoshal, 2005). Examples include: transaction-cost economics having opportunism with guile (Williamson, 1975); agency-theory (Jensen and Meckling, 1976); exit (Helper, 1990).

4.3.3.2.1.2 *Growing Relationships*: Long-term, Trust-Based

> *"A company run on the basis that nobody can be trusted will be a **dysfunctional** place that has little chance of achieving anything much for its shareholders, let alone its customers or those who work there…for **trust lies at the heart of wealth creation**."*[647]

[646] Fine, C.H. (1998), pp. 136-137.
[647] Gapper (2005), pg. 102.

Based on an ideology-based "positive organizational scholarship" (Ghoshal, 2005). Examples include: relational coordination (Hoffer-Gittell, 2003); relational contracting (Gibbons, 1999 and 2004); voice (Helper, 1990).

4.3.3.2.2 Costs of Quality (of Stakeholder Relationships)

In addition to the long-term cost reductions associated with the learning curve and economies of scale, the costs of quality of relationships can have a significant impact on transaction costs as shown in Figure 191 below.

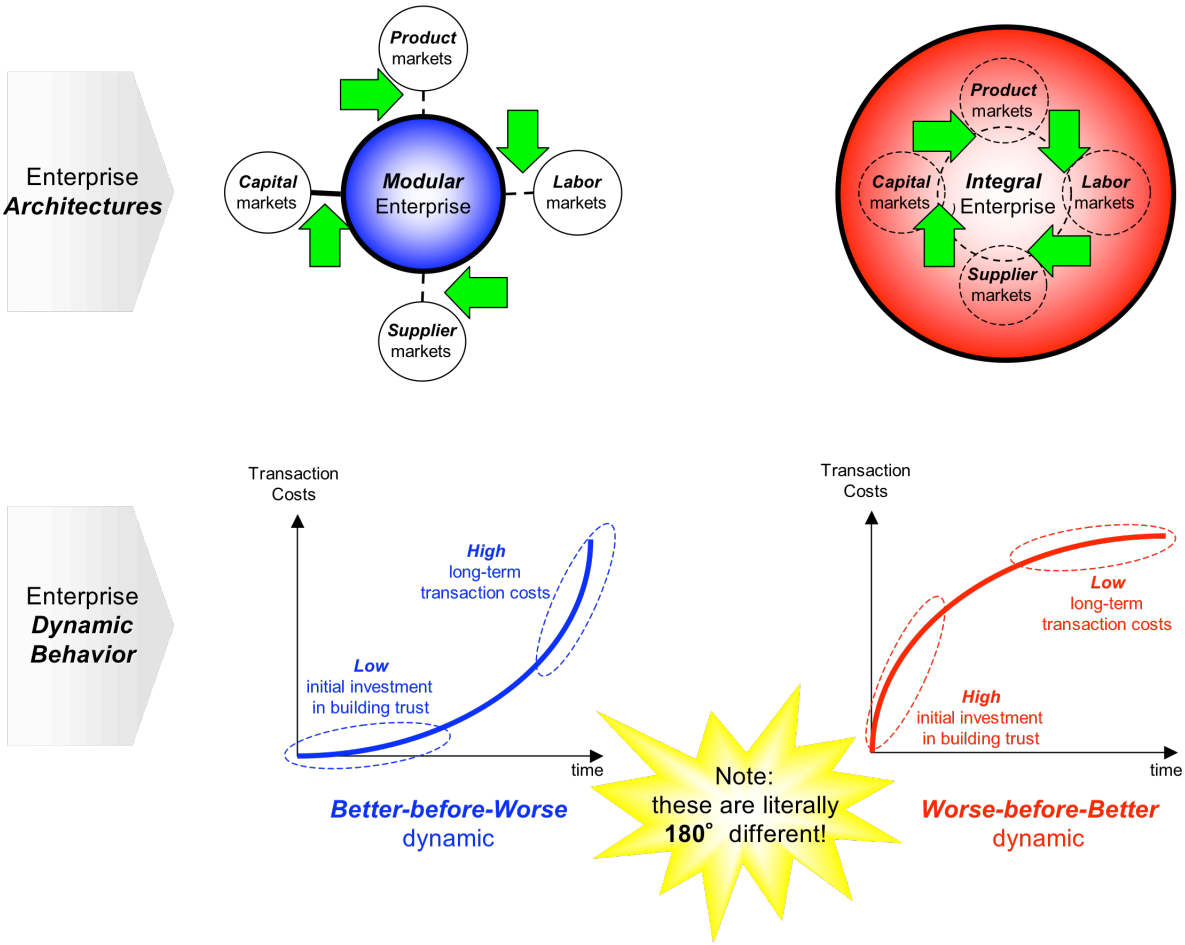

Figure 191: The Costs of Quality (of Stakeholder Relationships)

The properties of trust are highly nonlinear. It takes a long-time to build, and yet it can be destroyed instantaneously.

4.4 Enterprise Architectural *Forms* *(Isomorphic Archetypes)*

> *"The abstract concepts of **modularity** and **integrality** are shown to be useful for categorizing systems and illustrating how **architectural form** can influence important system characteristics."*[648]

This section will begin to differentiate between two extreme ends of the architectural continuum: modular and integral enterprise architectural isomorphic forms.

> *"Some architectures are easier to manage during **design**, others easier to manage during **operation**. Some are more robust to **deliberate attack**, while others are more robust to **random failures**."*[649]

4.4.1 Modular *Enterprise Architectures*

The "modern" notion of *architecture* arose in the 1960's (Simon, 1962; Alexander, 1964) around the early concepts of nonlinear systems thinking & complexity science. Modular architectures are based on the reductionist-based *linear* view of systems, whereby the system can be functionally decomposed, optimized, and the resulting performance is equal to the sum of the parts.[650] Integral architectures by contrast are based on the nonlinear view of systems, whereby design and global optimization occurs on the system level, and the performance can be equal to more than the sum of the parts.

Heuristic 1h:
A *modular* enterprise architecture will have relatively *narrowly* defined system *boundaries*[651], and its *interfaces* are characterized by *short*-term, arms-length management of contracts with many undifferentiated stakeholders, i.e. a *high quantity* of a given stakeholder type, and relatively *low-quality* stakeholder relationships.

Heuristic 1i:
Exploitation is best served by organizational forms which exhibit *differentiation.* Therefore, a *modular* enterprise architectural form will have a greater degree of *exploitation* (or revenue growth) potential than an integral enterprise architectural *form*.

> *".. organizations innovate by switching between **organic** structures during early phases of an innovation to **mechanistic** structures for execution phase."*[652]

Heuristic 1j:
The modular enterprise is based on the *offensive* routines of the market-*maker*.

[648] Whitney et al. (2004), pg. 1.
[649] Whitney et al. (2004), pg. 9.
[650] Adam Smith's "division of labor" is a classic formalization of efficiency-driven disintegration.
[651] The broad system boundaries implies an "open systems" approach to the firm.
[652] Tushman et al. (2004), summarizing Duncan (1976).

4.4.2 Integral *Enterprise Architectures*

Heuristic 1k:
An *integral* enterprise architecture will have relatively *broadly* defined system *boundaries*[653], and its *interfaces* are characterized by *long*-term, trust-based growing of relationships with few differentiated stakeholders, i.e. a *low quantity* of a given stakeholder type, and relatively *high-quality* stakeholder relationships.

Heuristic 1l:
Exploration / innovation (whether in products or processes) is best served by organizational forms which exhibit *integration.* Therefore, an *integral* enterprise architectural form will have a greater degree of *exploration* (product or process innovation) potential than a modular enterprise architectural form.

> *"**Cooptation** is the process of **absorbing** new elements into the leadership or policy-determining structure of an organization as a means of averting threats to its **stability** or existence. This is a **defensive mechanism**..."*[654]

Heuristic 1m:
The integral enterprise is based on the *defensive* routines (e.g. co-optation) of the market-*taker*.

Heuristic 1n:
The integral enterprise has a more symbiotic, integral, long-term trust based relationships with its *competitors* than do modular enterprises.

Heuristic 1o:
For an enterprise to have an *integrated* architecture, does not necessarily imply that it is "vertically integrated" in the classical sense of ownership of assets.[655]

[653] The broad system boundaries implies an "open systems" approach to the firm.
[654] Selznick, P. (1948), pg. 34.
[655] Novak, S. and Eppinger, S. (1998) noted this in the automobile industry; Fine, C.H. (1998) developed a richer set of dimensions of "proximity"; Dyer, J. (2000) developed a the concept of "virtual integration".

4.4.2.1 Intra-species Heterogeneity within the *Integral* Enterprise Isomorph

Although the framework has thus far focused on the development of isomorphic enterprise architectural forms (i.e. exhibiting homogeneity within an isomorph while simultaneously allowing for evolutionary heterogeneity, due to the stage of disintegration), this section will begin to describe the complexity within the integral enterprise architecture species.

4.4.2.1.1 *Institutional* Exogenous Push vs. *Individual* Endogenous Pull

Enterprise architecture integrality can arise from two centripetal forces: either it can arise from the *institutional* exogenous push from the external stakeholders, or *individual* endogenous pull from the central architect(s), located within the firm that keeps the stakeholders engaged in a long-term, trust-based way as shown in Figure 192 below.

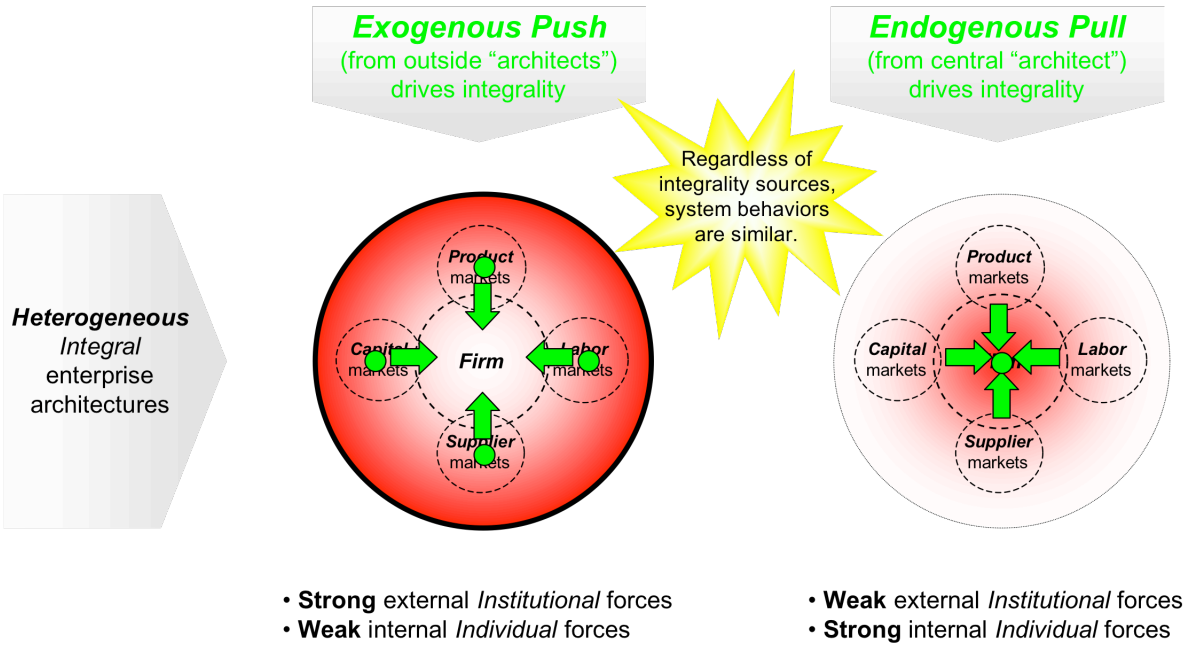

Figure 192: *Institutional* Exogenous Push vs. *Individual* Endogenous Pull

It will be argued in Essay #2, that regardless of which centripetal mechanism is operating, the dynamic behavior of the integral enterprise architecture is the same.

4.4.2.1.2 Examples and *Sustainability* of the Integral Enterprise Isomorph

We can use the three case studies used in the theoretical sample (*Airbus, Toyota* and *Southwest*) to infer different sources or combination of sources of enterprise integrality as shown in Figure 193 below.

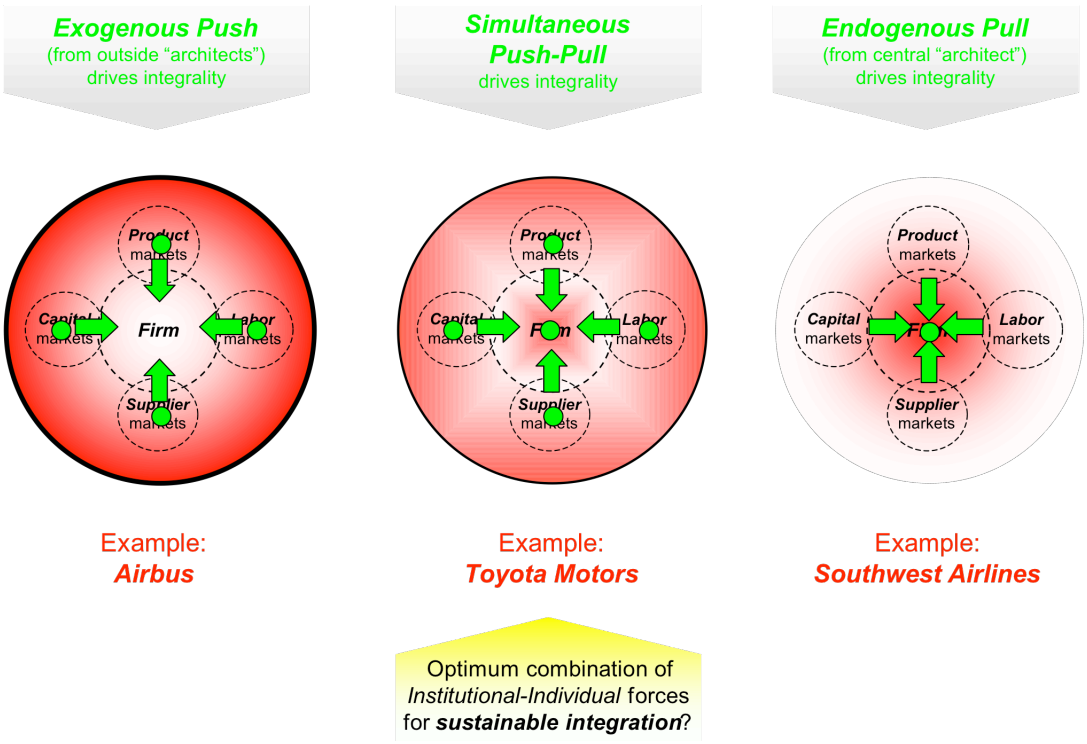

Figure 193: Examples and *Sustainability* of the Integral Enterprise Isomorph

Airbus might be an example of an integral enterprise architecture pushed together exogenously by strong environmental or institutional forces (e.g. European integration), while *Southwest* might be an example of an integral enterprise architecture pulled together endogenously by strong individual forces (e.g. CEO Herb Kelleher).

Toyota might however be an example of an integral enterprise architecture simultaneously pulled together endogenously by strong individual forces as well as exogenously by strong institutional forces. In fact, one might argue that the two forces feedback to create a more sustainable model, in which sustainable integrality is achieved by early internal architects which designed an exogenous environmental system which continues to nurture and select future internal architects, who continually redesign the relationship with the environment.

The sustainability of such a system arises from its mitigation of the continual concerns of leadership succession associated with the endogenous pull only (e.g. replacing a charismatic leader like Kelleher at *Southwest*), and from its mitigation of the continual concerns of broad and integrated social commitment associated with the institutional exogenous push only (e.g. maintaining a strong pan-European resolve via *Airbus* to challenge the US).

4.4.2.2 *Integral* Architecture and "New" Organizational Forms

> *"The business press heralds the twenty-first century corporation. Academic commentators identify new forms of organization, variously characterized as* ***'individualised', 'network', 'postmodern', 'federal',*** *or* ***'cellular'****."*[656]

Recently in the management literature, researchers have begun to claim that there are new organizational forms which are displacing the old (Daft and Lewin, 1993; Whittington et al., 1999). The improved performance associated with these forms however have not systematically been tested (Nohira, 1996), in fact some researchers have been rather critical of such claims (Victor and Stephens, 1994).

> *"For Hedlund (1994 p. 83), too, the N-form comprises an* ***'integrated set'*** *of practices, while Miles and Snow (1992) emphasize the '****systemic****' character of the new organizational forms."*[657]

This research attempts to acknowledge the existence of such "new" organizational forms, but aims to define them as "new" not in absolute terms, but in relative terms – relative that is to the state of industrial evolution. Although organizational forms will undoubtedly continue to follow a unique path-dependent trajectory, making them "new" at each new future, this research seeks to find the underlying and abstracted commonality, such that there is a predictable determinism in the chaos.

[656] Whittington et al. (1999), pg. 583.
[657] Whittington et al. (1999), pg. 584-585.

4.4.2.3 *Integral* Example: Japanese *Keiretsu*

> *"Groups allocate resources among their members according to a **long-term vision of collective welfare**. They provide a **safety net** for their weak members, **police profiteering** by imposing penalties when a member firm does too well, and insulate their membership from **the harsh scrutiny of tax authorities and investment analysts** by managing the reporting of profits and losses to show **steady, incremental growth**. The actions of groups in this regard are collectively **'rational'** for the existing membership as a whole, though not necessarily rational for its strongest members"*[658]

Keiretsu are typically organized either horizontally or vertically. (Lincoln, Gerlach and Ahmadjian, 1996). It appears that long-term corporate performance is different depending upon which type of keiretsu and under which environmental conditions they are operating. For example, Lincoln et al. (1996) noted that between 1965-1988, members of Japan's "big-six" horizontal keiretsu have lower profitability than independents. The same cannot necessarily be said for Japan's vertical keiretsu during that time frame.

Others. (Dyer, 1999?; Hino, 2006.)

4.4.2.3.1 *Horizontal* keiretsu

The "big-six" horizontal keiretsu in Japan include the three reincarnated pre-war *zaibatsu*: *Mitsui, Mitsubishi* and *Sumitomo* as well as the post-war bank-centered groups: *Fuyo, Dai-Ichi Kangyo* and *Sanwa* (Lincoln, Gerlach and Ahmadjian, 1996, pg. 68).

4.4.2.3.2 *Vertical* keiretsu

Vertical keiretsu are groupings of firms, their suppliers and distributors. In Japan for example some of the most noteworthy are: *Hitachi* or *Toyota* (Ahmadjian, 1995; Aoki, 1988; Asanuma, 1989).

[658] Lincoln, Gerlach and Ahmadjian, 1996, pg. 85 and 86.

4.4.3 Orthogonality *of Archetypes*

Modular and integral enterprise architectures are not just marked by differences in boundaries and interfaces, by the quantity and quality of relationships with stakeholders, but by different emphases in dominant stakeholders. The confluence of these influences begins to point out the orthogonality of the enterprise archetypes.

As shown in Figure 194 below, the *modular* enterprise architecture is characterized by supplier "push" in a capacity-constrained world, and is focused on shareholder profit-maximizing goals. Conversely, the *integral* enterprise architecture is characterized by consumer "pull" in a demand-constrained world, and is focused on labor-managed goals. Note that in each case, these are diametrically opposed or orthogonal constructs.

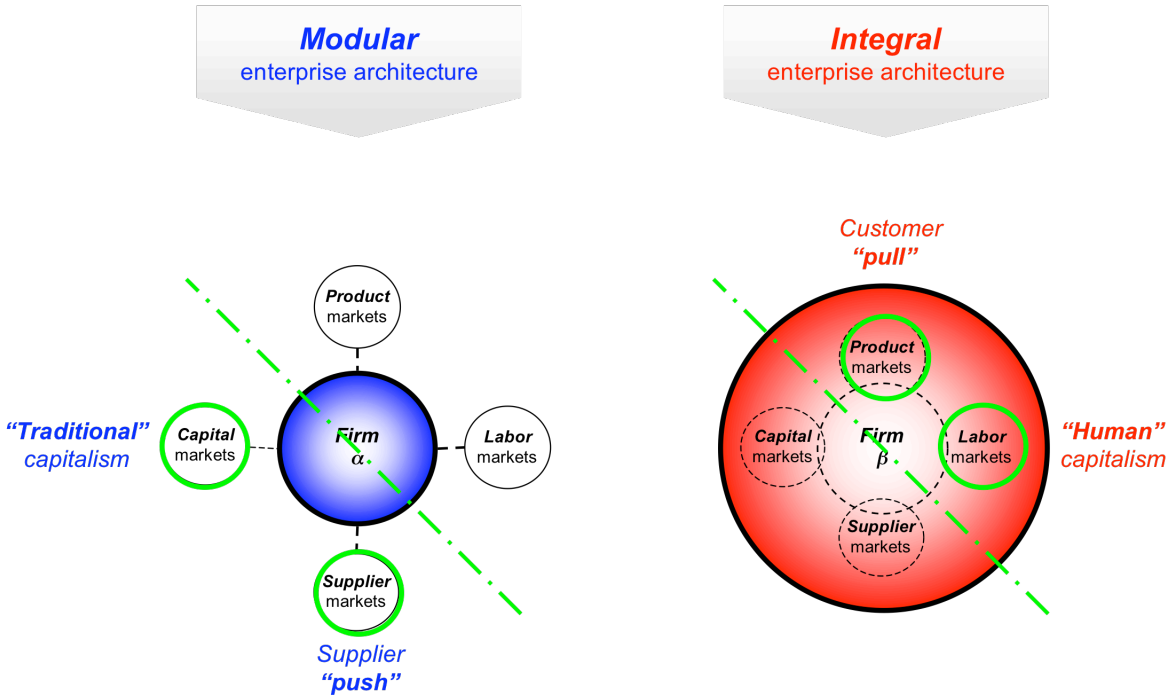

Figure 194: *Orthogonality* of Archetypes

4.5 On the *Origin* of Enterprise Architectural *Forms*

This section outlines the goals or objective functions which drive the ultimate forms of the firms and their extended enterprises – the "forcing" functions. In this sense, the objective functions are an acknowledgement of a goal-directed or *teleological* change process (Van de Ven, 1992).

4.5.1 *Corporate Governance:* Objective Functions

The objective function of the enterprise is broadly classified as a problem of corporate governance.

> *"Corporate governance deals with* ***the ways in which suppliers of finance to corporations assure themselves of getting a return on their investment****."*[659]

The following outlines two extremes in objective functions: maximization of *shareholder* value vs. the maximization of *stakeholder* surplus. While objective functions are complex and varied, this section will characterize them on a continuum from the traditional maximization of shareholder value to the more recent maximization of stakeholder surplus. Figure 195 below summarizes the spectrum of objective functions.

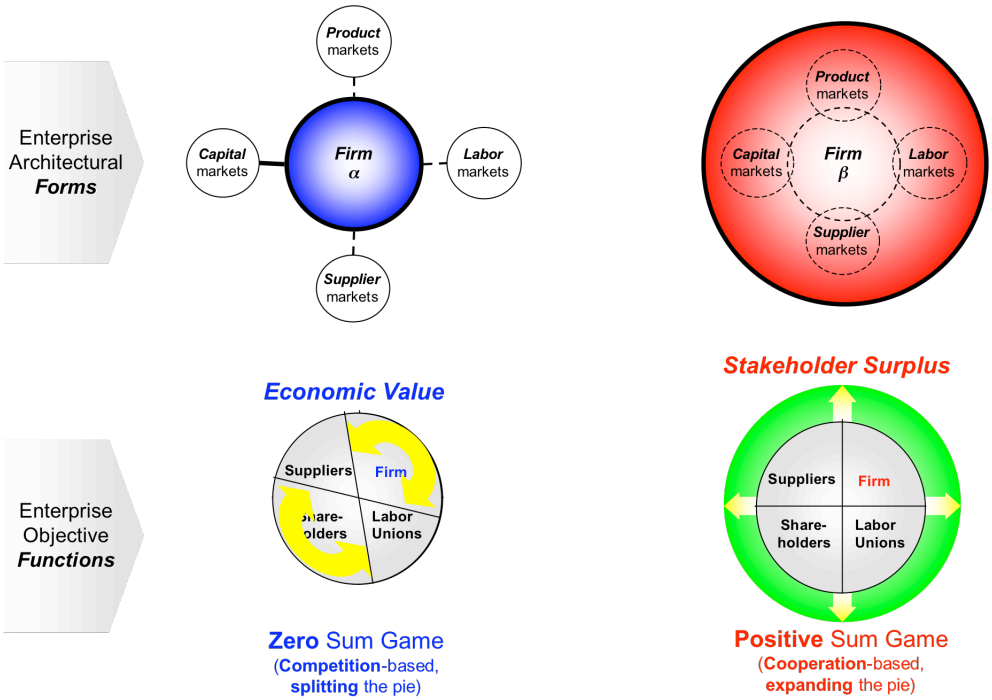

Figure 195: Enterprise *Objective Functions*

[659] Shleifer and Vishny (1997), pg. 737.

4.5.1.1 Maximizing *Shareholder* Value

> *"Milton Friedman* [said]*: 'Few trends could so thoroughly undermine the very foundation of our free society as the acceptance by corporate officials of a social responsibility other than to* ***make as much money for their stockholders as possible****' (Friedman, 2002, pg. 133).'"*[660]

The maximization of shareholder value is by its very title a very local optimization around a specific stakeholder group, the shareholders or equity investors.

> *"Whose income 'ought' to go down? Historically we have used economic growth to avoid having to make this judgment.* ***Economic growth*** *has been seen as the social* ***lubricant*** *that can* ***keep different groups working together****."*[661]

We will note in Chapter 5 that during times of high growth, the zero-sum game does create serious problems, as all stakeholders are growing. It is only when growth begins to slow down that the zero sum game starts to become dysfunctional.

4.5.1.2 Maximizing *Stakeholder* Surplus

Leading academics have recently begun to challenge the most fundamental assumptions driving business today, the firm's objective function (Ghoshal, 2005).

> *"After all, we know that* ***shareholders do not own the company*** *– not in the sense that they own their homes or their cars.* ***They merely own the right to the residual cash flows*** *of the company, which is not at all the same thing as owning the company. They have no ownership rights on the actual assets or businesses of the company. We also know that* ***the value a company creates is produced through a combination of resources contributed by different constituencies****: Employees, including managers, contribute their* ***human capital****, for example, while shareholders contribute* ***financial capital****. If the value creation is achieved by combining the resources of both employees and shareholders, why should the value distribution favor only the latter? If these truths are acknowledged, there can be no basis for asserting the principle of shareholder value maximization. There just aren't any supporting arguments. Why do we not fundamentally rethink the corporate governance issue?* ***Why don't we actually acknowledge in our theories that companies survive and prosper when they simultaneously pay attention to the interests of customers, employees, shareholders,*** *and perhaps even the communities in which they operate? Such a perspective is available, in* ***stewardship theory*** *for example (Davis, Schoorman, and Donaldson, 1987),"*[662]

Toyota, arguably the world's premier manufacturing company and the current dominant challenger in the automotive industry, states the following as its objective function:

> *"We maximize* ***shareholder value*** *over the* ***long term*** *by harmonizing the interests of* ***all our stakeholders****: customers, suppliers, employees, and members of the community at large, as well as shareholders."*[663]

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[660] Ghoshal, S., (2005), pg. 79.
[661] Thurow, L. (1980), pg. 17.
[662] Ghoshal, S., (2005), pp. 79-81.
[663] 1998 *Toyota* annual report.

4.5.2 *Functional Decomposition*

> *"**Decomposition** is a time-honored problem solving strategy (Simon, 1969). It **often works effectively**, provided the process under consideration is **not strongly coupled** to other systems. When **couplings are strong**, however, decomposition may lead to **ineffective** policies. Worse, piecemeal policies may **intensify the problem** (Forrester, 1971; Ackoff, 1978) or even lead to **catastrophe** (Perrow, 1984). Decomposition methods **ignore feedback** processes and **discount time delays** and side effects. Decomposition in complex, tightly coupled dynamic systems **optimizes the parts at the expense of the whole** and the **present at the expense of the future**."*[664]

As shown in Figure 196 below, the functional decomposition among stakeholders creates chunks (or stakeholder pairs) which are either functionally independent (in the case of modular enterprise architectures) or functionally interdependent (in the case of integral enterprise architectures).

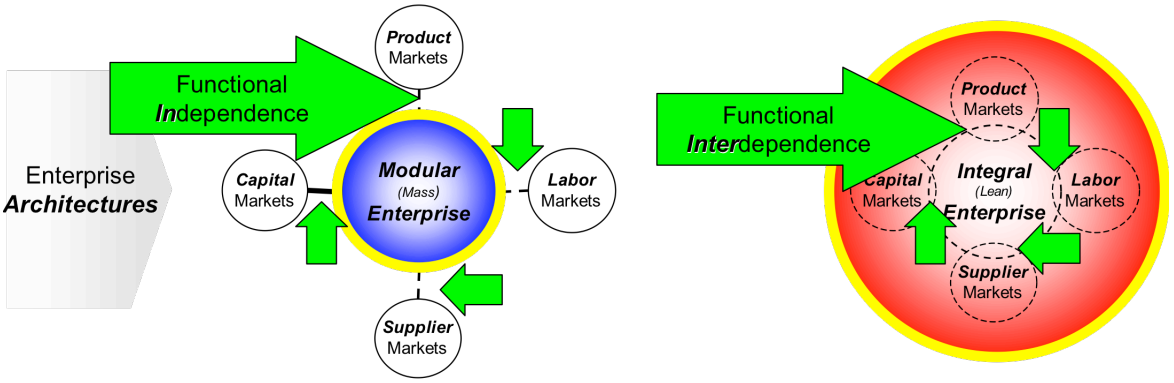

Figure 196: Functional In(ter)dependence

4.5.2.1 Functional *In*dependence

When an industry is in "push" mode, stakeholder power resides with the central firm. Therefore the interests of other stakeholders are relatively less important. Functions can be decomposed successfully to stakeholders in a modular fashion, and the zero-sum game of wealth distribution is played, particularly as this is the "dominant design" of enterprise architectures, and the winner is the one who plays it the most efficiently.

4.5.2.2 Functional *Inter*dependence

When an industry is in "pull" mode, the stakeholder power is more distributed within the enterprise. Therefore the interests of other stakeholders are relatively more important. Functions cannot be decomposed successfully to stakeholders in a modular fashion, and a positive-sum game of wealth distribution is played. The winner is the one who plays it the most efficiently.

[664] Sterman, Repenning and Kofman (1997), pg. 519.

4.5.3 *Enterprise Performance*

> *"In the presence of **strong interdependencies** (as is often the case in many complex products), the **system can not be optimized by separately optimizing each element** from which it is made. Indeed, in the case of strong interdependencies, it might well be the case that some, or even all, solutions obtained by tuning each component 'in the right direction' yield a **worse performance** than the current one. In the presence of strong interdependencies, the problem **cannot therefore be decomposed** into separate sub-problems which could be optimized separately from the others (Marengo, 2000)."*[665]

The maximization of stakeholder surplus is by its very title a more global optimization around the relevant stakeholders who impact the long-term strategic advantage of the firm. It recognizes that the enterprise-level decomposition of functions across different stakeholders can and often does result in sub-optimal system performance, particularly if strong interdependencies exist across stakeholders, as shown in Figure 197 below.

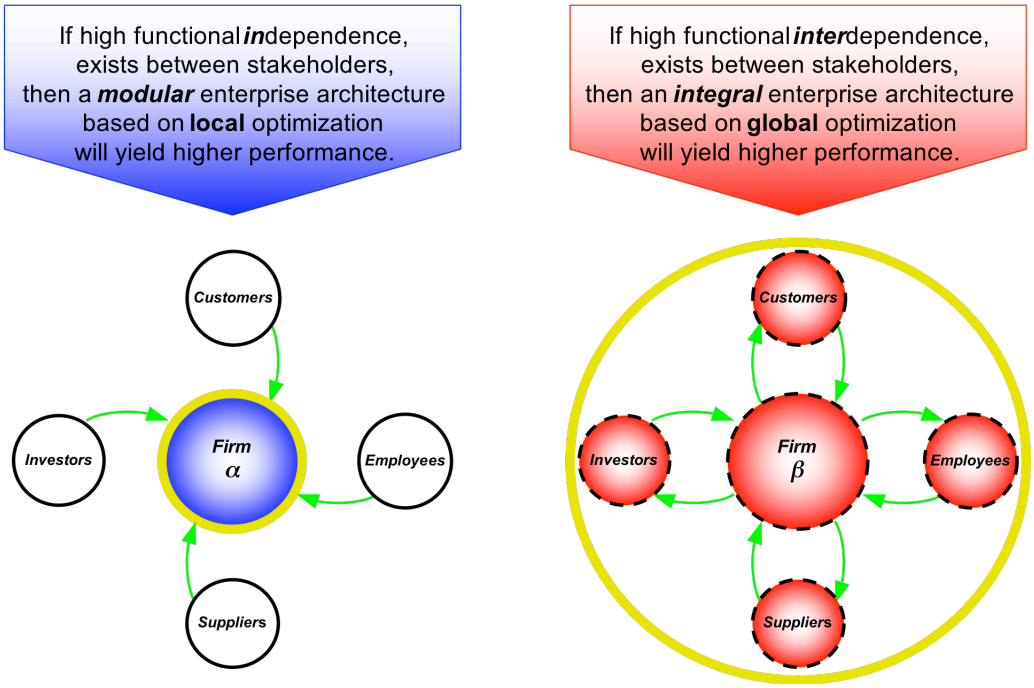

Figure 197: Performance and Functional In(ter)dependence

Note that the converse statements are also true and important. For example, if high functional *inter*dependence exists between stakeholders, then a *modular* enterprise architecture based on local optimization, would result in global sub-optimization and hence low performance. The formula one race car finding itself in a mud-bog, would be an example of increasing the functional performance of the parts (i.e. faster engine, or greater aerodynamics), would make the system performance no better, and in fact worse off if one considers the amount of resource spent on these activities as opposed to other "architectural" activities.

[665] Dosi et al. (2003), pg. 106.

The question regarding what circumstances produce the need for functional in(ter)dependence will be addressed in Essay #3.

4.5.3.1 *Local* optimization

4.5.3.2 *Global* optimization

This requires trade-offs in local performance for global performance.

4.6 The Process of *Architecting* Enterprises

The first step of architecting, is to understand the environmental conditions at a very deep level, and then to design the enterprise (or artifact) to fit within the requirements of the environment.

> *"There is an overriding management task in first **interpreting correctly** the market and technological situation, in terms of its **instability or of the rate at which conditions are changing**, and then designing the management system appropriate to the conditions, and making it work. 'Direction' is the distinctive task of managers-in-chief..."*[666]

Heuristic 1p:
Enterprise architectural "design" may or may not be a conscious, rational, strategic choice (i.e. voluntaristic vs. deterministic).[667] One determining factor is the maturity of the enterprise relative to the maturity of the industry.[668]

> *"We are called to be the **architects** of the future, not its **victims**."*[669]

> *"The architect must be a **prophet**... a prophet in the true sense of the term. If he can't see at least **ten years ahead,** don't call him an 'architect'."*[670]

Heuristic 1q:
Enterprise architectural "design" is possible, however it requires long-term vision to seek environmental signals through the noise, boundary-spanning negotiation skills, and the ability to simplify complexity.

Organizational theorists Karl Weick (1993) and Peter Senge et al. (1999), have noted that design can be viewed from the perspectives of *formal* and informal or *emergent* design. In civil architectural terms, these are also referred to as: *self-conscious* and *unselfconscious* design. These will be discussed briefly in the following subsections.

4.6.1 Formal (self-conscious) *design*

> *"**Formal** design* [is] *the **conscious, intentional** architecture of organizations, such **as guiding ideas and strategies, established structures, and policies and rules**."*[671]

4.6.2 Emergent (unself-conscious) *design*

> *"**Emergent** design* [is] *the ways that people **naturally 'redesign'** the organization **as they live in it**."*[672]

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[666] Burns and Stalker (1961), pg. viii (of the preface to the second edition by Tom Burns).
[667] Herb Kelleher, CEO of *Southwest Airlines*, architected the enterprise's integral form.
[668] For example, modular incumbents in a H.F.F. world were voluntaristic, while in a B.F.C. world, they become deterministic. See Astley and Ven de Ven (1983), and Whittington (2000)
[669] Buckminster Fuller: engineer, architect, philosopher.
[670] Frank Lloyd Wright.
[671] Senge et al. (1999), pg. 360.
[672] Senge et al. (1999), pg. 360.

4.7 Chapter Summary

This chapter was the first of three essays which forms an integrated framework which attempts to explain long-term firm performance. In this chapter, we defined the construct of an *enterprise architecture*, its sources and properties.

The context for this construct within the framework is shown below in Figure 198. In the following chapter, we will next discuss how these architectures provide the highest level explanations for the ensuing dynamic performance of the firm.

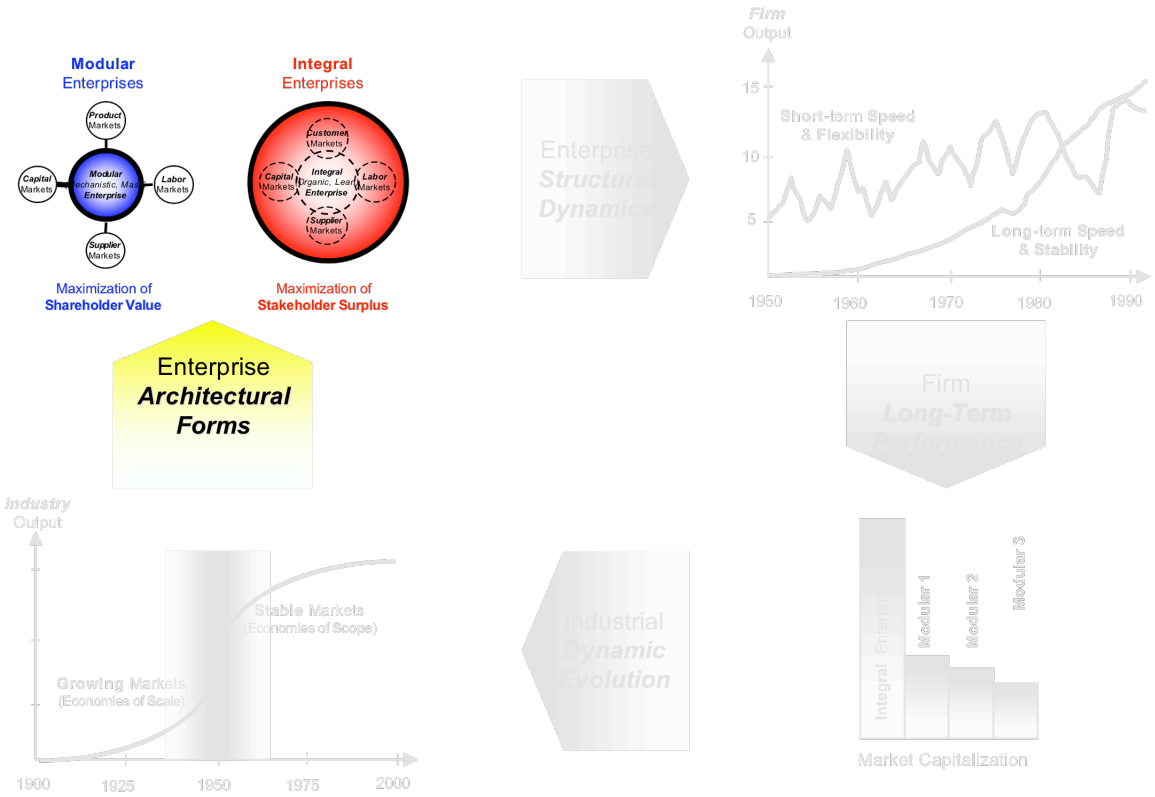

Figure 198: Enterprise *Architecture* within Framework

Chapter 5 Enterprise *Competitive Dynamics*

Having defined the various species occupying the ecosystem, we can now discuss competition both within and between species. As the new *Ford* CEO, Alan Mulally recently noted:

> *"We [Ford] have been **going out of business for 40 years**."*[673]

5.1 Introductory Constructs and Propositions

> *"We should have a **system of economics** that is **structure**. We do not have it. We are all hanging by our eyebrows from skyhooks economically, just as we are **architecturally**."*[674]

Having outlined a framework for the understanding of an enterprise architectural form, we now need to translate it operationally into a more concrete structural form, in order that we may understand and ultimately predict the dynamics of the enterprise.

5.2 Theoretical Foundations

The notion of *enterprise structural dynamics* can be constructed from a variety of eclectic theoretical management traditions ranging from general systems theory (von Bertalanffy, 1962) to system dynamics (Forrester, 1961). The following briefly summarizes a few of the threads in various fields within economics and sociology.

5.2.1 Economic *Theories*

5.2.1.1 Penrose and Firm Growth

> *"The question I wanted to answer was whether there was something inherent in the very nature of the firm that both **promoted its growth** and necessarily **limited its rate of growth**."*[675]

Theories of firm growth have tended to focus on corporate growth through the inorganic mechanism of mergers and acquisitions in the development of the diversified M-form and beyond.

Theories of growth of the strategic business unit or the single product firm are relatively rare. One of the first researchers to tackle the topic was Penrose, in her 1959 classic, *The Theory of the Growth of the Firm*. It tended to focus internally on the constraints and enablers of the development of resources of the firm, which ultimately led to the school of thought in strategic management today known as the *resource-based view* of the firm.

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[673] Ford CEO, Alan Mulally, "The New Heat on Ford," by David Kiley, *Business Week*, June 4, 2007.
[674] Frank Lloyd Wright.
[675] Penrose, E. (1959).

5.2.1.2 Marris and Growth vs. Profitability

> *"In the managerial utility function:* ***growth rate is a proxy for income, power****, prestige, and accompanying managerial gains from growth; and* ***stock-market value is a proxy for job security****."*[676]

Following in Penrose's search for the enablers and constraints to firm rates of growth, Marris (1963) noted that the separation of ownership from management created a principal-agent conflict regarding the tradeoff between growth and profitability as shown conceptually in Figure 199 below.

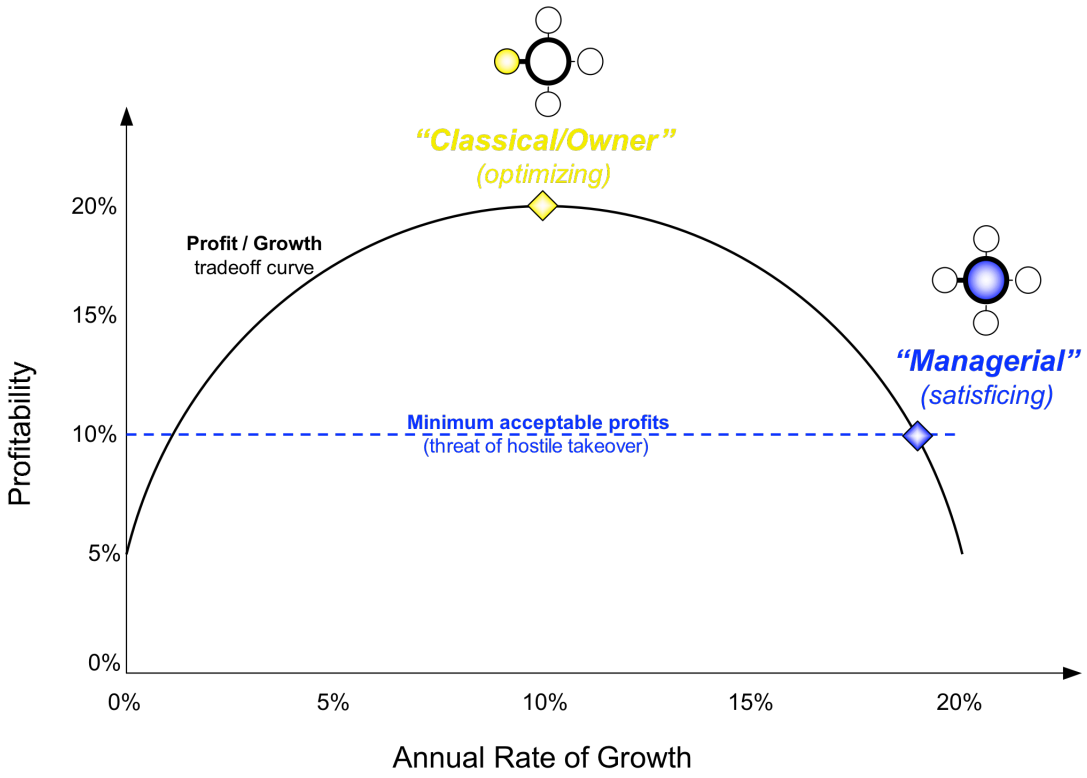

Figure 199: Principal-Agent conflicts in *Profits* and *Growth*

> *"****Growth models****, unlike managerial static models, required the development of* ***a new of transformation function*** *to specify the constraint against which utility was to be maximized. They required, that is to say, a body of theory* ***to indicate the trade-off between growth rate and stock-market value – a 'valuation curve'*** *with the (normalized) level of stock-market value on one axis and the expected growth rate of the size of the firm on the other."*[677]

It is interesting to note that the trade-off between profits and high rates of growth is hypothesized to lie in the general "dynamic diseconomies of scale", or degradation of capabilities.

[676] Marris, R. and Mueller, D.C. (1980), pg. 42.
[677] Marris, R. and Mueller, D.C. (1980), pg. 42.

> *"The relationships were also embellished by taking account of **the costs of administrative inefficiencies caused by rapid growth in size ('dynamic' diseconomies of scale**, not to be confused with static phenomena) as suggested by E.T. Penrose (1959)..."*[678]

Empirical evidence both in the U.S. (Holl, 1977) and Australia (Lawriwsky, 1984), supports the claims that managers – without contravening incentives – tend to maximize growth and satisfice profits.

As will be discussed in chapter 6, a life-cycle theory of the firm (Mueller, 1972), predicts that this severity of this owner-manager conflict varies throughout the age (and growth ability) of the firm.

5.2.1.3 Goodwin and the Business Cycle

> *"Goodwin showed that the **antagonist** relationship between **workers** and **capital owners** could lead to **cycles**."*[679]

Goodwin was one of the first economists who tried to combine the behaviors of growth and cyclicality (Weber, 2005), which was based on the classical predator-prey models (Lotka, 1925; Volterra, 1926).

Within the framework of the enterprise architecture presented herein, it is the tension created by the separation of the interests of the factors of production (i.e. the capital owners and the labor) which generates the business cycle oscillation as shown in Figure 200 below.

[678] Marris, R. and Mueller, D.C. (1980), pg. 42.
[679] Weber (2005), pg. 5.

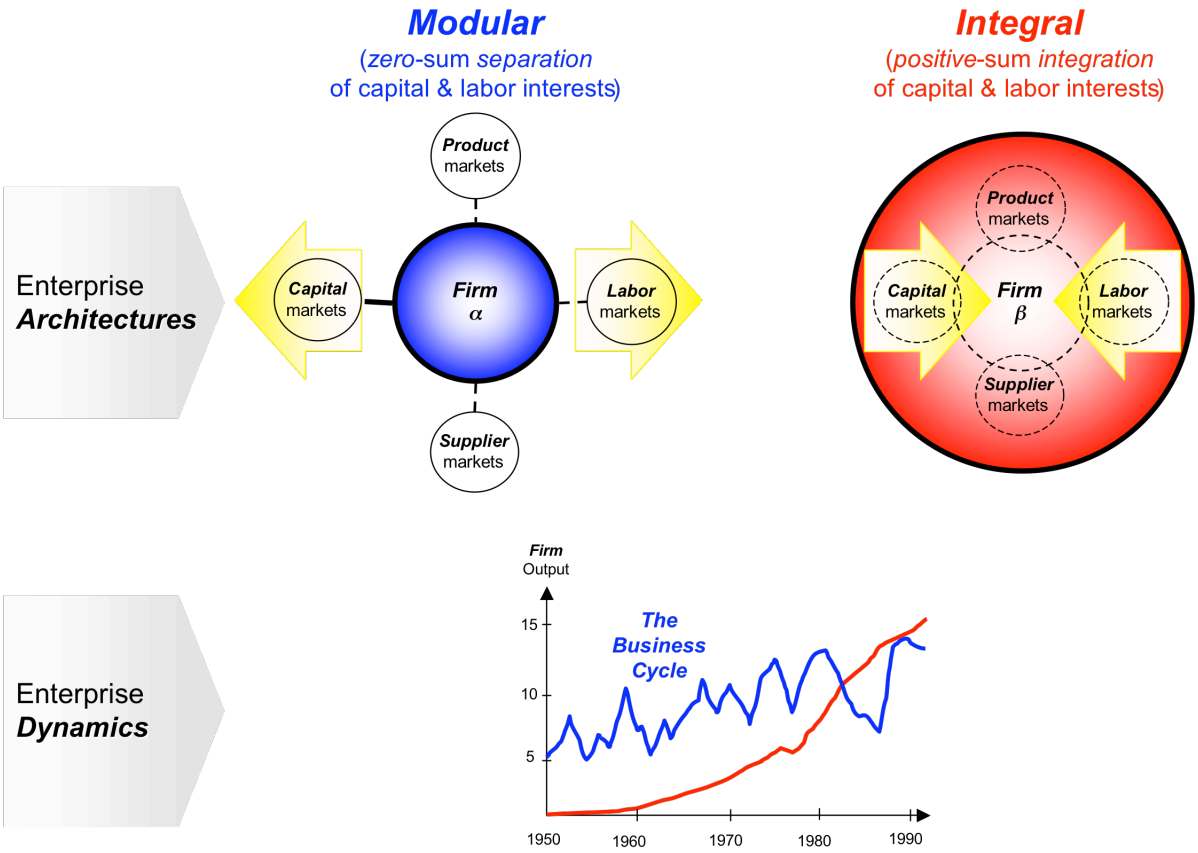

Figure 200: Enterprise Architecture as a Generator of the Business Cycle

Note that system dynamicists (e.g. Forrester, 1968b; Mass, 1976; Sterman, 2000) have long demonstrated via numerical simulation, the plausibility of workforce-inventory interactions in the form of a balancing loop with delay as the origin of the business cycle.

5.2.1.4 Kuznets and the Machine Investment Cycle

In addition to the lightly-damped, 3-5 year business cycle, the enterprise architecture can be used to idealize the heavily-damped 20-year machine-investment or Kuznets cycle. As shown in Figure 201 below, the enterprise architecture can be used to visualize the sources of both the business cycle (i.e. the balancing behavior with delays between firm's inventory and labor markets) and the Kuznets cycles (i.e. the balancing behavior with delays between the firm's inventory and capital markets).

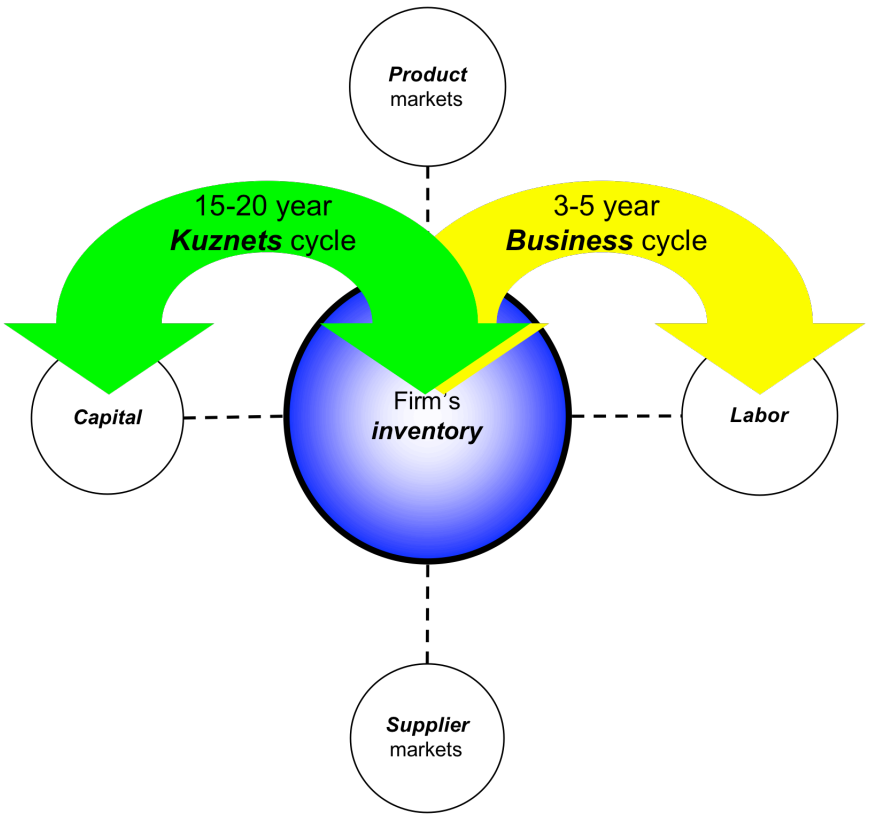

Figure 201: Enterprise Architecture and the *Business* Cycle and *Kuznets* Cycle

5.2.2 Sociology and Organizational *Theories*

A good discussion of the various threads can be found in Burrell and Morgan (1979).

5.2.2.1 Structural Functionalism

5.2.2.2 System Theory

The multidisciplinary field of general systems theory began in the 1950's with great ambition (von Bertalanffy, 1962). The intellectual traditions attempted to develop generic system characteristics across many fields from mechanistic to organismic to organizational.

5.2.2.2.1 System Goals: *Growth* and *Stability*

> *"Organization has **three goals** which are **growth, stability and interaction**."*[680]

Early social systems theorists (Henderson, 1935; Boulding, 1956; Forrester, 1961; Scott, 1961) explored the range of system goals. Henderson (1935) hypothesized the goals of stability, growth and interaction, which later researchers classified as development (Ackoff, 1999). Boulding (1956) and Forrester (1961) focused on growth and stability.

> *"The goal is 'enterprise design' to create more successful management policies and organizational structures…which influence **growth and stability**."*[681]

> System Dynamics *"is a quantitative and experimental approach for relating organizational structure and corporate policy to industrial **growth and stability**."*[682]

> *"Top-management structures have different forms, different attitudes, and different histories. They differ in courage, conservatism, flexibility, rapidity of reaching decisions, and in the objectives being sought. Just as the operating functions interact with one another to produce important dynamic behavior characteristics, so will the interaction between top-management structure and the operating departments favor different **growth** and **stability** patterns."*[683]

5.2.2.2.2 Open vs. Closed *Causal* Systems

Much of the theory of enterprise architectures and their resulting structural dynamics hinges upon assumptions of the boundary of the firm (or of the unit of competitive analysis) which defines how the firm engages its environment. This issue will become important again later in essay #3 as we investigate the implications for industrial evolution.

There is a rich and slightly incoherent view of firms as either closed or open systems in the social sciences. Clarification of the definitions of these terms is crucial to understanding the discrepancies.

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[680] Scott, W.G. (1961), pg. 20.
[681] Forrester, J.W. (1961).
[682] Forrester, J.W. (1961), pg. 13.
[683] Forrester, J.W. (1961), pg. 329.

5.2.2.2.3 Open – Closed Systems and Functional In(ter)dependence

Modular enterprise architectures are characterized by functional independence. This can be modeled causally as an open causal system.

Integral enterprise architectures are characterized by functional interdependence. This can be modeled causally as a closed causal system.

5.2.2.2.4 Feedback Systems: *Positive* & *Negative*

While organizational theorists (Lawrence and Lorsch, 1967) have discussed the integration-division dichotomy, systems theorists (Stacey, 1995) note that the forces of *integration* lead to *stable* equilibrium via *negative* feedback, while the forces of *division* lead to *instability* via *positive* feedback.[684] Both forms of feedback can lead to different forms of growth: stable and unstable.
It is interesting to note that the quest for *efficiency* is argued both for the forces of integration (Stacey, 1995, pg. 484) causing stability via negative feedback and for the forces of division (Smith, 1776), causing instability via positive feedback.

5.2.2.2.5 Feedback Systems: System Dynamics and Cybernetics

In a compelling historical review of feedback thinking, Richardson (1991) hypothesizes the existence of two subtle but important threads within the social sciences: the servomechanisms and cybernetics threads.

> System Dynamics *"is a quantitative and experimental approach for relating organizational structure and corporate policy to industrial **growth and stability**."*[685]

System dynamics is a method for understanding how structure drives behavior in a wide range of social and technical systems.

> *"To Professor Jay Forrester, for **codifying the dynamics of social systems** as long ago as the 1950's. I remain mystified as to why these essentially simple mechanisms that constitute the processes of change in all social systems have lain largely unnoticed for four decades."*[686]

[684] Stacey, R.D. (1995), pp. 484-485.
[685] Forrester, J. W. (1961), pg. 13.
[686] Warren, K. (2002).

5.2.3 Strategic Management *Theories*

5.2.3.1 Functional *Configurations*

Miles and Snow (1978) defined a configurational typology which ultimately led to one of the top ten most influential publications in strategic management (Ramos-Rodriguez and Ruiz-Navarro, 2004). By studying four industries: publishing, electronics, food processing and health care, they defined a typology of four strategic types: *prospectors, analyzers, reactors* and *defenders*.

These strategic types were deemed to be equally effective independent of the environmental conditions. In Essay #3, it will be shown that other researchers demonstrated environmental contextual variables govern the performance of strategic types (Hambrick, 1983).

5.2.3.1.1 The Four Types

5.2.3.1.1.1 Prospectors

> *"Prospectors are characterized by their **constant search for new** products and markets. They continually experiment with new product lines and venture into new markets. These organizations are the **creators of change** in their markets and are the forces to which competitors must respond. As such, prospectors are more concerned with searching for new opportunities and will **likely not be as efficient as defenders**."*[687]

5.2.3.1.1.2 Analyzers

5.2.3.1.1.3 Reactors

5.2.3.1.1.4 Defenders

> *"The defender has a **narrow and stable** product-market domain and **seldom makes major adjustments** in its technology or structure. The emphasis is on **better and more efficient ways to produce** a given product or service and on defending a market. A defender does little research and development. When defenders persue new products, they import the technology from outside the organization."*[688]

[687] Delery and Doty (1996), pg. 810.
[688] Delery and Doty (1996), pg. 810.

5.2.3.1.2 Empirical Examples

In Table 17 below, Arthur (1992) shows the results of an empirical study of IR practices and strategy of US Steel Mini-mills. Note that while it does show empirical match between strategy and IR practices, it does not specify levels of firm performance.

		Business Strategy	
		Low Cost	Differentiation
Industrial Relations System	Cost Reducing	8 (89%)	8 (40%)
	Commitment Maximizing	1 (11%)	12 (60%)

Table 17: Strategy-HRM Fit

It is important to note that the three case studies presented in this dissertation demonstrate the opposite matching, namely that commitment maximizing IR systems tend map to Low Cost strategies, contingent upon the state of the industry's evolution.

In Table 18 below, Delery and Doty (1996) show the following rankings from a survey study using Likert rankings of the banking industry.

Ideal Strategic Profiles Variables	Prospector	Analyzer	Defender
Technological progress	**5.64**	4.82	4.86
Product / market breadth	**5.68**	5.18	1.59
Product innovation	**6.95**	4.68	1.68
Quality	5.47	5.30	**5.86**
Price level	**6.61**	4.40	1.32
Active marketing	**6.52**	5.54	3.14
Long-range financial strength	4.11	**5.83**	4.88
Resources level	4.86	**5.18**	4.30
Investment in production	2.91	4.59	**6.18**
Internal analysis level	3.68	5.62	**6.82**
External analysis level	**6.95**	5.24	2.05
Level of risk	**6.00**	2.62	2.68
Proactive management style	**6.76**	4.90	2.86

Table 18: Configuration Attributes

5.3 Structural Mechanics

5.3.1 *Structural Building Blocks*

In order to build a theory translating architectural form into structural dynamics, we must next define the underlying structural building blocks which generate the dynamic reference modes.[689] These include the following, which will be described in more detail:

- Positive (reinforcing) feedback
- Negative (balancing) feedback
- Delays
- Carrying capacity

> *"Learning to recognize and account for time delays goes hand in hand with learning to be **patient**, to **defer gratification**, and to trade **short-run sacrifice** for **long-term reward**. The abilities do not develop automatically. They are part of a **slow process of maturation**.*
>
> *In a world of **short time horizons, of annual, quarterly or even monthly performance reviews**, the incentives people face often mean it is **rational for them to be aggressive** and ignore the delayed consequences of their actions.*
>
> *The problem is one of aggregation. **The individual firm tends to view itself as small** relative to the market and **treats the environment as exogenous**, thereby **ignoring all feedbacks** from prices to supply and demand."*[690]

The two key feedback relationships (positive and negative) will first be described along with the two essential building blocks of time delays and system carrying capacity. These will subsequently be assembled into a set of reference modes that capture the fundamental structural dynamics of the enterprise architectures.

> *"The qualitative distinction between these **two sorts of feedback mechanisms**, one **amplifying** heterogeneity and the other **sustaining** the current level of heterogeneity, is likely to be robust. Heterogeneity in competitive position is **sustained by existing market relations** and tends to be **amplified by overall market position**."*[691]

[689] Forrester, J.W. (1968).
[690] Sterman, J.D. (200), pp. 696-697.
[691] Levinthal, D. and Myatt, J. (1994), pg. 61.

5.3.2 *Fundamental Reference Modes*

Having defined the structural mechanics or principles of systems, we can next describe how these generate the fundamental reference modes which are summarized in Figure 202 below.

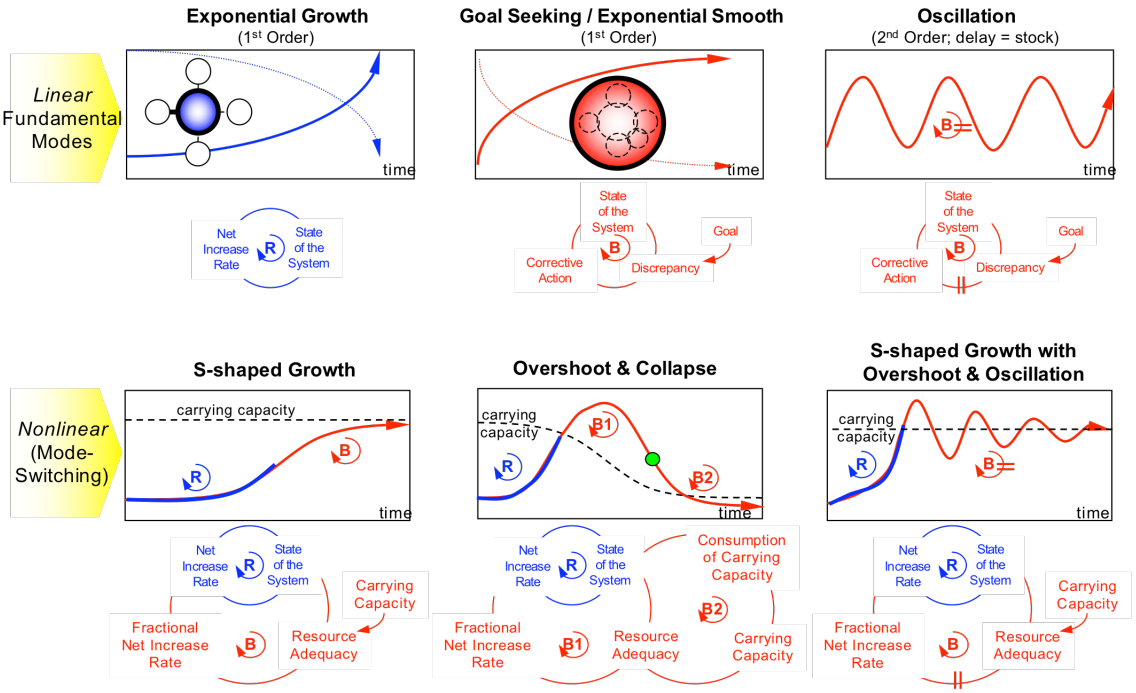

Figure 202: Fundamental *Reference Modes*

- Exponential Growth / Decay
- Goal-seeking Growth / Decay
- Oscillation
  - Balancing Loop with delays
  - Conflicting Goals[692]
- S-Shaped Growth
- Overshoot and Collapse
- Overshoot and Oscillate

> *"An appropriate caveat to these market positional advantages is that they are **self-reinforcing** in competitive environments in which the bases of competitive advantage are **stable**. Conversely, in **changing environments**, these same **self-reinforcing mechanisms** may lead to **decline** in the firm's competitive position (Levinthal, 1992)."*[693]

[692] See Peter Senge interview, "Illuminating the Blind Spot: Leadership in the Context of Emerging Worlds." on McKinsey/SoL joint research project.
[693] Levinthal, D. and Myatt, J. (1994), pg. 47.

5.3.3 *The "Physics" of Growth*

The physics of growth depends upon the assumptions of model boundaries and therefore exogenous constants. Figure 203 below summarizes the structures and behaviors of a variety of single and multi-loop, linear and nonlinear first order systems, with exogenous constants shown in green.[694] Note that one would not expect to see any oscillation in any of these behaviors, due to the fact that they are all first order systems.

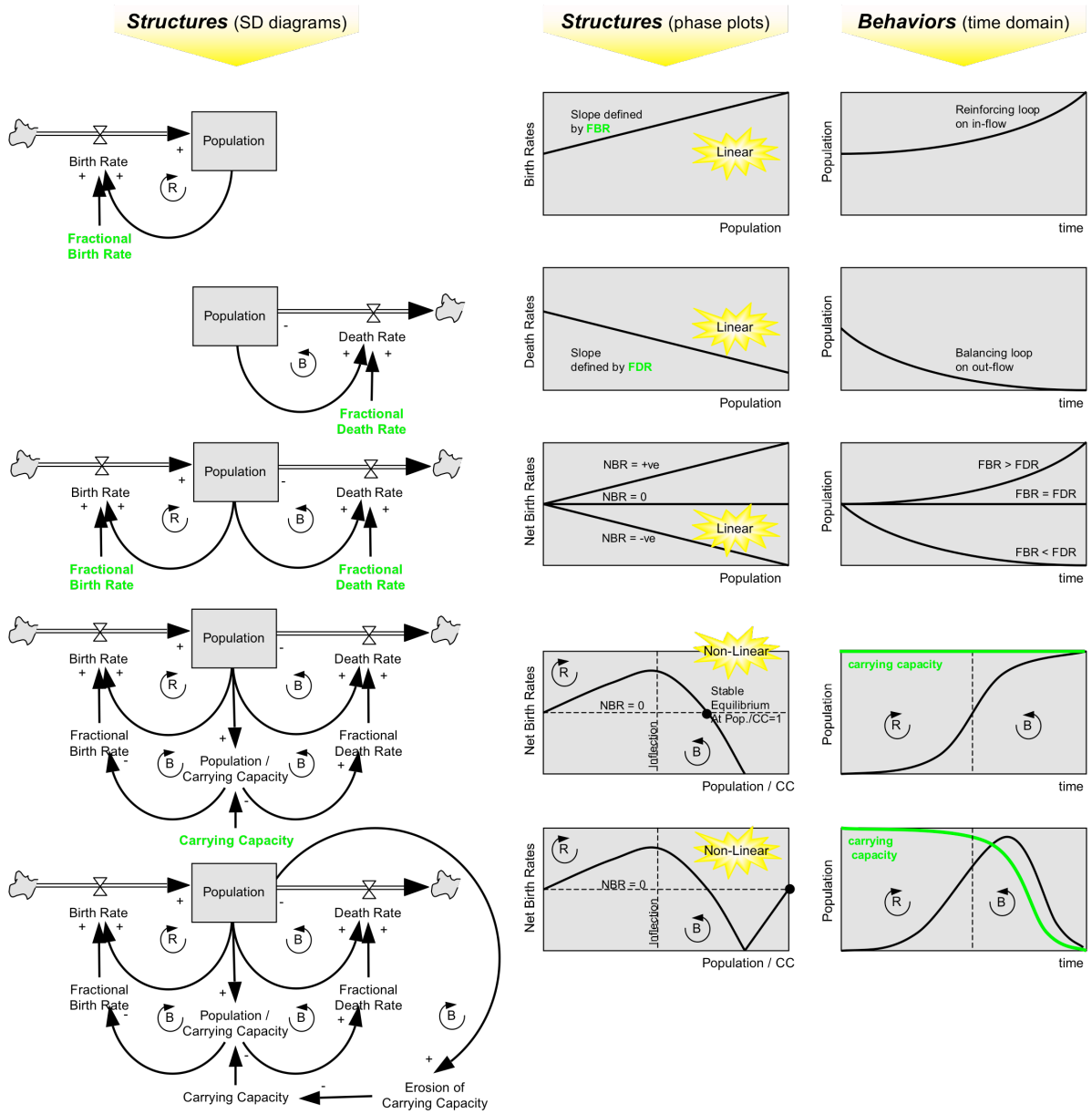

Figure 203: First Order Growth Systems

[694] Sterman, J.D. (2000) pp. 118-127 and 282-290 provides a good discussion of growth modes.

*"The question I wanted to answer was whether there was something inherent in the very nature of the firm that both **promoted its growth** and necessarily **limited its rate of growth**."*[695]

*"The analysis of the limits to growth – the factors determining the **maximum rate of growth** of firms – cannot, in its present formulation at any rate, be tested against the facts of the external world, partly because of the difficulties in expressing some of the concepts in **quantitative terms** and partly because of the impossibility of ever knowing for any given firm what is, or what would have been, its maximum rate of growth. Perhaps some of these difficulties will be overcome in **different formulations constructed by others**..."*[696]

*"In order to find comprehensive and rigorous answers to the questions Penrose (1959) posed concerning firm growth processes, **more conceptual and especially empirical research** needs to be done on the dynamics of growth, that is analyzing the paths and the effects of the outcome of different sequences in the growth process."*[697]

[695] Penrose, E. (1959).
[696] Penrose, E. (1959), pg. 4.
[697] Kor and Mahoney (2000), pg. 128.

5.3.4 *Enterprise* Inertias

In contrast to the traditional beliefs of "classical" strategic management, where managers have high degrees of *rationality* and search capabilities, and where organizations have high degrees of *plasticity,*[698] the notions of *inertia* posit that organizations are typically unable to react to environmental change in a timely manner.[699]

This framework, however broadens the perspective of strategy by identifying not one, but two separate forms of organizational inertia: *architectural* and *structural*, both of which ultimately arise from the enterprise's architectural form, as shown in Figure 204 below. Broadly speaking, architectural inertia limits the firm's response to *environmental* change, while structural inertia limits the firm's response to *operational* change.[700]

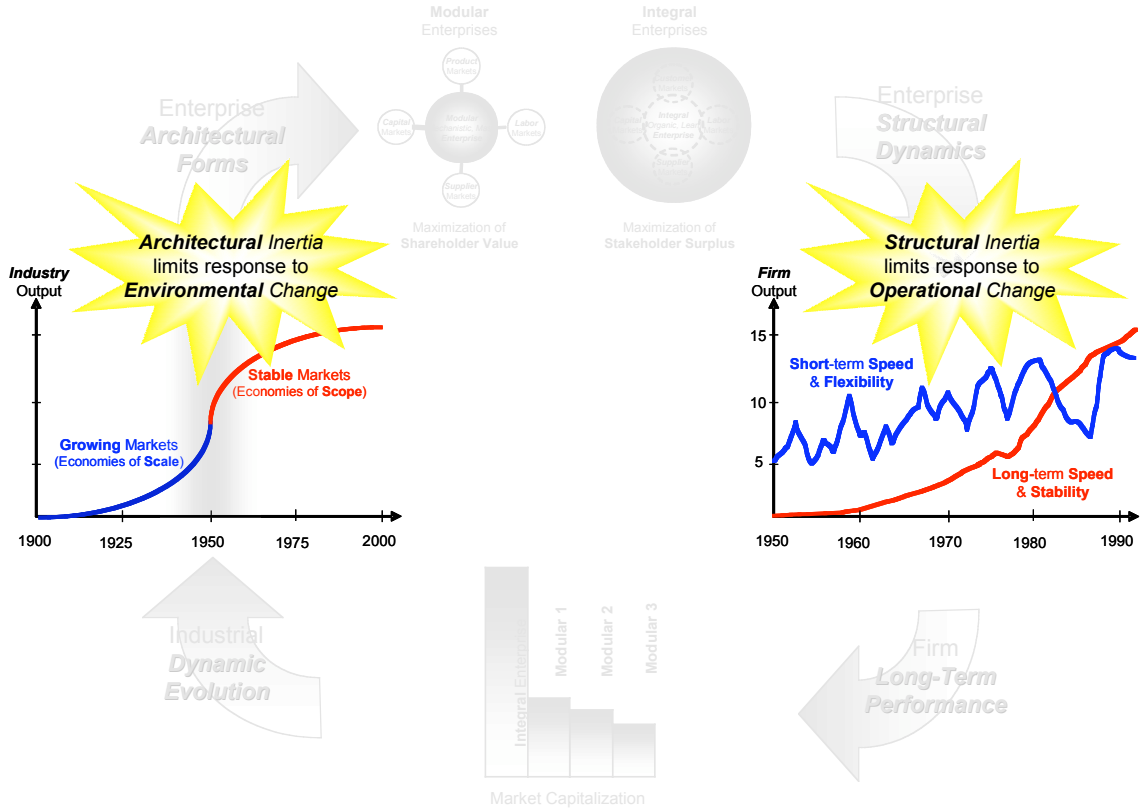

Figure 204: *Architectural* and *Structural* Inertia

The following subsection briefly explores structural inertia and its effects on the dynamics of operational change. Chapter 6 will explore architectural inertia and its effects on the evolution of enterprise architectures in response to environmental changes.

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[698] Gavetti and Rivkin (2004).
[699] Whittington, R. (2000).
[700] While the terms "architectural" and "structural" inertia are coherent and consistent with the overall framework developed herein, they will undoubtedly cause confusion in the strategic management community. My use of the term "architectural" inertia to describe resistance to *environmental* change is termed "structural" inertia by population ecologists, which is the term that I use to describe resistance to *operational* change.

5.3.4.1 *Structural* Inertia

The notion of *structural* inertia limits the firm's response to *operational* change. Specifically, when looking at aggregate system variables like firm output (Q), it is clear that some enterprises undergo more severe instability or oscillations than others when subjected to similar environmental shocks (like variable customer demands). Structural inertia therefore is fundamental in defining an enterprise's approach to such system goals as *growth* and *stability*.[701]

Heuristic 2a:
Modular enterprise architectures tend to have less structural inertia than equivalent integral enterprise architectures. As a result, modular enterprise architectures have greater short-term speed and instability than equivalent integral enterprise architectures.

The determinants of structural inertia are also different than the determinants of architectural inertia. Although age and size have secondary impact on structural inertia, the fundamental drivers are those material, information and mental state delays in the system, as shown in Figure 205. Such delays tend to inject time into the system, making its fundamental period of oscillation longer. Instability therefore occurs when the fundamental period of oscillation is close (i.e. near resonance) with the fundamental period of oscillation of the forcing function (e.g. customer orders).[702]

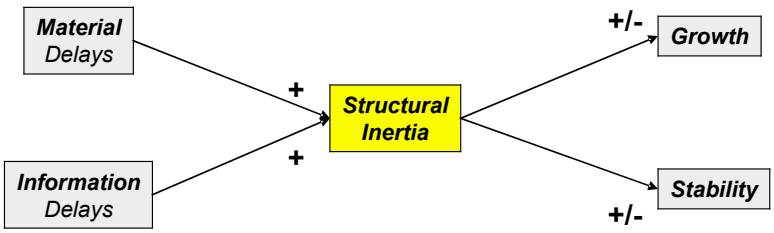

Figure 205: Sources of *Structural* Inertia

As an aside, please note that not only can structural inertia cause the amplification or attenuation of enterprise instability, but other structural quantities, like damping and stiffness can have similar effects. These will be discussed later.[703]

Heuristic 2b:
As the nature of customer demand changes tends to consist of a series of small, frequent, pulses, the "loading function" on the enterprise tends to be multi-frequency transients.

By way of a brief illustrative example, *Boeing*, the 90-year old large incumbent currently has a modular enterprise architecture. This would imply high architectural inertia (due to its age,

[701] The field of System Dynamics explicitly addresses the mechanics of social system inertia. See Forrester (1961, 1968).
[702] Piepenbrock, T. (2004).
[703] Piepenbrock, T. (2004).

size and routines) making it difficult to survive discontinuous environmental change[704], while its structural inertia is relatively low due to its short-term speed and growth objectives.

Conversely, *Airbus*, the 35-year old smaller challenger currently has an integral enterprise architecture. This would imply lower architectural inertia (due to its age, size and routines) making it easier to survive discontinuous environmental change[705], while its structural inertia is relatively high due to its long term speed and stability objectives.

> *"As we go back into a commodity supply system, the structural character begins to change. In the distribution system for manufactured products, goods are shipped in response to orders. A product is shipped to a customer only if he wants it. Stresses within the system manifest themselves more by a* ***change in the flow rate of goods than by changes in price****. We commonly observe that a factory will adjust production rate to market demand by* ***production-rate changes that are larger and faster than are the price changes****. By contrast, the commodity system tends to be one in which supply rates can be adjusted but* ***slowly****. The commodity is not produced to the specific order of the customer.* ***Price fluctuates more rapidly than supply rate.****"*[706]

[704] Like "disruptive innovations" at the low end of its market from *Embraer* and *Bombardier* for example. See Christensen et al. (2004).
[705] Ibid.
[706] Forrester, J.W. (1961), pp. 322.

5.3.5 Time *and the Causal Levels of Competition*

Wernerfelt (1984) argued for clarity in the strategic management literature by differentiating between competition based on *products* and competition based on a deeper generating mechanism, namely *resources*.

This research argues for a deeper generating mechanism, namely that of an *enterprise architecture*, which ultimately enables and constrains (but does not determine) what resources can be generated and how they might be built and maintained.

As shown in Figure 206 below, the research assembles a causal logic in which integral enterprise architectures are built based on the mutual consent of the stakeholder ecosystem to take the time required to develop the capabilities necessary to dominate a market over the long term. This is a "patient", long-term thinking ecosystem.

Conversely, modular enterprise architectures are built to extract as much rent from the ecosystem as possible to be given to the shareholders. This stakeholder group typically demand high rates of return (and therefore growth). This tends to be an "impatient" short-term thinking ecosystem.

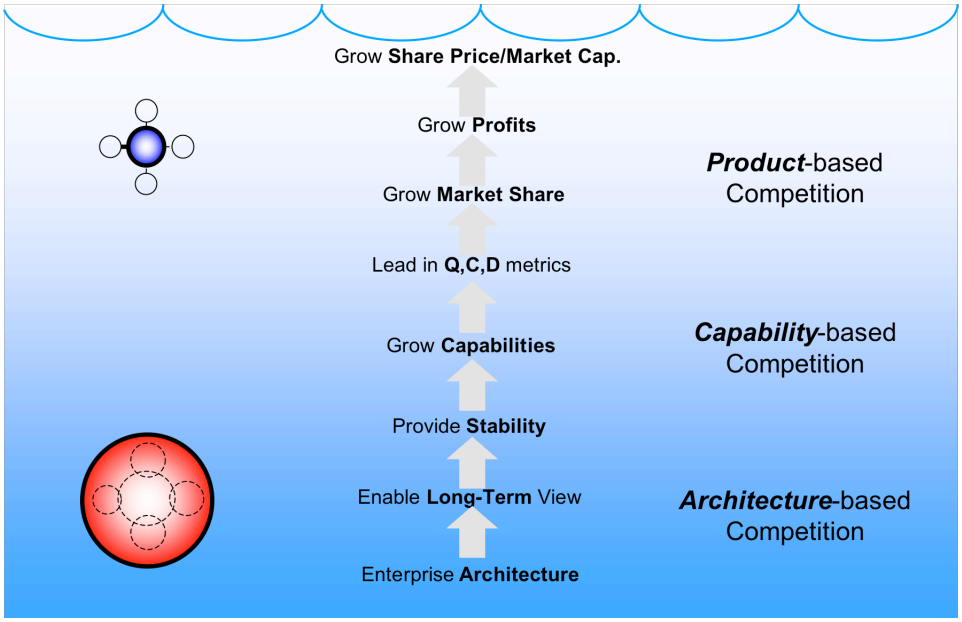

Figure 206: *Time* and the Causal Levels of Competition

It has been observed empirically[707], that when a modular architecture is competing against an integral enterprise architecture, and is losing ground over the long run, it tends to adopt the "surface details" of the integral enterprise architecture, without changing the fundamental nature of its modular architecture, making its long-term competitive position even worse.

[707] Empirical observations include: automobiles (Womack et al., 1990), airlines (Hoffer-Gittell, 2003) and large commercial airplanes (Piepenbrock, T. 2004).

5.4 Enterprise Architecture *Form-Structure* Mapping

Having dfined the characteristics of enterprise architectural forms, this section will now begin to map these forms to their associated "structures" or functional behaviors. These functional behaviors will be divided into *quantity*-based and *quality*-based growth variables.

5.4.1 Quantity *Growth* (Operations *Strategy)*

This sections deals with the growth in *quantity* of enterprise inputs (e.g. workforce, R&D spending) and outputs (e.g. annual number of cars produced, annual number of seat-kilometers flown).

> *"Top-management structures have different **forms,** different attitudes, and different histories. They differ in **courage, conservatism, flexibility, rapidity of reaching decisions**, and in the **objectives** being sought. Just as the operating functions interact with one another to produce important dynamic behavior characteristics, so will the interaction between top-management structure and the operating departments favor different **growth** and **stability** patterns."*[708]

Having defined the spectrum of enterprise architectural forms, characterized by the modular and integral archetypes in chapter 4, we will now begin a stylized mapping of their structural dynamics. As can be seen in Figure 207 below, the growth of the modular enterprise is characterized by instability (i.e. positive feedback), while the growth of the integral enterprise is characterized by stability (i.e. negative feedback). It is important to note that the growth trajectories of each enterprise architecture are not subtly different, in fact they are 180 degrees different.

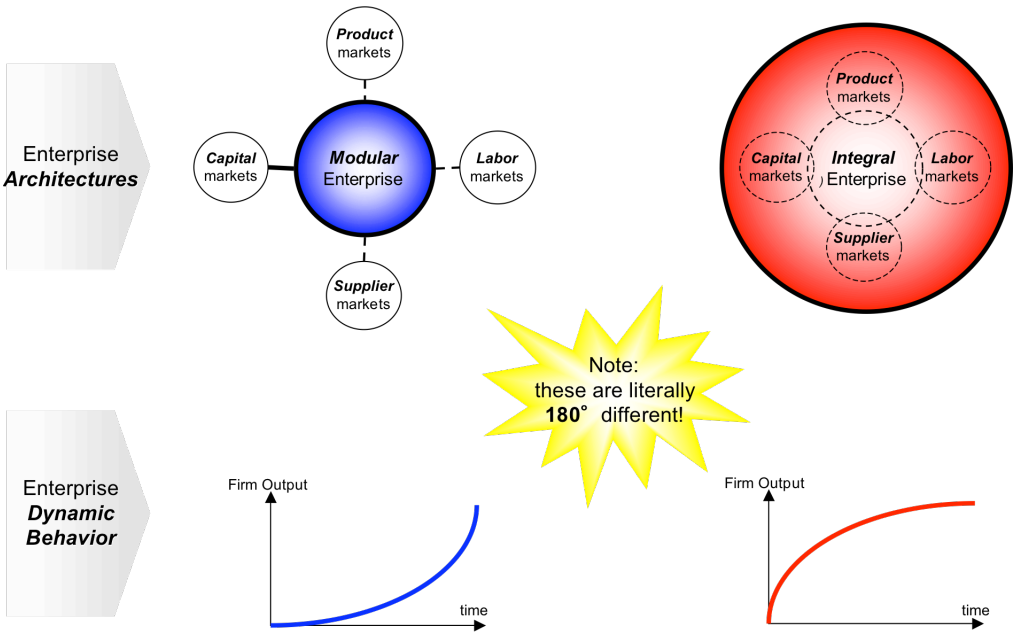

Figure 207: Enterprise Architecture Form-Structure Mapping

[708] Forrester, J.W. (1961), pg. 329.

Heuristic 2c:
The structural *dynamics* of an enterprise (growth vs. stability), will be governed by the architectural *form* (modular vs. integral) of the enterprise. The modular enterprise is "built" for exponential growth, while the integral enterprise is "built" for goal-seeking stability.

> *"Firm growth is a result of a process of development… in which an interacting series of internal changes leads to increases in size accompanied by **changes in the characteristics** of the growing object."*[709]

Heuristic 2d:
The dynamic response of any socio-technical system is governed by three structural properties: *structural inertia* (Hannan and Freeman, 1984), *structural damping,* (e.g. time constants used in exponential smoothing for decisions – i.e. level of "patience") and *structural stiffness.* Modular enterprise architectures tend to have shorter natural periods of oscillation (i.e. less inertia, less damping and/or more stiffness) than integral enterprise architectures.[710]

Heuristic 2e:
The dynamic response of the enterprise is a function of both the enterprise's endogenous structural properties, and those of the exogenous environment. The "dynamic amplification" of the enterprise is a function of the ratio of the natural periods of oscillation of the enterprise with respect to the environment.[711]

Heuristic 2f:
The structural mechanics of an enterprise defines the enterprise's *efficiency.* Enterprise *efficiency,* together with enterprise *effectiveness,* define an enterprise's performance capability. (Note: the more efficient enterprise structure may not exhibit the highest performance.)

Heuristic 2g:
A *modular* enterprise architecture having a greater degree of *exploitation* potential will be driven by *shorter*-term objectives, be able to have faster *short*-term growth rates, based on the *positive* or *reinforcing* feedback dynamics of economies of *scale*, associated with *mass* production. Rapid short-term growth is driven by competition for *building capacity* via the capital markets (known as "*capitalism*").

> *"**Mass** production is, in fact, a system ideally suited to the survival of large enterprises in a **highly cyclical** economy. Both workers and suppliers are considered **variable costs**. The problem with the American pattern is that it is **extremely corrosive** to the vital personal relationships at the core of any production process."*[712]

Heuristic 2h:
A *modular* enterprise operates under the following reinforcing circular managerial mental model: "demand for my products is *not* durable…therefore I *can't* keep my supply

[709] Penrose, E. (1959), pg. 1.
[710] Piepenbrock, T. (2004).
[711] Piepenbrock, T. (2004).
[712] Womack, Jones and Roos (1990), pp. 247-248.

stable…therefore my long-term costs are *not* lower…therefore demand for my products is *not* durable….

Heuristic 2i:
An *integral* enterprise architecture having a greater degree of *exploration* potential will be driven by *longer*-term objectives, be able to have faster *long*-term growth rates, based on the *negative* or *balancing* effects of economies of *scope,* associated with *lean* production. Rapid long-term growth is driven by competition for *growing capability* via the labor markets (known as "*human capitalism*").

> *"...the well-known **'lean** production system' was developed within a highly **integral** supply chain."*[713]

Heuristic 2j:
An *integral* enterprise operates under the following reinforcing circular managerial mental model: "demand for my products is *durable*…therefore I *can* keep my supply stable…therefore my long-term costs are *lower*…therefore demand for my products is *durable*….

5.4.1.1 Optimum Rates of Growth

A significant research area in strategic management explores whether there is an optimum rate of firm growth, and if so, what are its bounds

Raisch and Krogh (2007) posit that minimum rates of growth are determined primarily by competitive pressures for marktet share in order to achieve economies of scale and scope. They also posit maximum rates of growth are determined by external market limits, external or internal financial limits (i.e. the "sustainable growth rate"), or internal managerial limits (Penrose, 1959).

> *"**Not all growth is good**. An analysis of Fortune Global 500 companies shows that businesses that grew within the limits of their **growth corridors** performed far better than others – even those that grew faster."*[714]

Empirically, Raisch and Krogh (2007) demonstrate that "smart growth" firms which stay within their "growth corridor" deliver average returns to shareholders that are nearly double those firms that grow either faster or slower than their "growth corridors". They also note that such "smart growth" firms are relatively rare, comprising only 25% of their sample of *Fortune* Global 500 firms (between 1995 and 2004).

[Move "sustainable growth rate" PRAT section here – LFM thesis?]

[713] Fine, C.H. (1998). pg. 138.
[714] Raisch and Krogh (2007), pg. 65.

5.4.2 Quality *Growth (*Marketing *Strategy)*

> *"Many economists would be wont to propose that the **strategy** represents a **firm's solution of its profit maximization problem**, but this seems misconceived to me… firm strategies seldom determine the details of firm actions, but usually at most the **broad contours**."*[715]

> *"The architectural **form** is the **solution-neutral** restatement of the problem."*[716]

5.4.2.1 Structural vs. Strategic variables

This section begins to explore the role of strategy within the context of an enterprise architecture. It will attempt to contribute to the debate of the importance of "structural" variables vs. the importance of "strategic" variables.[717] As shown in Figure 208 below, the relationships between firm and industry structure are related to firm performance – either with or without strategy. As can be seen, the main strategic frameworks of SCP, SSP and RBV are shown.[718]

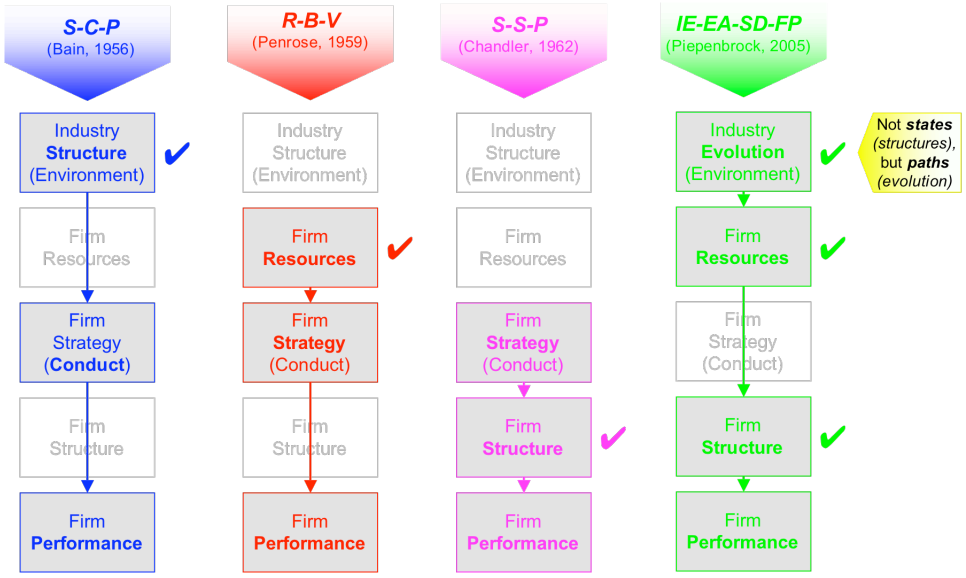

Figure 208: Strategy vs. Structure(s)

What this research aims to resolve therefore is the importance of strategy – namely under what conditions does it matter?[719]

[715] Nelson, R. (1991), pg. 67.
[716] Crawley E. and de Weck, O.
[717] Farjoun, M. (2002), footnote 14, pp. 577.
[718] Farjoun, M. (2002), pp. 573.
[719] Whittington, R. (2000).

5.4.2.2 Strategic Positioning: *Differentiation* vs. *Cost-Leadership*

Classical strategy defines that firms achieve competitive advantage via strategic choices of differentiation vs. cost-leadership (Porter, 1980).

5.4.2.3 Strategic Investment: *Flexibility* vs. *Commitment*

Pacheco-de-Almeida et al. (2008) highlight the strategic investment choices between flexibility and commitment, which lie at the center of the choice between modular and integral enterprise architectures: with the former being designed for flexibility, and the latter for commitment.

> *"This high-profile example [between **Airbus** and **Boeing**] illustrates the fundamental strategic trade-off between commitment and flexibility that managers face when deploying firm resources to establish product-market positions. **Commitment** and **flexibility** lie on the **opposite ends** of a firm's investment spectrum, and scholars have been divides as to which of the two strategies is the main driver of investment value."*[720]

5.4.2.4 Enterprise *Efficiency* vs. *Effectiveness*

Pfeffer and Salancik (1978) articulated clearly between internal *efficiency* and external *effectiveness*.

> *"The effectiveness of an organization is its ability to create acceptable outcomes and actions. It is important to avoid confusing organizational effectiveness with organizational efficiency. The difference between the two concepts is at the heart of the external versus internal perspective on organizations. **Organizaitonal effectiveness is an external standard** of how well an organization is meeting the demands of the various groups and organizations that are concerned with its activities. **Organizational efficiency is an internal standard** of performance."*[721]

The sources of long-term firm performance are known to emanate from the development of a sound strategy along with the execution of that strategy through its operations. The positioning school of strategy focuses on where in the cost-quality space to play, and the resource-based view school of strategy focuses on how to get to the firm's efficiency frontier (Porter, 1996; Markides, 2001; Saloner, Shepard and Podolny, 2001).

Porter (1996) famously argues that operational excellence is a necessary but insufficient condition for success as shown in Figure 209 below. Similarly, this research argues that strategy is a necessary but insufficient condition for success.

[720] Pacheco-de-Almeida, Henderson and Cool, (2008), pg. 517.
[721] Pfefer and Salancik, (1978), pg. 11.

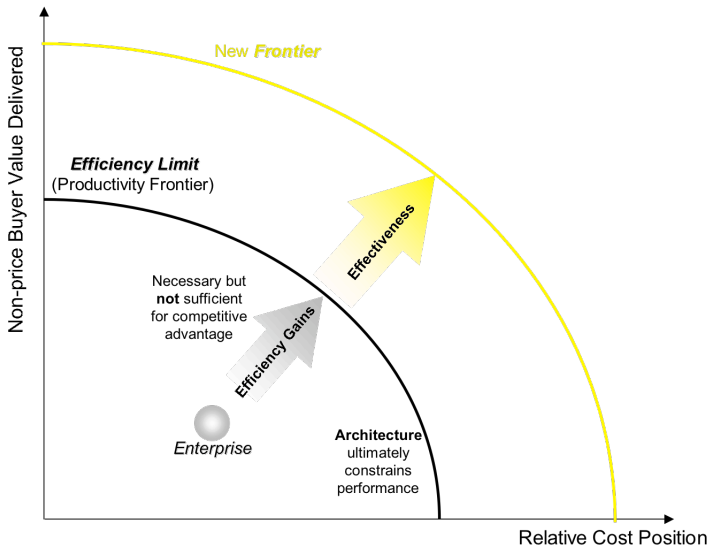

Figure 209: *Efficiency* vs. *Effectiveness* in Strategy Space

5.4.2.5 Strategic Biases of Enterprise Architectures

Unlike the previous discussion, this research will attempt to demonstrate that different enterprise architectures have different strategic predispositions, which bias shape of the performance frontiers. As shown in Figure 210 below, the modular enterprise architecture has historical biases toward differentiated products, and as such exhibits a vertical stretch of its performance frontier. Conversely, the integral enterprise architecture has biases toward low cost (via its high stability), and as such exhibits a horizontal stretch of its performance frontier. It will be argued thin chapter 6 that environmental pressures act to bias these performance envelopes.

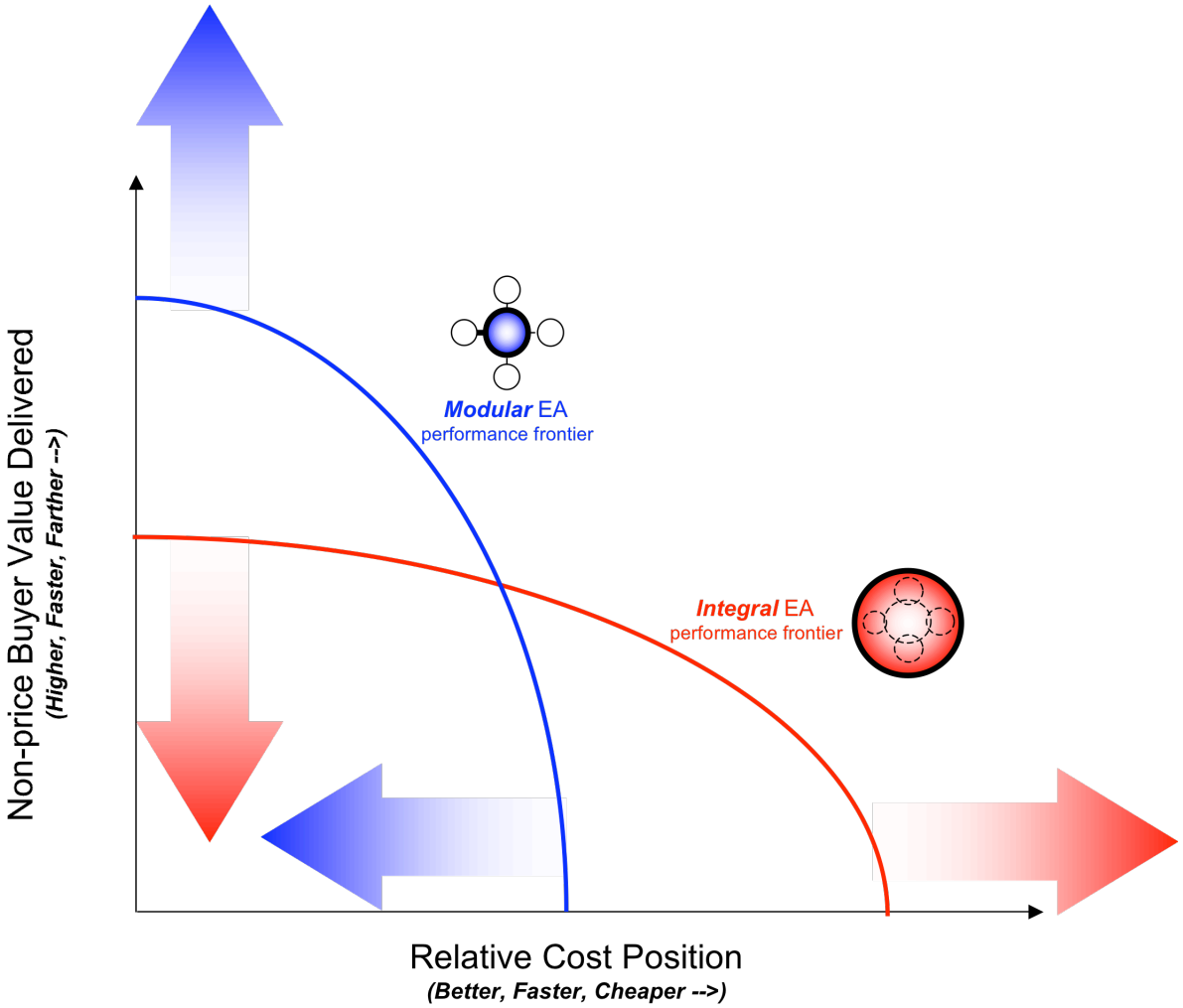

Figure 210: Efficiency Frontiers of the Enterprise Archetypes

This research attempts to illustrate that the construct of enterprise architecture, which both enables and constrains performance, lies above operations and even strategy. It can determine what strategies are viable, and what operations - no matter how efficient - will be effective.

5.4.2.6 Case Studies: Product Strategy in Commercial Airplanes

In order to illustrate the above concepts, we will focus on one link in the enterprise architecture: the relationship between the firm and its customers through product markets, as shown in Figure 211 below.

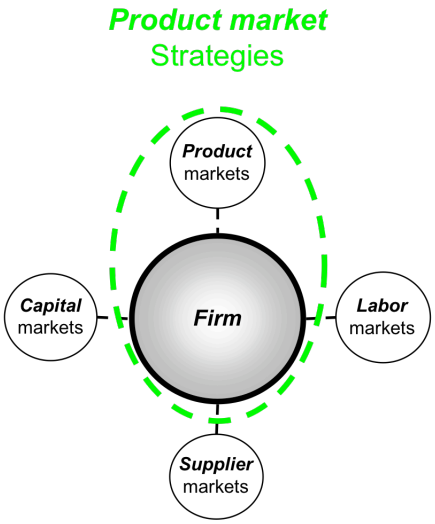

Figure 211: Examining the Product Market Strategies in Commercial Airplanes

Two cases will be briefly explored to illustrate systemic architectural thinking. The first is the alleged competition between the *Boeing 787* and the Airbus A380. The second is the real competition between the *Boeing 787* and the *Airbus A350,* and more importantly how the evolution of product strategies can be explained by the respective enterprise architectures.

Note that in both cases, whether in direct or indirect competition, the trajectories of each firm are out of phase.

5.4.2.6.1 *Boeing* 787 vs. *Airbus* A380

> *"Two companies with fundamentally different products, based on **diametrically opposite visions of the future**,* [are] *engaged in a Hatfields versus McCoys battle with billions of dollars at stake. Boeing versus Airbus is one of the **most hard-fought, closely watched marketing battles** out there. It is also one of the **most fascinating**. Not long ago, it appeared as if Airbus had gained the upper hand. If Boeing succeeds in winning this battle – and it appears to be well on its way – it will amount to **one of the great reversals of business fortunes**. It will also serve as proof of the wisdom of understanding the marketplace well enough to **lead, rather than follow**."*[722]

> *"Another **gamble by Boeing** [is] that the future of the airline business will be in **point-to-point** nonstop flights with medium-size planes rather than the current **hub-and-spoke model favored by Airbus**, which is developing the 550-seat A380 superjumbo as its premier long-haul jetliner."*[723]

Much has been said in the press about the "radically" different strategies of *Boeing* and *Airbus*, since *Boeing* abandoned its Sonic Cruiser for the 7E7, renamed the 787. It has been suggested that *Boeing* has adopted a strategy supporting "point-to-point" airline networks, with smaller airplanes traveling greater distances, as is evidenced by the 787. Conversely, *Airbus* has adopted a strategy supporting "hub-and-spokes" airline networks, with larger airplanes, as is evidence by the A380. This is another example of non-systemic "laundry list thinking". If one were to look *spatially* at the entire portfolio of products, as well as *temporally* the longitudinal timing and phasing of new product introduction initiatives, it is obvious that the "spin" in the press is just that (even though the sources of such spin come from the firm's PR functions themselves).

> *"A number of commentators have **spuriously** evaluated the prospects of the 787 and A380 as a question of the hub versus spoke concept of aviation growth. This is **wrong** because it is abundantly clear that the future will be characterized by **both**. These aircraft are not competitors; they are designed for **different markets**."*[724]

Figure 212 below illustrates the current product performance portfolios of both the incumbent (*Boeing*) and the challenger (*Airbus*).

[722] Babej, M.E. and Pollak, T. (2006) "Boeing versus Airbus," *Forbes*, May 24, 2006.
[723] Wayne, L. (2006) "Boeing Bets the House on Its 787 Dreamliner," *The New York Times*, May 7, 2006.
[724] Lawrence and Thornton (2005), pg. 149.

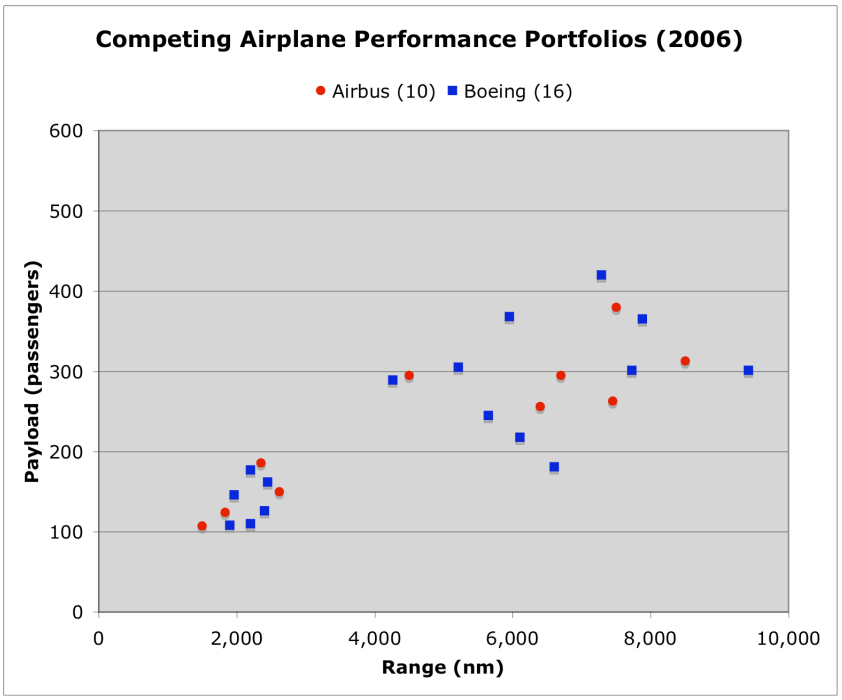

Figure 212: Product Performance Portfolios in Commercial Airplanes – *2006*

By way of comparison, Figure 213 below illustrates the future product performance portfolios of both the incumbent (*Boeing*) and the challenger (*Airbus*).

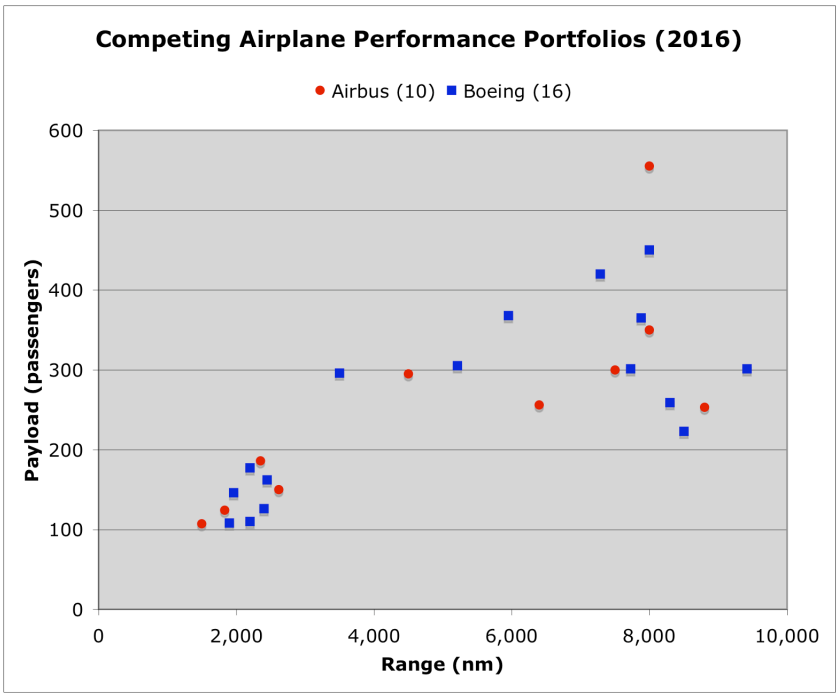

Figure 213: Product Performance Portfolios in Commercial Airplanes - *2016*

While *Airbus* will have added the (hub-and-spokes) A380 to finally round out its product portfolio, as well as the middle-market (point-to-point) A350, *Boeing* will have added its (point-to-point) 787 and its (hub-and-spokes) 747-8. There is no significant difference in product performance portfolio strategies.

5.4.2.6.2 The Evolution of *Boeing* 787 vs. the Evolution of the *Airbus* A350

The real competition in the "middle of the market" is between *Boeing's* 787 and *Airbus'* A350. It is interesting to observe the inherent architectural tendencies of each firm's product development trajectories (including their respective "false-starts").

As shown in Figure 214 below, *Boeing*, being true to its high-performance products culture, initially offered the radically-improved "higher, faster, farther" Sonic Cruiser. Due to performance oversupply, it was pulled by the market back down to the "better, faster, cheaper" solution of the 787.

Airbus conversely and subsequently responded with its incrementally-improved modified A330 in order to protect its "better, faster, cheaper" low-cost system design. Due to performance undersupply, it was pushed by the market up to the "higher, faster, farther" solution o the A350.

Note that in the final competitive space, it is anticipated that *Boeing's* 787 will be a higher performing, but higher initial cost product than *Airbus'* A350.

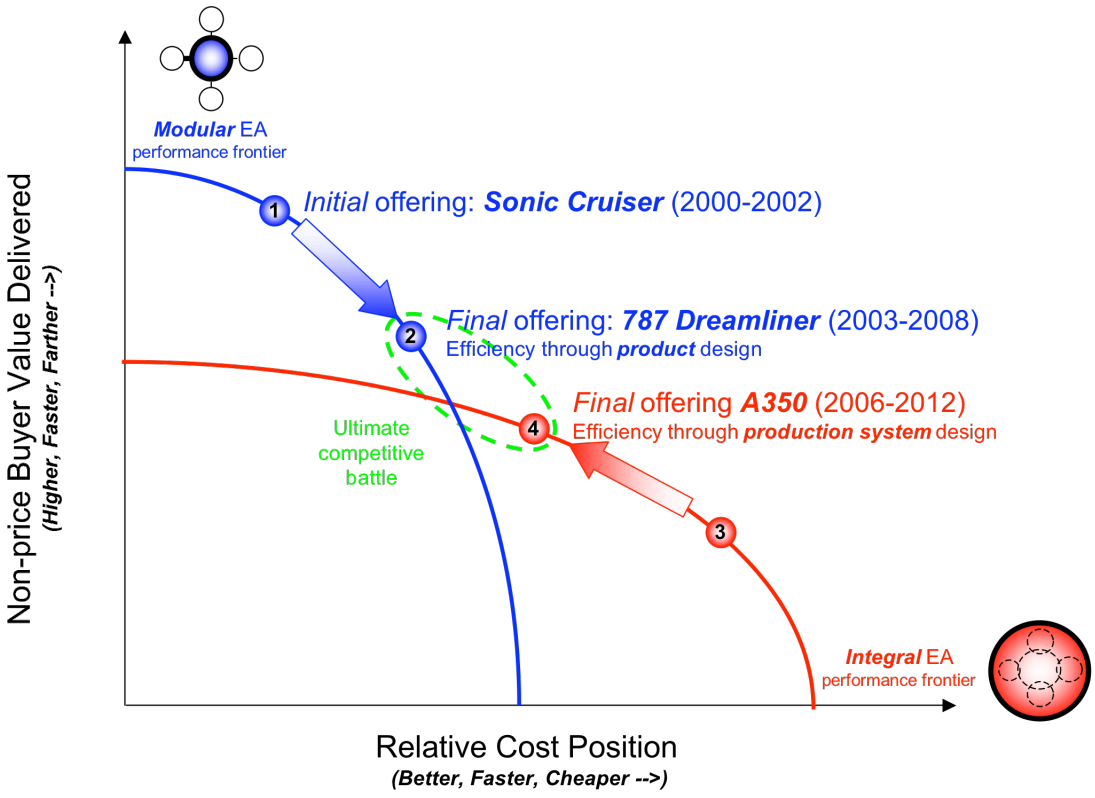

Figure 214: Evolutionary Trajectories of *Boeing* & *Airbus*' Recent Product Offerings

5.5 Opposing Dynamic Behaviors

5.5.1 *Opposing means to Profit:* Top-*line* Growth *vs.* Bottom-*line* Productivity

5.5.2 *Opposing Strategies Towards* Meeting Demand

> *"In some industries we find one company whose policies attract the **fluctuating** part of the market demand, whereas another company has policies that attract a **stable** underlying continuity of demand… Differences in policy that tend to differentiate a company on the basis of its dynamic characteristics will be an important aspect of **competitive** models."*[725]

As shown conceptually in Figure 215 below, different enterprises have fundamentally different approaches toward demand and strategies for how it is best served. These can be decomposed dynamically into the underlying stable demand and the superimposed fluctuating part.

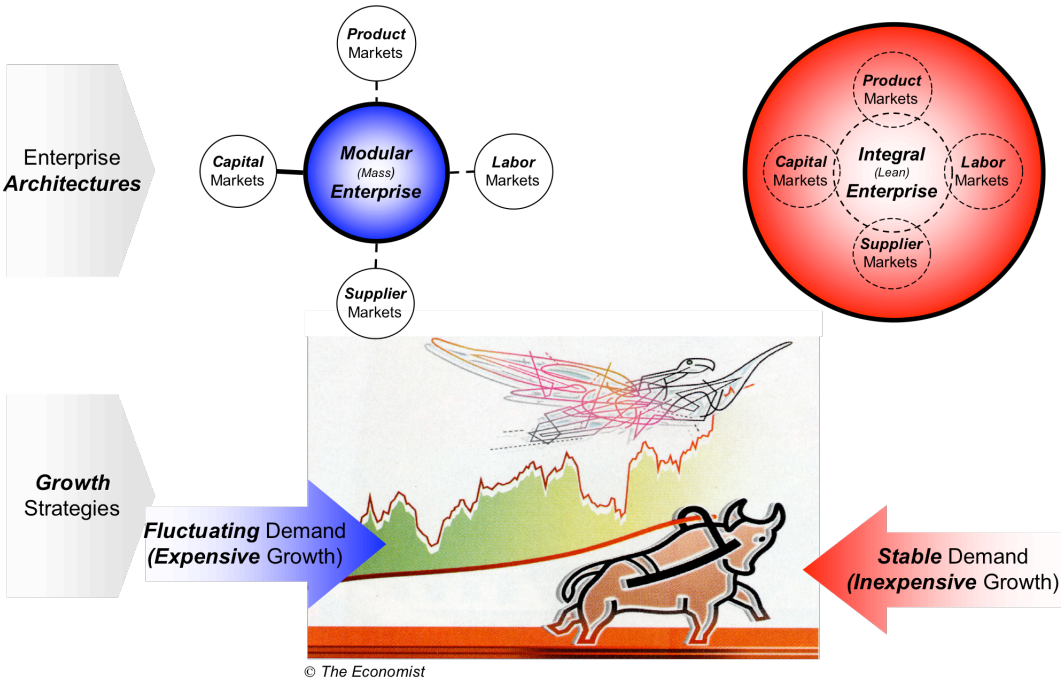

Figure 215: Opposing Strategies Towards Demand[726]

It will be argued later that the strategies chosen to chase the fluctuating part actually contribute to the very existence of the fluctuating part of demand. Additionally, chapter six will later begin to describe under what environmental conditions each growth strategy is more likely to be successful.

[725] Forrester, J.W. (1961), pp. 336-337.
[726] Graphic from *The Economist*.

5.5.3 *Opposing Assumptions of* Demand Durability

As shown in Figure 216 below, there is a different causal logic used by those firms chasing the fluctuating part of the market demand, than that used by those firms seeking the stable part of the market.[727]

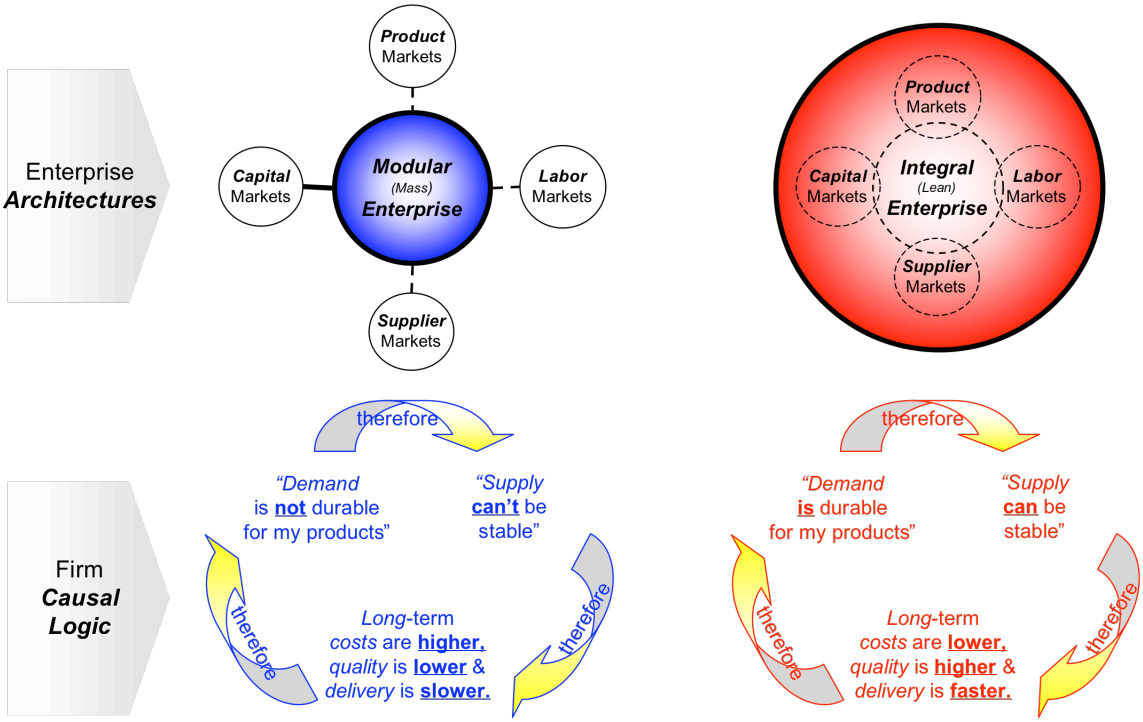

Figure 216: Opposing Assumptions of *Demand Durability*

> *"The company that follows the policy of pursuing every possible sale and having product available to **push** into the hands of the customer even in peak periods of demand may find it is unknowingly selecting peaks of demand as its share of the market. This will be especially true if the intrinsic value of the product in the eyes of the customer is less than that of competitors and if the company is taking advantage of sales that come to it because of the unavailability of preferred competitive products. On the other hand, a contrasting company policy could be to establish a preferred position in design, quality, and sales effectiveness so that all production is salable in the periods of lowered market demand. This company might forgo possible higher sales in periods of increased demand in the interest of **greater continuity of operations** and to **prevent dilution of the quality and skill**. In this situation the first company has a much higher percentage fluctuation in its operations than has the industry as a whole."*[728]

[727] These relations were obtained empirically from the case studies and will be discussed in more detail later.
[728] Forrester, J.W. (1961), pp. 336-337.

5.5.4 *Opposing Assumptions on* **Forecasting** (managerial cognitive inertia)

> *"Expectations are usually modeled in system dynamics as adaptive learning processes such as exponential smoothing.* ***Adaptive expectations (single exponential smoothing) outperform many other forecasting methods over the longer time horizons****."*[729]

As Sterman (2000, pg. 632) points out, various researchers have noted the long-term performance superiority of simple exponential smoothing (Makridakis et al. 1982; Makridakis et al. 1984; Carbone and Makridakis, 1986).

Figure 217 below summarizes the differences between managerial cognitive inertia and decision processes in modular and integral enterprises architectures.

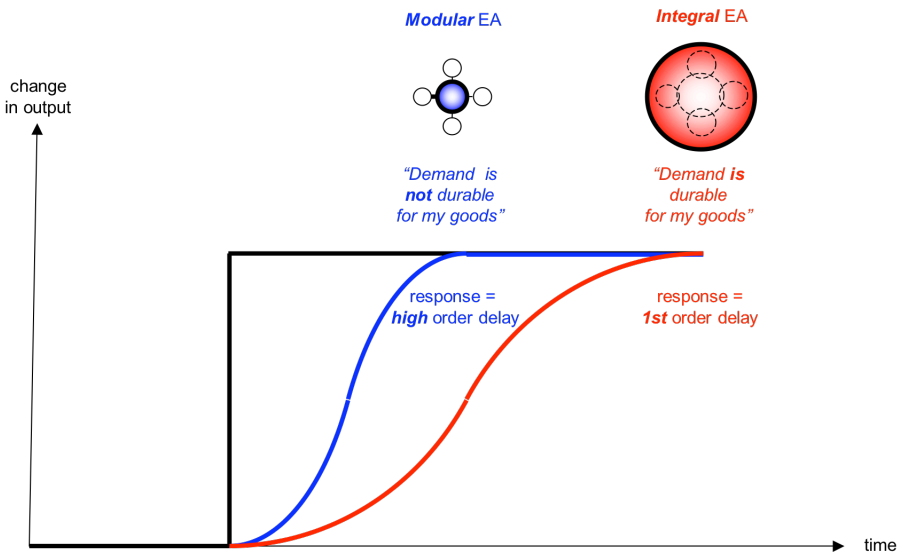

Figure 217: Opposing Assumptions on *Forecasting*

> *"In an embedded logic of exchange… on a microbehavioral level, actors follow* ***heuristic and qualitative decision rules****, rather than intensely calculative ones. These factors furnish an alternative mechanism for* ***matching customer demand to production****."*[730]

[729] Sterman, J.D. (2000), pg. 632.
[730] Uzzi, 1997, pg. 61.

5.5.5 *Opposing Assumptions of* Span of Enterprise Control

Given that the modular enterprise architecture locally optimizes on the performance of the firm, it sees other stakeholders largely as inputs largely beyond their control. As a result, important environmental phenomena like the business cycle are exogenous. More plainly, the business cycle exists because the modular enterprise architecture needs it to – i.e. it creates the instability that it serves.

Conversely, the integral enterprise architecture globally optimizes on the performance of the ecosystem, as it sees other stakeholders largely as inputs largely within their control. As a result, important environmental phenomena like the business cycle are endogenous. More plainly, the business cycle does not exist because the integral enterprise architecture does not want it to.

These two opposing assumptions and therefore managerial cognitive decision sets are summarized stylistically in Figure 218 below.

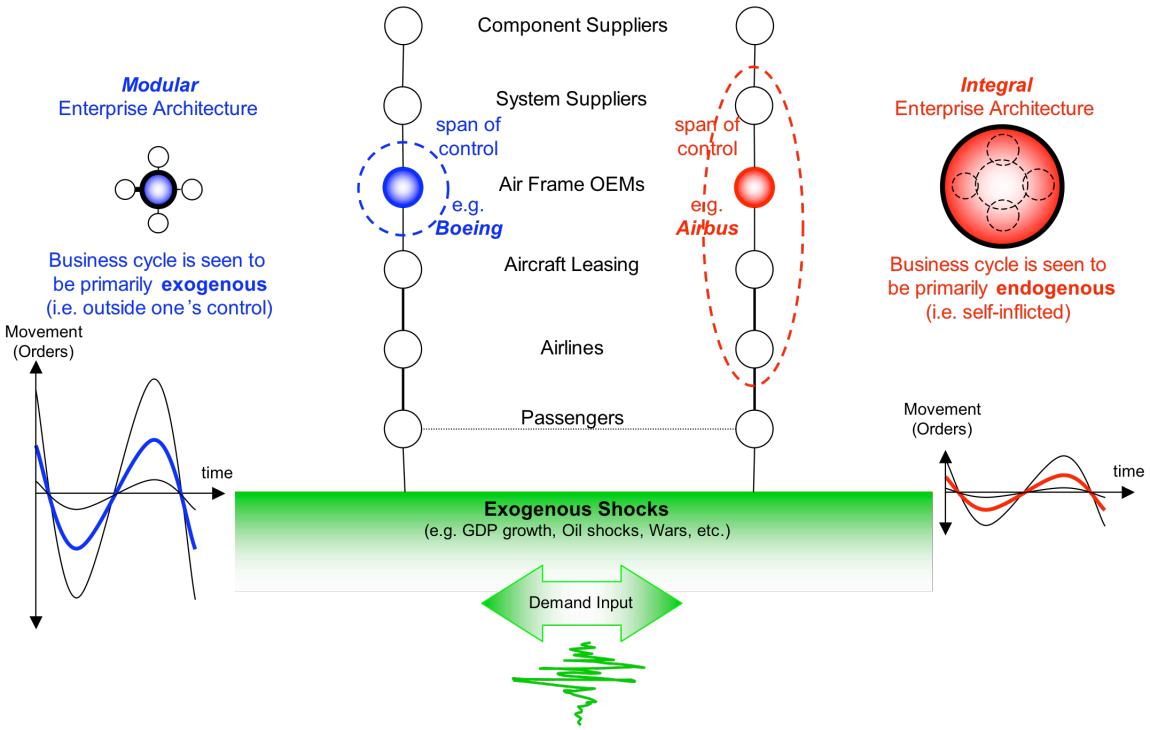

Figure 218: Opposing Assumptions of *Span of Enterprise Control*

This set of propositions clearly begins to offer problems for positivist science as it is stating that two "realities" exist with respect to what is the nature of the environment of the firm. This observation sits more comfortably with a relativist or interpretivist epistemology.

The question of which of the two "realities" offers competitive advantage will be addressed in chapter six.

5.5.6 *Opposing Views of Speed:* Short-*term vs.* Long-*term*

> *"The analysis of the limits to growth – the factors determining the* ***maximum rate of growth*** *of firms – cannot, in its present formulation at any rate, be tested against the facts of the external world, partly because of the difficulties in expressing some of the concepts in* ***quantitative terms*** *and partly because of the impossibility of ever knowing for any given firm what is, or what would have been, its maximum rate of growth. Perhaps some of these difficulties will be overcome in* ***different formulations constructed by others****..."*[731]

The causal mechanisms that underlie the dynamic reference modes can be used to predict and observe the structural dynamics of important macro enterprise response quantities like output. As shown in Figure 219 below which depicts data from the automobile industry, the output quantities can have significantly different dynamic characteristics, depending upon the underlying architectural forms.

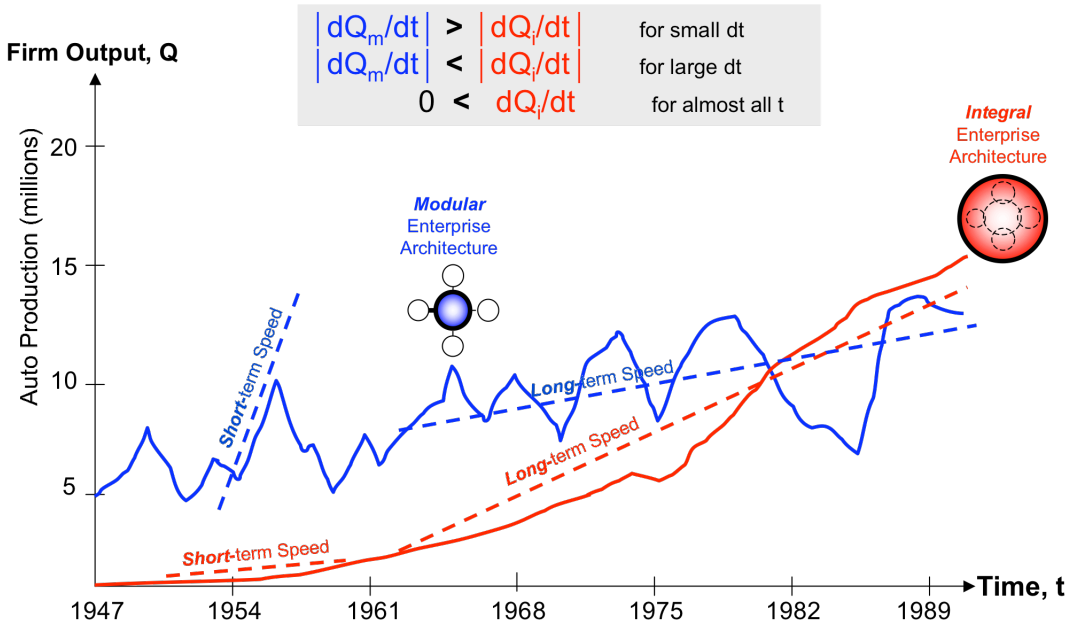

Figure 219: Enterprise Structural Dynamics in the *Automotive* Industry

From the above data, we can note the following observations:

For *short* time horizons, the absolute value of the rate of change of output of the modular enterprises tends to always exceed the rate of change of output of integral enterprises. Mathematically, this can be expressed as:

$$|dQ_m/dt| > |dQ_i/dt| \qquad \text{(for small dt)}$$

For *longer* time horizons, the absolute value of the rate of change of output of the integral enterprises tends to always exceed the rate of change of output of long enterprises. Mathematically, this can be expressed as:

[731] Penrose, E. (1959), pg. 4.

$$\left| dQ_m/dt \right| < \left| dQ_i/dt \right| \qquad \text{(for large dt)}$$

Taken together, these two observations comprise the "tortoise vs. hare" dynamic. Note that the hare wins the race given a sufficiently long race, as well as certain environmental race conditions which we will discuss later.

> *"**Slow** and **steady** wins the race."*[732]

In addition, it appears that rate of change of output of integral enterprises tends to not go negative. In other words, integral enterprises are designed to grow at such a rate that they will not have to significantly shrink output. Mathematically, this can be expressed as:

$$dQ_i/dt < 0$$

Causally, this observation can be explained as integral enterprises are in the pursuit of minimizing long-term costs. If competitive advantage arises from lower long-term costs and higher long-term quality, then advantage arises from stability conditions for the workforce in order to avoid degradation of capabilities. This in turn results in continuous learning and improvement. As market share is gained, then learning curve effects, as well as economies of scale drive competitive advantage. The above observations can also be seen in Figure 220 below in the large commercial airplane industry, currently dominated by the incumbent, *Boeing* and the challenger, *Airbus*.

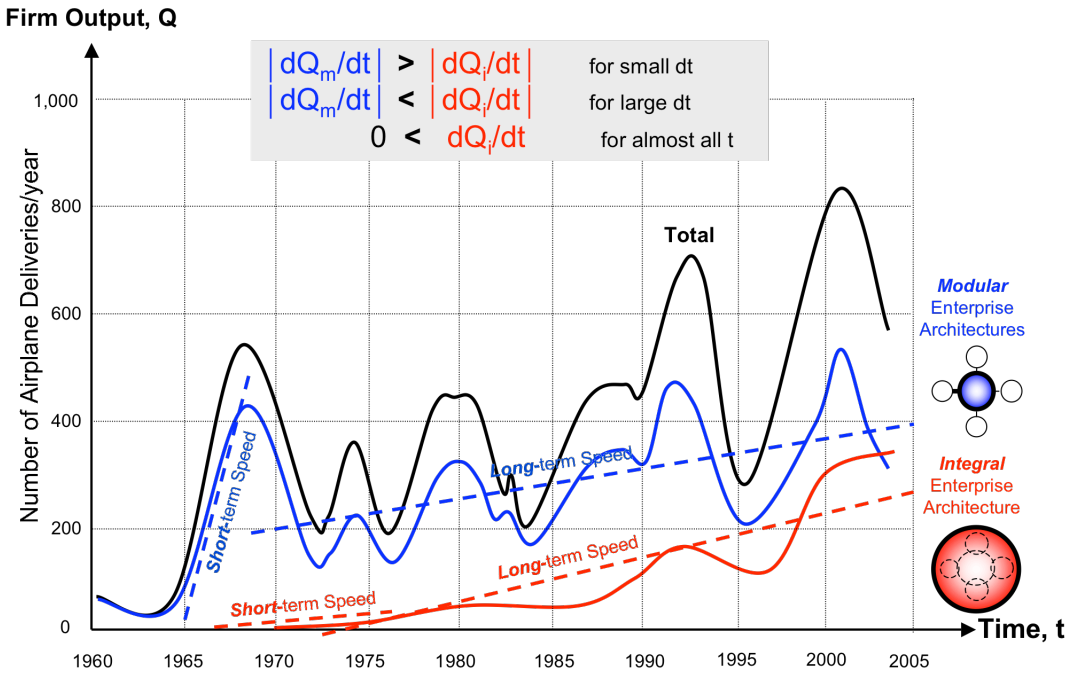

Figure 220: Enterprise Structural Dynamics in the *Large Commercial Airplane* Industry

[732] From the fables of Aesop.

5.5.7 *Opposing Assumptions of* Strategic Investment

When putting the enterprise architectural constructs in a head-to-head game theoretic setting, the equilibrium outcomes vary according to the homogeneity or heterogeneity of the duopoly as determined by the relative reaction functions of the firms (Law & Stewart, 1983; Mai & Hwang, 1989; Horowitz, 1991; Cremer & Crémer, 1992; Futagami & Okamura, 1994) as shown below in Figure 221.

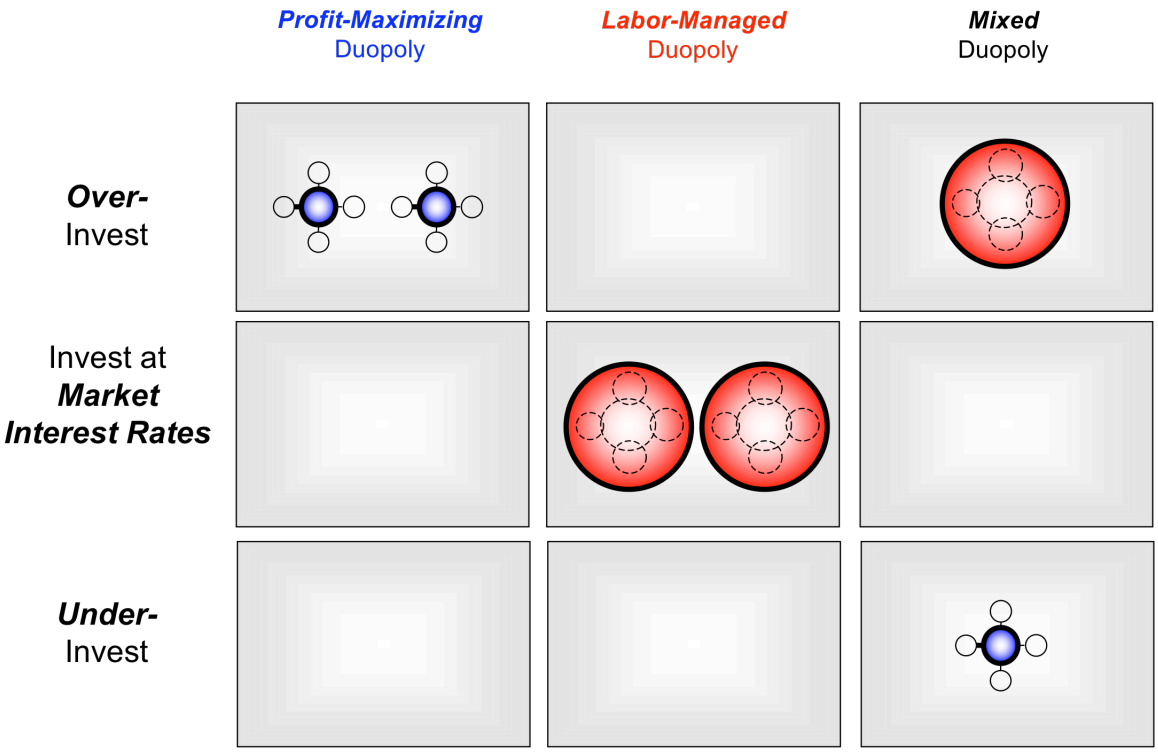

Figure 221: Opposing Assumptions of *Strategic Investment*

An interesting and counterintuitive result is that the outcomes of each architecture flip to near exact opposites when the composition of the duopoly changes from homogeneous to heterogeneous (or "mixed").

5.5.8 *Opposing* Financial *Strategies*

Integral enterprise architectures tend to employ more "conservative" financial strategies than their modular counterparts. Such strategies include maintaining lower debt levels as well as higher levels of cash on hand (Hoffer-Gittell, 2003, pp. 244-247).

> *"Most people think of us as this flamboyant airline, but we're really* ***very conservative from a fiscal standpoint****. We have the* ***best balance sheet in the industry****. We've always made sure that we* ***never overreached*** *ourselves.* ***We never got dangerously in debt, and never let costs get out of hand.*** *And that gave us a real edge during* [the Gulf War crisis of 1990 to 1994]. *"*[733]

> *"At Southwest, the maintenance of* ***financial reserves*** *is seen as* ***integral*** *to the organization's ability to maintain and even strengthen its relationships in the face of crises… Organizations with plentiful financial reserves in the form of* ***low debt levels*** *are better positioned to bolster their relationships by* ***maintaining commitments… to stakeholders*** *in times of crisis."*[734]

> *"A simple rank correlation analysis of these data shows that prior cash levels of the airlines did not predict the extent of their layoffs, but their* ***debt-equity ratios predicted the extent of their layoffs with 99 percent certainty****."*[735]

> *"Southwest* ***protects its financial reserves*** *by sticking to its policy of* ***gradual steady growth****, despite the fact that there is* ***sufficient demand*** *for Southwest's service to permit a* ***far-faster rate of growth****. According to John Denison, Southwest's former executive vice president of corporate services: 'We promise the marketplace 10 percent growth, but we are only going to grow as fast as we can manage… But we try to* ***maintain the balance sheet****. It is no accident that we are the only single-A rated company in the industry.'"*[736]

> *"Indeed, Southwest's leaders have often had to maintain their conservative financial policies in the face of* ***strong pressures from Wall Street to grow faster****. According to Matt Hafner, one of Southwest's regional directors: 'It is nothing new with Southwest. The* ***'experts'*** *always think we need to* ***expand at a more rapid pace****. What these so-called experts express is their desire for Southwest to jump at opportunities at a more rapid clip.* ***Apparently growth excites investors****.* ***[But] nobody is pushing us****. That could never happen.'"*[737]

> "[Southwest's] ***conservative approach has been criticized by Wall Street analysts****, who have argued that the airline should use its extra cash to make acquisitions or buy back stock. Goldman Sachs analyst Glenn Engel actually calls the* ***balance sheet 'too strong'*** *[though] Engel allows, 'this has meant that when times are tough, they have a lot more* ***flexibility.'"***[738]

> *"****Southwest's policy stands in contrast to accepted wisdom on Wall Street****. Southwest's policy also stands in contrast to the policy of People Express, an airline that, like Southwest, also faced tremendous demand for its services and tremendous pressure from Wall Street to grow rapidly and take advantage of every opportunity. While southwest has experienced* ***31 years of disciplined, steady, profitable growth,*** *always maintaining plenty of financial reserves to flourish in times of crisis, People Express under the leadership of Donald Burr* ***grew at an exponential rate*** *from 1981 to 1986 and then simply collapsed into its own wreckage."*[739]

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[733] *Southwest Airlines* CEO, Herb Kelleher, in Brooker, K. (2001).
[734] Hoffer-Gittell (2003), pg. 245.
[735] Hoffer-Gittell (2003), pg. 245.
[736] Hoffer-Gittell (2003), pp. 245-246.
[737] Hoffer-Gittell (2003), pg. 246.
[738] Mount, I. (2002).
[739] Hoffer-Gittell (2003), pg. 247.

5.6 Case Study: *the Business Cycle* (and other "Exogenous" Shocks[740])

Summarizing and integrating some of the observations from the previous section, this framework posits that the business cycle is not an absolute reality in the positivist science sense, but rather is a socially-constructed phenomena in the interpretivist paradigm. It exists because certain social structures are designed to create them, while other social structures are designed to mitigate them.

> *"Contemporary management literature contains two significant gaps: it has neglected the strategic problems of the **business cycle** and it lacks an adequate account of **strategic choice**."*[741]

One of the best tests to determine an enterprise's architecture is to observe its response to "exogenous" shocks from the environment, most notably the business cycle.[742] As noted by Whittington (1989), the business cycle is a unique litmus test as it teases out the underlying mental models and social constructs of enterprise leaders with respect to their notions of time.

> *"My contention shall be that the business cycle presents the strategic decision maker with a particularly **intriguing, even paradoxical** set of problems. The contradiction at the level of the firm is how to **balance short-term survival** during the recession with the need to **preserve long-term competitiveness** for the recovery."*[743]

5.6.1 *Cross-Industry Examples*

We will next explore the behavior of competing firms within four different industries, in their reaction to the business cycle.

5.6.1.1 *Appliance* industry

In the opening page of his book, *Corporate Strategies in Recession and Recovery*, Whittington captured the different recession strategies of two rival domestic appliance manufacturers coping with the 1979-81 recession in the UK:

> *"The director from Exemplar:*
>
> *When we come out of a recession in England, what happens? You begin to import like fury because everybody has abandoned their production capacity and run down. **This cycle has destroyed British industry** – this up and down – because no one can afford, due to the tax system et cetera, to develop during the recession. But that's what you've got to do, and that's why **we hung on** and that's what we did! (Bangs table)."*[744]

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[740] The word "exogenous" is kept in quotes to note later that various enterprise architectures have different degrees of environmental control, and therefore different frames of reference of what constitutes being "exogenous".
[741] Whittington, R. (1989).
[742] Note however that not all strategy scholars are equally impressed with the importance of the business cycle. Porter (1980), pg. 6 regards the business cycle as being of merely 'tactical' importance, especially when market penetration is deep.
[743] Whittington, R. (1989), pp. 15 & 19.
[744] Whittington, R. (1989), pg. 1.

> *"The director from Rose:*
>
> *It is important to preserve things for the future and one would like to do that, and to drive one's way through the recession by investment. But on the one hand the theory is good; but if you are faced with a factory loss this month one has to decide what to do… **We cut back heavily.**"*[745]

Whittington notes that these different strategies had very different consequences for firm performance both in the short- and long-term.

5.6.1.2 *Automobile* industry

> *"Westerners are resigned to the idea of the business cycle. Like **gravity**, it's simply there, although nobody quite knows why."*[746]
>
> *"The issue never arose in Japan. Neither the domestic auto market nor domestic production is cyclical. The Japanese domestic industry has always been able to plow through slumps in export markets by **cutting margins**. Indeed, the largest contraction in production in Japan over the past forty years is smaller than the smallest contraction in North America."*[747]

This difference in viewpoint has played out in the global automobile industry over the past 50 years, as was brought to the attention to the academic research and professional communities by Womack, Jones and Roos (1990). As a *General Motors* executive noted:

> *"When the Japanese producers encounter these gigantic market waves, they will quickly become **as mediocre as we are**. They will have to start **hiring and firing** workers along with suppliers and will **end up as mass-producers** in short order."*[748]

This statement reveals the mental models of a leader embedded within an enterprise architecture which enables and constrains what he/she can do. It does not necessarily have to be the case however for other enterprise architectures.

> *"Some observers have even wondered if the lack of a cyclical market in durable goods in Japan is a direct result of lean production: an inventoryless, highly flexible system that may **significantly damp cyclicality**."* [749]

In fact, some 15 years after the above *GM* quote, *Toyota* went on to systematically dismantle the US mass-producers with its integral enterprise architecture and a view of stability which is impossible for modular enterprise, mass producers.

> *"We will maintain **long-term, stable growth** by building a business structure that can respond to market fluctuations."* (Fujio Cho, President, *Toyota*). [750]

5.6.1.3 *Airplane* industry

[745] Whittington, R. (1989), pg. 1.
[746] Womack, Jones and Roos (1990), pp. 247.
[747] Womack, Jones and Roos (1990), pp. 249.
[748] Womack, Jones and Roos (1990), pp. 249.
[749] Womack, Jones and Roos (1990), pp. 249.
[750] Toyota 2004 Annual Report, "President's Message", pg. 11.

A similar story is recorded 20 years later in the airframe and airline industries in the recession of 1999-2001 and the exacerbating exogenous shock of the September 11th terrorist attacks in the US, as the leaders of leading firms in these industries attest:

> *"I am always a bit surprised by the **speed** with which Americans take decisions: that in three days after the attacks they announce 25,000 lay-offs at Boeing seems to me **totally stupefying**. Airbus has a bigger order book than Boeing and until now **growing market share**, which will allow the bumps to be smoothed out."*[751]

> *"We had to take necessary steps to manage the cycle profitably."*[752]

5.6.1.4 *Airline* industry

> *"At Southwest, we **manage in good times as though we were in bad times**."*[753]

> *"**Nothing kills your company's culture like layoffs**. Nobody has ever been furloughed* [at Southwest], *and that is unprecedented in the airline industry. It's been a **huge strength** of ours."*[754]

> *"We are willing to suffer some damage, even to our **stock price**, to protect the jobs of our people."*[755]

5.6.2 Exogenous *vs.* Endogenous *Views*

Modular EA's create the instabilities that they are designed to serve, while integral EA's create the stability that they are designed to serve. In other words, to the firm at the center of the modular EA (with its narrowly-defined span of control) the business cycle is exogenous, outside of its conrol, and the best it can do is to predict it, and "ride" it as tightly and efficiently as possible. Conversely, to the firm at the center of the integral EA (with its broadly-defined span of control) the business cycle is endogenous.

5.6.3 *Dominant Firm Behavior*

> *"When the Japanese producers encounter these gigantic market waves, they will quickly become **as mediocre as we are**. They will have to start **hiring and firing** workers along with suppliers and will **end up as mass-producers** in short order."*[756]

The mental model of leaders in modular EAs is that while integral EAs may be able to "get away with" being stable as challengers, once they begin to dominate an industry in terms of market share, they must begin to oscillate, just as the modular EAs have done. This research framework posits that such behavior is not necessarily true, which the evidence begins to support.

An interview with a senior executive in a modular EA prior to being overtaken by their competitor predicted:

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[751] *Airbus* CEO, Noel Forgeard, 20 Sept. 2001.
[752] Boeing executive, post- 9-11.
[753] Quote from *Southwest Airlines* employees, as cited in Hoffer-Gittell (2003), pg. 244.
[754] *Southwest Airlines'* Chairman, Herb Kelleher, from Hoffer-Gittell (2003), pg. 243.
[755] *Southwest Airlines'* CEO, Jim Parker, from Hoffer-Gittell (2003), pg. 242.
[756] Womack, Jones and Roos (1990), pp. 249.

> *"Once* [our competitor] ***takes more than 50% of the market****, they will have to become unstable, just as we are."* [757]

Deeper probing revealed that the mental model is that the business cycle is a given, and that whoever dominates the supply of that market must swing with it. In a subsequent interview with the same executive three and a half years later (after the data showed that their prediction did not come true), the executive offered the following explanation:

> *"Once* [our competitor] *starts* ***behaving rationally****, they will have to become unstable, just as we are."*[758]

Again the mental model is that the competitor is of the same architecture, therefore if they do not pursue the same policies, they must be behaving irrationally. This research offers that both competitors are highly rational, given their enterprise archtictures.

5.6.4 *Signal-to-Noise Ratios*

The data suggests that as over time, as modular EAs are under pressure from integral EAs, they oscillate more severely, with their signal-to-noise ratios (on output) decreasing.

Conversely, as integral EAs begin to dominate, their signal-to-noise ratios remain high, and in fact they tend to "discipline" the market, giving it a higher signal-to-noise ratio, commensurate with their own behavior.

[757] Interview took place in January 2002.
[758] Interview took place in August 2005.

5.7 *Interspecies* Competition and *Mixed* Duopoly

Interspecies competition is a relatively new concept which is therefore underrepresented in the economics and sociology literatures. In economics, it takes the form of "Mixed Duopoly" competition, while in sociology (and biology), it takes the form of "Interspecies Competition" between heterogeneous organizational set architectures under the heading of Community Ecology (Astley, 1985).

5.7.1 Interspecies *Competition in* Community *Ecology*

> *"This paper distinguishes between **two ecological perspectives on organizational evolution**: population ecology and community ecology. The perspectives adopt different levels of analysis and produce contrasting views of the characteristic mode and tempo of organizational evolution. **Population ecology** limits investigation to evolutionary change unfolding within established populations, emphasizing factors that homogenize organizational forms and maintain population stability. Population ecology thus fails to explain how populations originate in the first place or how evolutionary change occurs through the proliferation of heterogeneous organizational types. **Community ecology** overcomes these limitations: it focuses on the **rise and fall** of populations as basic units of evolutionary change, simultaneously explaining forces that produce **homogeneity and stability within populations and heterogeneity between them**."*[759]

Even the original classic work on population ecology (Hannan and Freeman, 1977) highlights this important form of competition.

> *"The greater the unexhausted capacity in the environment, the faster should be the rate of growth of populations of organizations. But **the rate at which populations of organizations can expand into unused capacity varies among forms of organization**. So there are two distinctive ecological considerations: the capacity of the environment to support forms of organizations and the rate at which populations grow (or decline) when the environmental support changes."*[760]

> *"Up to this point, we have presumed that the limits to growth reflect the finite nature of the environment. It is now time to **reintroduce competition**. According to Hawley, competition enters indirectly when the competitors lower the fixed supply. We can model this by following the lead of bioecologists and **extending the logistic growth model**. The two populations are said to **compete if the addition of units [of market share] of either decreases the rate of growth of the other**. This will be the case when both populations are sustained by the same types of resources."*[761]

> *"If two populations [or species] of organizations sustained by identical environmental resources differ in some **organizational characteristic [like organizational set architecture]**, that population with the characteristic **less fit** to environmental contingencies will tend to be **eliminated.** The stable equilibrium will then contain only one population which can be said to be isomorphic to the environment."*[762]

The state of the environment has a significant effect on interspecies competition. Lenox, Rockart and Lewin (2006) develop simulation models to theorize about the nature of environmental interdependencies, and their effects on firm and industry profitability.

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[759] Astley (1985), pg. 224.
[760] Hannan and Freeman (1977), pg. 941.
[761] Hannan and Freeman (1977), pg. 942.
[762] Hannan and Freeman (1977), pg. 943.

*"For **high** PIA-industries [Potential for Interdependencies among Activities], we expect a few high performers and a relatively large number of laggards. High levels of PIA produce industries where most firms cluster around low profit levels and a few firms occasionally achieve vastly superior profits."*[763]

*"In **low** PIA-industries, individual firm profits are driven by the ability of all firms to find low cost positions absolutely; while in **high** PIA-industries, individual firm profits are driven by the ability of the best firms to find better cost positions relative to those of rivals."*[764]

*"In high PIA-industries the potential exists for an individual firm to discover **a highly efficient configuration of business practices relative to rivals** and to realize profits well-above the industry average. Thus, the average profits in high-PIA industries are bolstered by the occasional highly successful firm. While the existence of this kind of skewed profit distribution is striking when observed, it remains **a relatively infrequent outcome** even in high-PIA industries. Paradoxically, it is within these otherwise **unattractive industries** that we are most likely to observe an outstanding firm that is both high performing and highly profitable."*[765]

*"**Medium** PIA-industries, present firms with a real potential for competing for a very long period without becoming competitive."*[766]

*"The overall result that average industry profits are highest for **intermediate levels of PIA** proves robust from one extreme of pure **innovation** to the opposite extreme of pure **imitation**."*[767]

*"Our results provide guidance for identifying **likely industries** where competitive advantage accrues to a chosen few firms that have valuable, rare, nonsubstitutable, and hard-to-imitate resources and capabilities that allow for favorable market positions relative to rivals. In this way, **interdependencies** provide an explanation not only for what sustains profit heterogeneity within and across industries, but why it emerges in the first place in some industries more than in others. By recognizing that industries can vary in terms of potential interdependency due to technology and other structural factors, we also see **the beginning of a reconnection of firm-level and industry-level analyses**. To the extent that the potential for interdependency is driven by structural elements of an industry, industry structure [SCP] can be used to explain differences in firms' resources, capabilities, [RBV] and profits."*[768]

*"There has been a great deal of interest among economists in how **firm heterogeneity** may affect the **structural evolution of industries**."*[769]

*"Perhaps the most promising, **those studying industry dynamics** may find that **a more explicit treatment of interdependency** provides **new insights into the structural evolution of industries**."*[770]

5.7.2 Mixed *Duopoly in Economics*

[763] Lenox, Rockart and Lewin (2006), pg. 766.
[764] Lenox, Rockart and Lewin (2006), pg. 766.
[765] Lenox, Rockart and Lewin (2006), pg. 769.
[766] Lenox, Rockart and Lewin (2006), pg. 770.
[767] Lenox, Rockart and Lewin (2006), pg. 771.
[768] Lenox, Rockart and Lewin (2006), pg. 771.
[769] Lenox, Rockart and Lewin (2006), pg. 771.
[770] Lenox, Rockart and Lewin (2006), pg. 772.

5.7.3 *System Dynamics Models*

5.7.3.1 Classic System Dynamics Models of Enterprise Architectures

The following section defines the development of a formal model using the system dynamics methodology (Forrester, 1961; Lyneis, 1980; Sterman, 2000) to quantify and simulate the nonlinear dynamic interactions between the firm and its key input providers – its extended enterprise. As shown in Figure 222 below, the key stakeholder interactions that have been modeled in the system dynamics tradition, have tended to focus primarily on the value chain axis of *firm-supplier* interaction (Forrester, 1961) and *firm-market* interaction (Forrester, 1968), although a secondary focus on *firm-employee* interaction and *firm-investor* interactions were also made.

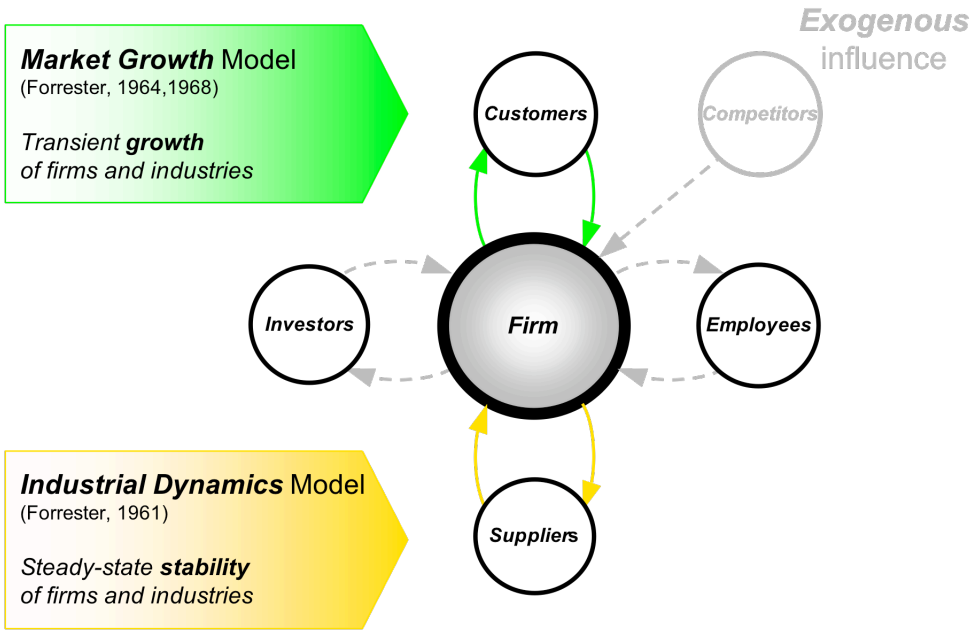


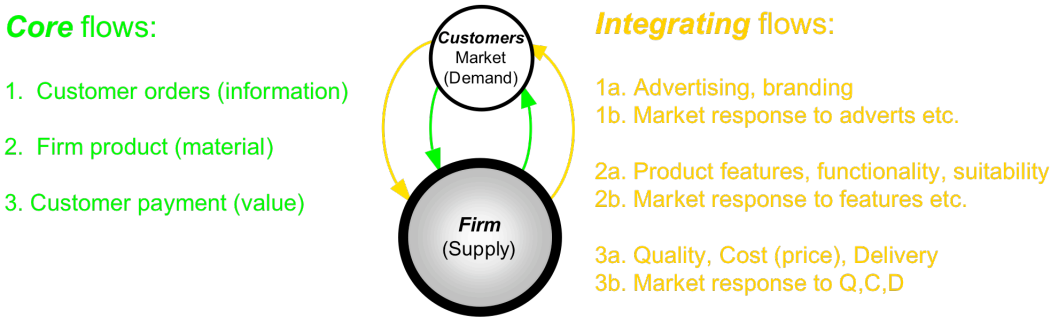
Figure 222: System Dynamics *Enterprise* Subsystem Diagram

Note that Forrester's two seminal studies have focused on the system goals of steady-state *stability* appropriate to mature industries (Forrester, 1961) and transient *growth* appropriate to new industries (Forrester, 1968) respectively.

> *"The first phase dealt primarily with the **'steady-state'** dynamics of **mature** industries. The new phase will deal more with **transient** situations… of **industry and company growth**."*[771]

[771] Forrester, J.W. (1961), pg. viii.

By way of example of stakeholder interactions, the classic *firm-market* interaction (Forrester, 1964) can be seen in Figure 223 below.[772] Aside from the information (i.e. orders), material (i.e. products) and value (i.e. money) flows, the two stakeholders are coupled through competitive signals which importantly define the level of *integration* between stakeholders.



Source: Forrester (1964)

Figure 223: System Dynamics *Firm-Market* Subsystem Diagram

5.7.3.2 Modeling the Enterprise Archetypes: *Modular* & *Integral*

As shown in Figure 224 below, each firm in the mixed duopoly has a fundamentally different view of its relationships with the key stakeholders in its extended enterprise. While the firm at the center of the modular enterprise is an open system, exchanging information, material and value with its environment, it also sees itself as *causally open*, with little ability to control the strategic interests of the stakeholders in its extended enterprise. While the firm at the center of the integral enterprise is also an open system, exchanging information, material and value with its environment, it sees it self as *causally closed* (i.e. having many important strategic feedbacks), with significant ability to control the strategic interests of the stakeholders in its extended enterprise. The presence of a feedback rich environment, is both a cause and effect of the fact that an integral enterprise architecture is managed to longer time constants.

[772] Other examples of system dynamics firm-environment interactions can be seen from Forrester's "Market Growth" model (1968) and Sterman, Repenning and Kofman's (1997) quality improvement program.

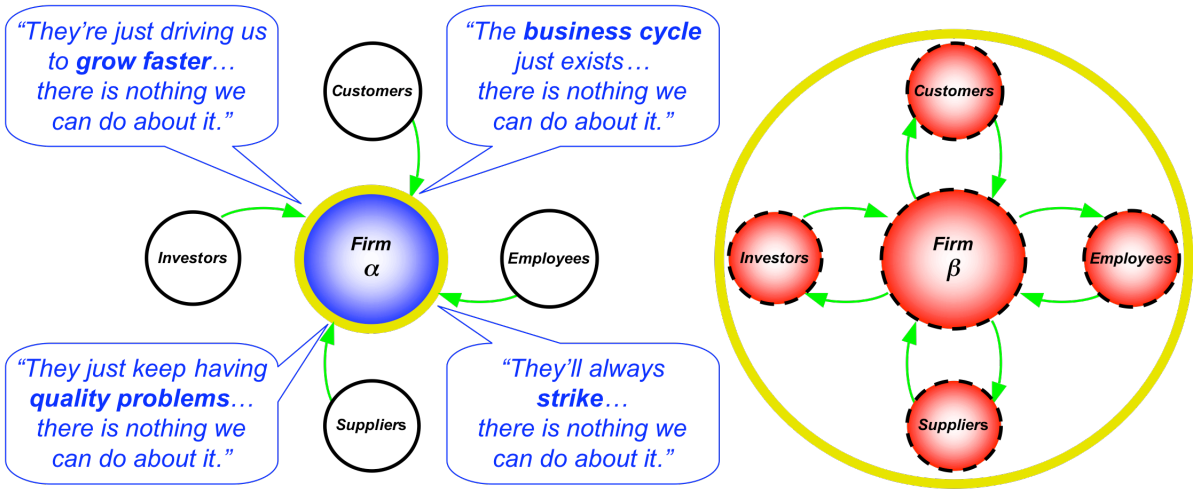


Figure 224: Enterprise Archetypes: Modular and Integral

5.7.3.3 Modeling the *Competitor* subsystem

In Forrester's early seminal studies, competition was treated as passively via an exogenous benchmark representing relative attractiveness of the firm's products in the market (Kunc and Morecroft, 2004). The assumption being that the industry structure supports multiple similar competitors engaged in perfect competition. As a result, the feedbacks between competitor decisions are deemed weak and are not assumed to significantly alter the competitive environment over the time horizons of interest in the study (Kunc and Morecroft, 2004). A more detailed survey of the treatment of competition within the system dynamics tradition is shown in Appendix H.

5.7.3.3.1 Competition for *Customers*

In order to model the competitor subsystem in system dynamics, it is important to first acknowledge which stakeholders will be characterized as territory for competition. While the competitor stakeholder is typically modeled as competing through the customer stakeholder, in principle the "competitive coupling" could take place across all stakeholders as shown in Figure 225 below. In fact, in pursuit of competition for customers (or market share), one could argue that the successful firm will be the one that manages the highest quality providers of investors, employees and suppliers (as an integral part of possessing the best strategy). Note this is where the SCP paradigm begins to meet the RBV paradigm in strategic management. For each stakeholder, there is a spectrum of quality ranging from undifferentiated commodity to differentiated, dedicated asset.

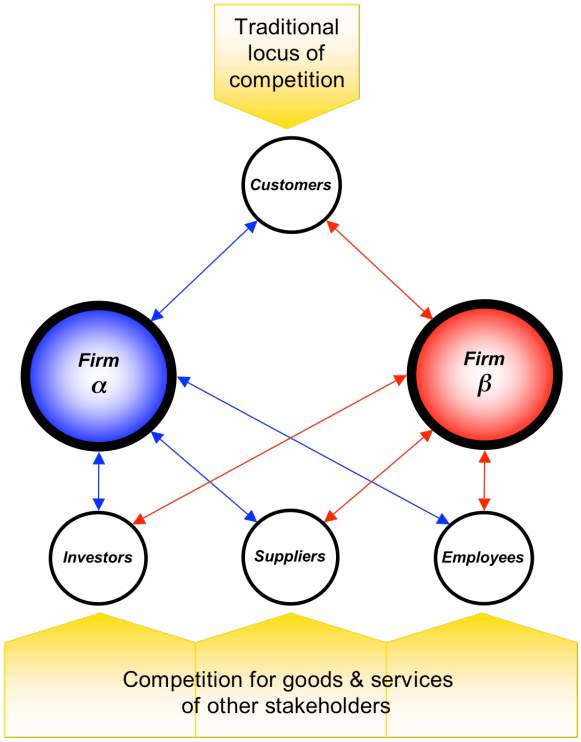


Figure 225: Theoretical Competitive Coupling between all Stakeholders

5.7.3.3.2 Competition for *Investors*

While firms are in principle competing for investors or providers of capital, such input can (but not always as we shall discuss later) be seen as an undifferentiated commodity. Although the *quantity* of capital available may be large, the *quality* of capital may not be. Therefore, although an institutional investor may like the structure of a particular industry (e.g. the duopoly structure of the large commercial airplanes industry), they may choose between firms based on a more integrated, dedicated logic.[773]

5.7.3.3.3 Competition for *Employees*

In addition, firms are in principle competing for employees or managerial talent, as is occasionally evidenced by the switching of high-profile executives in the automotive industry.

5.7.3.3.4 Competition for *Suppliers*

Finally, firms are in principle competing for suppliers, and not necessarily to create captive supply. Although suppliers in some industries can make parts, subassemblies or subsystems for competing OEMs, recent research (Dyer, 2003) has indicated that it not a given that such supply is commodity. In other words creating a high quality relationship with a supplier who has a low quality relationship with your competitor can be a competitive advantage, in terms of productivity, continuous improvement, etc. Such relationships have "sticky" value.

The primary case study of this research focuses on the *Boeing-Airbus* duopoly which is primarily characterized by a partial coupling between the stakeholders along the value chain – namely the customers and suppliers as shown in Figure 226 below.

Each firm has its own "dedicated", "captive" or non-shared providers of capital and labor. Competition takes place along the value chain for customers (either shared or dedicated) and suppliers (also either shared or dedicated).

[773] Consider for example *EADS* composed of *Daimler*, and *BAE Systems* as institutional investors in *Airbus*.

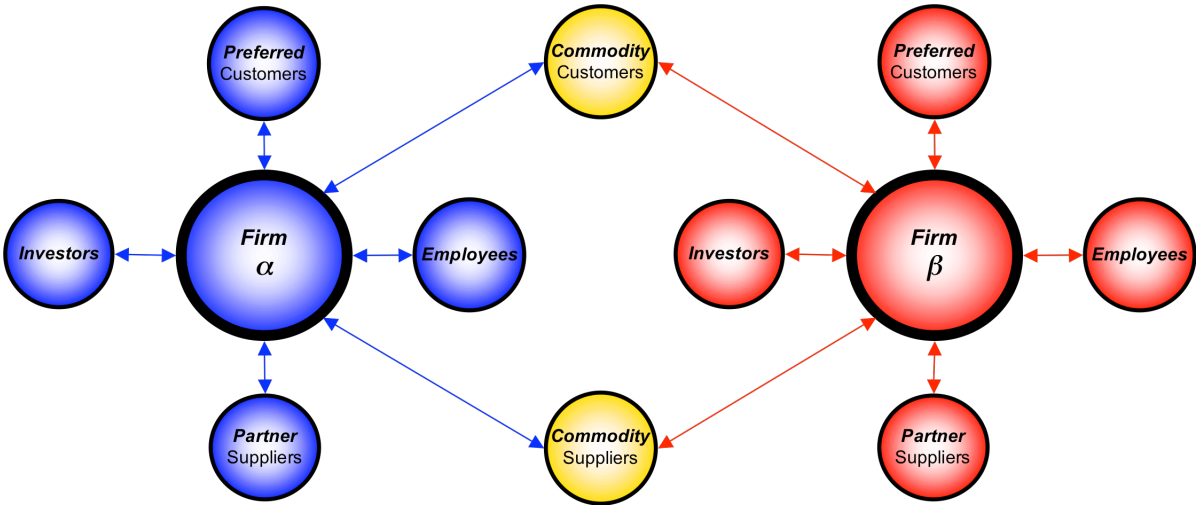


Figure 226: Competitive Coupling between *Value Chain* Stakeholders

5.8 Tying Structural Dynamics to Valuation and Firm Performance

From above, it appears that modular enterprise architectures are driven by "profitable growth", while integral enterprise architectures are driven by "sustainable growth". *Profitable* growth can be achieved by chasing demand in a market upturn, and releasing capacity (and thus short-term costs) in a market downturn. *Sustainable* growth can be achieved by the opposite strategy, namely, not chasing demand in a market upturn, and maintaining capacity in a market downturn. The following quotations from leaders of various enterprise architectures illustrate the mental models.

> *"Aiming to achieve **sustainable growth**, Toyota will implement a financial strategy emphasizing the balance of growth, efficiency and **stability**."* (Ryuji Araki, Executive Vice President, Finance and Accounting, *Toyota).*[774]

> *"I believe, no matter what the era, a company that has lost its appetite for growth cannot develop. In my view, **sustained growth** drives **corporate value**."* (Fujio Cho, President, *Toyota).*[775]

[774] *Toyota Motors* 2004 Annual Report, pg. 14.
[775] *Toyota Motors* 2004 Annual Report, "President's Message", pg. 13.

5.9 Chapter Summary

This chapter was the second of three essays which forms an integrated framework which attempts to explain long-term firm performance. In this chapter, we defined the construct of enterprise structural dynamics, its sources and properties. In addition, we discussed how these dynamics drive the associated performance,

The context for this construct within the framework is shown below in Figure 227. In the following chapter, we will next discuss how firm performance drives and is driven by the evolution of the industry.

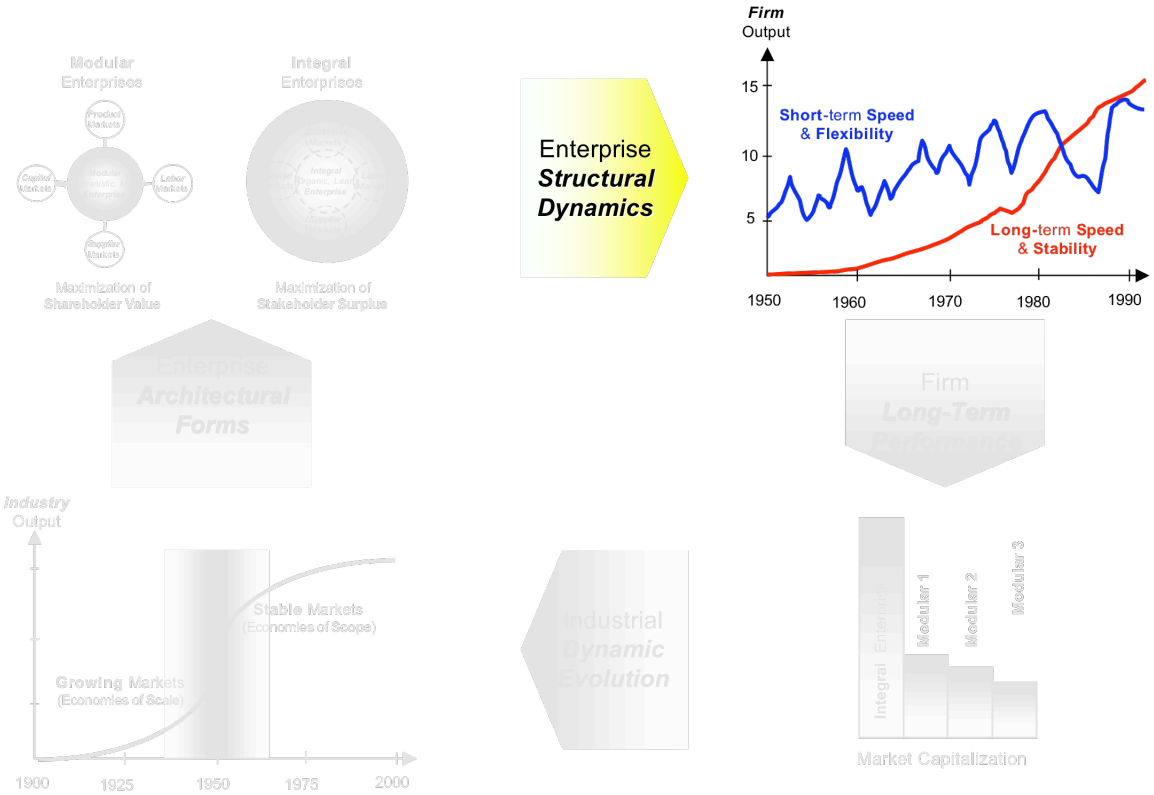


Figure 227: Enterprise *Structural Dynamics* with Framework

Chapter 6 Enterprise–Environment *Co-Evolution*

6.1 Introductory Constructs and Propositions

> *"**Industry evolution** takes on **critical importance** for formulation of **strategy**."*[776]

Having discussed how the enterprise architectural form drives the enterprise structural dynamic behavior, this section will explore the link between the enterprise's structural dynamic behavior and the financial performance of the "keystone" firm and ultimately with the dynamic evolution of the environment and co-evolution with the firms.

First, we will explore the enterprise's *architectural* evolution from integral to modular, as exploration gives way to exploitation. Second, we will explore the environment's simultaneous *structural* evolution from growth to stability. Third, we will explore industry's simultaneous *architectural* evolution from modular to back to integral as exploitation gives way to a new type of exploration (noting that change now takes place at a population level instead of at a firm level, signaling the birth of a new integral firm in a new environment). This feedback mechanism will attempt to explain the co-evolution of firm's ecosystem with the competitive environment.

> *"One of the **enduring problems** facing the field of **strategic management** is the lack of theoretical tools available to describe and predict the **behavior of firms and industries**. The fundamental problem is that industries evolve in a dynamic way over time as a result of **complex interactions** among firms, government, labor, consumers, financial institutions, and other elements of the environment. Not only does industry structure influence firm behavior, but firm behavior in turn can alter the structure of an industry and the **contours of competition**."*[777]

6.1.1 *Change from a System Perspective*

Organizational and environmental change has been profitably expressed and subsequently decomposed from a systems perspective (Bossel, 2007), which are the result of different processes associated with different time constants. The following subsections address three processes each having longer time constants and therefore deeper causality: adaptation, self-organization and evolution as summarized in Figure 228 below.

[776] Porter, M.E. (1980), pg. 156.
[777] Levy, D. (1994), pg. 167.

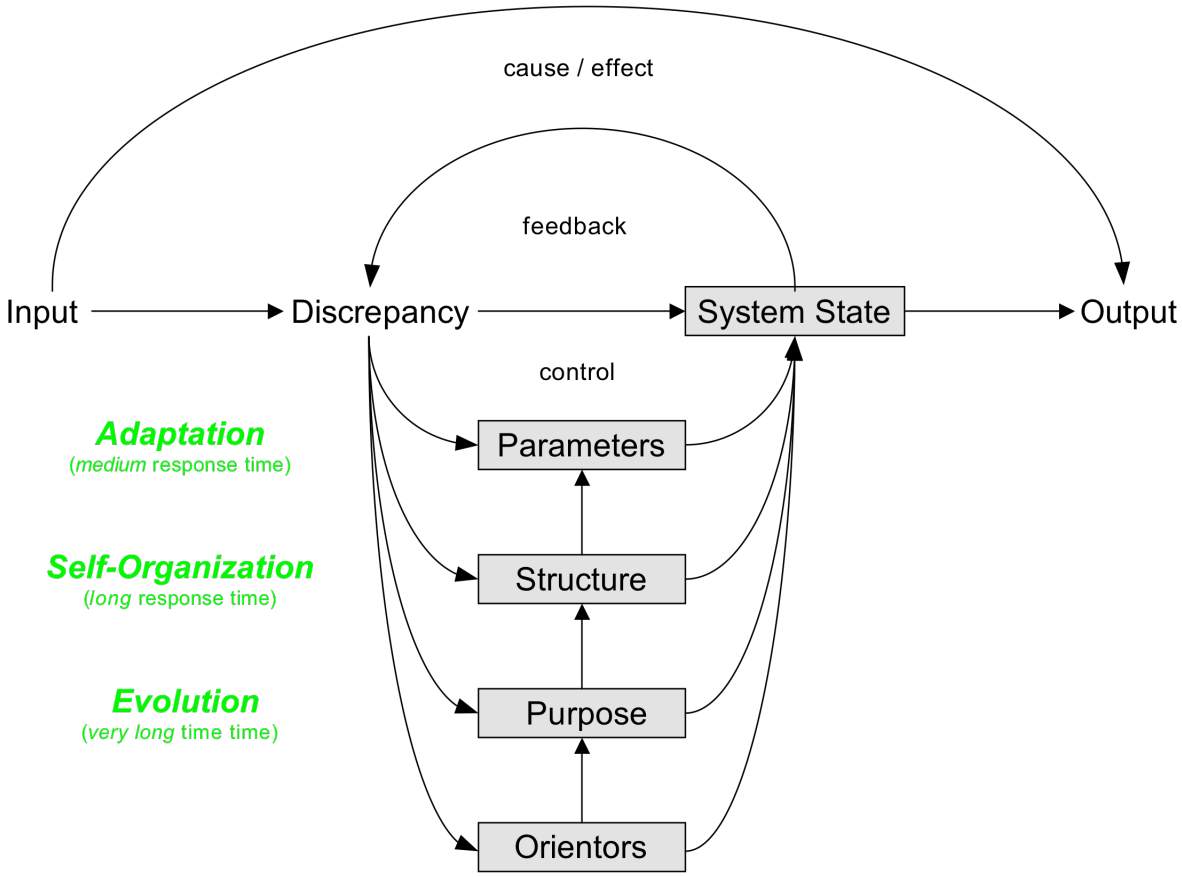


Figure 228: The Structure of *Adaptation*, *Self-Organization* and *Evolution*

6.1.1.1 Adaptation

> *"Processes of **adaptation** ... in this case the system **maintains its basic influence structure**, but **parameters are adjusted** to adapt to the situation. Adaptation means adjustment to a change in the system environment by changing the **system parameters** and/or **limited structural change**."*[778]

Within the context of this framework, *adaptation* of an enterprise architecture lies in its relatively minor adjustments towards efficiency, while keeping the existing architecture constant.

6.1.1.2 Self-Organization

> *"On the next higher level we find processes of **self-organization** in respsonse to environmental challenges. This means **structural change** in the system. Self-organization denotes the ability of a system to change its **system structure and its functions** to cope with new challenges."*[779]

Within the context of this framework, *self-organization* speaks to the change of the underlying structure (and associated functions), for the example, the natural dis-integration (or modularization) of the enterprise architecture.

[778] Bossel, H. (2007), pp. 13 and 48.
[779] Bossel, H. (2007), pp. 13 and 49.

6.1.1.3 Evolution

> *"A system may also **change its identity** in the course of an **evolutionary** process. This means that its **functional characteristics**, and hence its **system purpose**, change with time. Evolution is adaptation and self-organization under **fitness competition** in a population of similar systems."*[780]

Within the context of this framework, *evolution* speaks to the change of the deep underlying identity, function and purpose of an enterprise, for the example, the re-integration of the enterprise architecture.

6.1.2 *Employing Multiple Views on Change Processes*

> *"It is the **interplay between different perspectives** that helps one gain a more comprehensive understanding of organizational life, because any one theoretical perspective invariably offers only a partial account of a **complex phenomenon**."*[781]

Van de Ven and Poole (1991 and 1995) conducted an extensive review of the management literature and discovered four distinct theories of change processes: life cycle, teleology, dialectics and evolution (Van de Ven, 1992) – the former two being deterministic and predictive and the latter two being probabilistic and non-predictive.

> *"**Life-cycle, teleology, dialectics** and **evolution** are viewed as abstract ideal types of theories of change processes. These ideal types are based on **fundamentally different logics**, which represent the underlying generative mechanisms or laws that explain why observed events occur in particular sequence progressions when specific circumstances or conditions exist."*[782]

[780] Bossel, H. (2007), pp. 13 and 49.
[781] Van de Ven and Poole, (1995), pp. 510-511.
[782] Van de Ven, (1992), pg. 169.

The following subsections will briefly describe each, and as is shown in Figure 229 below, essay #3 will explore the change processes which occur in enterprise architectures from the primary viewpoints.

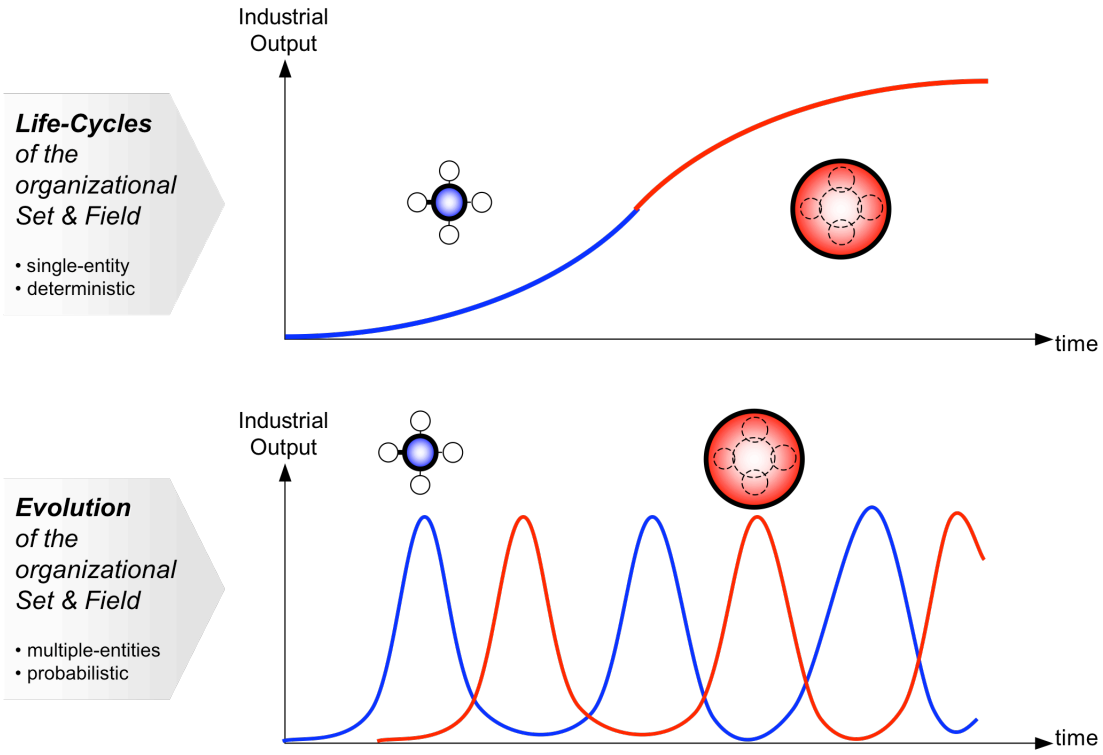


Figure 229: Integrating Theories of Change Processes

6.1.2.1 *Life-Cycle* theory

> *"The **grandfather of concepts** for predicting the probable course of **industry evolution** is the familiar product **lifecycle.**"*[783]

The mode of change of life-cycle theory is deterministically prescribed and focuses on continuity. The unit of change of life-cycle theory is the single entity, whether in the case of this research, the entity is the enterprise (i.e. organizational *set*) or the ecosystem (i.e. organizational *field*).

> *"According to life cycle theory, **change is imminent**; that is, the developing entity has **within it an underlying form, logic, program or code** that regulates the process of change and moves the entity from a given point of departure toward a subsequent end that is **prefigured** in the present state."*[784]

As Van de Ven (1992) notes, Greiner's (1972) model of organizational growth is rooted in a life-cycle perspective in distinct opposition to a teleological perspective.

[783] Porter, M.E. (1980), pg. 156.
[784] Van de Ven and Poole, (1995), pg. 515.

> *"…**historical forces** [organizational age, size, growth rate, and stages of evolution and revolution] shape the future growth of organizations… the future of an organization may be less determined by outside forces than it is by the organization's history… **behavior is determined primarily by previous events and history, not by what lies ahead**."*[785]

6.1.2.2 *Teleological* theory

> *"A teleology process theory is based on the assumption that the developing entity is **purposeful** and **adaptive**."*[786]

The mode of change of teleological theory is emergent and focuses on discontinuity. The unit of change of teleological theory is the single entity, whether in the case of this research, the entity is the enterprise (i.e. organizational *set*) or the ecosystem (i.e. organizational *field*). Although teleological theory is rooted in the purposefulness of human actors, this brings up an interesting question: if an organizational set or organizational field are purposeful, who administers this purpose and how?

The primary fields which have supported this theory include *functionalism, general system theory* and *strategic planning*.

> *"Unlike life-cycle theory, teleology **does not prescribe a necessary sequence of events** or specify **which trajectory** development of the organizational entity will follow."*[787]

The underlying purpose or goal of an enterprise architecture is captured by its objective function, whether maximization of shareholder value or maximization of stakeholder surplus. To the extent that the enterprise architect(s) (e.g. CEO) are purposeful actors, teleological theory applies to our theory of the evolution of business ecosystems. The question becomes, to what extent does the enterprise architecture enable and constrain purposeful action and strategic choice?[788] And at what stages in the development of an ecosystem do teleological factors dominate?

6.1.2.3 *Dialectical* theory

> *"Different patterns for resolving dialectical oppositions can push an organization to flow toward **equilibrium**, to **oscillate in cycles** between opposites, or to **bifurcate** far from equilibrium and spontaneously create **revolutionary changes**."*[789]

The mode of change of dialectical theory is emergent and focuses on discontinuity. The unit of change of dialectical theory are multiple entities, whether in the case of this research, the entity is the enterprise (i.e. organizational *set*) or the ecosystem (i.e. organizational *field*). As will be discussed below, dialectical theory is necessary (along with evolutionary theory) to explan the emergence and disappearance of organizational forms in a community ecology approach.

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[785] Greiner, L. (1972), pg. 166.
[786] Van de Ven, (1992), pg. 178.
[787] Van de Ven and Poole, (1995), pg. 516.
[788] Recall from the *Airbus* case, the CEO's inablility to implement proposed changes to the enterprise architecture led to his exit in 1996 after only 100 days on the job.
[789] Van de Ven, (1992), pp. 179.

> *"Dialectical theory begins with the assumption that the organizational entity exists in a pluralistic world of colliding events, forces or contradictory values that **compete** with each other for domination and control. These oppositions may be **internal** to an organizational entity because it may have several **conflicting goals or interest groups** competing for priority. Also, oppositions may be **external** to the organizational entity as it pursues directions that **collide with the direction of other organizations**."*[790]

Within the enterprise architecture or organizational set, a zero-sum competition between stakeholders for residual cash-flows is a form of dialectic. Also, external competition between organizational sets represents a form of dialectic. The creation of a "win-win" is an example of *thesis* and *anti-thesis* generating *synthesis*, while a "win-lose" is an example of maintenance of *thesis* or replacement with *anti-thesis* (Van de Ven and Poole, 1995, pg. 517). Unpredictable change therefore can result within an organizational set from a power-struggle that results in either the creation or destruction of a "win-win" in the enterprise's objective function. As inter-enterprise competition is likely to preclude collusion, such unpredictable dialectic change would be less common.

6.1.2.4 *Evolutionary* theory

> *"The **evolutionary model** suggests a **blurring** of the hard lines defining the **adaptation-selection** debate ."*[791]

The mode of change of evolutionary theory is probabilitisically prescribed and focuses on continuity. The unit of change of evolutionary theory are multiple entities, whether in the case of this research, the entity is the enterprise (i.e. organizational *set*) or the ecosystem (i.e. organizational *field*).

> *"**Variations**, the creations of novel forms of organizaitons are often viewed to emerge by **blind** or **random** chance (Aldrich, 1979; Campbell, 1969). **Selection** of organization occurs principally through the **competition** for scarce resources and the environment selects entities that best fit the resource base of an environmental niche. (Hannan and Freeman, 1977). **Retention** involves forces (including **inertia** and persistence) that perpetuate and maintain certain organizational forms."*[792]

Evolutionary studies of organizations are comprised by the economics and the sociology traditions (Barron, 2003). These tend to characterize the debate of whether *managerial adaptation* or *environmental selection* dominates organizational change. Both processes can be expressed in evolutionary terms, i.e. based on the processes of variation, selection and retention as shown in Figure 230 below.

> *"Organizational scholars who adopt **Darwinian** evolution argue that traits are inherited through **intergenerational** processes; whereas those who follow **Lamarck** argue that traits are acquired **within a generation** through learning and imitation. A Lamarckian view on the acquisition of traits appears more appropriate than strict Darwinism for organization and management applications."*[793]

[790] Van de Ven and Poole, (1995), pp. 517.
[791] Scott, (2003), pg. 222.
[792] Van de Ven and Poole, (1995), pg. 518.
[793] Van de Ven and Poole, (1995), pg. 519.

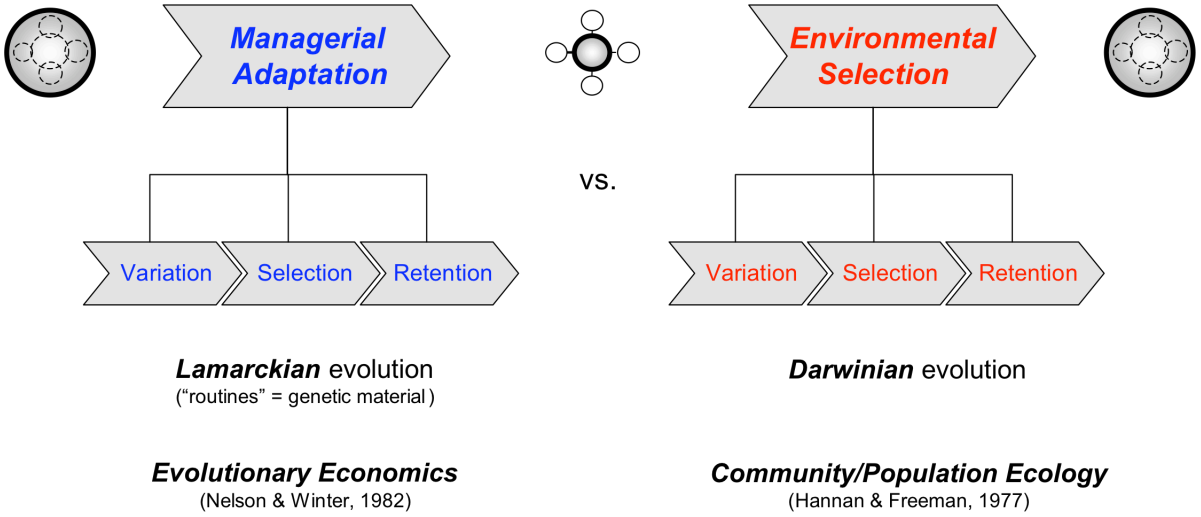


Figure 230: Evolution in *Managerial Adaptation* & *Environmental Selection*

6.1.2.4.1 Evolutionary Economics

Nelson and Winter (1982) define "routines" as the underlying genetic material of organizations. Their approach to evolution is Lamarckian as the governing mechanism is the transfer of genetic material across generations via learning.

6.1.2.4.2 Population Ecology

Hannan and Freeman (1977) note that the unit of selection are the organizations themselves within their environment.

6.1.2.5 Combinations of theories

Van de Ven and Poole (1995) assemble the fore aforementioned change theories into combinations of theories to describe how well-known meta-theories are constituted. For example, while population ecology is certainly an evolutionary theory, its more general parent discipline, community ecology is rooted in both evoloutionary theory and dialectical theory, thereby allowing for the explanation for the emergence and disappearance of new forms, which population ecology does not focus on.

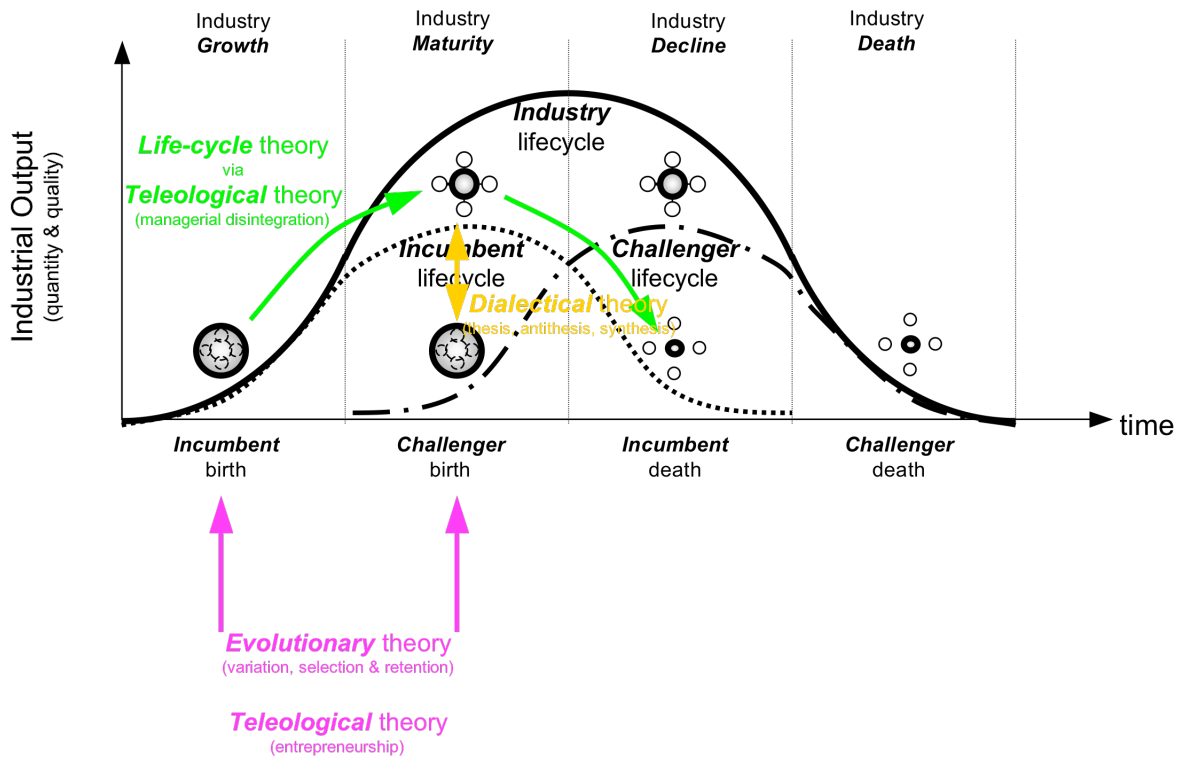
Figure 231 below summarizes the combination of change theories on the framework. At the enterprise level, change occurs both via life-cycle theory, where organizations (like organisms) go through the sequential stages of birth and death; and via teleological theory, where managerial adaptation can work to disintegrate enterprises.

At the ecosystem level, change occurs both via evolutionary theory, where new organizational forms (like *Toyota*) appear in "blind" *variation*, they are competitively

selected and their forms are *retained* (like the adoption of "lean"); and via teleological theory, where managerial adaptation via entrepreneurship is evident.

At the interface between enterprise and ecosystem, change occurs via dialectical theory, where thesis and antithesis compete and vie for synthesis.

Figure 231: Change Theories and the Evolution of Business Ecosystems



6.2 Theoretical Foundations

> *"Models that integrate **sociological** and **economic** aspects of the **environment,** or that move beyond traditional life-cycle conceptions of its evolution, are lacking."*[794]

As this chapter aims to understand the nature of the evolution of the environment, and it cause and effect on the evolution of the enterprise, I will draw from a diverse set of theoretical traditions spanning economics and sociology.

6.2.1 Economic *Theories*

> *"In classical economic theory… change was within the structure but the **structure was always stable**. Institutional economists examine institutions that provide economic order, and they study the **endogenous forces that cause these institutions to evolve**."*[795]

While *classical* economics is rooted in natural law, *institutional* economics rooted in human organization. The framework derived from this research embraces both epistemologies. Change is described both from the natural law of Newton's tradition, as well as from the human organization of Darwin's tradition.

The most notable and influential economic theories of evolution come from Nelson and Winter (1982). Unlike the sociological view of Darwinian evolution, they are avowedly Lamarckian in their focus on learning routines.

6.2.1.1 Life Cycle Theory of *Industry Structure, Technologies & Markets*

Oliver Williamson (1975) gave an early economics description of the different stages in an industry's evolution, which predates some of the more established work on this topic in the field of technology and innovation (Abernathy and Utterback, 1978):

> *"Three stages in an industry's development are commonly recognized: an early exploratory stage, an intermediate development stage, and a mature stage. The first or **early formative stage** involves the supply of new product of relatively primitive design, manufactured on comparatively unspecialized machinery, and marketed through a variety of exploratory techniques. Volume is typically low. A high degree of uncertainty characterizes business experiences at this stage. The second stage is the **intermediate development stage** in which manufacturing techniques are more refined and market definition is sharpened; output grows rapidly in response to newly rcognized applications and unsatisfied market demands. A high but somewhat lesser degree of uncertainty characterizes market outcomes at this stage. The third stage is that of a **mature industry.** Management, manufacturing, and marketing techniques all reach a relatively advanced degree of refinement. Markets may continue to grow, but do so at a more regular and predictable rate…established connections with customers and suppliers (including capital market access) all operate to buffer changes and thereby to limit large shifts in market shares. Significant innovations tend to be fewer and are mainly of an improvement variety."*[796]

Subsequently, Gort and Klepper (1982) conducted one of the most extensive studies of industrial evolution in which they examined the life cycles of nearly 50 industries which

[794] Farjoun, M. (2002), pg. 585.
[795] Atkinson G. (2004), pg. 275.
[796] Williamson, O. (1975), pp. 215-216, as cited in Klepper (1997), pp. 146-147.

originated between 1887 and 1960 and which represented a diverse mix of products. As shown in the quote below, they found a number of general (although not universal) patterns in the evolution of the structure of industries along the dimensions of: number of firms, industry output growth, prices, and rate of innovations.

> *"[Gort and Klepper, 1982]… observed that industries for new products pass through a brief period with few firms, followed by a rapid increase in the **number of firms**, which then falls rapidly to a relatively stable level (p. 639). During the evolution of the industry, [they] also observed that **output growth** is initially hight but declines steadily (p. 645); **prices** fall rapidly but at a decreasing rate (p. 647); and the rate of both **major innovations and minor innovations** rise, peak, and then remain stable over time, with major innovations peaking earlier (p. 648)."*[797]

While many researchers have focused on the causal mechanisms of scale advantages, recent researchers like Lenox, Rockart and Lewin (2007) have generated numerical simulation models to which use the the mechanism of interdependency to demonstrate similar patterns in the evolution of the structure of industries:

> *"This model is able to recreate the patterns observed in **improvements in efficiency** (continued but with less-substantial improvement as time passes), **industry output** (increasing at a decreasing rate), **prices** (steady decline at a decreasing rate), and **industry participation** (rapid entry is followed by mass exit, leading to a shakeout and a stable number of competitors)."*[798]

[797] Lenox, M.J., Rockart, S.F., Lewin, A.Y. (2007), pp. 600-601.
[798] Lenox, M.J., Rockart, S.F., Lewin, A.Y. (2007), pp. 610-611.

6.2.1.2 Life Cycle Theory of *Finance and Governance*

In advancing a life cycle theory of the firm, Mueller (1972) posited that the distribution of dividends back to investors would follow the traditional life cycle curve as shown in Figure 232 below.

> *"We therefore expect the growth-maximizing management to **undertake-more investment** than a stockholder-welfare maximizer, **pay equivalently smaller dividends, grow at a faster rate**, and have a **lower market value for its firm**."*[799]

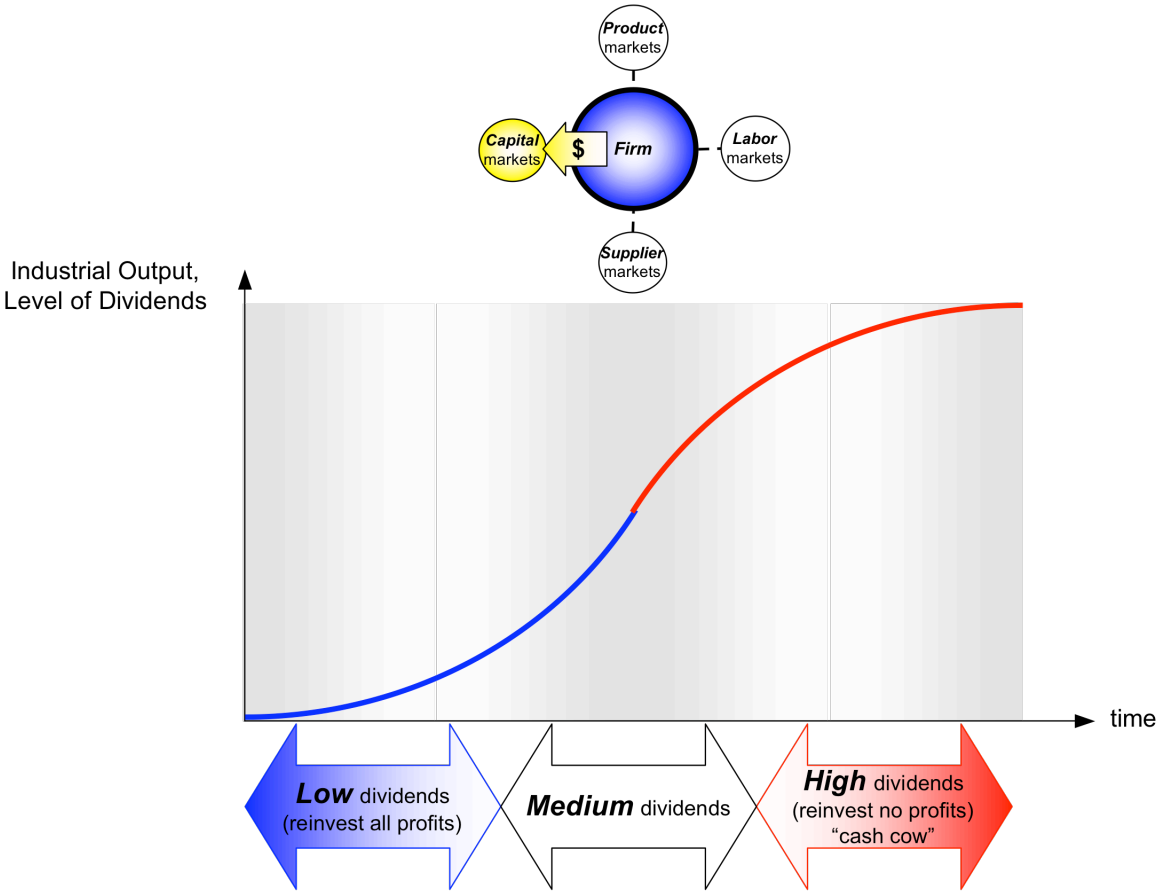


Figure 232: Dividend Distribution Life Cycle

> *"This paper attempts to fill this void by developing a life cycle theory in which **the tendency of managers to pursue growth, rather than stockholder welfare, increases as the firm grows and matures**."*[800]

Building off of Marris' work (1963), Mueller (1972) also noted that as a market was emerging, with increasing rates of growth, there was no negative trade-off between growth

[799] Mueller, D.C. (1972), pg. 206.
[800] Mueller, D.C. (1972), pg. 199.

and profitability, therefore principal-agent problems were minimized. However, as the market was maturing, with decreasing rates of growth, there was a negative trade-off between growth and profitability, exacerbating principal-agent problems, as shown in Figure 233 below.

> *"He postulated the existence of 'young' firms… that had **'taken off' into a process of fast, accelerating growth associated with good profitability. The valuation curve presented no negative trade-off between growth and stock-market value** because at this stage the return on retained profits was better than could be obtained elsewhere. Later, as the exceptional circumstances fade, **the optimum growth rate for stockholders gradually declines** and may finally become negative. During this phase, which may be very long if not indefinite, **conflict between managerial and stockholder interests emerges.**"*[801]

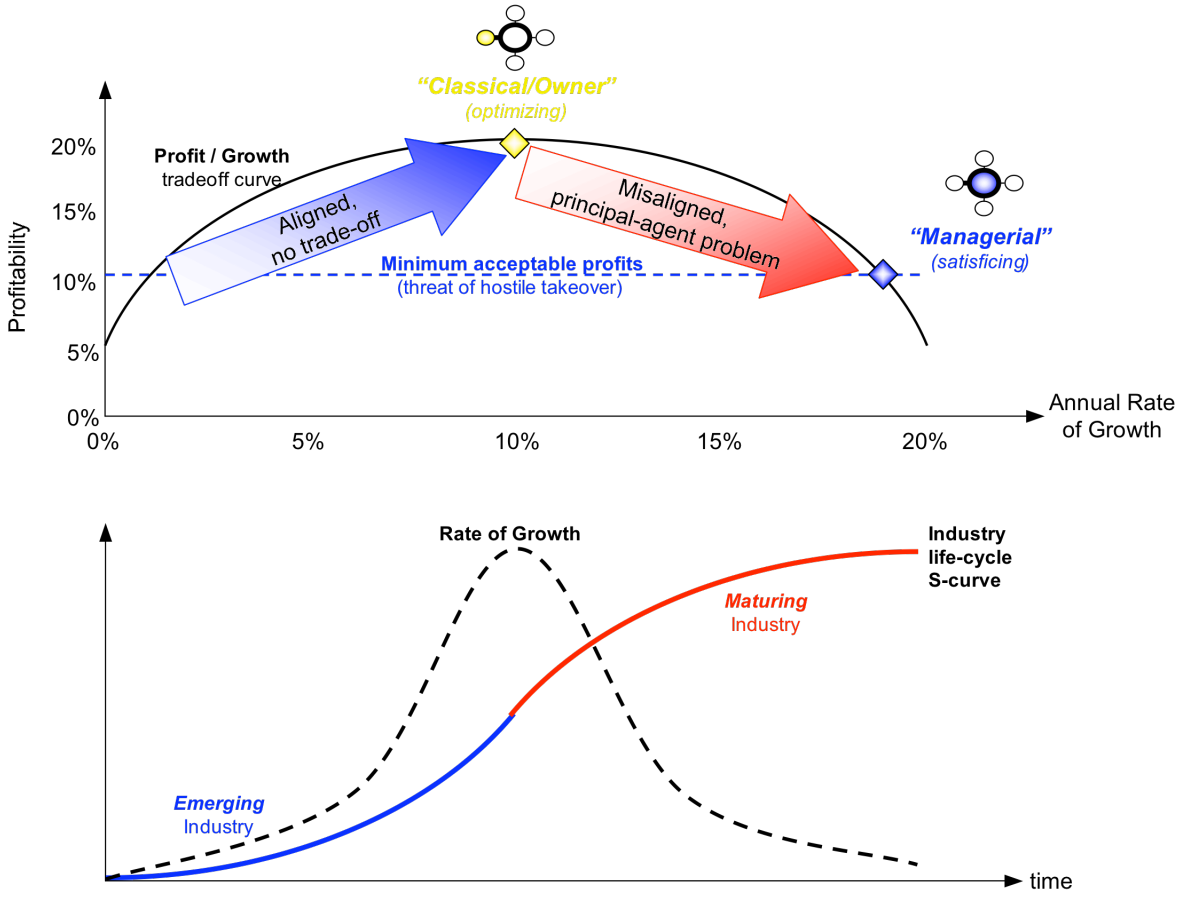


Figure 233: Emergence of the Principal-Agent Problem with Industry Maturity

> *"**Mergers** are an obvious way to **avoid the slowdown in growth** that product maturity brings."*[802]

[801] Marris, R. and Mueller, D.C. (1980), pg. 44.
[802] Marris, R. and Mueller, D.C. (1980), pg. 45.

6.2.2 Sociology and Organizational *Theories*

6.2.2.1 Environmental Descriptions

Sociologists and organizational theorists have long characterized the environment within which firms operate, as they have established the environment as a source of critical contingencies with respect to firm performance. The following summarizes some of the most influential in order to situate their theories within the proposed framework.

6.2.2.1.1 Six ***Dimensions*** (Aldrich)

> *"Use of a **single dimension** of an industry's environment to **build theory** and to test proposed relationships empirically may result in a **failure** to investigate alternative plausible explanations of observed relationships."*[803]

Population ecologists have long identified multiple "dimensions" for characterization of the environment (e.g. Aldrich, 1979, pp. 63-74), the most common of which include:

- Environmental *Capacity*
- Environmental *Homogeneity-Heterogeneity*
- Environmental *Stability-Instability*
- Environmental *Concentration-Dispersion*
- Domain *Consensus- Dissensus*
- *Turbulence*

Other organizational theorists have combined these dimensions into various descriptors of the environment as will be seen below.

6.2.2.1.2 Four ***Causal Textures*** (Emery & Trist)

Emery and Trist (1965) identified four 'ideal types' of causal texture, which are briefly summarized below and interpreted within the context of the industry life-cycle S-curve in Figure 234 below.

> *"Together, the four types may be said to **form a series** in which the degree of **causal texturing is increased**."*[804]

6.2.2.1.2.1 Step #1: Placid, Randomized

The economist's "classical market" corresponds to this type. The firm can be though of as entrepreneurial.

6.2.2.1.2.2 Step #2: Placid, Clustered

[803] Dess, G.G., Ireland, R.D., and Hitt, M.A. (1990), pg. 16.
[804] Emery and Trist (1965), pg. 23.

> *"Organizations tend to **grow in size** and also to become **more hierarchical**, with a tendency towards **centralized control and co-ordination**."*[805]

The economist's "imperfect competition" corresponds to this type.

6.2.2.1.2.3 Step #3: Disturbed-Reactive

The economist's "oligopolic market" corresponds to this type. Strategic interaction is now important.

6.2.2.1.2.4 Step #4: Turbulent Fields

> *"The **dynamic properties arise** not simply from the interaction of the component organizations, but **also from the field itself.** The 'ground' is in motion."*[806]

Note that other researchers speak of discontinuity. Abernathy et al. (1983) speaks of industrial "de-maturity".

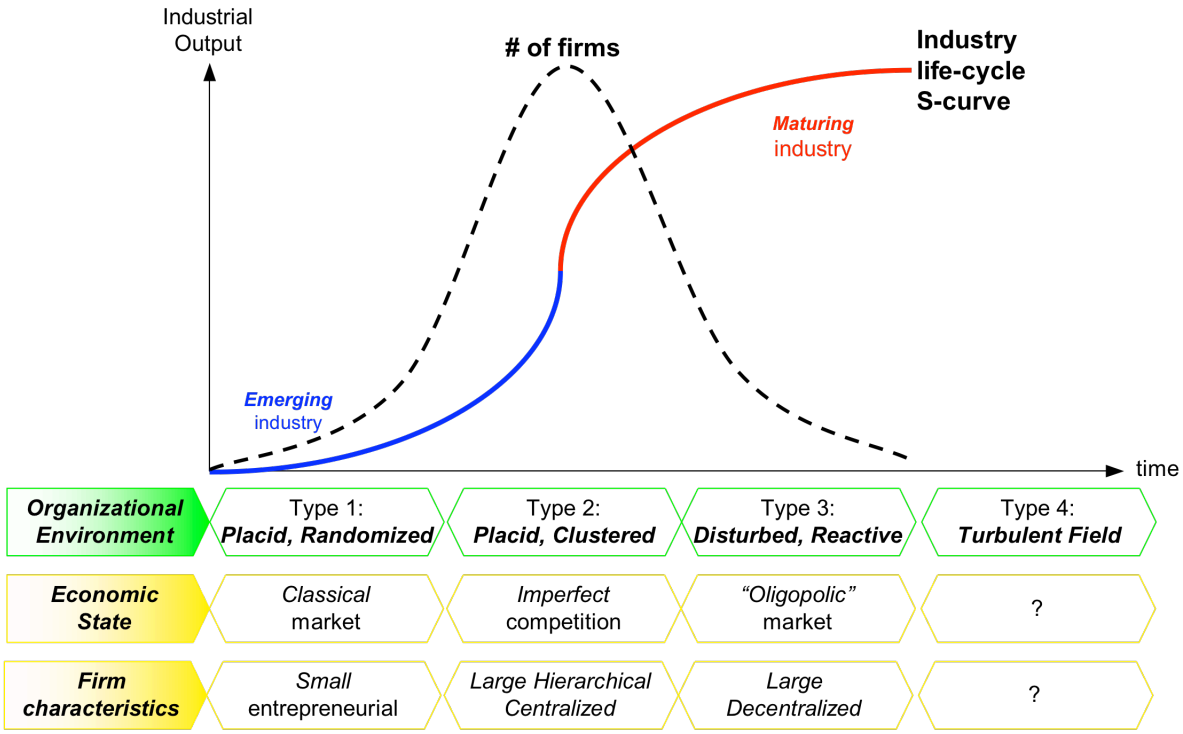


Figure 234: Four Causal Textures and the Industry Life Cycle

[805] Emery and Trist (1965), pg. 23.
[806] Emery and Trist (1965), pg. 24.

6.2.2.1.3 **Three Dimensions** (Dess & Beard)

Aldrich (1979) defined the environment using six dimensions: geographic concentration and heterogeneity, stability and turbulence, and domain consensus and capacity. In a subsequent influential paper, Dess and Beard (1984) condensed these dimensions to three: munificence, dynamism and complexity.[807]

6.2.2.1.3.1 Munificence

Environmental munificence is the scarcity or abundance of resources (e.g. demand) in a given environment. It represents the extent to which the environment can support sustained growth (Starbuck, 1976). In the language of system dynamics, environmental munificence can be considered as environmental "carrying capacity", which may or may not be constant over time.

High environmental munificence creates favorable supply-demand tradeoffs and therefore makes it easier for firms to survive, perform successfully or create profit (Hart and Banbury, 1994). Poorly managed firms can still survive and create profits, discouraging their efficiency levels or improvement capabilities.

Conversely, low environmental munificence makes it harder for firms to perform successfully and therefore forces firms to make more frequent adjustments to access resources from the environment (Koberg, 1987).

> *"In a **high-growth** period, productivity can be raised by anyone. But how many can attain it during the more difficult circumstances induced by **low-growth** rate? This is **the deciding factor** in the success or failure of an enterprise."* [808]

Lean competitors based on integral enterprise architectures tend to make frequent or continuous incremental "kaizen" improvements in response to a mature, saturated anti-munificent environment. The are well-suited to their harsh environment like a cactus in the desert.

6.2.2.1.3.2 Dynamism

Environmental dynamism is the level of change or rate of volatility in the environment. More precisely, it is the extent to which such change is *unpredictable* (Dess and Beard, 1984). An environment having a high level of dynamism has also been described as "unstable" (Mintzberg, 1990).

Note: from a system dynamics perspective, this instablilty mathematically corresponds to dominant positive feedback generating exponential growth or decline.

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[807] Environmental "dynamism" and "complexity" are often combined under the concept of environmental "uncertainty".
[808] Ohno, T. (1978), pg. 114.

6.2.2.1.3.3 Complexity

Environmental complexity is the number and diversity of "forces" (e.g. stakeholders) with which interaction is required, and the extent to which an organization must have sophisticated knowledge about customers, competitors etc. (Aldrich, 1979).

> *"The environmental contexts in which organizations exist are themselves changing, at an **increasing rate**, and towards **increasing complexity**. This point, in itself, scarcely needs labouring."*[809]

This research posits that environments with high environmental complexity tend to exhibit more boundedly rational behavior (March and Simon, 1958), and therefore present opportunities for integral enterprise architectures to develop.

6.2.2.1.3.4 Discussion

When considering the trajectories of the three dimensions of an organizational environment, it is clear that they have opposite levels (Castrogiovanni, 1996), as shown in Figure 235 below.

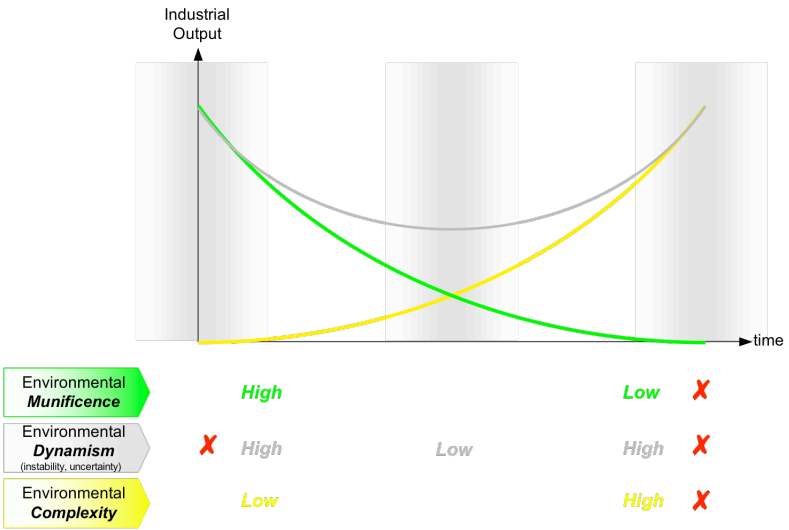

Figure 235: Trajectories of the Three Dimensions of Organizational Environments

One can then begin to map these three dimensions of organizational environment onto the industry life-cycle S-curve. As shown in Figure 236 below, emerging industries tend to exhibit high levels of environmental munificence and dynamism and low levels of complexity, while conversely, maturing industries tend to exhibit low levels of environmental munificence and dynamism and high levels of complexity.

[809] Emery and Trist, (1965), pg. 21.

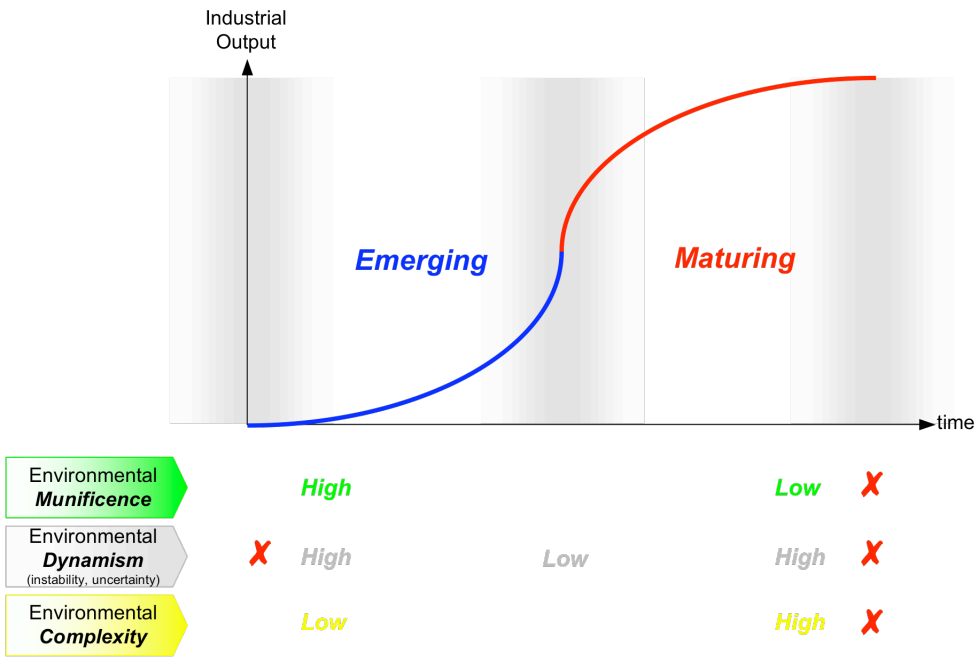

Figure 236: Three Dimensions of Organizational Environment & the Industry Life-Cycle

6.2.2.1.4 **Two Dimensions** (Burns & Stalker)

In their classic exposition on Contingency Theory, Burns & Stalker (1961) describe the environment as different rates of change in *technical* or *market* variables.

> *"These extrinsic factors are all, in our view, identifiable as **different rates of technical or market change**. **By change we mean the appearance of novelties**: i.e. new scientific discoveries or technical inventions, and requirements for products of a kind not previously available or demanded."*[810]

Burns and Stalker (1961) conceived of their two characterizations of the environment via observing empirically the technical and market conditions for electronics during World War II, which they called "stable", and those conditions after the war, which they called "unstable".

> *"When **novelty and unfamiliarity** in both market situation and technical information become the accepted order of things, a fundamentally different kind of management system be comes appropriate from that which applies to a **relatively stable** commercial and technical environment."*[811]

6.2.2.1.5 **Three Dimensions** (Chandler)

Chandler (1962) also conceded that different environmental conditions demanded different (strategies and therefore) structures. These conditions were characterized as the rate of environmental change in technology, markets and supply.

> *"As long as an enterprise belonged in an industry whose markets, sources of raw materials and production processes remained relatively unchanged, few entrepreneurial decisions had to be reached. In that situation, such a weakness was not critical, but **where technology, markets and sources of supply were changing rapidly**, the defects of such a structure became more obvious."*[812]

6.2.2.1.6 **Two Dimensions** (Lawrence & Lorsch)

In their classic exposition on Contingency Theory, Lawrence and Lorsch (1967a, pg. 157) describe two external variables: *certainty* and *diversity* of the environment.

6.2.2.1.6.1 ***Certainty*** (Dynamic-Stable)

Lawrence and Lorsch (1967a, pg. 151-152) describe environmental *certainty* as either *dynamic (i.e. uncertain* or *unstable)* or *stable (i.e. certain)*. Their empirical sample covered three different industrial environments: plastics, packaged foods and standardized containers, ranging from most dynamic to most stable. The following excerpt illustrates their definition of a stable environment.

[810] Burns, T. and Stalker, G.M. (1961), pg. 96.
[811] Burns, T. and Stalker, G.M. (1961), pg. vii.
[812] Chandler, A. (1962), pg. 41.

> *"One important consideration was to select industries with **slower rates of environmental change**. We therefore sought one industry whose **rates of growth and change were very slow… the most stable environment**. Here the **rate of sales increase** was **only slightly higher than the growth in national population**."*[813]

*6.2.2.1.6.2 **Diversity*** (Diverse-Homogeneous)

Lawrence and Lorsch (1967a, pg. 151-152) describe environmental *diversity* as either *diverse (heterogeneous)* or *homogenous*. The following excerpt illustrates their definition of a homogeneous environment.

> *"Even more important, **no significant new products had been introduced in the past 20 years**."*[814]

6.2.2.1.6.3 Critique

It appears that Lawrence and Lorsch's two characterizations of the environment - i.e. *certainty* (or *stability*) and *diversity* (or *heterogeneity*) correspond roughly to the two dimensions in this research (i.e. *quantity* and *quality*).

It also appears that these two external variables are meant to be used together, and therefore define the "diagonal" states where dynamic (unstable) and diverse (heterogeneous), or stable and homogeneous go hand in hand. It is not clear if they intended to cover the "off-diagonal" cases of dynamic (unstable) and homogeneous or stable and diverse (heterogeneous). In a similar way, the two external variables used in this research are meant to be used together although not necessarily coincident temporally. Therefore the rate of change in quantity of output has similar mapping to the rate of change in quality of output.

It is very important to note however that (unlike this research), Lawrence and Lorsch do not appear to posit a continuous evolution between the two different environmental states, e.g. that dynamic/diverse environments precede stable/homogeneous environments in the typical S-curve of environmental development.

6.2.2.1.7 Environmental *Uncertainty*

While Aldrich (1979) and Dess (1984) have focused on six and three dimensions respectively characterizing the environment, other researchers have combined these and other variables into a notion of environmental uncertainty. Some researchers have combined Dess' environmental "dynamism" and "complexity" into the concept of environmental "uncertainty".

> *"**Uncertainty** appears as the **fundamental problem** for complex organizations, and coping with uncertainty, as the essence of the administrative process."*[815]

Anderson and Tushman (2001) observed empirically the mortality rates of firms in longitudinal studies of two industries.[816] Instead of using Dess' three dimensions of

[813] Lawrence, P.R. and Lorsch, J.W. (1967a), pg. 85.
[814] Lawrence, P.R. and Lorsch, J.W. (1967a), pg. 85.
[815] Thompson, J.D. (1967), pg. 159.

munificence, dynamism and complexity, they used the three dimensions of munificence, *uncertainty* and complexity and found that *uncertainty* is the key dimension which determines organizational mortality. While firms can slowly adapt to changes in environmental munificence and complexity, it is rather more difficult to respond quickly to unpredictable changes in the quantity and quality of demand.

Moberg and Koch (1975, pg. 115) observe that such a contingency variable as environmental uncertainty has been operationalized in many different ways: Dill (1958) uses "homogeneous-heterogeneous", Thompson (1967) uses "stable-shifting" and Lawrence and Lorsch (1969) use "clarity of environment related information", "degree of certainty of cause-effect relationships" and "time span of definitive feedback."

6.2.2.1.8 Rates of Environmental Change

> *"Perhaps the **most ubiquitous force** leading to structural change is a change in the **long-run industry growth rate**. Industry growth is a **key variable** in determining the intensity of rivalry in the industry."*[817]

Various researchers in fields ranging from economics to sociology – specifically, strategy (Porter, 1980; Levinthal and Myatt, 1995) and organizational theory (Burns and Stalker, 1961; Chandler, 1962; Lawrence and Lorsch, 1967a) – have argued that the rates of change of the environment impact the development of organizations. These have typically been applied to technological and market changes.

> *"Perhaps the **most basic attribute** of the markets and customers served that will impact the development of the firm's capabilities is their **growth rate**. Is the firm serving customers and markets segments that are **growing rapidly** and thereby can provide a rich experience base for the firm? Similarly, consider the co-evolution of a firm's capabilities when the **industry is in decline**. As markets shrink, so does reinvestment in equipment. This yields a vintage effect on the firm's production capabilities."*[818]

Researchers (e.g. Levinthal and Myatt, 1994) have posited the beneficial effects of positive feedback in the generation of capabilities, and thus identify the underlying growth rate of markets as a driver of success. It is interesting to note that this point of view is valid for modular enterprise architectures as "market makers" in growing markets, while it is also valid for integral enterprise architectures as "market takers" who grow by taking market share off incumbents and therefore build capabilities, even when underlying growth rates of markets are low.

6.2.2.1.8.1 *Supply* change

6.2.2.1.8.1.1 *Quality* of supply (Technology)

Lawrence and Lorsch (1967a, pg. 19) focus on the rates of *technological* change in both products and processes.

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[816] The industries were the US cement industry (1888-1980) and the minicomputer industry (1958-1982).
[817] Porter, M.E. (1980), pg. 164.
[818] Levinthal, D. and Myatt, J. (1994), pg. 48.

6.2.2.1.8.1.2 *Quantity* of supply

Chandler (1962), as reported in Lawrence and Lorsch (1967a, pg. 197-198), focuses on rates of change in "*technology, markets,* and *sources of supply*".

6.2.2.1.8.2 *Demand* change

6.2.2.1.8.2.1 *Quality* of demand

6.2.2.1.8.2.2 *Quantity* of demand (Markets)

Burns and Stalker (1961), as reported in Lawrence and Lorsch (1967a, pg. 187), focus on "rates of change in the *scientific techniques* and *markets*".

6.2.2.2 Theories of Firm Evolution

Scott (1971), Greiner (1972) in Van de Ven, (1992).

6.2.2.3 Open Systems Theory

> *"The environment sets conditions that help shape the organization **even as** the organization shapes and influences its environment."*[819]

One of the most fundamental theoretical assumptions used is that of firms as *open systems*. A considerable amount of open systems theories have proliferated, some of the most noteworthy include: structural contingency theory (Burns and Stalker, 1961; Woodward, 1965; Thompson, 1967; Lawrence and Lorsch, 1967), institutional theory (Selznick, 1957), population ecology (Hannan and Freeman, 1984), economic theories of organizations (e.g. transaction cost economics), resource dependence theory, and network theory.[820]

> *"There is no one best way to organize…any way of organizing is not equally effective."*[821]

Heuristic 3a:
The enterprise performance is contingent upon: the environment's evolutionary state, the architectural form (i.e. its effectiveness), and the structural dynamics (i.e. its efficiency).

Contingency theorists Lawrence and Lorsch (1967), highlight the opposing forces of *differentiation* and *integration*. Other organization theorists (Scott, 2002) introduce the notions *rational* and *natural* systems. The rational (differentiation) perspective sees conflict as something unhealthy to be resolved, while the natural (integration) sees conflict as part of the healthy negotiation process of attaining consensus. These support the following propositions:

Heuristic 3b:
The *modular* enterprise architecture is based primarily on *differentiation* and *rational optimization*. The *integral* enterprise architecture is based primarily on *integration* and *natural compromise*[822].

6.2.2.4 Structural Contingency Theory

Structural contingency theory has been an important mode of explanation of firm effectiveness or performance in the organizational theory literature using *context-structure-performance* relationships.

One of the important contributions of structural contingency theory is the notion of "fitness" of an organization with its environment. Not only does Van de Ven (1979) enumerate four different conceptual definitions of "fit, he also (Drazin and Van de Ven, 1985), considers three different notions of "fitness".

[819] Lawrence and Dyer (1983), pg. 295.
[820] As noted in Smelsner and Swedborg (1994), pg. 537.
[821] Galbraith, J. (1973).
[822] Simon referred to cognitive global suboptimization as "satisficing".

> *"Recently a **systems** approach to contingency theory has emerged. Advocates of this approach assert that the understanding of **context-structure performance** relationships can only advance by addressing simultaneously the many contingencies, structural alternatives and performance criteria that must be considered **holistically** to understand organization design."*[823]

6.2.2.5 Population (Organizational) Ecology

Within the field of sociology, population ecology explores the evolution (i.e. the birth, growth and death rates) of populations of firms.

> *"Organizational **ecology,** unlike strategic management or industrial organization economics, **models competition as an explicitly dynamic phenomenon**. Ecologists see **competition and environmental characteristics** as having an **interactive effect** on the success of a given **strategic approach**."*[824]

Boeker (1991) notes that strategic management researchers have classified *strategy* typologies/taxonomies in much the same was as organizational ecology researchers have classified *organizational forms* typologies/taxonomies.

6.2.2.5.1 Variation, Selection, Retention

Natural selection works best in a static population, and is disguised by rapid growth of the population.[825]

6.2.2.5.2 Structural Inertia

Hannan and Freeman (1977 & 1984).

6.2.2.5.3 Co-Evolutionary Dynamics

Recently, a proliferation of research on the co-evolution of firm and environment has come out of the "Rotterdam school" Volberda and Lewin (2003).

6.2.2.6 Structuration

An enterprise architecture is a socially-enacted structure which simultaneously and recursively enables and constrains, but does not determine human action. This duality of structure is called "structuration" by its proponents (Giddens, 1979; Whittington, 1992; Yates, 1997).

> *"Giddens resists post-modernist pessimism as to the possibility of **humanly engineered progress**. Nevertheless, he concedes that control within an organization is unlikely to be complete."*[826]

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[823] Drazin and Van de Ven (1985), pg. 519.
[824] Boeker, W. (1991), pg. 614.
[825] *The Economist*, December 24th 2005, pg. 12 of "A Survey of Human Evolution".
[826] Whittington, R. (1992), pp. 695.

6.2.3 Technology and Innovation *Theories*

6.2.3.1 *Product* Life Cycle

> *"**Organisms** are depicted as proceeding through distinct cycles in their life as they age (Bonner, 1993, pp. 15-35). Can the same be said for **industries**? Is it meaningful to talk, as has been done, about a **product** life cycle that captures the way many industries evolve? If so, what are the characteristics of this life cycle?"*[827]

Product life cycles were postulated more than fifty years ago by a variety of authors including Dean (1950), Levitt (1965), Vernon (1966), Cox (1967) as a means for firms to exploit deterministic continuity of industrial evolution to their advantage.

6.2.3.2 *Industry* Life Cycle

The industry life-cycle gained acceptance in strategic management as a dominant model for analyzing the external environment as a dynamic extension of Porter's (1980) five forces model.[828] Both were derived from the Structure-Conduct-Performance (SCP) paradigm of the Industrial Organization (IO) economics tradition.

6.2.3.3 Technological Discontinuities

> [Technological discontinuities] "*…command a decisive **cost or quality advantage** that strike not at the **margins** of the profits and the outputs of existing firms, but at their **foundations** and their very lives."*[829]

Like Schumpeter before them, researchers Tushman and Anderson focused on the technological aspects of the organization's environment as a key determinant of environmental change. They authored two influential papers (briefly discussed below) which define *technological discontinuities* and their relationship to the other key punctuating event in the evolution of a technology, the *dominant design*.

> *"**Discontinuities** predictably affect environmental **uncertainty, munificence**, and **organizational growth rates**."*[830]

Tushman and Anderson (1986) noted that major technological breakthroughs or "discontinuities" increase both environmental uncertainty and munificence. They noted that such discontinuities can both enhance and destroy firm competence, with new firms (challengers) typically initiating competence-destroying discontinuities which have increased environmental turbulence (or uncertainty) and existing firms (incumbents) typically initiating competence-enhancing "discontinuities" which have decreased environmental turbulence (or uncertainty).

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[827] Klepper, S. (1997), pg. 145.
[828] Farjoun, M. (2002), pp. 565.
[829] Schumpeter, J. (1942), pg. 84.
[830] Anderson, P. and Tushman, M.L. (1990), pg. 606.

More recently, Anderson and Tushman (1990) further clarify, refine, develop and extend their concepts of technological discontinuities, particularly with vis à vis dominant designs, in their cyclical model of technological change.

> *"**Technological discontinuities** (innovations that dramatically advance an industry's price vs. performance frontier) trigger a period of ferment that is **closed by the emergence of a dominant design**. A period of incremental technical change then follows, which is, in turn, broken by the next technological discontinuity."*[831]

Furthermore, they began to quantify further relationships, namely:

> *"**Sales always peak after** a dominant design emerges. **Discontinuities never become** dominant designs, and dominant designs **lag behind the industry's technical frontier**."*[832]

From these two complementary pieces of research, one can begin to infer an internally consistent set of propositions represented in Figure 237 below.

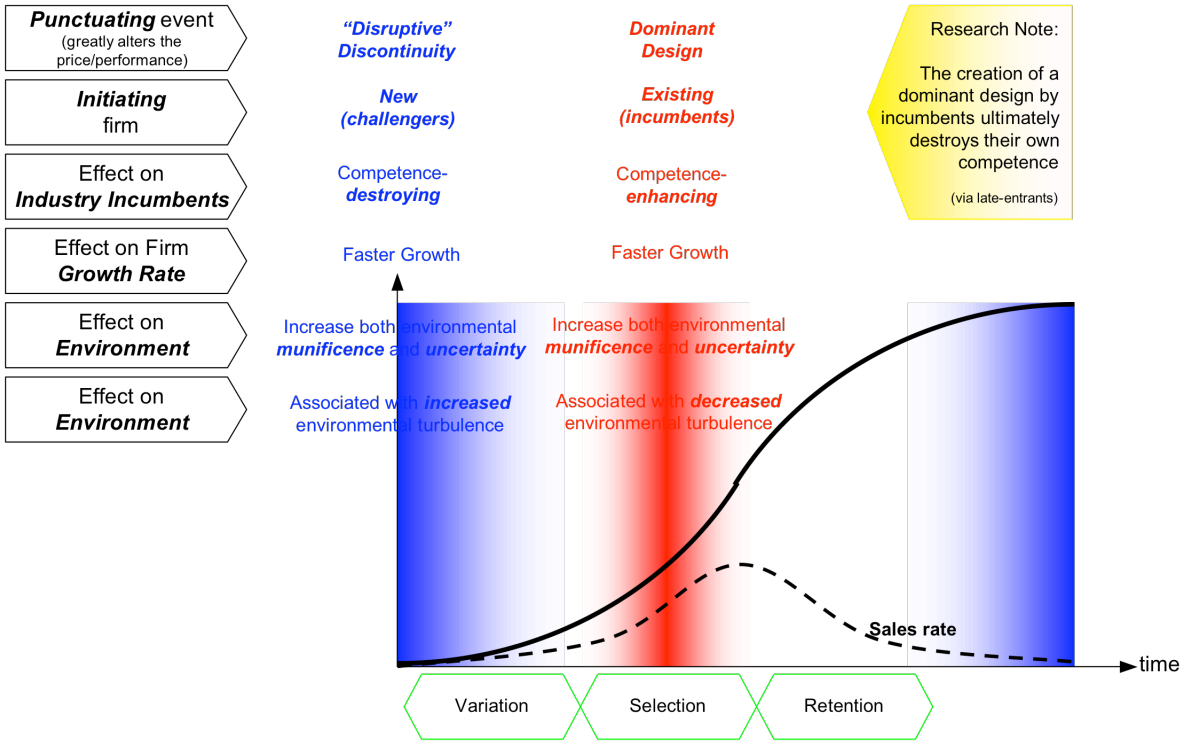

Figure 237: Discontinuities and Dominant Designs

6.2.3.4 Dominant Designs

> *"Linking **technology cycles** and **dominant designs** to **organizational architectures** and competencies is a way to get more deeply to the roots of **dynamic organizational capabilities**. Much exciting theoretical and empirical work remains in coupling dominant designs and technology cycles to environmental conditions and organizational evolution."*[833]

[831] Anderson, P. and Tushman, M.L. (1990), pg. 604.
[832] Anderson, P. and Tushman, M.L. (1990), pg. 604.
[833] Tushman, M. and Murmann (1998).

Abernathy and Utterback (1978), Tushman and Murmann (1998).

6.2.3.5 Disruption

An important endogenous mechanism whereby firm performance feeds back to shape the industrial evolution is the over-serving existing markets and the subsequent creation of disruptive innovations (Christensen and Bower, 1996; Christensen, 1997).

6.3 Industrial Evolution

> *"The desired dynamic characteristics of the management structure depend on the kind of markets, **rate of technological change**, and the other characteristics of the industry. Different organizational forms are seen to favor different classes of products. The management attitudes that work well in one situation falter in another because the **life cycle** of the product is longer or shorter, the ratios of the times needed to develop a product in comparison with the time for putting it into production are different, or the **market is more sensitive** to certain of its characteristics and less sensitive to others."*[834]

The final construct shown in Figure 238, the industry life-cycle (or S-curve)[835] has its theoretical underpinnings in the following literatures: the management of technology (Utterback, 1994), evolutionary economics (Nelson, 1991), organizational ecology (Hannan and Freeman, 1989) and strategic management theory (Porter, 1980).[836] It is used to help describe and understand the longitudinal, evolutionary nature of the forces driving the dynamics of industrial evolution.

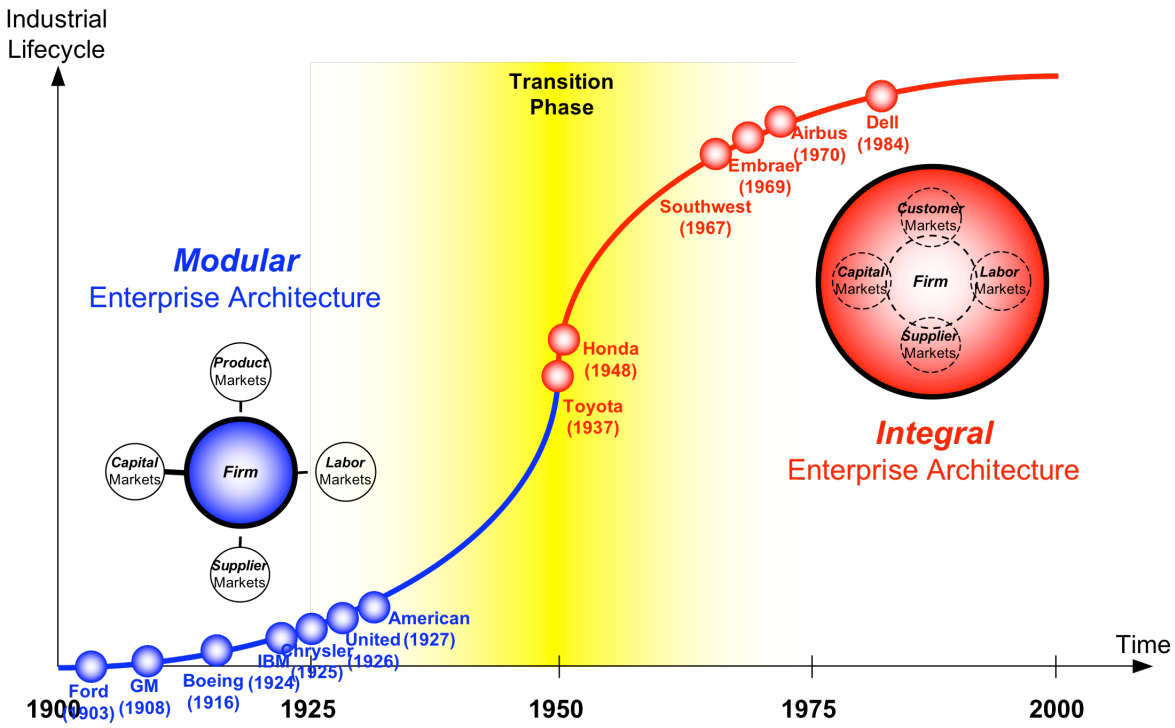

Figure 238: Industrial/Ecosystem *Evolutionary Dynamics*

Lawrence and Lorsch (1967) argued that the amount of uncertainty, and the *rate of change*[837] of an environment impacts the development of the internal structure of the

[834] Forrester, J. (1961), pg. 329.
[835] Also known mathematically as the "logistic" function based on the Lotka-Volterra model.
[836] As described in Agarwal, Sarkar, and Echambadi, R., 2002.
[837] Note that 'rates of change" can refer to the industry *quantitatively* (i.e. amount of industrial output and *qualitatively* (type of industrial output).

organization. From the stylized S-curve of industrial output, it can be seen that rates of change in *quantitative* output increase up to the dominant design, and diminish thereafter. Uncertainty, however in the *qualitative* output (i.e. when will the dominant design emerge, and what will it be? or when will the discontinuity emerge, and what will it be?) decrease up to the dominant design and increase thereafter.

> *"To cope with these various environments, organizations… have differing structural features…including **planning time horizon**."*[838]

While the dynamics of industrial consolidation or shakeout can arise from a number of exogenous sources including technological, regulatory and geographic discontinuities, this research focuses on the traditional Schumpeterian technological discontinuity as the primary driving force behind industrial shakeout.

While the population ecologists have theorized and demonstrated that the success rate of new entrants diminishes as the industry matures along its life-cycle, and the total number of firms diminishes during a "shake-out", this theory suggests a nuanced observation:

Heuristic 3c:
While the success rate of new entrants into a post-dominant design industry may be diminished, it is likely that these new entrants possess the modular enterprise architectures of the incumbents. Those few who survive are likely to have an integral enterprise architecture, which will significantly challenge the incumbent modular architectures. Therefore incumbent inertia, once thought to be a strength in selection, is now a potential weakness.[839]

> *"Rumours of the death of the **old-style big businesses** are greatly exaggerated…big old businesses have **great staying power**."*[840]

> *"Very often the individual companies in an industry are similar. The conspicuous manifestations are those of the industry as a whole rather than those uniquely marking one company. Other industries are characterized by the evident **differences** between the companies, but this is more apt to be in the **earlier parts of the life cycle of an industry.** In the older more mature industries we often find similarity of companies, a rather highly competitive environment, and often a marked degree of industry instability."*[841]

[838] Scott, R. (2002), pg. 89.
[839] It is important to note that due to "survivor bias", the number of integral enterprises born pre-dominant product design is unknown, due to their hypothesized early mortality.
[840] Whittington and Mayer (2000), pg. 49.
[841] Forrester, J. (1961), pp. 340.

6.3.1 *Definitions of States of Industrial Growth*

6.3.1.1 Emerging Industry

6.3.1.2 Maturing Industry

An environment is deemed to be "stable" when neither customers nor competitors substantively alter their aggregate behavior (Gilbert and Strebel, 1988; Miller, 1986, 1988). Ward et al. (1996) equates this to "mature" industries.

> *"By conservative estimates, **10 percent** of the invested capital in industrialized countries is in industries that are suffering a **decline in demand**."*[842]

The interest in maturing industries that are experiencing declining long-term demand is gradually growing and will continue to do so for some time in the future as only a small fraction of invested capital is subjected to this environment today.

6.3.1.2.1 Disintegration of the Investor Stakeholder Group

> *"Agency theory predicts that there will be **greater divergence** between the interests of **managers and shareholders** in **declining industries** than in general."*[843]

Jensen (1986, 1988) noted that agency theory can be used to explain how and why the interests of principals (investors) and agents (managers) diverge more in maturing or declining industries. He argues that the *value*-driven goals of investors can be incompatible as shown in Figure 239 below.

> *"Jensen (1988) suggests that the growth-oriented goals of managers during phases of industry growth are compatible with shareholder goals because the opportunities in the industry simultaneously address shareholder **wealth maximization** and **revenue maximization** (the latter is one of the more important managerial motives). However, in the decline phase of the industry, these goals are incompatible. Managers would still like to enlarge the firm or reduce risk through diversification, whereas shareholders would rather let the firm shrink so that they can reinvest the capital in better opportunities. Hence, managers may be biased in favor of diversification-oriented acquisitions in the decline and mature stages of a business because such acquisitions represent a feasible path toward growth in such environments."*[844]

Chandler (1977) argues for the evolution of investor-management relationships as firms grow and evolve. He notes the transition from *personal* enterprise to *family* capitalism to *financial* capitalism to *managerial* capitalism.[845]

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[842] Anand, J. and Singh, H. (1997), pg. 99. They cite Ghemawat and Nalebuff (1990).
[843] Anand, J. and Singh, H. (1997), pg. 100. They cite agency theorists in Amihud and Lev (1981) and Jensen (1986).
[844] Anand, J. and Singh, H. (1997), pg. 101. They cite agency theorists in Jensen (1988).
[845] As cited in Putterman and Kroszner (1996), pg. 83.

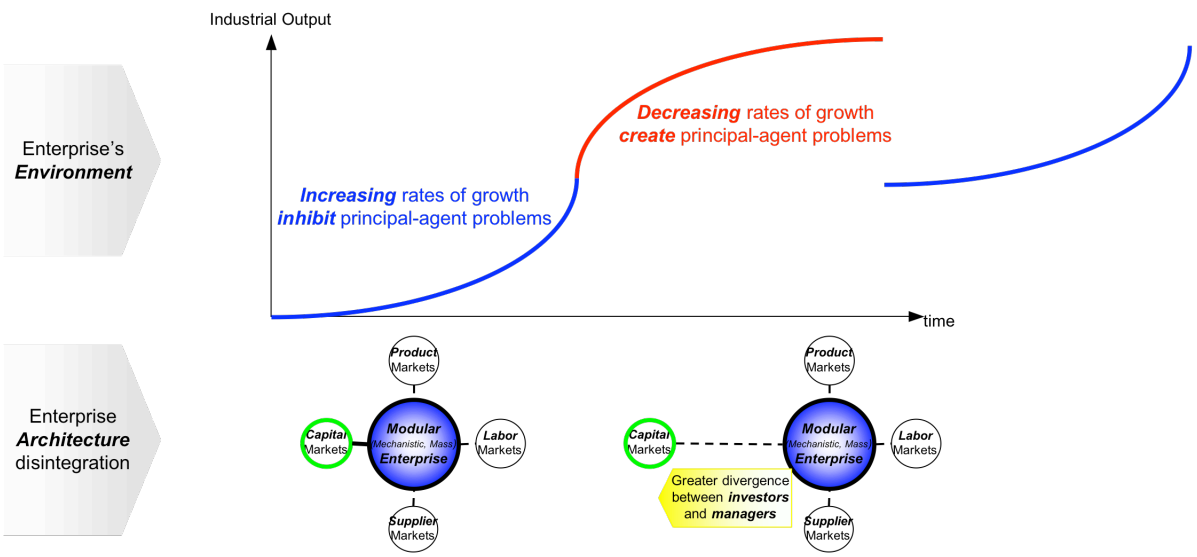


Figure 239: Investor Disintegration in Maturing Industries

6.3.2 *Industry Maturity Assessment Metrics*

Recall that population ecologists have long identified multiple "dimensions" for characterization of the environment (e.g. Aldrich, 1979, pp. 63-74), the most common of which include:

- Environmental *Capacity*
- Environmental *Homogeneity-Heterogeneity*
- Environmental *Stability-Instability*
- Environmental *Concentration-Dispersion*
- Domain *Consensus- Dissensus*
- *Turbulence*

6.3.2.1 Environmental *Capacity*

> *"...those firms that possess more skill and/or luck in anticipating changes in **demand and technology** will be able to earn above average profits (Kirzner, 1973)."*[846]

When characterizing the evolutionary state of the industry, this research will adopt multiple dimensions, in an effort to ensure greater internal validity. Two exogenous variables will be discussed herein: the ecosystem carrying capacities in terms of *quantity* (e.g. demand or population size of consumers) and *quality* (e.g. ability of consumers to absorb technological innovation. The existencs of these exogenous variables, define logistic growth functions or S-curves which define the growth trajectories of the industry life-cycle summarized in Figure 240 below.

More importantly, the rates of change of these two S-curves will be demonstrated to define key dynamics in the evolution of business ecosystems.

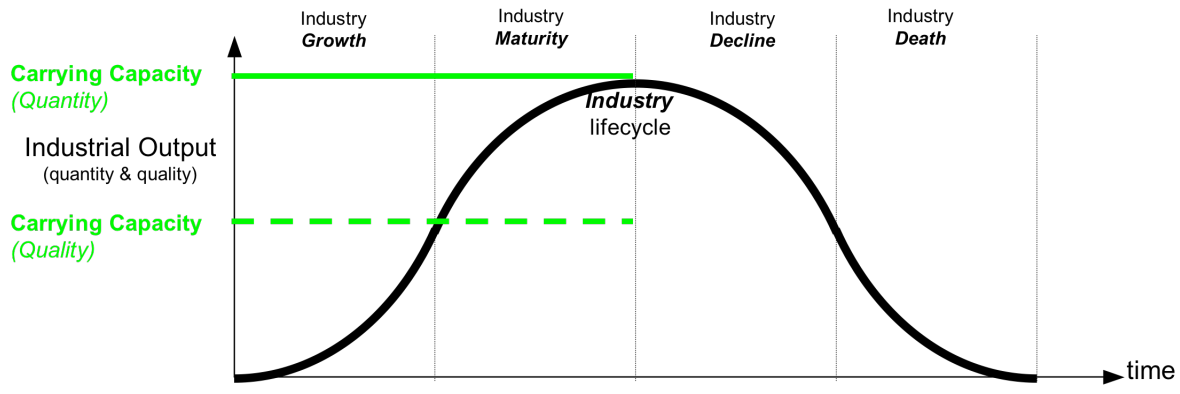


Figure 240: Dual S-Curves (*tight*-coupling assumption)

[846] McWilliams, A. (1993).

The depiction of the above figure may imply that as industries evolve, their quantity and quality grow and mature at identical rates, i.e. that there is tight-coupling between these two environmental variables relating to carrying capacity. However, in order to present a more generalizable framework, one must allow the two sub-dimensions to uncouple as is summarized in Figure 241 below, which is characteristic of mature commodities.

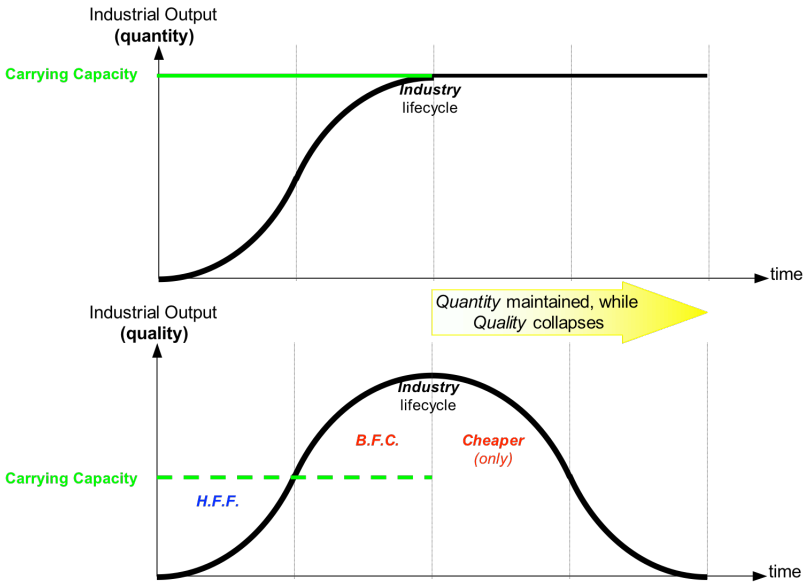


Figure 241: Dual S-Curves (*loose*-coupling) Quality precedes Quantity

Another example of such loose-coupling of the quantity-quality space is illustrated in Figure 242 below, where the quantity diverges before full-exploitation of the quality space, due to say, the invasion of a disruptive new innovation.

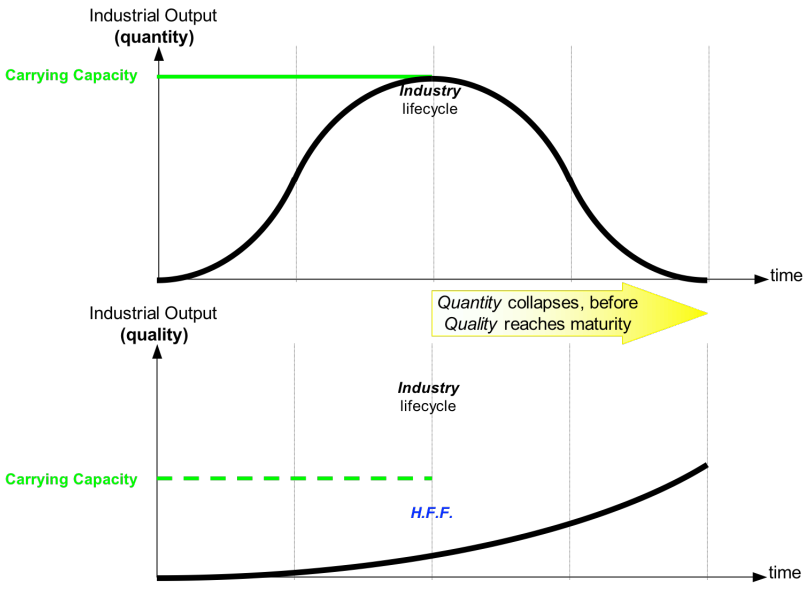


Figure 242: Dual S-Curves (*loose*-coupling) Quantity precedes Quality

6.3.2.1.1 *Quantity* of Output

By way of example from the airline industry, empirical data shown in Figure 243 below shows the state of maturity in quantity space by plotting global available seat kilometers (ASK's) over time.

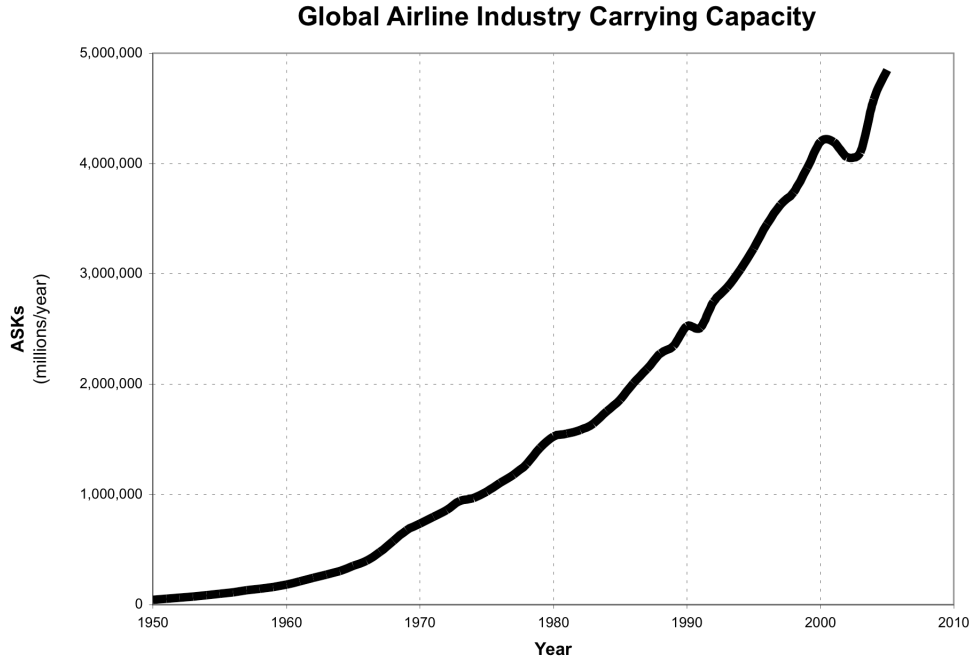


Figure 243: Carrying Capacity of the Global Airline Industry

As can be seen, the carrying capacity is clearly growing, but what is not evident is the rate of change of growth. For this, we need either the first derivative of the underlying growth, or the compound annual growth rate (CAGR) to determine if growth is speeding up or slowing down. Again from Figure 244 below, we can see that the industry is growing but at a decreasing rate, apparently converging toward a long-term growth rate in global GDP.[847]

[847] Note, the significant increase in global ASK CAGR that occurred in the late 1960's is due to the extremely high production of new jet aircraft, relative to the small stock of jets in existence at the time. In other words, the temporary technological emergence of the "jet age."

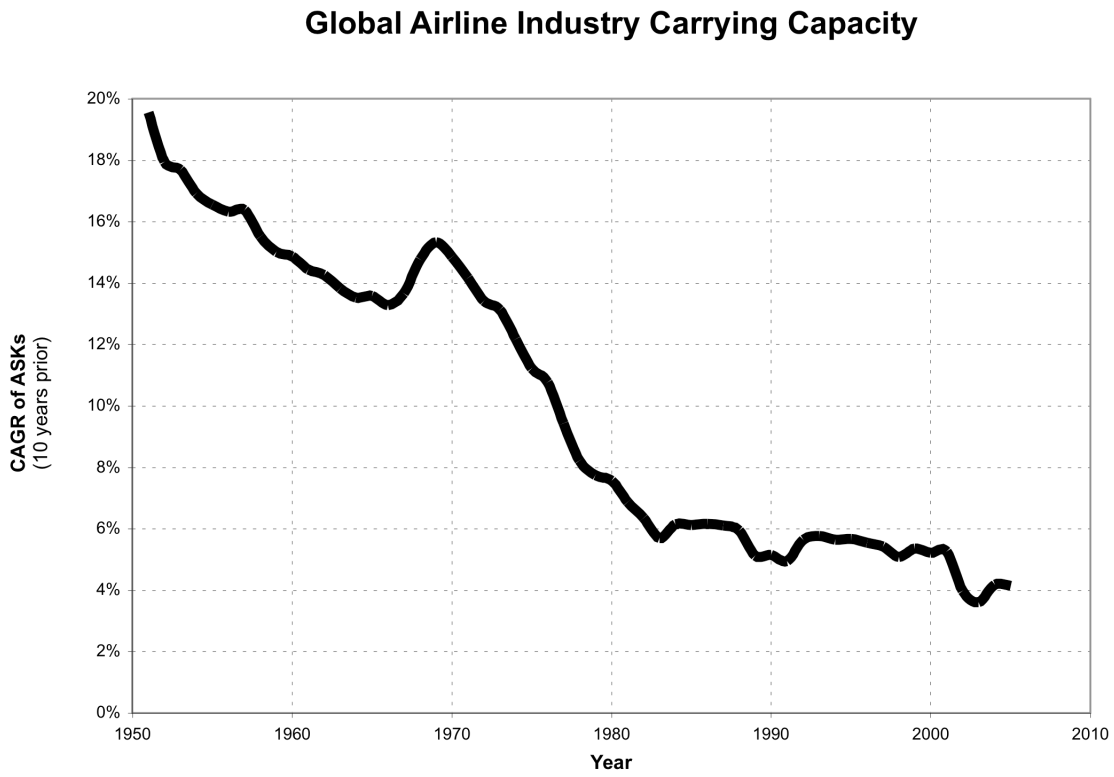


Figure 244: *Rate of Change* of Carrying Capacity of the Global Airline Industry

6.3.2.1.2 *Quality* of Output

Although the quality of output tends to grow as industries evolve, the rate of change of output quality tends to go from fast to slow, which can be modeled as logistic growth.

> *"Sahal (1981, pg. 32) noted that… once a branch of industry is established, the **core technology** on which it was founded **remains largely unchanged**. Modifications that are made tend to be, from a design standpoint, only **incremental, even if thay are highly significant improvements from a cost standpoint**. Sahal cites as examples the farm tractor, **airplane**, and electric motor industries, all of which rely on core technologies introduced over a half century ago. These technologies have undergone a **great deal of cost improvements** since then, but such progress has occurred only through **a gradual refinement of essentially invariant patterns of design**. Moreover, as Kuznets (1930) and others have noted, gradual modifications and improvements in a given basic form of technology can only go so far. **The marginal returns of further innovative advances inevitably decrease as their marginal costs increase**. The development of a technology eventually reaches certain dead ends, with little prospect for further advances in its capability."*[848]

[848] Astley, W. G. (1985), pg. 224.

6.4 Firm *Entry* and *Exit*

From the previous section, growth rates (in both quantity and quality) are deemed to be important in defining the state of the environment. There is also considerable empirical evidcence to suggest that such variables are important in defining firm entry and exit, as well as their inherent birth and death rates.

> *"**Industry profitability** does **not** seem to have any significant effect on **entry and exit**, which are instead positively correlated with **industry growth**."*[849]

[849] Dosi, G., Malerba, F., Marsili, O., Orsenigo, L. (1997), pp. 7-8.

6.5 Evolution of "Landscapes"

Fitness landscapes evolve over time from rugged, multi-peak to smooth, single-peak, and back to rugged, multi-peak. Due to the complex interdependencies associated with integral architectures, these correspond to integral, modular and integral enterprise architectures.

Figure 245 below shows the two-phase equivalent, whereby landscape smoothness is increasing with each time-step in the first phase, and subsequently landscape smoothness is decreasing with each time-step in the second phase.

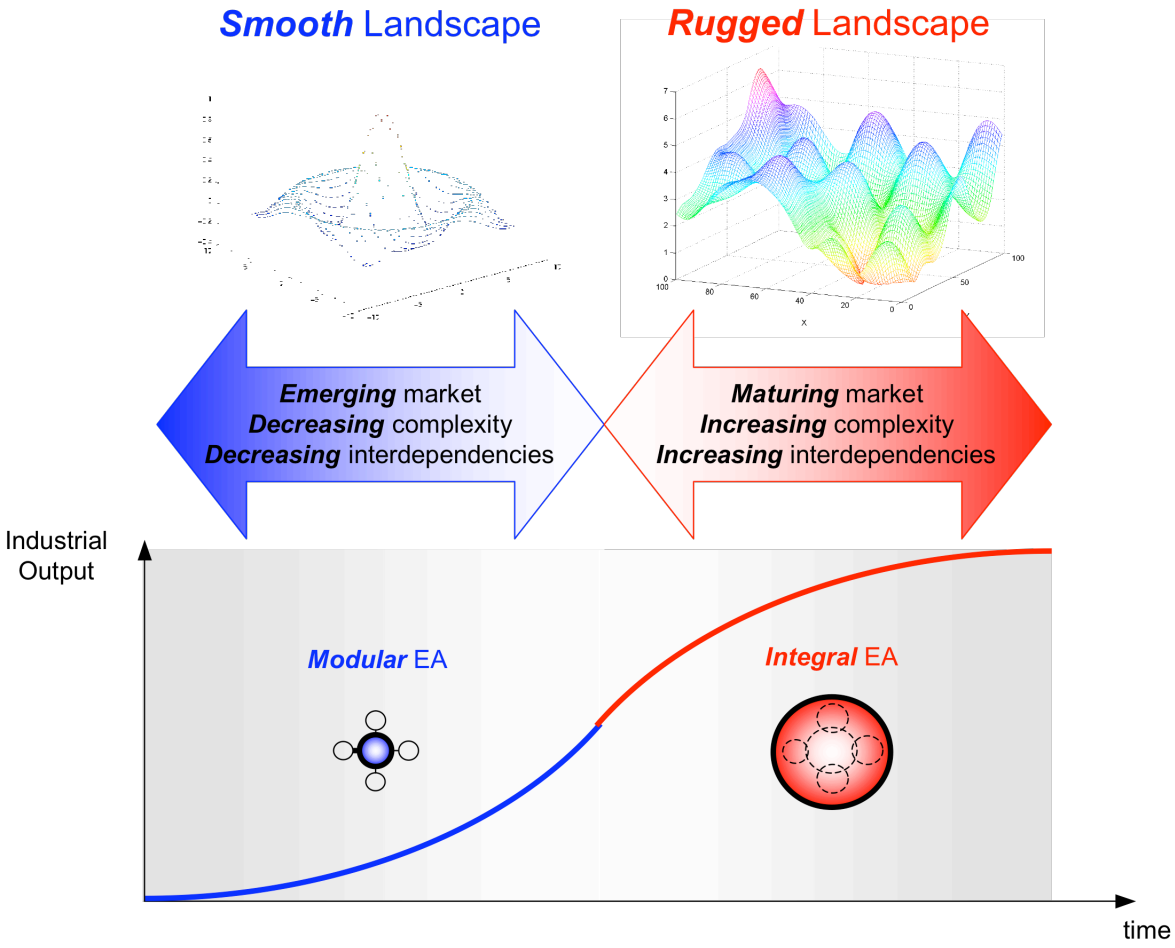


Figure 245: Landscape Evolution

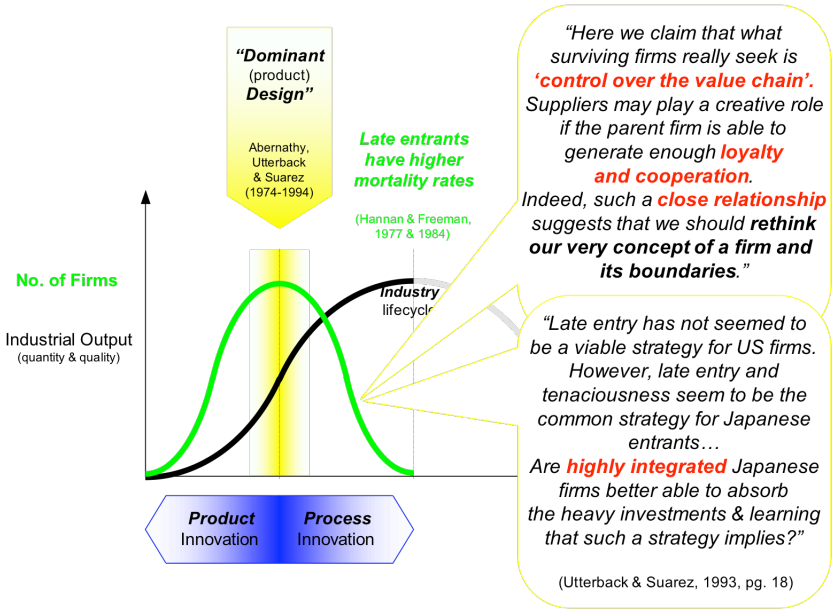
6.6 Evolution of Dominant *Designs* in Enterprise Architectures

The notion of a "dominant design" is well-established in the field of product and technological innovation (Abernathy, 1978; Abernathy and Utterback, 1978), and their effects on both technological and organizational evolution have been noted.

Dominant designs have been demonstrated to end periods of radical change (ferment) and initiate periods of incremental change. Tushman and Murman (1998) observe that dominant designs have been linked by various researchers to: shifts in innovation types, product and firm performance, firm entry and exit rates, organizational fate, shifting industry structures, and industrial and organizational evolution.

What this research aims to discover is that there are dominant designs at the inter-firm organizational level or enterprise level.[850] The definition of the dominant design of enterprise architectures will be discussed within the context of industry and technology cycles. Recent researchers (Sigouris, 2007, pg. 334) have called this "the Piepenbrock Hypothesis."

This research posits that there are "dominant designs" in enterprise architectures which arise at different times and for different reasons. Specifically, it is hypothesized that the modular enterprise architecture is the dominant design when the industry is going through its rapid growth phase, while the integral enterprise architecture is the dominant design when the industry is going through its maturing phase (i.e. when the rates of growth are diminishing over time). As shown in Figure 246, Utterback and Suarez (1993), postulate the existence of a new dominant design in organizations which centers on value chain integration.



[850] The field of Organizational Design has historically tended to focus on "intra-firm" design. This research however focuses on enterprise or "inter-firm" design. Prof. Michael Tushman, specialist in organization design, exclaimed at a June 2005 lecture at the London Business School, "Design died 20 years ago…the last great work on design was Thompson (1967)."

Figure 246: Dominant Designs in Enterprise Architectures

As shown in Figure 247 below, if in addition to simple stable maturity, the industry has a high degree of dynamic complexity, resulting in a higher mode "boom and bust" oscillation, or an overshoot and collapse dynamic, modular enterprise architectures will exhibit even lower long term performance (provided that an integral enterprise architecture exists).

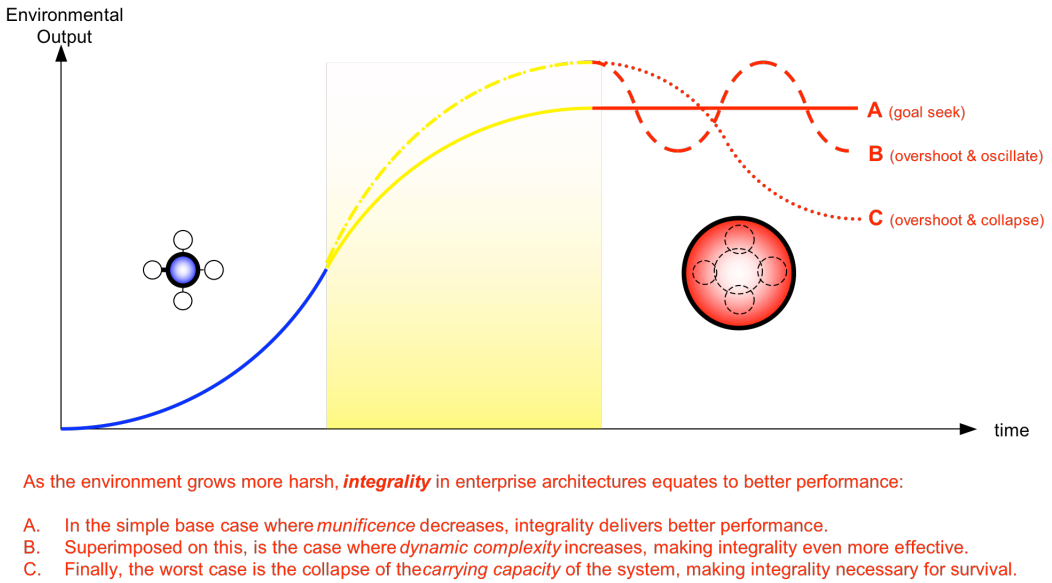


Figure 247: Superposition of Oscillation and Overshoot and Collapse on Maturity

6.7 Evolution of Dominant *Factor of Production*

As can be seen in Figure 248 below, the environment defines the dominant factor of production in the extended enterprise. In the growth phase of the industrial evolution, the capital markets are the dominant factor of production where the focus is on quickly building capacity. Conversely, in the maturity phase, the labor markets are the dominant factor of production, where the focus is on slowly growing capability.

It is important to note that this implies that the firm objective function or "teleological pull" changes, with dramatic implications on enterprise form, structure and behavior.

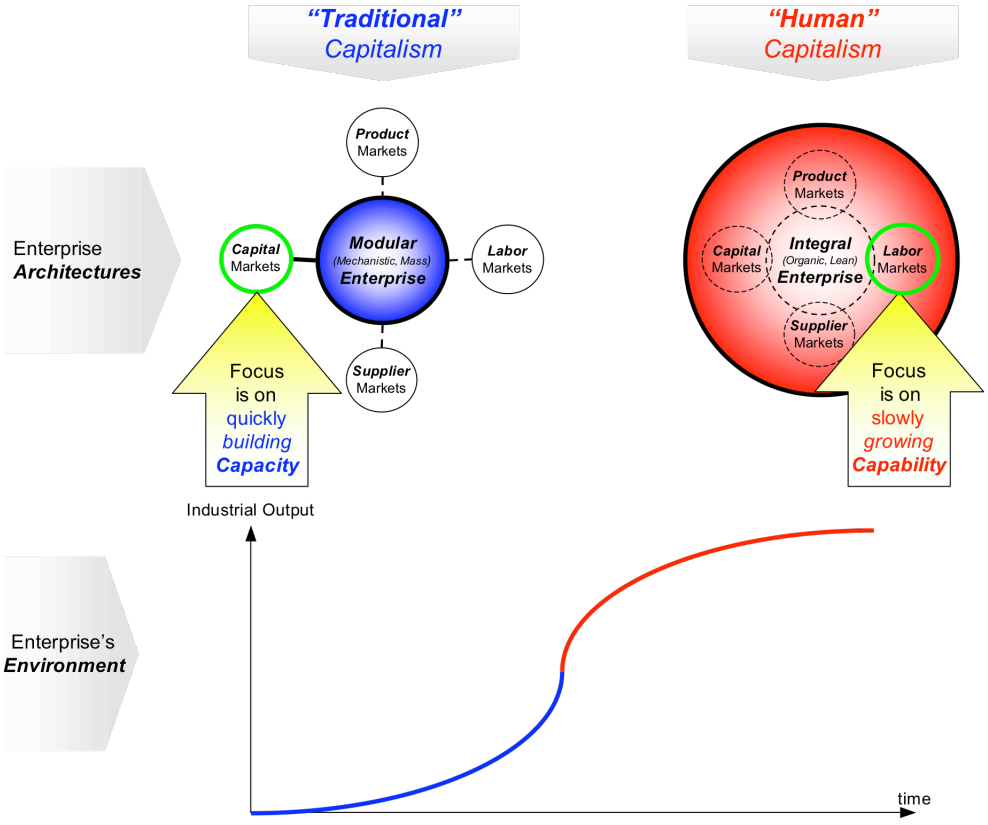


Figure 248: Evolution of Dominant *Factor of Production*

6.7.1 Traditional *capitalism*

> *"This period* [the 1980s] *also corresponded to the growing numbers and power of institutional investors and the declining numbers and power of trade unions.* ***Capital became more important than labor****, whether in the public mind or the productivity equation."*[851]

> *"Practically speaking, the change in climate for American corporate executives started in the mid-1980s, due to an extraordinary wave of hostile take-over bids, in which profitable*

[851] Kanter, R.M. (2005), pg. 94.

*companies, such as Gillette and Disney, were targeted by raiders who thought that these companies could be **even more profitable** in their hands (Ward, 1997). The message to corporate executives was stunningly clear: 'Your days of **satisficing** are over; from now on, you must **maximize**. If you don't we will.' At the same time, institutional investors held larger shares of major companies (Useem, 1996), and these powerful owners exerted more pressure for financial performance."*[852]

6.7.2 Human *capitalism*

*"A growing body of scholarly research shows the relationship between **profitability** and the good treatment of **employees and customers** or between financial success over time and an emphasis on **all stakeholders**."*[853]

[852] Hambrick, D.C. (2005), pg. 106.
[853] Kanter, R.M. (2005), pg. 95.

6.8 Evolution of Dominant *Production* Strategy

Researchers (Poire and Sabel, 1984; Womack, Jones and Roos, 1990) have posited the evolution of dominant production strategies: ranging from *craft* to *mass* to *lean* production. This can be mapped onto the industrial S-curve as shown in Figure 249 below in order to posit that rates of growth enable and constrain certain production technologies.

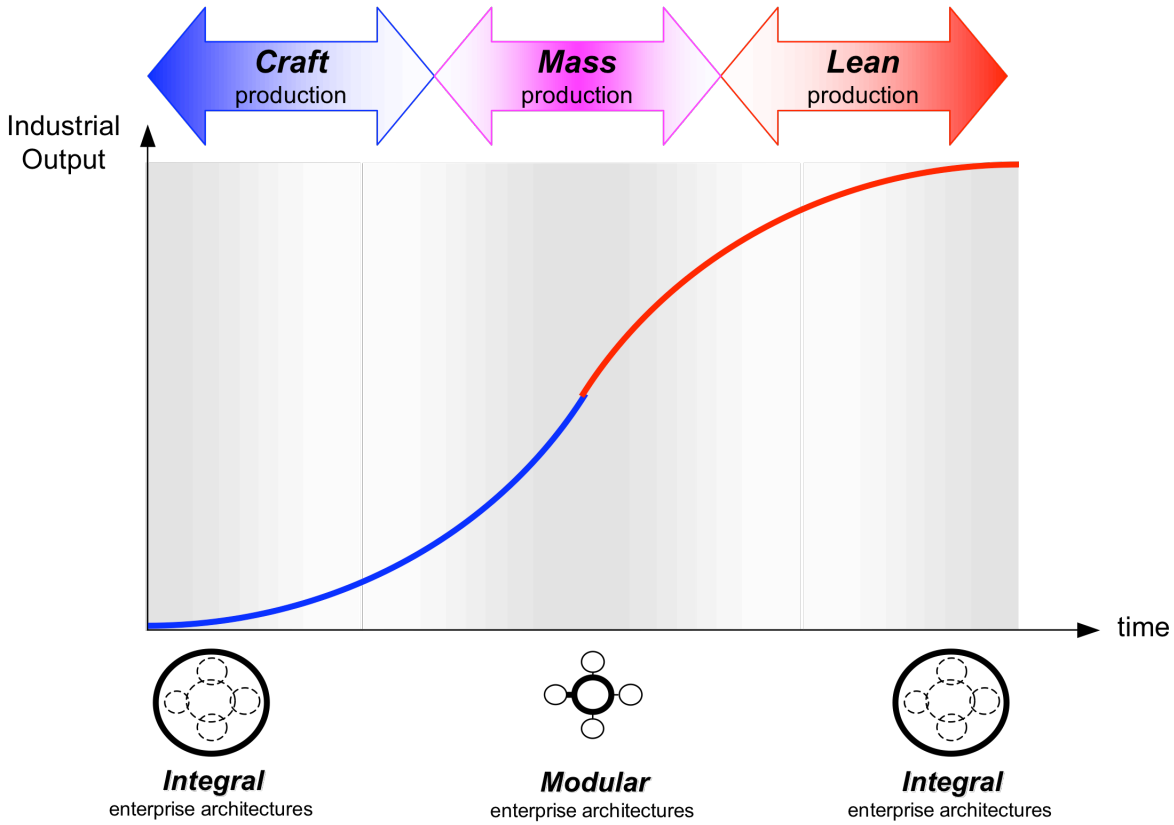


Figure 249: Evolution of Dominant *Production* Strategy

6.8.1 Craft *production*

Here *product* innovation is important which requires experimentation and close collaboration with manufacturing. As innovation is best served by integral organizational structures, one would expect to see integral internal design-produce functions as well as integral enterprise architectures.

6.8.2 Mass *production*

> *"**Mass** production is, in fact, a system ideally suited to the survival of large enterprises in a **highly cyclical** economy. Both workers and suppliers are considered **variable costs**. The problem with the American pattern is that it is **extremely corrosive** to the vital personal relationships at the core of any production process."*[854]

[854] Womack, Jones and Roos (1990), pp. 247-248.

Here rapidly ramping up production capacity in order to access mass markets is important. This requires economies of scale in production, and a clear division of labor internally between the design-produce functions as well as modular enterprise architectures.

6.8.3 Lean *production*

Here process innovation is important which requires experimentation and close collaboration with manufacturing. Like craft production, as innovation is best served by integral organizational structures, one would expect to see integral internal design-produce functions as well as integral enterprise architectures.

6.9 Evolution of *Dominant Designs* & *Product* vs. *Process* Innovation

> *"We argue that the search for a **dynamic theory of strategy** and for a **link between the product-market and resource-based views** may be incomplete without an explanation of **the evolution of the technology** that underlies products and heterogeneous firm capability. The evolution determines what kinds of products (low cost, niche or differentiated) can be offered at each stage of evolution."*[855]

Researchers have demonstrated a life-cycle theory of product and process innovation, with the establishment of a "dominant design" as the catalyst marking the tipping from one regime to the other. This literature has evolved through the following theoretical phases:

- Product-Process evolution (Utterback & Aernathy, 1975)[856]
- Dominant Designs (Abernathy & Utterback, 1978)
- Technological discontinuities & political processes (Tushman & Anderson, 1986)
- Dominant designs on firm entry & exit (Utterback & Suarez, 1993)

Table 19 below summarizes some of the research in this space.

Table 19: Chronological Research in *Dominant Designs*

Year	Citation	Empirical Basis	Notes
1966	Fabris (PhD dissertation)	US Auto.	Empirical basis of product innovationa and demography for much of Abernathy-Utterback research.
1974	Utterback (paper)	--	Presents a model of *product* evolution: performance-maximization, sales-maximization & cost minimization
1975	Abernathy & Townsend (paper)	--	Presents a model of *process* evolution; uncoordinated, segmental, and systemic.
1975	**Utterback & Abernathy** (paper)	5 industries in 120 firms (Myers & Marquis)	**Model of *product* and *process* evolution.** ("Rate of innovation" means number of innovations, not product performance). No mention of "Dominant Design".
1978	Abernathy (*Productivity Dilemma*)	US Auto.	
1978	**Abernathy & Utterback** (paper)	Electric light bulb, auto., airplane	**"Dominant Design" mentioned for the first time.** Examples given: **Model T** in 1908 and **DC-3** in 1935. Three phases identified: Fluid, Transitional & Specific.
1983	Abernathy, Clark & Kantrow (*Industrial Rennaissance*) (pp. 109-118)	US Auto. (see Appendix D)	"Dominant Design" term used, but not explained. "Transilience" used to define competitive effects of technology. "*Revolutionary change with the closed steel body in the mid-1920's... in the 1940s, the dominant design was completed.*"
1985	Abernathy & Clark (paper)	US Auto.	Summary of 1983 book. 1908 Model T → 1913 moving line → 1923 closed steel body → 1965 sports car.
1986	**Tushman & Anderson** (paper)	Minicomputers, Cement, Airlines	Dominant design (e.g. Model T in 1908) creation as a **technological discontinuity** emerging from a **political**

[855] Afuah and Utterback (1997), pg. 184.
[856] Note that product & process innovation was typically measured by *number* of innovations ("transilience") and note level of product or process performance.

			process.
1988	Butler (paper)	747 airplane	
1990	Anderson & Tushman (paper)	Minicomputers, Cement, Glass	
1993	Utterback & Suarez (paper)	Typrwriter, Auto., TV, TV tubes, Transistor, IC, Calculator, Supercomputer	For auto. industry, Fabris data, dominant design in 1923 with peak number of firms.
1994	Utterback (*Dynamics of Innovation*) (pp. 34-37)	Assembled & Non-Assembled	"The (1923) *Dodge* all-steel closed body became the dominant design *for the auto body*..."
1995	Suarez & Utterback (paper)	Typrwriter, Auto., TV, TV tubes, Transistor, IC, Calculator, Supercomputer	Explicit reference to population ecology.
1995	Nelson (paper)	--	Explores "dominant designs" as an outcome of "dynamic increasing returns".
1996	Klepper (paper)	--	Math model that supports the Abernathy-Utterback hypothesis.
1997	Afuah & Utterback (paper)	--	Applies strategy (IO and RBV) theories to dominant designs.
1997	**Klepper** (ICC paper)	US Automotive	Transilience revisited for product and process innovation. **Data show a peak in firm no. in 1908.**
1997	Klepper & Simons (82 page ICC paper)	Autos., Tires, TVs, Penecillin	Generalizes Klepper's 1997 paper to 4 industries.
1998	Christensen, Suarez & Utterback (paper)	Rigid Disc Drive	
1998	**Mazzucato** (paper)	US Auto.	**Their data show a peak in firm no. in 1908.**
1998	Windrum & Birchenhall (paper)	--	Dominant designs emerge in niche markets.
1999	Mazzucato & Semmler (paper)	US Auto.	Effect on share price volatility
2003	Simmons (paper)	US Auto.	Their data seems to match Mazzucato (1908 peak)
2006	**Murmann & Frenken** (paper)	--	Summarize theory on Dominant Designs and **integrate Architectural/Modularity theory.**

The concept of a "dominant design" is itself fluid and evolving. The following for example summarizes the claims in the automotive industry:

- *Ford* Model T in 1908 (Abernathy & Utterback, 1978)
- *GM's* Automatic transmission in 1940 (Abernathy, Clark & Kantrow, 1983, pg. 115)
- *Dodge* all-steel closed body in 1923 (Utterback & Suarez, 1993)
- *Ford* Model T in 1908 (Klepper & Simons, 1997)[857]

Attempts have been made recently to numerically model the interactions between products and processes (Milling and Strumpfe, 2000), albeit over relatively short time horizions, and not over the evolution of industries.

[857] Klepper and Simons (1997) pg. 448 noted a potential error in Utterback & Suarez's dataset.

6.10 Evolution of Dominant *Product* Strategy (Position)

Miles and Snow's (1978) classic typology identified four different configurations which could theoretically be equally successful in different environments: *defenders, prospectors, analyzers* and *reactors.* Subsequent researchers, however have identified that different environmental conditions produce different successful configuration types. Hambrick (1983a) for example found that *defenders* consistently outperformed *prospectors* on profitability and cash flow metrics in all markets, while *prospectors* performed better than *defenders* in market share change in markets with high product innovation.

Researchers Kim and Lim (1988) found that high-performing differentiators and high-performing cost-leaders were more likely to compete in different environments. More explicitly, Miller (1988) found that successful firms pursuing a strategy of differentiation were more likely to compete in unstable environments, while successful firms pursuing a strategy of cost-leadership were more likely to compete in stable environments.

As shown in Figure 250 below, this research finding, coupled with the proposition that enterprise architectures are built to excel at different tasks, helps to explain how firms having different enterprise architectures will fare in different environmental settings.

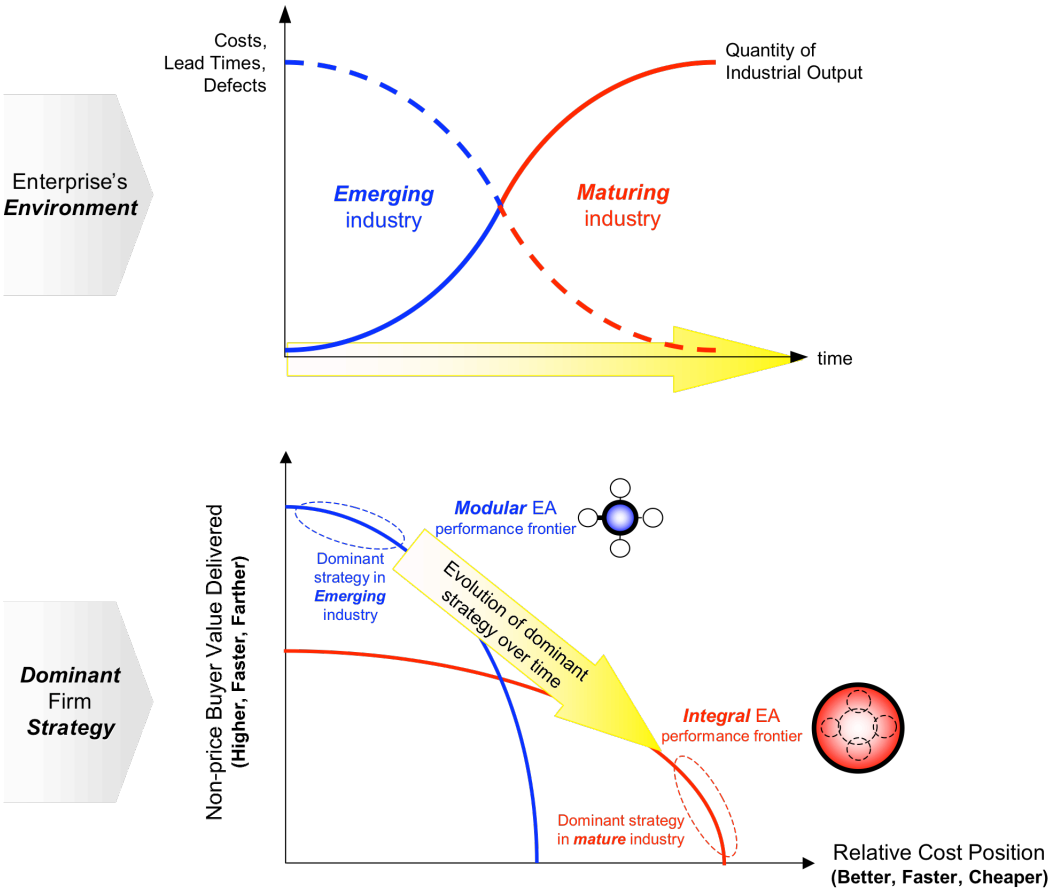


Figure 250: Evolution of Dominant *Product* Strategy

6.10.1 Differentiated *(Higher, Faster, Farther)*

6.10.2 Cost Leadership *(Better, Faster, Cheaper)*

6.11 Evolution of Dominant *Economic Offering*

Once a competitive landscape matures, often another is born. Typically, these can take the form of either complements or substitutes to the original competitive landscape as is shown in Figure 251 below.

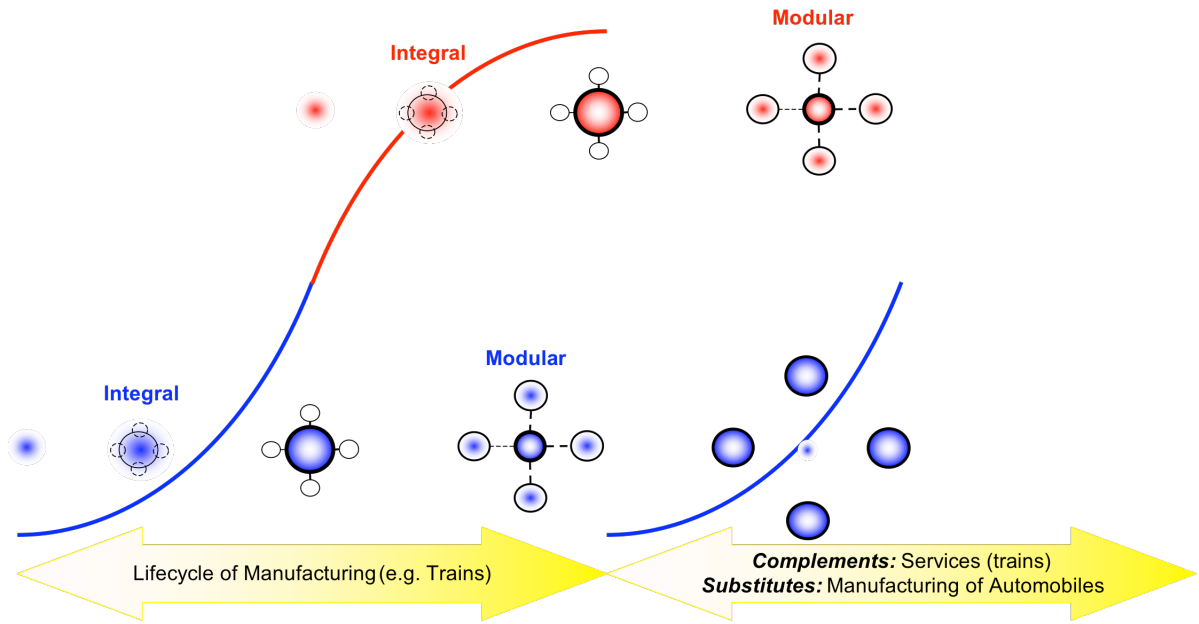


Figure 251: Evolution of *Complements* and *Substitutes*

6.11.1 *Co-Existence of* Complements

Once an S-curve has begun to end, and an existing industry is beginning to decline, a new growth opportunity exists in the form of complementary products or services. For example, going from agriculture to manufacturing; or going from manufacturing to services, etc.

6.11.2 *Co-Existence of* Substitutes

Once an S-curve has begun to end, and an existing industry is beginning to decline, a new form of competition – substitutes - emerges that does not directly challenge the old (Porter, 1980). Substitutes exist as competition on a higher level of abstraction. For example, when rail travel reached market saturation, it was overtaken by another form of indirect competition, automobiles.

6.12 Evolution of Dominant *Strategic Management Theories*

This framework posits that the dominant theories in strategic management literature would reflect the state of evolution of most major industries of the time.

6.12.1 *External SCP*

This framework posits that as the majority of industries in the dominant region where strategic management research was being undertaken – i.e. the US – was experiencing a boom of mass production from the 1920's to the 1960's the strategic management literature reflected this industrial phenomenon. As such exogenous industry structural variables would seem particularly relevant. The Industrial Organization school (Mason,1939; Bain, 1959) reflected this external view of structural variables.

6.12.2 *Internal RBV*

Additionally, this framework posits that as the majority of industries in the dominant region where strategic management research was being undertaken – i.e. the US – was experiencing a saturation of the mass production markets from 1960's onwards, the strategic management literature reflected this industrial phenomenon.

As the focus was then on growth in firms and/or industries experiencing limited rates of growth, productivity would then be more important. Economies of scope would replace economies of scale in such industries. Learning and the internal capabilities of the firm would begin to dominate the external strategy schools. The Resource-Based View which initially began with Penrose in 1959 was largely ignored until the mid-1980's (Wernerfelt, 1984).

> *"The question I wanted to answer was whether there was something inherent in the very nature of the firm that both **promoted its growth** and necessarily **limited its rate of growth**."*[858]

From Penrose's most fundamental question, one can infer that she was studying a firm that while growing, its rate of growth was slowing down. In graphical terms, this is a firm in the later stages of its "S-curve".

If a firm's rate of growth is in some way limited by the carrying capacity of the firm's environment, then one might posit that Penrose was studying a firm in the later, maturing stages of its development. It turns out that Penrose's classic 1959 book was based on the study of one firm, The Hercules Powder Company, a commodity materials company, which in 1959 could be demonstrated to be in the maturing stages of its industry.

This posited evolution of strategic management theoretical focus may have mapped approximately to the evolution of major US industries as shown in Figure 252 below.

[858] Penrose, E. (1959).

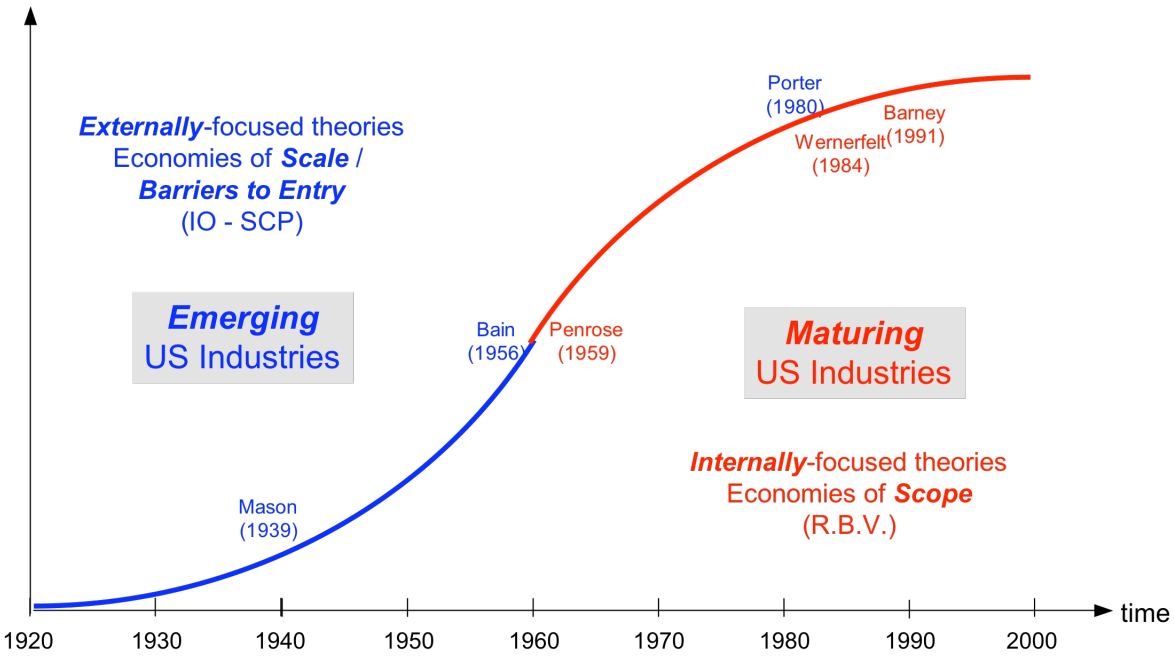


Figure 252: Evolution of *Strategic Management Theories*

6.13 Evolution of Dominant *Levels of Cognitive Inertia*

As was discussed in essay #2, each form of enterprise architecture is driven by a different level of managerial cognitive inertia. As shown in
Figure 253 below, it is posited that the state of environmental evolution – i.e. the rate of environmental change – drives the dominant level of cognitive inertia. Specifically, when the environment is speeding up, managers must think and act quickly, that is they must have low cognitive inertia. Conversely, when the environment is slowing down, managers must think and act more slowly, that is they must have higher levels of cognitive inertia.

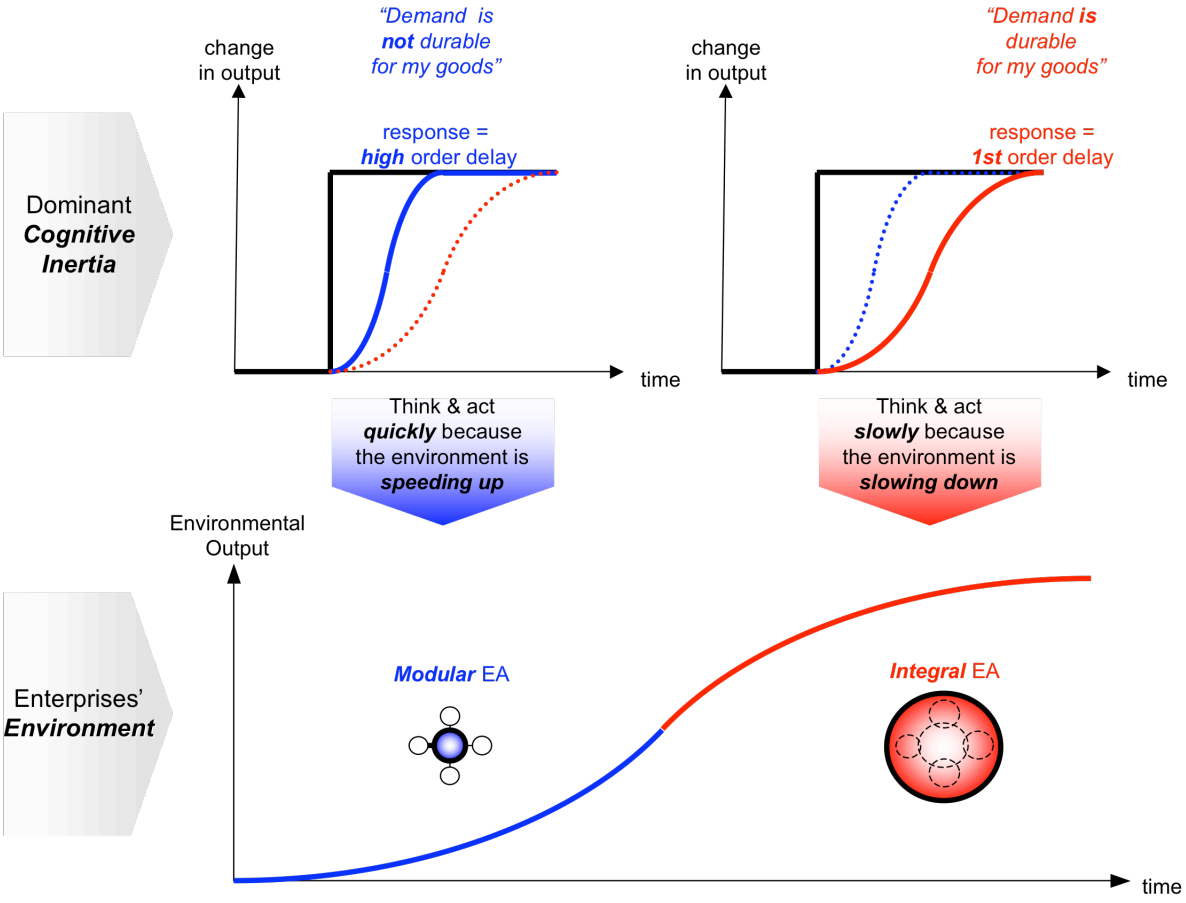


Figure 253: Evolution of Dominant *Levels of Cognitive Inertia*

6.13.1 Hare *mentality*

6.13.2 Tortoise *mentality*

6.14 Evolution of Dominant *Growth* Strategy

6.14.1 *Growth Strategies*

6.14.1.1 *Inorganic* Growth (mergers & acquisitions)

6.14.1.1.1 Diversification objective

6.14.1.1.2 Consolidation objective

6.14.1.2 *Organic* Growth

6.14.1.2.1 Diversification objective

Toyota's current market dominance in the automotive industry comes after a successful (organic) diversification from another manufacturing sector, textiles (Sako, 2006, pg. 94).

6.14.2 *Market Environments*

> *"Jensen (1988) suggests that the growth-oriented goals of managers during **phases of industry growth** are compatible with shareholder goals because the opportunities in the industry simultaneously addres shareholder wealth maximization and revenue maximization (the latter is one of the more important managerial motives). However, in the **decline phase** of the industry, these goals are not compatible. Managers would still like to enlarge the firm or reduce risk through diversification, whereas shareholders would rather let the firm shrink so that they can reinvest the capital in better opportunities. Hence, managers may be biased in favor of diversification-oriented acquisitions in the decline and mature stages of a business because such acquisitions represent a feasible path toward growth in such environments."*[859]

6.14.2.1 *Emerging* markets

6.14.2.2 *Maturing* markets

> *"Our results indicate that **consolidation**-oriented acquisitions **outperform** **diversification**-oriented acquisitions in the **decline** phase of their industries in terms of both ex ante (stock market based) and ex post (operating) performance measures."*[860]

When facing a maturing or declining market, a firm and its enterprise is faced with a dilemma: should it stay (and *fight*), or should it exit (and *take flight*) towards an existing market with higher rates of growth and more favorable competitive dynamics, or even create a new market. This decision is particularly problematic if a clear integral competitor has begun to grow.

Different enterprise architectures will face this maturing market in different ways. The modular enterprise (which is built for rapid short-term growth), is faced with the dilemma: is

[859] Anand, J. and Singh, H. (1997), pg. 101.
[860] Anand, J. and Singh, H. (1997), pg. 99.

it easier to change oneself (i.e. re-architect the enterprise architecture towards more integrality) or to change the environment (i.e. create the next discontinuity)?

If the modular enterprise architecture remains in tact with its demands for high short-term growth rates from the investor stakeholder group, it often grows inorganically via mergers and acquisitions.[861] As was discussed earlier, agency theory predicts the further "disintegration" of the relationship between shareholders and managers (principals and agents). The question then becomes, if growth is to come via acquisition, should one have a strategy of consolidation or diversification? Consolidation can be thought of as being a proxy for "fighting" (i.e. staying, maintaining focus on existing markets, attempting re-architecture with stakeholders to enable long-term focus on cost and productivity, etc.). Diversification can be thought of as being a proxy for "taking flight" (i.e. maintaining the modular architecture and exiting a low-growth environment).

As a mature or declining market will tend to have overcapacity, it is necessary for the industry to extract some competitors. The natural inclination of the ecosystem is to consolidate (as verified by data from population ecologists who have noted the number of firms fall after the emergence of a dominant design). One would therefore postulate that modular architectures that "go with the forces of the ecosystem" and acquire for consolidation in a maturing industry would perform better than those who do not or even who try to diversify out. In fact, one would expect that firms attempting to grow via consolidation acquisitions while the industry is pre-dominant design, while the number of firms entering the industry is still growing would perform worse than those that do not or that diversify in the hopes of securing what will ultimately be the dominant design.

> *"Although firms in declining industries may **not have good prospects** within their own industry, they cannot enhance their value by diversifying to **escape** the unattractiveness of their own industry."*[862]

These propositions can be summarized as follows and as shown in Figure 254 below.

Heuristic 3d:
In *growing* industries, modular firms that grow via *diversification* acquisitions will perform better than firms who do not, or firms who grow via consolidation acquisitions.

[861] The strategic management literature on the value/performance of acquisitions is rich, led by Rumelt (1974).
[862] Anand, J. and Singh, H. (1997), pg. 113.

Heuristic 3e:
In *maturing/declining* industries, modular firms that grow via *consolidation* acquisitions (i.e. who stay and fight) will perform better than firms who do not, or firms who grow via diversification acquisitions (i.e. who take flight).

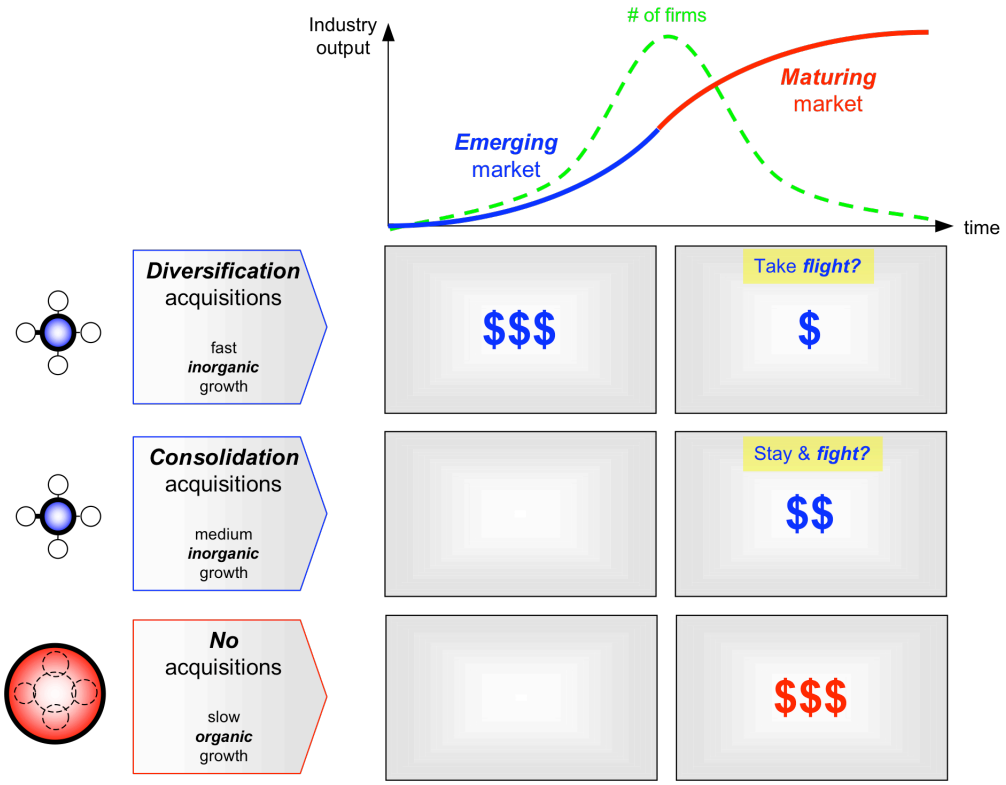


Figure 254: *Diversification* and *Consolidation* Strategies and the Industrial Evolution

Recent and rare empirical research on strategies in declining industries by Anand and Singh (1997) indicate that for industries in the US defense sector between 1981-1992, the above propositions appear to be valid.[863]

In a twenty year study of acquisition policies in a representative declining industry - the US defense sector between 1978-1996 – Anand and Singh (1997) noted that consolidation oriented acquisitions outperformed diversification oriented acquisitions, both in terms of *ex ante* stock market valuations and *ex post* operating performance metrics.

This lends some credence to the "fight" stance in the question of "fight or flight" strategies of incumbent modular architectures that find themselves in harsh environments for which they are not suited.[864]

[863] It is interesting to note their "inverted" findings: namely *given* that a firm wants to consolidate, it will be more successful doing so in a mature/declining industry; while *given* that a firm wants to diversify, it will also be more successful in a mature/declining industry, but consolidating will be even more successful in a mature/declining industry.
[864] Hambrick and Schecter (1983) highlight similar findings for "mature industrial-product business units".

6.15 Evolution of Dominant *Intra*-firm Structure

6.15.1 Mechanistic *vs.* Organic *structure*

Much work in contingency theory deals with intra-firm structures which only have indirect references to a theory of evolution which focuses on *continuity*, as opposed to *discontinuity*.

Burns and Stalker (1961) predicated their version of contingency theory not based on a natural continuous logistic growth model of the technical and commercial environments, but rather on a model of discontinuous change, which for their empirical dataset arose when the *"stable"* environment of World War II supported *mechanistic* organizational structures, was displaced by the *"unstable"* discontinuity of the war ending, producing an *organic* organizational structure.

As a precursor to the much later organization ecologists (e.g. Hannan & Freeman, 1977), Burns & Stalker observed that transition of organizational structures between their ideal types is rather difficult:

> *"The first question is why some concerns – **indeed most of those which took part in the studies – did not change their management system from mechanistic** to **organic** as the general context, technical and commercial, of their operations changed from **relative stability** to **fairly rapid change**."*[865]

In fact, like the entropy proposition generated in this research, in which all enterprise architectures tend toward dis-integration, Burns & Stalker observed a similar trend:

> *"A **mechanistic** system is more economical of the individual's effort. Commitments to the working organization are more prescribed the closer the approximation to mechanistic form. The tendency is for most individuals to **oppose extending such commitments and to try to reduce them**, and thus to **exert pressure towards a mechanistic system**. If conditions are stable, this means that overall economy in human resources may be effected. If conditions are unstable, a mechanistic system becomes extravagant in numbers of persons employed each with his limited commitment to the working organization."*[866]

6.15.2 Functional *vs.* Project *structure*

At approximately the same time, another systems scientist, Jay Forrester made similar claims regarding the difficulty in organizational change from one form to another.

> *"The dynamics of the long-term evolution of management structure are interesting in that most small new companies begin with the **project** form. As they grow, they break into the **functional** subdivision driven by a desire to achieve an apparent gain in effectiveness. This gain may be short-term, lasting but a few years. The functional organization provides a poor training ground for the type of man necessary for project or top-management leadership, so that **the transition back [to project organization] becomes less and less possible** as the organization ceases to regenerate the kind of wide-ranging leaders necessary for perceiving the interactions of all facets of an enterprise."*[867]

[865] Burns, T. and Stalker, M. (1961), pgs. xi and 6.
[866] Burns, T. and Stalker, M. (1961), pg. 210.
[867] Forrester, J.W. (1961), pp. 330-331.

6.16 Evolution of *Ecosystem Entropy* ("The Architect's Dilemma")

> *"A social system left to itself **gravitates toward equilibrium – maximum entropy** so to speak. All efforts to **avoid this death** must aim at **lowering the barriers that impede communication** between the discipline-oriented and the [customer]-oriented wings of the [organization]."*[868]

As shown in Figure 255 below, there appears to be a natural drift toward disintegration of enterprise forms, that is a trajectory from integral to modular forms as it is hard to maintain *centripetal* forces in the face of *centrifugal* forces. This drift towards disintegration marks the process of *creative destruction* (Foster and Kaplan, 2001). This inevitable and steady deterioration of a system is not unlike the concept of entropy.

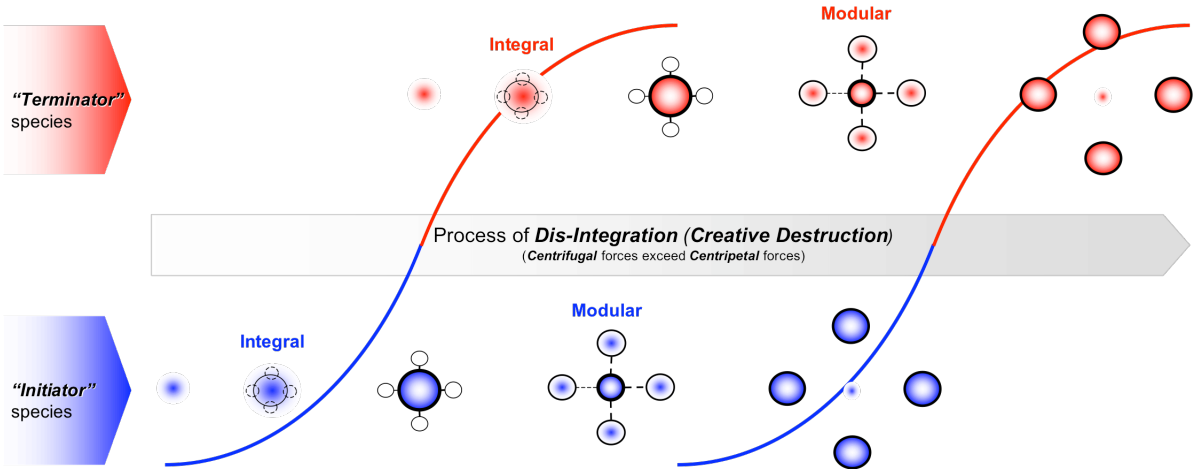


Figure 255: The Evolutionary Trajectories of Architectures

Enterprise architectures are not static, but rather dynamic or more precisely evolutionary constructs. In this sense, the enterprise architecture can be seen as a DNA coding specific to a species. The "species' that grows in *emerging* markets can be thought of as the *initiator* species. It begins with an integral architecture and over time begins to disintegrate, or become more modular.

Through the processes of variation, selection and retention, the environment selects an enterprise form that has the DNA of the species that initiated the industry, but which is now too "efficient" to begin to bring innovation in processes. The environment again selects an integral enterprise form that grows in *maturing* markets and can be thought of as the *terminator* species.

> *"Scope, permeability and **modularity** are the crucial factors for success. By judiciously **adjusting them over time**, a business can remain competitive even as its **industry matures**."*[869]

[868] H. Simon (1967).
[869] From "The Make-or-Buy Question in Mature Industries," Sloan Management Review, Spring 2008, pg. 6. This references Santos, Abrunhosa and Costa (2006).

6.16.1 *Example:* Commercial Airplane *Industry*

The following example shown in Figure 256 below, chronicles the phased trajectories of dis-integration of *Boeing* and *Airbus* in the large commercial airplane industry. Key events or phases are summarized chronologically for each enterprise in the subsections below, with particular attention paid on the effects on the enterprise architectures.

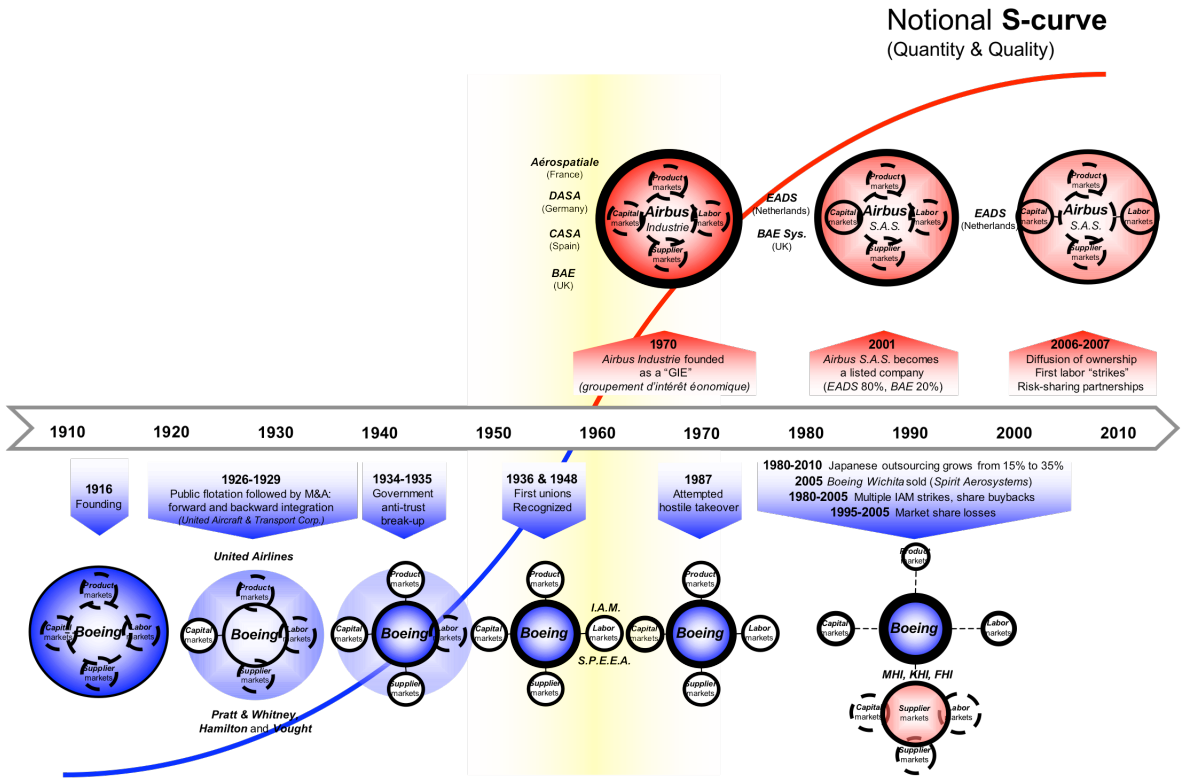


Figure 256: Enterprise *Architectural Disintegration* in the Commercial Airplane Industry

6.16.1.1 *Boeing* (1916): Founding

On July 15, 1916, founder Bill Boeing incorporated the *Pacific Aero Products Company*, which would subsequently be changed to the *Boeing Airplane Company* with the US Navy as *Boeing's* first customer as a result of World War I. As will be discussed in the following subsection, the US government would also be the first customer for *Boeing's* imminent commercial business.

The Navy contract for 50 Model C airplanes, was worth $575,000. Prior to winning its first contract, *Boeing* had invested its own money building and testing a total of seven airplanes.

6.16.1.2 *Boeing* (1925-27): Airplanes/Airlines (forward integration)

Less than a decade after *Boeing* was founded, the U.S. Post Office required a new mail plane, for which *Boeing* built its first commercial airplane, the Models 40 and 40A. Congress subsequently passed the Contract Air Mail Act (a.k.a. the Kelly Act) in 1925, which privatized airmail. That *Boeing's* first commercial customer was the US government would begin a long and symbiotic relationship.

The *Boeing Airplane Company* (BAC) forward-integrated into airlines by establishing a subsidiary, *Boeing Air Transport* (BAT) on February 17, 1927 that purchased *Boeing* 40A airplanes from its BAC parent.

Soon thereafter, *Boeing* purchased a competitor to BAT, named *Pacific Air Transport* (PAT). By the end of 1928, BAT was carrying 30 percent of the US's mail and passenger traffic (Sterling, 1992, pg. 16).

6.16.1.3 *Boeing* (1928): Public Flotation (owner-manager dis-integration)

On November 1, 1928, *Boeing* became listed on the New York Stock Exchange. The capital raised allowed expansion via acquisitions and the formation of a holding company a few months later.

6.16.1.4 *Boeing* (1928-31): *Vertical* Acquisitions (value chain integration)

A holding company, *United Aircraft and Transport Corporation* (UATC) was founded on February 1, 1929 with the merger of engine manufacturer, *Pratt and Whitney* (who themselves had bought out two propeller companies: *Hamilton* and *Standard Steel*), and *Chance Vought*, a manufacturer of naval aircraft.

UATC then went on to acquire *Stearman Aircraft*, which made light biplanes, *Northrop Aircraft*, which made military trainer aircraft, and *Sikorsky*, which made amphibian aircraft.

Between 1929 and 1931, UTAC increased its purchases of airlines, including: *Varney, Stout Airlines,* and *National Air Transport*, combining them into a subsidiary called *United Air Lines, Inc.*

In addition, UATC established the *Boeing School of Aeronautics* to train pilots and mechanics, *Boeing of Canada* to build aircraft, and an aircraft export subsidiary.

6.16.1.5 *Boeing* (1934-35): Government Break-up (value chain dis-integration)

Amidst charges that the high profits of the largest US carriers were an abuse of public funds, the US Congress passed the Air Mail Act (a.k.a. the Black-McKellar Act) On September 28, 1934 which dis-integrated the aviation industry into airplane manufacturers and airlines (Lawrence and Thornton, 2005, pp. 15-16).

6.16.1.6 *Boeing* (1936-48): Labor Unions Established (labor dis-integration)

Boeing recognized its firs union in 1936, the Local Lodge 751 of the International Association of Machinists (IAM).

In 1948, the IAM initiated a strike over seniority rights which lasted 140 days and which also resulted in the creation of a union for engineers, called the Seattle Professional Engineering Employees Assiciation (SPEEA).

Since its first strike in 1948, the IAM has staged six strikes approcimately every ten years over the past 60 years. The strikes occurred at or slightly after the bottom of the ten-year airplane delivery cycle, precisely at the time when labor was in a strong political position, facing large impending production schedules.

6.16.1.7 *Boeing* (1970): Patient Finance (customer integration)

6.16.1.8 *Boeing* (1987): Hostile Takeover Bid (investment horizon shortened)

> *"Throughout the 1980s, the giants of American industry had been cut to shreds by **aggressive** young investment bankers and junk bond merchants of Wall Street who had taken it upon themselves to revitalize what they considered the **tired, struggling dinosaurs** of the country's commercial establishment...'Some Wall Street executives say Boeing's characteristics make it a particularly good candidate for **recapitalization** that could yield a bonanza for shareholders,' reported the Wall Street Journal. To the stockbrokers the argument was simple: Boeing was **sitting on a pile of cash** – about $3 billion – **which it had set aside for developing new planes**."*[870]

In 1987, *Boeing* (like much of corporate America in the mid-1980s) was beginning to feel the pressures of another quality of stakeholder in the capital markets, one optimized in the name of efficiency to very narrow boundaries of stakeholder space and time, an outlier on the spectrum of impatient capital, known generally as the "corporate raider" and in this particular case, as T. Boone Pickens. Having identified a cash reserve on *Boeing's* balance sheet, which - given his assumptions of stakeholder space and time - was logically and rationally computed to be inefficient, Pickens allegedly launched a hostile takeover bid. Instead of responding to this new stakeholder in *Boeing's* enterprise with a narrow and constrained solution space (i.e. focusing exclusively on financial strategies), *Boeing* responded by more degrees of freedom in stakeholder space and time.

> *"*[Washington] *State **lawmakers**, meeting in **emergency** session, **overwhelmingly approved anti-takeover legislation** today to help the Boeing Company fend off unwanted suitors such as T. Boone Pickens…. The legislation* [was] *sought by the aerospace giant, **the state's leading employer**. The majority **brushed aside critics** who called the measure **unconstitutional** and **against free enterprise**. Sponsors called it a **wise** step **to protect the 85,000 Boeing jobs** in the state. '**The company is very, very appreciative**,' said Boeing's **chief lobbyist**, Forrest Coffrey."*[871]

In response to the unfriendly takeover bid, senior managers at *Boeing* co-opted a broad stakeholder group including state and federal government (i.e. political markets) as well as labor markets. Although a modular enterprise architecture exchanges with its environment, it tends to do so in an emergency, short-term, ad-hoc way. An integral enterprise architecture conversely interacts with its relevant environment in a sustained, longer-term and systematic way. Through *Boeing's* "architectural" actions with it's stakeholders, it

[870] Lynn, M. (1997), pp. 184-187.
[871] "State Passes Bill for Boeing," *The New York Times*, August 11, 1987.

chose the *quality* of capital that it wanted in its enterprise, and in the process it defined the goals and objectives of the enterprise. In system dynamics parlance, the system chose *stability* over *growth*, or more precisely *stable* growth over *unstable* growth.

> *"But even without a Pickens bid, the Texan had done them* [Airbus] *a valuable service. The Boeing management was looking nervously over its shoulders before it made a decision, and could only become* ***more cautious*** *and more financially conservative… The takeover scare died, but the challenge from Airbus did not, and Boeing was* ***now in a weaker position*** *from which to fight."*[872]

This non-sustained integration episode would have longer term implications for the future disintegration of *Boeing's* enterprise architecture, as it seeks alternate ways to finance investments for growth (i.e. without having cash sitting idle to attract impatient investors), like "risk-sharing" partnerships with suppliers.[873]

6.16.1.9 *Boeing* (1997): *Horizontal* Acquisition (inorganic growth)

In 1997, *Boeing* merged/acquired one of its long time competitors, *McDonnell Douglas*, and in doing so, brought the large commercial airplane industry down to a global duopoly with *Airbus*.

Unlike the major *vertical* acquisitions of customer (i.e. airline) and supplier (i.e. engine manufacturer) that took place 70 years earlier to create a vertically integrated company with diversified market power in a rapidly growing an uncertain environment, this major *horizontal* acquisition of its competitor was done in a maturing industry, primarily (on the commercial side) for *consolidation* reasons.

The merger could be argued both on the grounds of *consolidation* in a maturing (commercial aircraft) industry, or *diversification* in a growing/changing (defense) industry, as *McDonnell Douglas* had both commercial and defense businesses, for which empirical research demonstrates different success outcomes (Anand and Singh, 1997).

6.16.1.10 *Boeing* (2005): Risk-sharing Partners (value chain dis-integration)

> *"Hearing in June 2005 that Boeing has just announced another 10 million US$2.7bn* ***share buy back scheme*** *does not square with the requirement for major product investment. As the aerospace analyst Scott Hamilton notes, the money Boeing has spent buying back its own stock – more than* ***US$9 billion*** *since December 2000 – could easily have funded an entirely new airplane."*[874]

As shown in Figure 257 below, *Boeing* has begun to outsource more to the supply base in recent years for a number of reasons, not the least of which is the access to investment capital from their suppliers. This has been pursued under the strategy rubric of "large-scale systems integration".

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[872] Lynn, M. (1997), pg. 187.
[873] Note, *Southwest Airlines'* more integral enterprise architecture has by definition a more sustained dialogue with key stakeholders, allowing it to have carry more debt to manage in difficult times (e.g. cyclical downturns). See Hoffer-Gittell (2003), pp. 244-247.
[874] Lawrence and Thornton (2005), pg. 151.

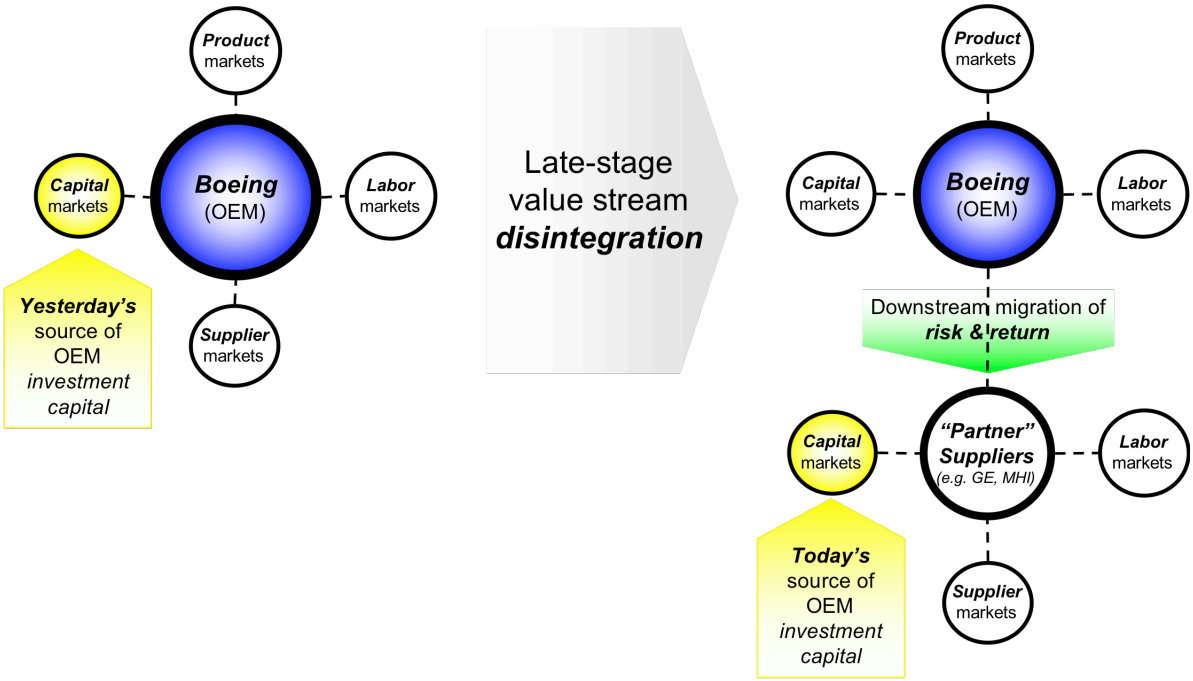

Figure 257: Value Chain Disintegration (for "Risk-Sharing")

> ***"Remember, we're all on the same system. So we understand the design parameters and design specifics on a real-time basis as well with our partners as we do in our own engineering shops. So we are very agile and very quick*** *in terms of being able to go back and put resources on some of that. Other things we're doing, there has been some production process help we've given a couple of suppliers as they're setting up new facilities and needed some* ***boundary-less kind of collaboration*** *between our production people and theirs to move it along a little faster. It's all the kinds of thing we anticipated.* ***It's all the kinds of things that you do when you share a supply chain with people who have a lot of skin in the game with you. But the good news about a lot of skin in the game is we are both incented to get it done. It is not us pointing at them and them pointing at us. It's us getting together..."***[875]

Three years later as *Boeing's* vision for its new supply-chain model was beginning to take shape, comments from suppliers began to reveal how modular this intendedly integral architecture really was:

> *"**As a supplier to the 787 program**, I see a problem that hasn't gotten a lot of press. **The partner model is seriously flawed. In the perfect world, each parner performs their tasks in lockstep with the others - analogous to a rowing team. The reality is that each partner is lashed to its own suppliers in a sort of three legged race against the other partners. The problem is that no one wants to win - everyone wants to come in second to last. Losing, or being the one holding up the schedule, draws international embarrassment, so no one wants to lose. But, completing the assigned task more than a week or so before the slowest partner means holding very expensive ($millions) inventory. This has created a stage for all sorts of theatrics. The partners can see, often more easily than Boeing managers, who is going to be holding up the program (keeping in mind that this race is like the Tour de France, where there are dozens of race segments.) But no partner is going to tell Boeing, 'We aren't going to hit our promise dates because we know that the spoilers***

[875] Jim McNerney, CEO, *The Boeing Company*. Q3 2006 Earnings Call.

> ***will be late.' Instead, they brick wall over a 'spec change.' Or, they tacitly conspire to tangle fastener procurement to the point of non-functionality*** *(FUBAR might be better used here.)* ***Or, they find a Boeing selected single source supplier in their ranks and hobble that supplier so that a delay in the partner schedule is traceable back to Boeing. (The way they do it is like a kid tripping his little brother every time mom looks away and then claiming the little brother can't walk.) Boeing managers have dismissed the theory because they do not believe that the partners are sufficiently clever to perpetrate such schemes. But the partners had schedules requiring them to build hundreds of millions of dollars worth of assemblies yet they knew they wouldn't be paid for months, even years. The partners had to figure a way out of that trap. The partners resorted to all sorts of shinanigans at the level of the minute details with the ultimate effect of deliberately misleading Boeing at all levels.*** *The latest side body join problem may be entirely encompassed by Boeing's internal communication loop. But,* ***the entire program has been rife with deceptions vigorously advanced from low levels at the partners to low levels at Boeing over small details. This creates context for senior partner managers to rationalize delays to senior Boeing managers. The delays appear fixable to Boeing management because they are presented as quantifiable technical or commercial problems. Boeing still hasn't realized that those problems were created and have been nurtured as the partners means of controlling the schedule and thus, their cash flow. The problems won't get solved until the partners decide to let them be solved (or Boeing decides to take and pay for each deliverable on each partner's schedule.) The thing about airplanes is that they don't fly until the last bolt is torqued down and the last i is dotted. The devil really is in the details. Boeing's internal communications are based almost exclusively, because of the partner model, on communications from the partners. Who knows? Boeing may not be able to avoid making garbage out of good information. I do know that Boeing is not clever enough to make good information of the garbage that is coming in."***[876]

6.16.1.11 *Boeing* (2005-2009) 787: "The Game-Changer"

6.16.1.12 *Boeing* (2008) Departure of "The Red Queen"

> *"It takes all the running you can do, to keep in the same place."*[877]

The vice-president and general manager of airplane programs at *Boeing Commerical Airplanes*, until her retirement in December 2008, was was Carolyn Corvi. She was acknowledged as fundamental in leading *Boeing's* "lean" efforts, resulting in significant productivity gains over the years. Her passion for executive learning in general, and her sponsorship of this research project (commonly referred to at *Boeing* as "Red-Blue", short for Integral-Modular) in particular, lead to her reputation within *Boeing Commercial Airplanes* as "The Red Queen."

Her rather abrupt departure (giving two weeks notice) was announced on Dec. 11, 2008, on the day that *Boeing* announced its fourth delay to its 787. Although a "retirement" she was only 58. As the leader of *Boeing's* Integral Enterprise Architect, her departure can be interpreted as a further disintegration of *Boeing's* Enterprise Architecture.

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[876] Blog posted by "Mel", on *Flightblogger*, 10 July 2009 in "Commentary: Its Time for *Boeing* to Talk. To Itself" (Jon Ostrower).
[877] Quote from "The Red Queen" in Carroll, L. (1871).

6.16.1.13 *Airbus* (1970): Founding (enterprise co-option and integration)

> *"American industry spills out across the world primarily because of the energy released by the American corporation.* [This is a] *highly organized economic system based on large units,* ***financed and guided by national governments****. Most striking of all is the strategic character of American industrial penetration. One by one, U.S. corporations capture those sectors of the economy with the* ***highest growth rates****."*[878]

European sentiment in the late 1960's was driven to emulate what it assessed as the driving success behind American industrial dominance: integrated corporate and national interests (Servan-Schreiber, 1967), or portions of an integrated enterprise architecture. It was in this spirit that *Airbus Industrie* was formally founded in December, 1970.

> *"Airbus was a 'groupement d'intérêt économique', a form of commercial partnership established in French law in the mid-1960's, which was mainly intended to help wine growers. A GIE, as it is known, is a* ***flexible*** *and user-friendly* ***form of corporate structure****, although it tends to baffle Anglo-Saxons – and Americans in particular – used to the* ***rigid structure of the limited company****. A GIE is* ***not a company****, and escapes many of the obligations of a company. For example, it does not have to pay taxes, unless it chooses to do so. It simply pools the capital contributed by its members, and its results are taken out of the books of its member companies in proportion to their share of the enterprise."*[879]

Airbus Industrie was initially founded as a "groupement d'intérêt éonomique" (GIE), a flexible "corporate" structure that co-opts the stakeholder environment (Selznick, 1948). One of the key architectural features of this enterprise was the function-sharing of the stakeholders: e.g. the governments (i.e. political markets) served as investors (i.e. capital providers). The suppliers also served as the capital markets as well as securing access to customer markets.

> *"Beteille* [CEO] *was serious in his desire to* ***widen the Airbus consortium****...it was crucial to get as many of the European powers involved with Airbus as possible. Only as a* ***strong, united*** *European force could the consortium be a success. A sure way of* ***increasing sales*** *was to rope more countries into the consortium. Negotiations with the Spanish in 1971 showed how* ***fruitful*** *this could be."*[880]

6.16.1.14 *Airbus* (1974-77): Strategy (low cost & financing, stable production)

> *"The A300 was* ***not a very innovative*** *plane in terms of aeronautical engineering, and was* ***never intended to be****; in terms of* ***financial engineering****, however (like all subsequent Airbus planes), it was one of the* ***most innovative machines ever built****. It was competing mainly against the DC-10 and the Lockheed L-1011 Tristar, but it was* ***much smaller*** *than both, and* ***cheaper****. Boeing was too wrapped up in the 747 to consider that section of the market, and Douglas too involved in the DC-10, and both thought it* ***too small a market to be of much interest****."*[881]

Airbus started out offering only a single product, the A300, aimed at a very narrow and relatively unattractive niche in the market. Competing against the other modular enterprise architectures of *Boeing*, *McDonnell Douglas* and *Lockheed*, which offered "higher-faster-

[878] From Servan-Schreiber (1967), quoted in Lynn, M. (1997), pg. 103.
[879] Lynn, M. (1997), pg. 113.
[880] Lynn, M. (1997), pp. 111 and 115-116.
[881] Lynn, M. (1997), pp. 110, 115 and 121.

farther" products, *Airbus* offered a "better-faster-cheaper" product to over-served customers like *Eastern Airlines*. In addition, *Airbus* offered innovative low risk, low cost financing. And finally, *Airbus* kept long-term stable production in the absence of short-term demand.

> *"The months wore on without any new orders. And planes were still being produced. It was during that year that the term* ***"whitetails"*** *became part of the industry jargon."*[882]

6.16.1.15 *Airbus* (2000-01): Public Flotation (owner-manager dis-integration)

> *"The German* [industrial] *side accepted the large French* [state] *shareholding very* ***reluctantly****. In announcing the agreement at the time* [2000]*, the other EADS co-chairman, Manfred Bischoff, who was also chief executive at DASA, described the concession to the French* [state] *as* ***'the toad that we had to swallow'*** *to create EADS."*[883]

The creation of *Airbus's* parent organization, the *European Aeronautic Defense and Space Company* (*EADS)* as a publicly listed company in 2000 was the product of industrial and political compromise between French, German and Spanish business and governments. The decomposition of ownership of *EADS* was as follows:

- Dutch Law "Contractual Partnership" (65.5% stake in *EADS*)
  - 30% by the French holding company, *SOGEADE*
    - 15% by the *Lagardère Group*
      - original owner of *Matra,* now the merged *Aérospatiale Matra*
    - 15% by the French state
      - former owner of *Aérospatiale*
  - 30% by German "interests"
    - 30% by the German company, *DaimlerChrysler*
      - owner of *DASA* Aerospace division
  - 5.5% by the Spanish state holding company, *SEPI*
      - owner of *Construcciones Aeronáuticas, CASA*

- European Stock Markets free float (34.5% stake in *EADS*)

> *"'Some people consider today* [2006] *that this pact doesn't give enough power to the* [French] *state because I remind you that in this pact, concluded in 2000, it was the* ***industrial shareholders****, Lagardère and DaimlerChrysler, who* ***assumed operational control****,' Mr. Breton* [the French finance minister] *said. '****The state*** *was there to only* ***validate strategic options.****'"*[884]

> *"'Today, the* ***French state only has an advisory role****,' he* [a spokesman for Lagardère, Jean-Pierre Joulin] *said."*[885]

[882] Lynn, M. (1997), pg. 118.
[883] Clark, N. "France Seeks More Control of *Airbus* Parent," *International Herald Tribune*, June 20, 2006.
[884] Clark, N. "France Seeks More Control of *Airbus* Parent," *International Herald Tribune*, June 20, 2006.
[885] Clark, N. "France Seeks More Control of *Airbus* Parent," *International Herald Tribune*, June 20, 2006.

Soon after the formation of *EADS* in 2000, *Airbus* became a single fully integrated company in 2001, incorporated under French law as a simplified joint stock company or Société par Actions Simplifiée (S.A.S.). Its relatively concentrated ownership had the following composition, which is summarized in Figure 258 below:

- *EADS* (80% stake in *Airbus*)
- *BAE Systems* (20% stake in *Airbus*)

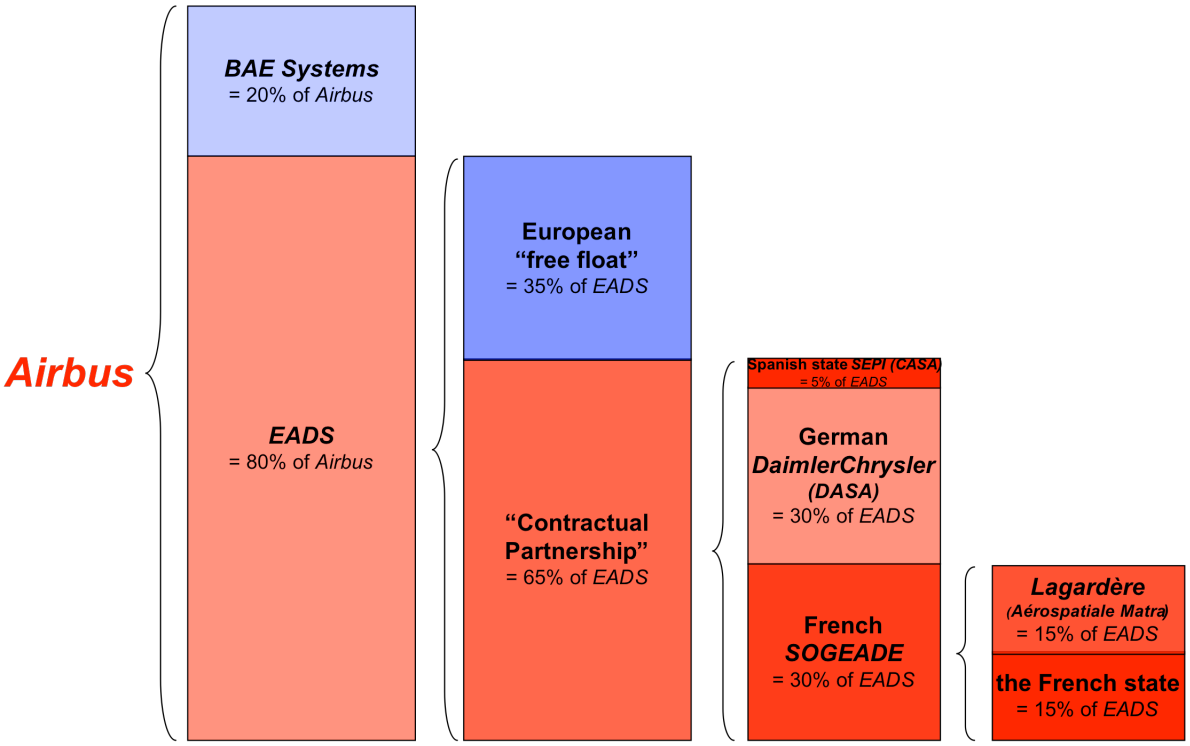

Figure 258: *Airbus'* "ownership" in 2001

6.16.1.16 *Airbus* (2001): Shareholders and the Response to 9-11

Just as *Airbus* had dis-integrated its capital stakeholder, a severe exogenous shock placed demands on the new enterprise. One might conjecture that having myopic shareholders would drive *Airbus* to make significant downsizings to reflect the downturn in the airline industry as a result of 9-11. However, unlike *Boeing* which did downsize immediately after 9-11, *Airbus* did not. This *may* serve as an indication of the relative patience of the capital-providers of *Airbus* vis a vis *Boeing*.

6.16.1.17 *Airbus* (2006): Evolutionary Diffusion of "Ownership"

Six years after the creation of *EADS* in 2000 and the public flotation of *Airbus* in 2001, the ownership of *Airbus* began to become slightly more diffuse, with sell-offs both from *EADS* and from *BAE Systems*.

6.16.1.17.1 Russian State Banks buy *EADS* shares

In September 2006, the Russian state-controlled bank, *Vneshtorgbank (VTB)* purchased a 5% stake in EADS from the available free float. Although it did not get a seat on the board of directors, it did seek to formalize industrial partnerships, for example the conversion of A320 passenger aircraft into cargo planes.[886]

Over one year later, after *VTB* was privatized, its investors began to complain that the *EADS* shares were losing value.[887] In response, *VTB* sold its shares to another state-owned bank, *Russia's Bank of Development*.

6.16.1.17.2 *BAE Systems* sells shares to *EADS*

On October 13, 2006, *BAE Systems* sold off its 20% stake in *Airbus* to *EADS*, giving *EADS* 100% ownership of *Airbus*. The reason that *BAE Systems* gave for its sale of *Airbus*, was that it wanted to focus on it core business of defense, particularly on future potnential acquisitions in the US defense market. It is noteworthy that *BAE Systems* only received an estimated 50% of the value of their stake due to short-medium term valuation reductions due to problems with the A380.

> *"'The fact that BAE is selling its stake should not come as a surprise' Gustav Humbert, the chief executive of Airbus, said last week. '**This is a business decision, not an industrial one.**' Its departure could be **transformational for Airbus**, which is seeing its **ownership – and decision making – structure evolve**."*[888]

The architectural differences in *Airbus'* two shareholders (*EADS* and *BAE Systems*) is evident, and these differences transcend national boundaries, where the UK's *BAE Systems* took a relatively short-term, arm's length approach to *Airbus*, while the French/German/Spanish *EADS* took a relatively long-term, collaborative approach to investment in *Airbus UK*. It was *EADS* of continental Europe which invested over the long term in developing UK capabilities, not the UK's *BAE Systems*:

> *"[Roger Berry]: 'Do you think that BAE Systems sold out on the future of UK civil aerospace?' [Iain Gray, Managing Director, Airbus UK]: 'BAE Systems had a strategy which was progressively to move out of civil aerospace… They were an **arm's length shareholder**. Over the last five years we have seen **significant investments coming into Filton and Broughton [UK] through EADS's commitment to Airbus.**'"*[889]

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[886] Approximately one year later, *VTB* explored selling its stake ("Russian Bank Exploring Sell of EADS Stake", *International Hearald Tribune*, July 11, 2007).
[887] Robertson, D. "VTB Sells EADS Stake to Another Russian Bank," *The Times*, December 28, 2007.
[888] Clark, N. "*BAE* Turns Toward U.S. as it Ends *Airbus* Ties," *International Herald Tribune*, May 24, 2006.
[889] "*Recent Developments with Airbus*," Uncorrected transcript of oral evidence to be published as HC427-i, UK Parliament, House of Commons, Trade and Industry Committee, March 27, 2007.

"[Lindsay Hoyle]: 'Do you think the [EADS] board would allow a [future] ***partnership*** *with BAE in composite technology?' [Iain Gray, Managing Director, Airbus UK]: 'I would not envisage that being the outcome. I do acknowledge that BAE Systems are a* ***supplier*** *to Airbus.'"*[890]

6.16.1.17.3 *Dubai International* buys *EADS* shares

Dubai Internaional Capital LLC bought 3.12% of *EADS*' free float shares on July 5, 2007. The move could be interpreted as a form of backward integration, as *Dubai International* owns *Emirates Airlines*, the largest customer for *Airbus'* A380. They, however have no plans to take a board seat or an active role at *EADS*.

*"'They clearly have their interpretation of where the business is going,' said Harry Breach, an analyst with JP Morgan in London. '****They see material upside in the long term****.'"*[891]

6.16.1.17.4 Future Posssible Diversification

6.16.1.17.4.1 German Bank, *KfW* to buy half of *Daimler/Chrysler's* stake

When *Daimler/Chrysler* sells half of its stake, the German government (initially through its development bank *KfW*, or even through the Hamburg city government) is rumored to purchase it.

6.16.1.17.4.2 French Government to buy half of *Lagardère* stake

When *Lagardère* sells half of its stake, the French government is rumored to purchase it, leaving the following owernship structure in place.

"'EADS is starting to go from being a ***minority*** *floated company to a* ***majority*** *floated company,' Aboulafia said. 'That ultimately changes your* ***compartment****.'"*[892]

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[890] Gray, I. (Managing Director, *Airbus UK*), "*Recent Developments with Airbus*," Uncorrected transcript of oral evidence to be published as HC427-i, UK Parliament, House of Commons, Trade and Industry Committee, March 27, 2007.
[891] McSheehy, W. and Oliver, E. "*Dubai International Buys 3.1% of Airbus Parent EADS*," *Bloomberg.com*, July 5, 2007.
[892] Clark, N. "*BAE* Turns Toward U.S. as it Ends *Airbus* Ties," *International Herald Tribune*, May 24, 2006.

- Dutch Law "Contractual Partnership" (reduced to 50.5% stake in *EADS*)
  - 22.5% (reduced by 7.5%) by the French holding company, *SOGEADE*
    - 7.5% by the *Lagardère Group* (sells 7.5%)
      - original owner of *Matra,* now the merged *Aérospatiale Matra*
    - 15% by the French state
      - former owner of *Aérospatiale*
  - 22.5% (reduced by 7.5%) by German "interests"
    - 15% by the German company, *DaimlerChrysler* (sells 7.5%)
      - owner of *DASA* Aerospace division
    - 7.5% by the German bank, *KfW* (buys 7.5% from *DaimlerChrysler?)*
  - 5.5% (unchanged) by the Spanish state holding company, *SEPI*
      - owner of *Construcciones Aeronáuticas, CASA*

- European Stock Markets free float (49.5% stake in *EADS*)
  - 5% by *Russian State Bank, VTB (*then to the *Russian Development Bank)*
  - 3.1% by *Dubai International Capital LLC*

This new ownership structure is summarized in Figure 259 below.

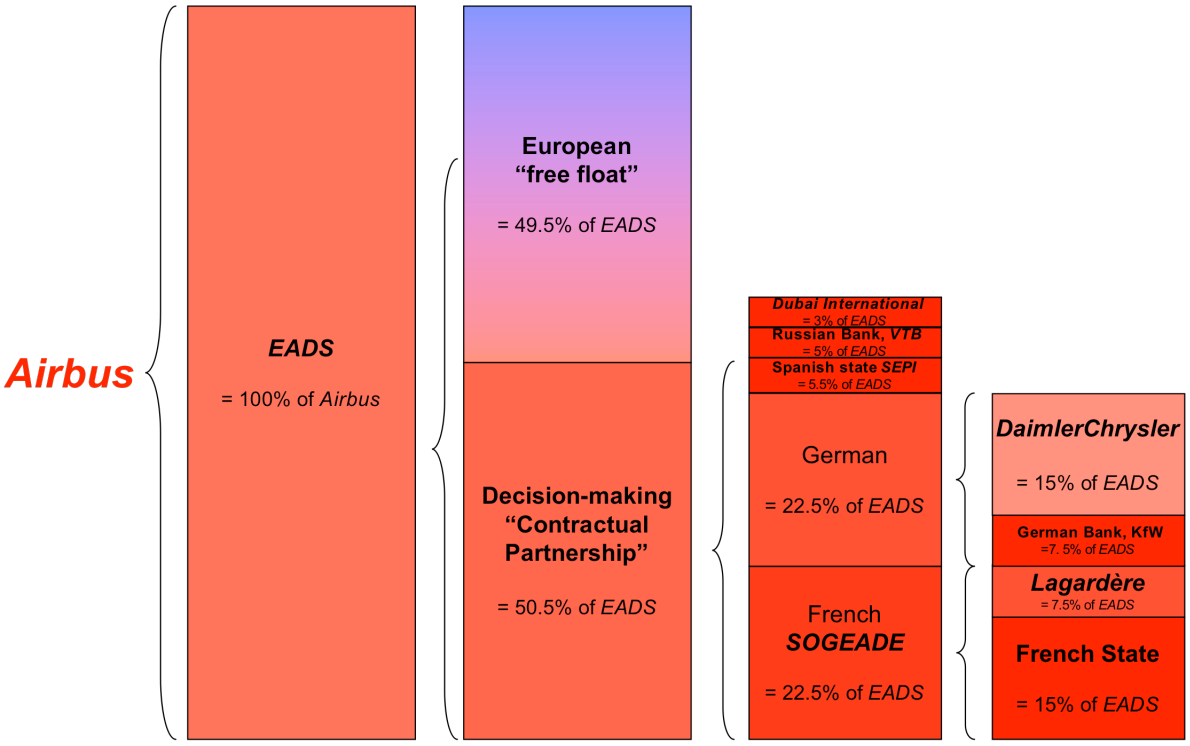

Figure 259: *Airbus'* "ownership" in 2007

6.16.1.18 *Airbus* (2006): CEO transitions

In the wake of announced production delays on the A380 in the summer of 2006, *Airbus* CEO Noel Forgeard resigned. Christian Humbert, the first German *Airbus* CEO took over, and resigned one year later in July 2006.

Christian Streiff took over and proposed significant structural changes to *Airbus* within his first few months in control, which included a rebalancing of work and power within the delicately-balanced political consortium. The *EADS* board did not support his recommendations and after only 100 days on the job, he resigned.

> *"I progressively came to the conviction that the **governance of Airbus did not allow my plan to succeed**."*[893]

Streiff was succeeded as *Airbus* CEO by *EADS* co-chair, Louis Gallois who occupied both jobs. Gallois is a Frenchman with significant experience in French aerospace industry (formerly with both *Aerospatiale* and *SNECMA*).

Streiff apparently tried to use conventional firm-bounded logic to transition *Airbus* away from its core strength as a world-class political-economic enterprise into a "rational" profit-maximizing firm. His stakeholder ecosystem apparently rejected his efforts to "rationalize" or narrow down the boundaries of the enterprise too much too soon. In our parlance, *Airbus's* integral enterprise architecture (with its strong enterprise stability) resisted attempts to dis-integrate too rapidly, and rejected its "modularizing" architect.

The theory predicts that enterprises disintegrate over time (which *Airbus* and *Boeing* both appear to be doing). The point of question seems to be the rate at which this will happen for *Airbus*. The data seems to continue to support the view that *Airbus'* disintegration will continue at a slower rate than would be expected by a modular incumbent. Does *Airbus* have (short-term) *efficiency* problems? Certainly. Are they abandoning their (long-term) *effectiveness* platform to solve these problems? Apparently not. Gallois appears to be a more natural integral architect, and his dual-appointment as CEO of both *Airbus* and *EADS* appears to be a return to the integrality that made *Airbus* successful.

Certain elements of the popular business press were beginning to observe the differences between Streiff and Gallois as "architects", and the resulting success.

> *"Considering that Airbus, before its latest difficulties, managed to become number one in the industry suggests that there is nothing wrong with the model. If anything, it has become a **template for success**. In short, for such a model to work, you need a **skilful architect** who has all the plans in his head, knows what needs to be done, and can keep politics and meddling shareholders out of the factory."*[894]

In July 2007, *EADS* ended the bi-national management structure that it began with at its inception: dual French and German CEOs as well as chairmen, in an effort to streamline decision making. Frenchman, Lois Gallois went from being *EADS* co-CEO (with

[893] *Reuters*, Monday, October 9, 2006.
[894] *Financial Times*, October 12, 2006.

German, Thomas Enders) and *Airbus* CEO, to *EADS'* sole CEO, while Enders gave up his *EADS* co-CEO job to become the sole *Airbus* CEO. Finally, German Ruediger Grube became the sole *EADS* chairman.

6.16.1.19 *Airbus* (2007): Supply Chain Restructuring

The new CEO, Louis Gallois moved to restructure *Airbus*' production facilities in order to improve cost-competitiveness in the "Power 8" program. This included the proposed sale of a number of internal factories, "layoffs" (or hiring freezes) and the increase in risk-sharing partnerships. The proposal resulted in "tensions" between France and Germany as well as between management and labor. Former *Airbus* chief Jean Pierson expressed his concerns as well as his confidence in this new architect:

> *"This system cannot continue. EADS is a company which is up against the wall. I cannot see who will agree to make concessions. This Franco-German rivalry cannot continue, this environment is noxious and the system ungovernable… "I am not familiar with the current cost cutting plan, but I know [Airbus chief executive] Louis* ***Gallois****. I do not doubt that this plan will be both* ***serious*** *and* ***reasonable in industrial and social terms*** *and that it will also be* ***balanced****."*[895]

In response to Gallois' balanced proposal, German Chancellor Angela Merkel and French President Jacques Chirac came to an agreement:

> ***"****The* ***competitiveness of Airbus is the most important factor in the company's restructuring****, German Chancellor Angela Merkel said on Friday. '****The competitiveness of the company is the top priority for us****.'"*[896]

While such measures appear to be a drastic dis-integration or modularization of the firm-supplier link, closer inspection reveals a much more slow and modest dis-integration. The announced "layoffs" were in reality more akin to "announced attrition" – something unheard of in Liberal Market Economies. The "strikes", while new to *Airbus*, were different in both quantity and quality to those experienced in modular enterprise architectures like *Boeing*. Instead of lasting continuously for weeks or months, they were organized as a series of one-hour walkouts staged every few weeks. The integral nature of labor and capital was exercised with "voice" used over "exit" (Hirshman, 1970).

Similarly, capital remained "patient", with major partner investors sharing negative "rents" with the ecosystem:

> *"Lagardere recently reported a 57% drop in 2006 profit, due largely to the poor performance of its 7.5% stake in EADS. Chief executive Arnauld Lagardère, who also co-chairs EADS, also ruled out the sale of the company's stake in EADS when announcing his annual results.* ***'I will play my role*** *and I want to carry on being part of EADS's growth,' he told Le Monde. So concerned was Lagardère that* ***he vowed to return any upcoming dividend back to the company.*** *'The Airbus situation has* ***affected everyone,*** *the employees above all, but also the shareholders and the small investors who have suffered from the drop in shares,' he said."*[897]

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[895] Former *Airbus* chief, Jean Pierson, in *Les Echos*, Thursday 22 February 2007.
[896] *Reuters*, February 23, 2007.
[897] *Forbes*, March 14, 2007.

Finally, with regards to outsourcing major work to "risk-sharing" partners as *Boeing* had "pioneered" on its new 787 program, *Airbus* began to pursue a similar strategy, albeit at a much more measured pace:

> *"It is not exactly Boeing but it is radically different. It's about **halfway to Boeing** and that is pretty **radical for Airbus**.". "*[898]

Although *EADS* looked to sell some of its assets to the US's *Spirit Aerosystems*, it decided at the last minute to sell UK plants to *GKN*, a UK firm; German plants to *OHB Technology Aerospace*, a German firm; and French plants to *Latecoere*, a French firm.

> *"In the end, we just couldn't close a business case that met both our **customer** requirements and our **shareholder** requirements."*[899]

> *"The three partners had better offers commercially and technically, were more aggressive than Spirit in the last round of negotiations. Politics had no influence."*[900]

[898] *Flightglobal.com*, March 30, 2007.
[899] *Wichita Eagle*, December, 20, 2007
[900] *Wichita Eagle*, December, 20, 2007.

6.16.2 *Example:* Automotive *Industry*

6.16.2.1 *General Motors* (1916): Incorporation

The General Motors Corporation was incorporated in 1916, succeeding the *General Motors Company*.

6.16.2.2 *General Motors* (1926): Vertical Integration of *Fisher Body*

The classic textbook case study for vertical integration to reduce opportunistic "hold-up" is *General Motor's* 1926 acquisition of one of its auto body suppliers, *Fisher Body* (Klein, Crawford and Alchian, 1978).

The case has created alternate viewpoints, however in that vertical integration can in fact create, not reduce, hold-up (Freeland, 2000); and that vertical integration was simply done to improve coordination, not reduce opportunism (Casadesus-Masanell and Spulber, 2000).

6.16.2.3 *General Motors* (1999): Vertical Dis-integration of *Delphi*

In 1999, *General Motors* spun off its internal parts manufacturer, *Delphi*, which is *GM's* chief supplier, and the largest U.S. auto parts supplier. *Delphi* struggled since it was spun off and ultimately filed for bankruptcy less than six years later in 2005.

In a related move, *Ford* spun off its internal parts manufacturer, *Visteon* in 2000. It, too struggled on its own, with *Ford* still accounting for 70% of its business, it filed for bankruptcy in 2005.

6.16.2.4 *General Motors* (2005): Vertical "Re-integration" of *Delphi*

As both *GM* and *Ford* struggled to revive their critical parts suppliers which included important contract renegotiations from the United Auto Workers labor unions, *Ford's* CFO clearly stated the resolve of the modular enterprise architecture:

> *"Our **goal** is to approach a **true arms-length relationship** with Visteon."*[901]

Recent data suggests that investors are interested in taking over these former internal suppliers from public to private equity settings.

6.16.2.5 *Daimler* & *BMW* (1994-2007): Acquitision & Divestiture of Rivals

In addition to the above examples of the divestiture of internal divisions from modular enterprise architectures, there is also evidence of acquisition and immediate divestiture of rival OEMs in the cases of *Daimler-Chrysler* and *BMW-Rover*.

> *"Bayerische Motoren Werke AG, experienced a serious cash shortage in 1999 following the **disastrous acquisition** of the British carmaker Rover Group Ltd. five years earlier… CEO*

[901] "*Ford* to Take Back 24 Ailing *Visteon* Plants", Dee-Ann Durbin, *Associated Press*, May 26, 2005.

> *Joachim Milberg responded to the crisis by **selling off** the loss-making Rover and Land Rover units and refocusing the company's core business of producing and marketing premium cars."*[902]

> *"DaimlerChrysler moved to undo the **most expensive** and one of the **least successful mergers** in auto industry history Monday as it agreed to essentially **pay to dump** the money-losing Chrysler unit which it paid **$37 billion** for nine years ago. A private investment firm like Cerberus will provide management with the opportunity to focus on their **long-term plans** rather than the **pressures of short-term earnings expectations**."*[903]

6.16.2.6 *General Motors* (2008-9): Becomes No. 2 & Bankruptcy Protection

After approximately 90 years dominating the global automobile market, *General Motors* finally ceded its number one position to the late entrant *Toyota*.

Soon thereafter, *General Motors* found it very difficult to weather the global financial crisis of 2008-2009 and sought bankruptcy protection. In an effort to save the company from bankruptcy, the highly modular and disintegrating enterprise architecture attempted a radical attempt at "re-integration" when two unlikely shareholders, the US Government and the United Auto Workers union became some of the largest investors.[904] While the *structure* of this move may appear to be a move toward integrality, the *function* of this new stakeholder set re-configuration may not necessarily be integral or long-term, trust-based.

6.16.2.7 *Toyota* (1937): Founding through Organic Diversification

In August, 1937 *Toyota Motor Co. Ltd.* was established as an internal or organic diversification away from *Toyoda Automatic Loom Works, Ltd.*

6.16.2.8 *Toyota* (1949): Spin-off of *Nippondenso* (value chain dis-integration)

While *GM* and *Ford* spun-off their largest internal parts divisions (a.k.a. *Delphi* and *Visteon*) in 1999, *Toyota* made a similar move literally 50 years earlier, by spinning-off *Nippondenso* (now *Denso*) in 1949.

> *"Denso began life as a **spin-off division of Toyota** in 1949, and over time grew into one of the largest auto-parts manufacturers in the world."*[905]

Toyota however, maintained a significant equity stake in *Denso*, which in 1999 it was 25%.

6.16.2.9 *Toyota* (1950): Recession, Lay-offs, Strikes, Bankruptcy & Bailout

> *"The resulting **recession**, however, led many large firms to **reduce their work force** and produced bitter labor confrontations. The three dominant truck producers – Toyota, Nissan, and Isuzu – all underwent **strikes**. Toyota faced **bankruptcy** due to **inventory mismanagement**, until it was **bailed out** by Bank of Japan."*[906]

---

[902] Raisch and Krogh (2007), pg. 69.
[903] CNN.com May14, 2007, "*Daimler* pays to dump *Chrysler*".
[904] I am indebted to Charlie Fine, for pointing out this fact.
[905] Smitka, M.J. (1990), pg. 165..
[906] Smitka, M.J. (1990), pg. 165..

In 1950, after the post-war recession, *Toyota Motor Corporation Ltd.* fired approximately one quarter of its workforce. The resulting strikes, led to near-bankruptcy and a bank bail-out. A precondition of this bail-out was the separation of sales from its production operations, by creating the *Toyota Motor Sales Co. Ltd.*

6.16.2.10 *Toyota* (1982): Reintegration of Sales and Operations Companies

In 1982, after 32 years of forced separation between sales and production functions, *Toyota* reintegrated these companies into the new *Toyota Motor Corporation*.

6.16.2.11 *Toyota* (1988): Vertical Integration in Auto Electronics

Having apparently vertically disintegrated in automotive electronics in 1949, by spinning off *Nippondenso*, *Toyota* reintegrated in auto electronics in 1988, not by inorganically repurchasing the world-leading *Denso,* but by organically opening its Hirose plant, which is the location of four electrical engineering divisions.

At a time when *GM* and *Ford* were disintegrating or considering selling off it internal parts divisions, *Toyota* appeared to be on the opposite trajectory. Researchers have posited theoretical explanations for this architectural move, by synthesizing governance-based transaction cost economics explanations with learning based explanations (Ahmadjian and Lincoln, 2001).

6.16.2.12 *Toyota* (1995-99): Vertical Integration with *Daihatsu*

In 1995, *Toyota* increased its equity stake in *Daihatsu* from 17% to 33%, and again in 1999 to 50%, making it a legal subsidiary (Ahmadjian and Lincoln, 2001).

6.16.2.13 *Toyota* (2008): First Annual Loss

In 2009, *Toyota* recorded it first annual loss for 2008 in 71 years amid the global financial crisis. Note that this exogenous event, which affected all auto manufacturers seemed to negatively impact *Toyota's* modular competitors (e.g. *General Motors* and *Chrysler*) more severely as they not only reported massive losses, they were forced to seek bankruptcy protection and/or merger possibilities.[907]

[907] *Fiat* proposed a takeover of *Chrysler* as well as the purchase of *General Motor's* European brands.

6.16.3 *Example:* Airline *Industry*

The following chronicles the evolutionary trajectories of two enterprise architectures: an incumbent, *United Airlines*[908], and a challenger, *Southwest Airlines*[909].

6.16.3.1 *United Airlines* (1928-30): Pre-founding (value chain integration)

In 1928, *Boeing Airplane - Transport Corporation* (BATC) is incorporated in Delaware and acquires *Boeing Air Transport* (BAT), *Pacific Air Transport* (PAT), and the *Boeing Airplane Company* (BAC) as subsidiaries.

In 1929, BATC subsequently changes its name to *United Aircraft and Transport Corporation* (UATC), and it acquires other subsidiaries, including *Pratt & Whitney Aircraft*, *Hamilton Standard Propeller Company.* and *Chance Vought Corporation.*

In 1930, UATC acquires *National Air Transport* (NAT) and *Varney Airlines*.

6.16.3.2 *United Airlines* (1931): Founding (value chain dis-integration)

United Air Lines Incorporated (UAL) is incorporated as a management corporation to coordinate operations of UATCs airline subsidiaries.

6.16.3.3 *United Airlines* (1931): Formation of Labor Unions

A few days after the official incorporation of UAL, pilots organize the *Air Line Pilots Association* (ALPA), which affiliates with the *American Federation of Labor* (AFL). The airline industry's first labor agreement with pilots is signed Oct. 8, 1940.

6.16.3.4 *United Airlines* (1975-85): Labor Strikes (labor dis-integration)

In 1975, IAM-affiliated mechanics and related crafts employees stage 16-day strike at *United*. Four years later, in 1979, the same organizations stage a 58-day strike at *United*.

In 1985, members of the *Air Line Pilots Association* (ALPA) stage a 29-day (six-week) strike at *United*. Members of the *Association of Flight Attendants* (AFA) stage a sympathy walkout.

6.16.3.5 *United Airlines* (1994): ESOP (attempted re-integration)

(Lowenstein, 2002).

[908] Much historical information on *United Airlines* was obtained from its website: www.united.com.
[909] Much historical information on *Southwest Airlines* was obtained from its website: www.southwest.com.

6.16.3.6 *United Airlines* (2001): Bankruptcy (dis-integration)

6.16.3.7 *United Airlines* (2003): Launch of *Ted* (inorganic diversification)

In an attempt to compete with *Southwest Airline's* low cost model, *United Airlines* created a low cost airline, *Ted* within it corporate boundaries. While it attempted to mimic many of *Southwest's* features, it did not replicate *Southwest's* underlying integral enterprise architecture, and was unsustainable.

6.16.3.8 *Southwest Airlines* (1971): Founding

6.16.3.9 *Southwest Airlines* (2001): Response to 9-11

6.16.3.10 *Southwest Airlines* (2008): Quarterly Losses

6.17 *Profiles in Courage:* Why Re-Integration is Difficult

> *"This book is about that most admirable of human virtues – **courage**. **'Grace under pressure**,' Ernest Hemmingway defined it. And these are the stories of the **pressures** experienced by eight United States Senators and the grace with which they endured them – **the risks to their careers, the unpopularity of their courses, the defamation of their characters, and sometimes, but sadly only sometimes, the vindication of their reputations and their principles**.*
>
> *These problems do not even concern politics alone – for the same basic choice of **courage or compliance continually faces us all**, **whether we fear the anger of constituents, friends, a board of directors or our union, whenever we stand against the flow of opinion on strongly contested issues**. A man does what he must – in spite of personal consequences, in spite of obstacles and dangers and pressures – and that is the basis of all **human morality**.*
>
> *To be courageous, these stories make clear, requires **no exceptional qualifications, no magic formula, no special combination of time, place and circumstance.** The stories of past courage can define that ingredient – they can teach, they can offer hope, thay can provide inspiration. But they can not supply courage itself. For this each man must look into **his own soul**."*[910]
>
> *"Few men are willing to brave the **disapproval** of their fellows, the **censure** of their colleagues, the **wrath** of their society. **Moral courage is a rarer commodity than** bravery in battle or **great intelligence**. Yet it is the one essential, vital quality for those who seek to change a world which yields most painfully to change."*[911]

Based on thousand of hours of interviews and ethnographic observation with the top management teams in the primary case study, one of the striking constructs which emerged from coding and analysis of the data, is that of "courage."

> *"If I understand what you are speaking about, you are likely to find* [in your research] *that the key to our transformation is **courage** – which is a rare commodity* [in our company] *these days – and I wish you the best of luck."*[912]
>
> *"How dare you insult me – of course we know this* [research] *is correct! The reason we don't implement it is that we **don't have the courage to**!"*[913]

Connecting knowledge (strategy) and courage (leadership) is fundamental in delivery of high-performing enterprises.

> *"Between the **idea** and the **reality**, between the **conception** and the **creation**, falls the **shadow**. This is the way the world ends; This is the way the world ends; This is the way the world ends; Not with a **bang** but a **whimper**."*[914]

[910] Kennedy, J.F. (1955), pp. 1, 224-225.
[911] Kennedy, R.F. (1966), speech.
[912] Initial interview with VP at the beginning of this research project in pilot study, Jan, 2002.
[913] Interview with current case-study CEO, Summer, 2006.
[914] Elliot, T.S. (1925).

6.17.1 *Unsustained Re-Integration Attempts*

The following examples document attempts at re-integrating disintegrating modular enterprise architectures in a variety of industries.

6.17.1.1 Automotive Industry: *Saturn* at *GM*

6.17.1.2 Automotive Industry: Stallkamp at *Chrysler*

(Dyer, 2000)

6.17.1.3 Airline Industry: ESOP at *United*

(Lowenstein, 2002)

6.17.1.4 Airplane Industry: Corvi at *Boeing*

6.18 Evolution of Architecting Processes

> *"A pure **top-down** process **cannot succeed** in the **early phases** of a technology or **industry**. Thus as technologies **mature**, the active choices are **pushed lower and lower**, ultimately to the **component level**."*[915]

The process of system architecting evolves over time to suit the demands of the environment. As shown in Figure 260 below, the process switches from a bottom-up process in the early phases of an industry to a top-down process in the middle phases of an industry, and finally back to a bottom-up process, or more explicitly whereby the top-down architecting enables bottom-up process.

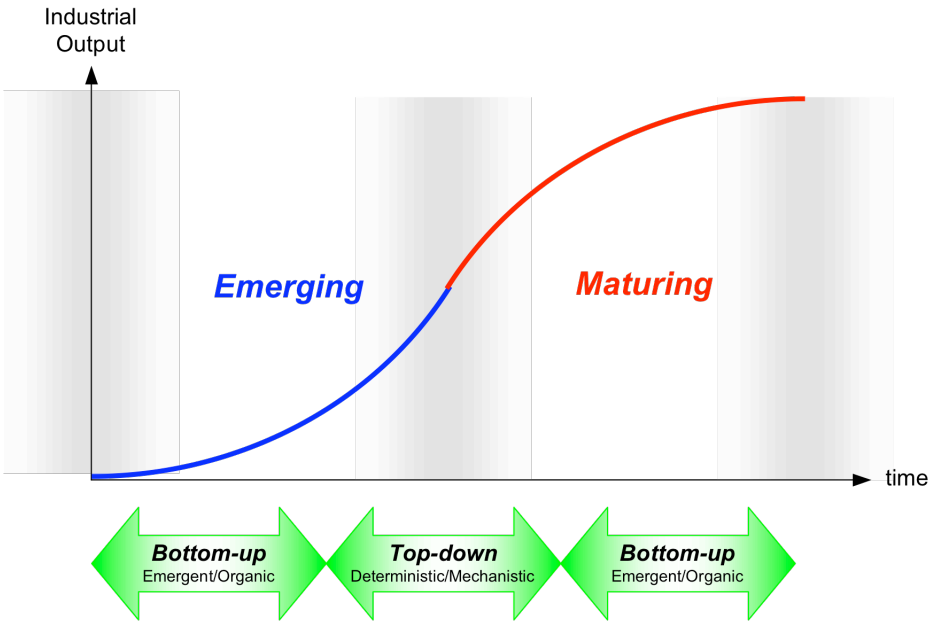

Figure 260: Evolution of Architecting Processes

[915] Whitney et al. (2004), pg. 4.

6.19 Enterprise Architectural *States* (Fit) and *Paths* (Change)

6.19.1 *Enterprise Architectural* Fit[916]

> *"The ultimate object of design is **form**. The form is the solution to the problem; the context defines the problem. **Fitness** of the system is the degree to which the system and its context are 'mutually acceptable'."*[917]

From this construct, the co-evolution of firm and industry architectural dynamics can be developed. It is here that the framework closes the feedback loop whereby the dynamics of the enterprise architecture can be seen to have "fit" with the environmental dynamics. This architectural notion of enterprise-environmental fit is well understood in classical architectural theory (Alexander, 1964).

In addition, this notion of fit is seen to be a source of competitive advantage (Powell, 1992), as was made influential by the organizational contingency theorists (Burns and Stalker, 1961; Lawrence and Lorsch, 1967). The *consonance hypothesis* is stated as follows:

> *"Those organizations that have **structures** that more **closely match** the requirements of the environment are more **effective** than those that do not."*[918]

In fact, as Stinchcombe (1965) famously observed, there are long-term, path-dependent, lock-in effects associated with the firm's "birth". The environmental imprint on the firm at the time of its founding encodes a form of DNA that has a lasting influence on the structure of the firm. This begins to explain the structural inertia associated with firms in the evolution of industries.

It is in this way that architectural fit can be seen as a meta-strategic framework which mediates between the external competitive positioning view of strategy and its counterpart, the internal resource-based view of strategy.

Heuristic 3f:
The enterprise architectural forms will grow and prosper in different industrial competitive regimes, where they have better growth-fit characteristics. Modular enterprise architectures will grow and prosper in pre-dominant design regimes, where competition is based on *discontinuous radical product* innovation (a.k.a. "higher, faster, farther" regime). Integral enterprise architectures will grow and prosper in post-dominant design regimes, (populated by shake-out survivor modular architectures) where competition is now based on *continuous incremental process* innovation (a.k.a. "better, faster, cheaper" regime).

> *"In the **later developing** states there was, often, a much readier sponsorship accorded to approved associations who were thereafter **co-optated**, in the case of labour unions, brought into the corporate structure of the sector or firm (Loveridge, 1983). Thus what is seen as the **more tightly***

[916] In Organizational Behavior, the notion of "fit" has surfaced primarily in *structural contingency* theory and *complexity* theory (e.g. "fitness" landscapes).
[917] Alexander, C. (1964), pp. 15 and 19.
[918] Pfeffer (1982). pg. 148.

__socially integrated systems__ of later developing national business systems has much to do with the management of the process of institutionalization."[919]

Heuristic 3f (advanced refinement)**:**
The enterprise architectural forms will grow and prosper in different industrial competitive regimes, where they have better growth-fit characteristics. Integral enterprise architectures will grow and prosper where industry rates of growth are relatively slow and stable, where competitive capabilities center on *exploration* and competition is based on *innovation* in product (and ultimately process). On the contrary, modular enterprise architectures will grow and prosper where industry rates of growth are relatively fast and unstable, where competitive capabilities center on *exploitation.*

Heuristic 3g:
The two types of technological change which facilitate the conditions for integral enterprise architectures are: the emergence of a discontinuous technological change in which integrality is needed for *product* innovation, and the emergence of a dominant product design in which integrality is needed for *process* innovation.

Heuristic 3h:
The successful birth rate of integral architectures post-dominant design is dependent on the clockspeed of the industrial development. As integral architectures tend to take existing markets in a low-cost, high quality world, via a strategy based upon human capitalism, based on stability in order to deliver continuous improvement, some industries may evolve too quickly to allow for stability to be a viable mechanism. In other words, Schumpeter's "winds of creative destruction" may be too rapid and frequent for human capitalism to take hold.

Heuristic 3i:
There is an optimum rate of firm growth that is contingent upon where in the industrial evolution cycle the firm operates. The optimum growth rate is governed either by the competitive dynamics associated with building of capacity or the growing of capability. For the pre-dominant design regime, the optimum rate of growth is near the fastest possible, while for the post-dominant design regime, the optimum rate of growth is significantly slower than the maximum possible.

"As to what is the maximum efficient rate… a __too rapid__ expansion will introduce so many disharmonious elements that __efficiency will be destroyed__."[920]

"Virtually all natural systems including organizations have intrinsically optimal rates of growth, which is __far less than the fastest possible__."[921]

"The Toyota Production System can be realized only when all the workers become __tortoises__. __Speed is meaningless without continuity__. Just remember the tortoise and the hare".[922]

[919] Loveridge, R. (2003).
[920] Robinson (1932).
[921] Senge, P. (1990), pg. 62.
[922] Ohno, T. (1978), pg. 63

Heuristic 3j:
The enterprise's structural dynamics (growth vs. stability), judged within the context of the environment or industry's structural dynamics will contribute to the mechanism defining long-term financial performance of the firm.

> *"Perhaps the most **ubiquitous force** leading to structural change is a **change in the long-run industry growth rate**. Industry growth is a key variable in determining the **intensity of rivalry** in the industry and it sets the pace of expansion required to maintain share, thereby influencing the supply and demand balance and the inducement the industry offers new entrants."*[923]

> *"In a **high-growth** period, productivity can be raised by anyone. But how many can attain it during the more difficult circumstances induced by **low-growth** rate? This is **the deciding factor** in the success or failure of an enterprise."* [924]

Finally, it is worth noting that some research exists to challenge the notion of contingent fit as a source of organizational efficiency. Nickerson and Zenger (2002), for example observe that "being efficiently fickle" via modulation between centralization and de-centralization, can in some instances lead to higher efficiencies – independent of what the environment dictates. The logic of such apparent oscillatory "fickleness" appears to lie in the physics of control theory, namely the presence of a balancing loop with delays.

[923] Porter, M.E. (1980), pg. 164.
[924] Ohno, T. (1978), pg. 114.

6.19.2 *Enterprise Architectural* Change

There are two distinct mechanisms for architectural change in the face of environmental change: managerial *adaptation* or environmental *selection.* The degree to which each mechanism governs the change process is defined by the amount of *architectural inertia* within the organization or enterprise. Each change process will be discussed in turn.

> *"Theories typically placed in the **adaptational camp** include **contingency theory** (Woodward 1965, Lawrence & Lorsch 1967), **resource dependence theory** (Pfeffer & Salancik 1978, Burt 1983, 1992), **institutional theory** (Meyer & Rowan 1977, DiMaggio & Powell 1983), and **transaction cost economics** (Williamson 1975, 1985). Theories residing in [the **selection camp**] include **organizational ecology** (Hannan & Freeman 1977, 1989) and, on occasion, **evolutionary economics** (Nelson & Winter 1982)."* [925]

6.19.2.1 (Managerial) Adaptation

As the enterprise architecture both enables and constrains but does not determine action, there is room for both the mechanisms of managerial adaptation as well as environmental selection. This research intends to present a balanced explanation for which mechanisms govern and when.

Managerial adaptation is underpinned by the notions of free-will (Burrell and Morgan, 1979), strategic choice and strategic renewal (Volberda and Lewin, 2003). The change process theories that underpin it are those that are *predictive*, e.g. life-cycle and teleological (van de Ven, 1992).

> *"I agree with the main content of your research. My difficulty has more to do with the **slightly fatalist** tone of the work. I understand what you are trying to do, but it is hard for me to accept the **determinism** of the blue-red duality. Then again, my perspective is tainted with the **engineering mindset of being able to fix anything if you try hard enough**. Yes, you have to make tough decisions, and you have to approach the problem from a systems perspective on many fronts at the same time, you have to dismantle old value systems, and attack cultural problems, and realign incentives, and have an integrated strategy that considers all major stakeholders and you need a good plan to implement it, but I still think you can do it. It is very difficult, but I don't think it is impossible. **Maybe I'm being overly optimistic…**"* [926]

Throughout the process of creating the grounded theory in this proposed framework, constructive criticism frequently came back from the knowledge co-creators that (some presentations of) the framework came across as too fatalistic and deterministic, that it understated the power of management. These viewpoints were very valuable in the creation of the theory, and the proponents tended to have similar backgrounds: relative inexperience with leading in large, complex enterprises, and relatively little exposure to the theories of structural inertia of the environmental schools.

This framework does not intend to understate the power of human agency, but in fact to do the opposite; that is to state that such adaptation, while rare is very possible, but it requires a very special and rare type of leadership – *architectural* leadership.

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[925] Barnett and Carroll, 1995, g. 218.
[926] Critique of framework from MIT PhD student. Received via email on 18 May 2006.

6.19.2.2 (Environmental) Selection

Environmental selection is underpinned by the notions of determinism (Burrell and Morgan, 1979). The change process theories that underpin it are those that are *explanatory*, e.g. dialectic and evolutionary (van de Ven, 1992).

6.19.2.3 Enterprise Inertia Part II: *Architectural* Inertia

> *"Grant me the **serenity** to accept the things I cannot change, the **courage** to change the things I can, and the **wisdom** to know the difference."*[927]
>
> *"**Wisdom** is the ability to see the long-run consequences of current actions, the willingness to sacrifice short-run gains for long-run benefits, and the ability to control what is controllable and not to fret over what is not. Therefore the essence of wisdom is the **concern for the future**. It is not the type of concern with the future that the fortune teller has; he only tries to **predict** it. The wise man tries to **control** it."*[928]

The notion of organizational inertia is well-established in the fields of sociology and organizational behavior (Hannan and Freeman, 1984). It accounts for the reason that there is a time delay in an organization's ability to adapt to *environmental* change. For this reason, the framework adopted herein refers to *architectural* inertia.

As shown in Figure 261 below, architectural inertia, as asserted by the population ecologists is a function of a number of organization attributes, including: age, size and reproducible structure (which is derived from institutionalization and standardized routines).[929]

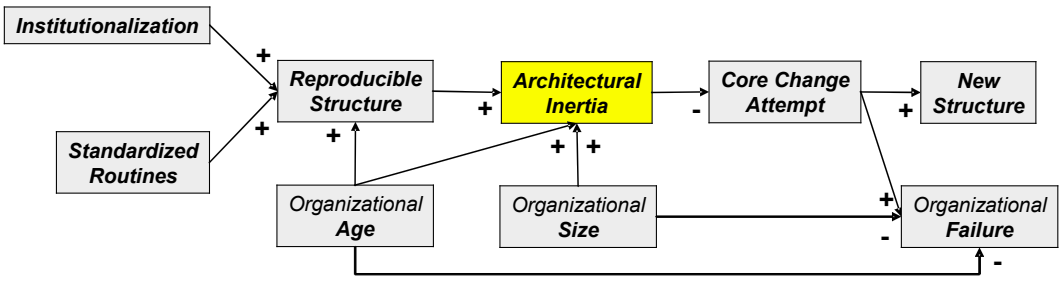

Figure 261: Sources of *Architectural* Inertia[930]

Although the notion of inertia was derived over 300 years ago in the physical sciences, in that setting, mass or inertia was typically seen as a constant in most problems of physics. In an organizational setting, inertia is a function of organization age (as shown above), and is therefore not a constant but variable with respect to time. This makes the dynamic equations of motion coupled and therefore nonlinear.

[927] Attributed to Boethius, 5th century Roman philosopher.
[928] Ackoff, R. (1999). pg. 99.
[929] Kelly and Amburgy (1991).
[930] Kelly and Amburgy (1991).

Architectural inertia constrains timely evolution of enterprises in response to environmental shifts. As shown in Figure 262 below, architectural inertia presents difficulty for modular enterprises which are post-dominant design and competing with integral enterprises; as well as for integral enterprises which face the discontinuity of creative destruction.

Architectural inertia impacts the nature and importance of strategy as the firm evolves over time. In other words, is architectural inertia low enough that strategic choice is possible, or is it high enough that environmental pressures dominate?

Heuristic 3k:
Dominant designs in enterprise architectures grow unchallenged for most of the industry lifecycle, acquiring architectural inertia, before a new architectural form emerges, making it very difficult to change its form.

As each enterprise architectural form typifies the initiation of a particular competitive regime (e.g. modular architectures initiate discontinuities and dominate until the establishment of a dominant product design, while integral architectures dominate once the dominant design is established until the next discontinuity is created[931]), it will have a significant amount of time to age (i.e. approximately half the duration of the industry S-curve) to grow architectural inertia, making it very difficult to change when a new enterprise architecture is created.

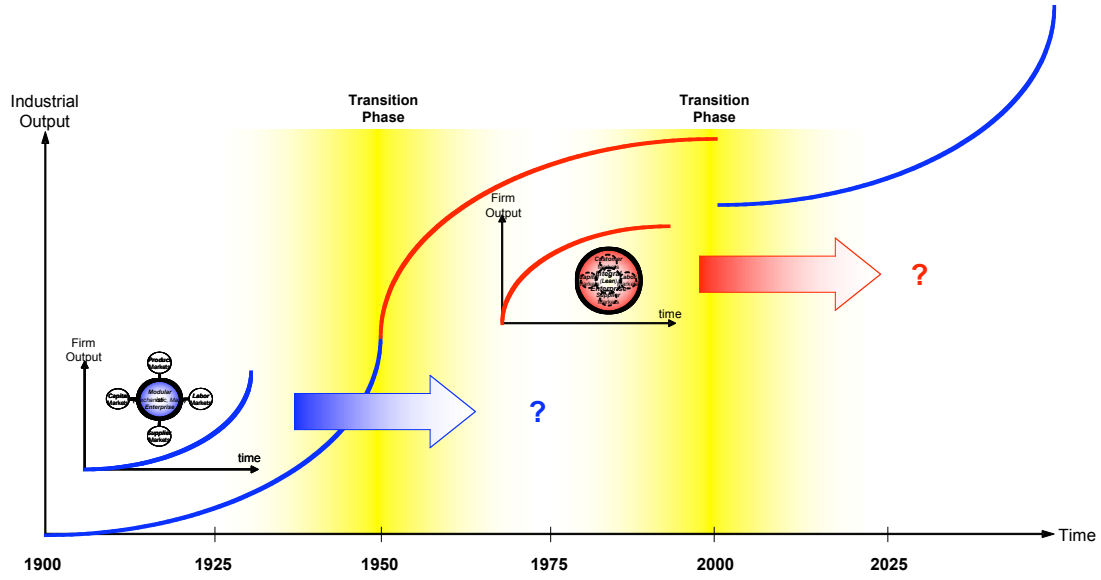

Figure 262: Strategic Renewal

Heuristic 3l:

[931] At this stage, the discussion assumes a two-stage modular-integral evolution, as opposed to the three-stage form discussed later.

Enterprise architectures that become out-of-fit with their environments, do not rapidly adjust and can continue to exist (albeit in a less competitive state) long after the emergence of a dominant design or a technological discontinuity due to architectural inertia.

Architectural inertia, while seemingly a function of organization age and size, have different sub-determinants depending upon whether they are modular or integral.

Modular enterprise architectures are highly flexible and adaptable to environmental change due to their modular "plug-and-play" interfaces with stakeholders. However architectural inertia grows over time due to their age, size and routine development.

Heuristic 3m:
Modular enterprise architectures develop architectural inertia over time due to age, size and routine development, in spite of their inherent flexible, adaptable design.

Integral enterprise architectures are highly inflexible to environmental change due to their high commitment to stakeholders around a specific environmental regime (e.g. a stable, saturated market). From architectural design theory, integral architecture forms are highly optimized to minimize risk and uncertainty in the external environment.

Heuristic 3n:
Integral enterprise architectures also develop architectural inertia over time due to age, size and routine development, which supplements their inherent inflexible environment-specific form.

> *"**Integrated** structures reduce a system's **flexibility** and ability to adapt to environmental changes thus increasing **architectural inertia**."*[932]

Heuristic 3o:
As the nature of technological discontinuities tends to consist of large, rare, discrete step-changes, the "loading function" on the enterprise tends to be a pulse, in the spirit of Shumpeter's "creative destruction."[933]

Finally, using the theory developed thus far, one can begin to explain why change often does not occur, even long after the environment has begun to change. Do managers not see the environmental change? Do they see it, but the inertia is too high making change very slow?

If modular enterprise architectures are built to thrive in growing environments, and integral enterprise architectures are built to thrive in a less munificent environments, why do modular architectures continue to pursue their strategies long after the inflection of the environment? The answer may lie (at least for dynamically complex industries, which exhibit significant "boom and bust" cycles) in the fact that although the underlying "signal" of the S-curve has long saturated, there is a second mode "boom and bust" oscillation that is superimposed on the saturated market (i.e. "noise").

[932] Eytan Lasry (University of Toronto, working paper).
[933] The enterprise response spectra therefore tend to be *shock spectra*, Piepenbrock, T. (2004).

In other words, even though the commercial airplane market (with its current 10-year "boom and bust" cycle) may have started to saturate fifty years ago, *Boeing* is still modular because every five years there is a tremendous growth opportunity. Modular architectures built for rapid growth stay modular, because rapid growth opportunities still exist as shown schematically in Figure 263 below.

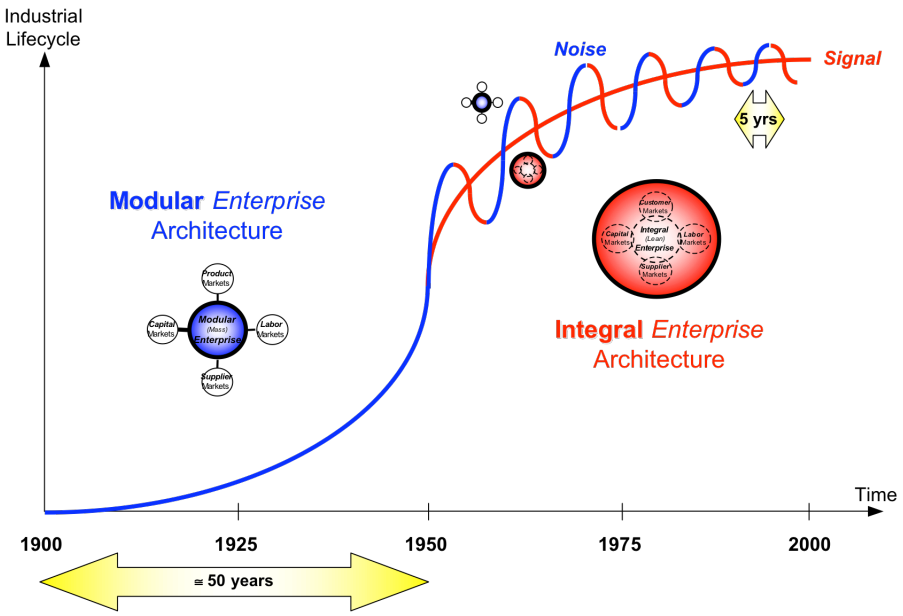

Figure 263: Cyclical Growth Spurts in a Maturing Industry Inhibit Architectural Change

6.19.2.4 The "Physics" of Architectural Change

Tushman and Romanelli (1985) argued that punctuated organizational change will occur if the following three conditions are present:

- The *pressure* to change is high (i.e. poor performance).
- The *ability* to change is high (i.e. low structural inertia).
- Environmental *misfit* is perceived (i.e. visionary leadership).

Sastry (1997) developed a formal system dynamics model of these punctuated change processes which has been modified as shown in Figure 264 below to adapt to the framework.

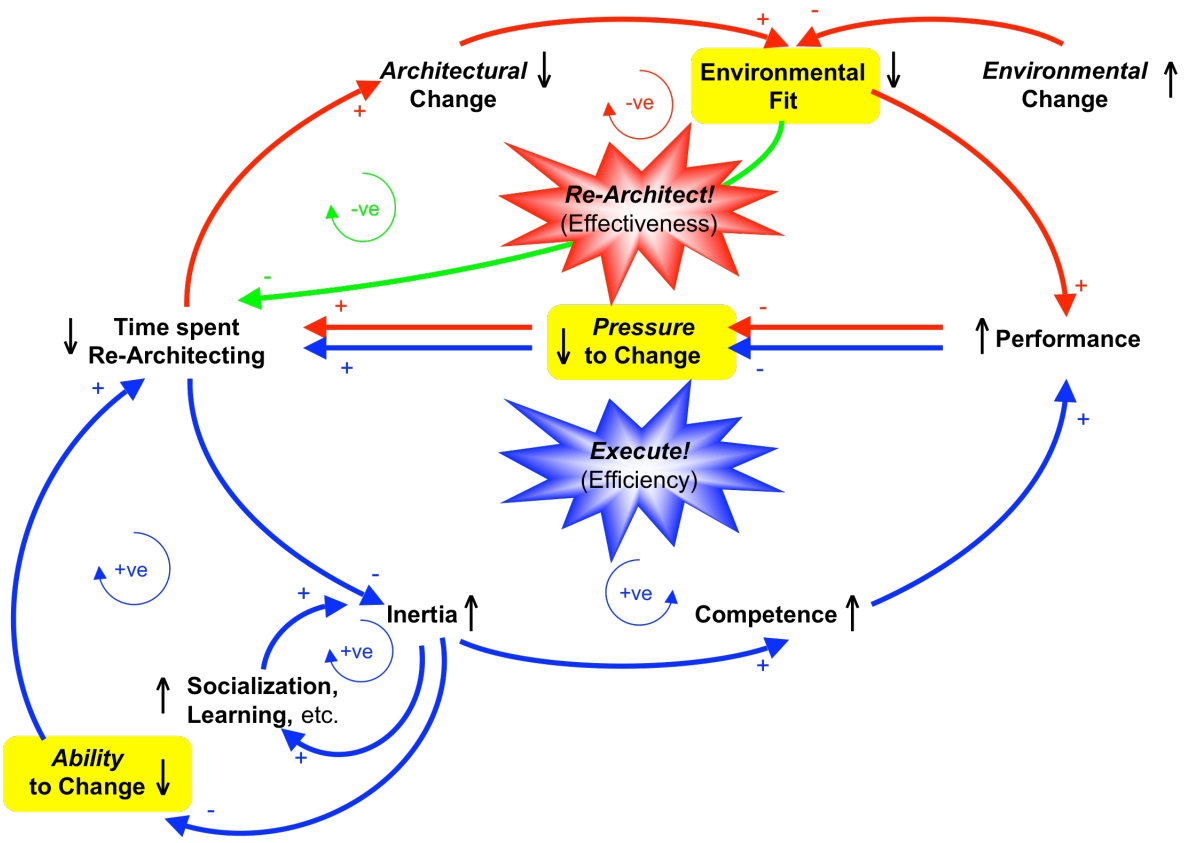

Figure 264: Exploit-Explore Dynamics of Architectural Change

From this figure, one can see the competing dynamics of change in the face of poor performance as being either:

- Execute faster and harder (bottom *reinforcing* loop).
- Realign to achieve environmental fit (top *balancing* loop).

When not facing poor performance, these mechanisms can translate into the well-known mechanisms of *exploitation* and *exploration*.

As can be seen, time spent executing builds inertia, which prevents future change if/when the environment changes. Therefore, the best way to "dissolve" the inertia or at least keep the effects of inertia at bay is to continuously take frequent but incremental forays up into the top balancing loop (mapping out a figure eight around the causal loops) to ensure fit and/or to explore. This appears to be what *Toyota* has done well. This may also explain how modular enterprise architectures which tend toward short-term exploitation, grow significant structural inertia, making the infrequent attempts at architectural change less successful.

In addition, if there are time delays in determining and implementing architectural change in response to environmental change, this will result in a worse-before-better tradeoff and oscillation due to the existence of delays on a balancing loop, which again is a problem associated with modular enterprise architectures.

6.19.2.5 Facing the Discontinuity: *Re*-integration to *Fight* or for *Flight*?

When faced with a maturing industry, is it easier/better for an incumbent to stay and fight by re-integrating itself around *process* innovation in order to fit more with the new evolving demands of the environment or is it easier/better to take flight by re-integrating itself around new *product* innovation? An example of the former might be *Chrysler* in the early 1990's under the direction of Thomas Stallkamp in which re-integrated supplier networks around quality, cost and delivery metrics brought new success (Dyer, 2000), while an example of the latter might be *IBM* in the 1990's under the direction of Lou Gerstner in which a re-integration around services took place (Gerstner, 2002).[934]

In either case, re-integration of a modular (and dis-integrating) enterprise is not straightforward, as it often appears to require the re-building of trust with existing stakeholders, which is often harder than new integral enterprise starting from scratch.

6.19.2.6 Facing the Discontinuity: *Dis*-integration to *Fight* or for *Flight*?

Finally, is it easier/better for a modular incumbent in a maturing industry to continue to dis-integrate and either: stay and fight by "integrating" competitors via consolidation or is it easier/better to take flight by continuing to exploit and "diversify" and re-deploy capital (i.e. to exit)? As was discussed earlier, post-dominant design dis-integrating enterprises are successful when they consolidate as opposed to diversify.

[934] I am indebted to Prof. Charlie Fine for suggesting these to me, and for his own development of these hypotheses in his own research.

6.20 *Symbiotic* Competition within Heterogeneous Architectural Ecosystems

The following section discusses various formal simulation models used to understand the competitive interaction between firms embedded within heterogeneous enterprise architectures and the co-evolution with their industry.

6.20.1 Biological *(Boreal)* *Ecosystem*

Before investigating *business* ecosystems, the following discussion of the evolution of *biological* ecosystems is used to illustrate the framework. We look at the well-known forest (or Canadian boreal) ecosystem consisting of pine, aspen and spruce species of trees.[935]

As shown in Figure 265 below, the lifecycle of the ecosystem consists of the symbiotic competition between two sets of species, designed to grow in different environments: the jack pine and aspen in post-fire soil which is rich in nutrients, and the black spruce in later pine and aspen environments.

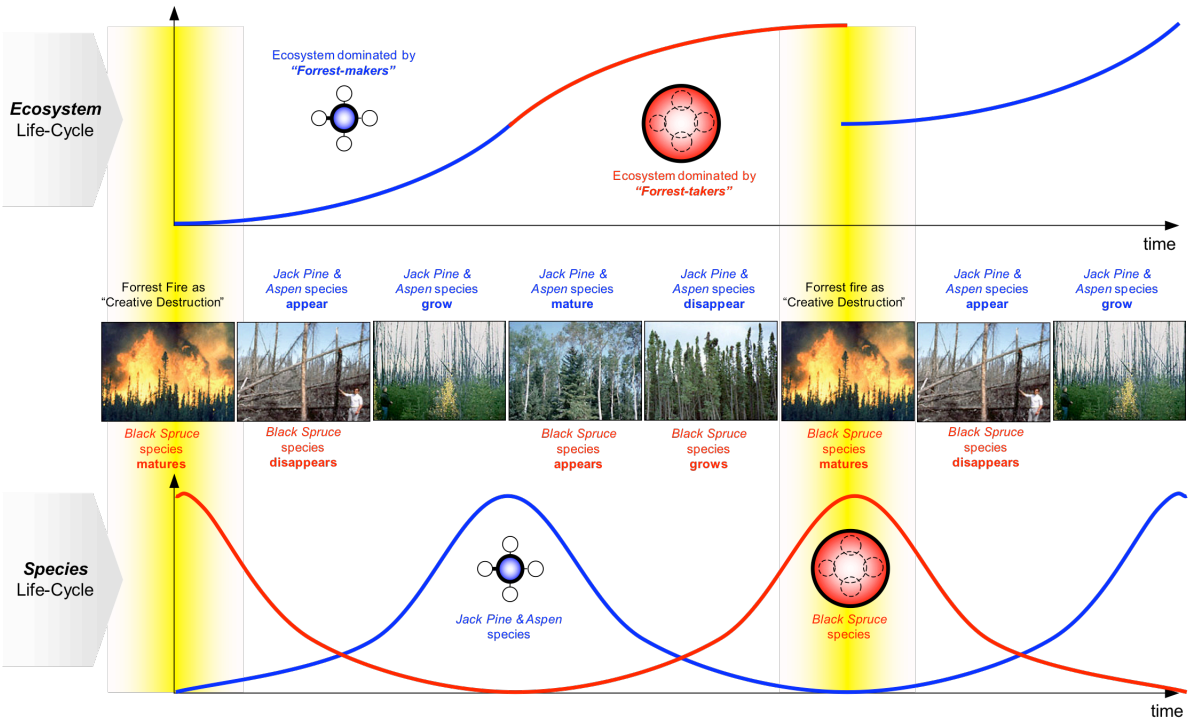

Figure 265: Symbiotic Competition in a Biological (boreal) Ecosystem

[935] I am indebted to MIT PhD student, Jason Jay for bringing this example to my attention during one of my lectures at the MIT PhD class, *Enterprise Architecting*, in Spring 2006. Photos are from *earthobservatory.nasa.gov/study/boreasfire/*.

The two species do not merely exist, they co-exist symbiotically, i.e. create the conditions for the growth and ultimate destruction of the other species. In other words, they create and destroy their own carrying capacities. The spruce create the conditions for "market-clearing" creative destruction (Schumpeter, 1939) via forest fire; the forest fire creates the clear sunlight and rich soil necessary to grow the "pioneer species", the pines and aspen; the pines and aspen create the environment for the spruce, which ultimately choke off their sunlight. While the two species are in a competitive struggle to the death, they need each other to create the conditions for life.

Note that like the framework presented herein for business ecosystems, this example shows how the biological ecosystem evolves over time from one species of dominance to another, yet it does not describe how the very long-term random processes of variation, selection and retention evolve the species of trees that exist in the forest.

Recall this symbiosis was proved mathematically by the mixed duopoly economics of *profit-maximizing* firms (i.e. pines & aspen) vs. the *labor-managed* firms (i.e. spruce), in which the LM firms grew to slowly to survive in the rich growth environment.

The causal physics of the nonlinear dynamic interplay between the two species will be discussed in subsequent sections under the classical "predator-prey" formulation.

6.20.2 *Historical Modeling of* Competition

First, we will briefly survey the formal (mathematical) modeling traditions in populations of organisms and organizations.

6.20.2.1 *Biological* Competition within the *Mathematical* Modeling Tradition

6.20.2.1.1 Population Growth of Verhulst (1838)

> *"The **positive loop** corresponds to the tendency of the population to grow at a rate proportional to itself. The **negative loop** corresponds to the growth-limiting effects Verhulst envisioned in conflict and stress. Thus over time **the system changes its own growth tendencies**. In feedback terms, the system shows a **gradual shift in loop dominance**."*[936]

Verhulst (1838).

6.20.2.1.2 Predator-Prey Ecosystem of Lotka-Voltera (1925-1926)

> *"But unquestionably his* [Lotka's] *most quoted contribution is the model of a **closed ecosystem** attributed jointly to him and to Volterra (1931)."*[937]

Predator-Prey "competition" within a biological ecosystem. (Lotka, 1925; and Volterra, 1926).

6.20.2.2 *Firm* Competition within the *System Dynamics* Tradition

Within the 50-year history of system dynamics, an intellectual thread has developed which has embraced competitive dynamics between firms. After Forrester's original work in the 1960's (Forrester, 1961 and 1968), the thread is picked up again by Sterman (Sterman, 1989; Sterman, 1991; Paich and Sterman, 1993; Sterman, Henderson, Beinhocker, Newman, 1995; Langley, Paich, Sterman, 1999; and Sterman, 2000) and again more recently by researchers in the UK (Sice, Mosekilde, Moscardini, Lawler, and French, 2000; Warren, 2002; Kunc, 2004; Kunc and Morecroft, 2004).

6.20.2.2.1 Embracing *Macro*-Structures: Forrester (1960-1970)

> *"If **substantially different policies** would be **desirable for the industry**, there then arises the question of what will happen should **one company unilaterally adopt these policies**. Differences in policy that tend to differentiate a company on the basis of its **dynamic characteristics** will be an important aspect of **competitive models**."*[938]

While Forrester (1961) originally noted the potential for explicit modeling of the competitive dynamics of firms having differing policies, his first research effort focused on understanding the dynamics of an industry composed of homogeneous firms.

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[936] Richardson, G.P. (1990), pg. 33.
[937] Richardson, G.P. (1990), pg. 36.
[938] Forrester, J.W. (1961), pp. 336 and 337.

> *"It seems **wise** to start a study of dynamic characteristics with the **industry as a whole**. Once the nature of the industry is adequately understood, the study of different policies between companies becomes important."*[939]

Forrester's subsequent research effort the "Market Growth Model" (1966) also represented the competitive environment passively by specifying the exogenous benchmarks for competitive success. The purpose of this benchmark was not necessarily to simulate the true behavior of competitors, but to represent abstractly the standards that customers judge product attractiveness (Kunc and Morecroft, 2004).

6.20.2.2.2 Embracing *Micro*-Behaviors: Sterman (1985-2000)

> *"The **playing field is level** – the **structure and parameters** for the firm and its competitor are identical."*[940]

The focus on firm performance picks up again with the development of management flight simulators looking at specific firms like *People Express Airlines* (Sterman, 1988), and more generally, the *Boom and Bust Enterprises* (Sterman, 1991). The emphasis now was less on industry dynamics but on managerial perceptions and misperceptions using behavioral decision theory. This time, competition is modeled slightly more explicitly and directly, as a matrix of discrete competitor pricing strategies and market environment scenarios.

6.20.2.2.3 Embracing the *Meso*-Interactions: Morecroft (2000-2005)

(Sice, Mosekilde, Moscardini, Lawler, and French, 2000).

> *"The model reflects the essential relationships of **two equivalent competitors** and reveals the possible dynamics of the battle for customers."*

(Warren, 2002; Kunc, 2004; Kunc and Morecroft, 2004).

> *"However, not all business dynamics problems can be modeled as individual firms or as aggregate industries. **Industry evolution** is one important exception. During the evolution of industries, the process of mutual adjustment between **heterogeneous firms** is particularly relevant because the actions of individual firms sooner or later influence the responses of other firms in the same industry."*[941]

[939] Forrester, J.W. (1961), pg. 336.
[940] Paich and Sterman (1993), pg. 1442.
[941] Kunc and Morecroft (2004), pg. 4.

6.20.3 *Formal Models of Business Ecosystems*

6.20.3.1 *Bertrand* Competition & "The Principle of Competitive Exclusion"

In ecosystem biology and population ecology (Hannan & Freeman, 1977), interspecies competition, is traditionally modeled with rather simple and severe assumptions. "The Principle of Competitive Exclusion" states no two species can occupy the same niche in equilibrium. The underlying assumption to this principle is based on Bertrand (1883) or price-based competition, in which, the winner-takes-all.

6.20.3.2 *Boom & Bust Enterprises* Revisited

Paich and Sterman (1993) identify a variety of competitive strategies ranging from "Adaptive" to "Ballistic" in their models of competition to build a market.

"Adaptive" vs. "ballistic" strategies win at different phases during the industry lifecycle.

6.20.3.3 *Predator - Prey Ecosystem* Revisited

From essays #1 and #2, it is plausible that the *modular* enterprise architecture, which seeks growth and disregard for its environment can be modeled as a "prey" species, whereas the *integral* enterprise architecture, which seeks stability and harmony with its environment can be modeled as a "predator" species, in the classic population ecological sense.

The governing growth dynamics of each population of species are driven separately by S-shaped growth dynamics (Lotka, 1925; and Volterra, 1926).[942] However, when "competing" together in an ecosystem for resources (e.g. sales revenues), their dynamics are coupled as one provides the carrying capacity for the other. This coupled nonlinear dynamic system generates stable but unpredictable chaotic oscillations as shown in Figure 266 below, the likes of which were discussed in the preceding sections.

[942] These S-shaped growth dynamics are generated by a reinforcing loop on the inflow and a balancing loop on the outflow of the population; as well as the existence of a carrying capacity which modifies that fractional birth and death rates.

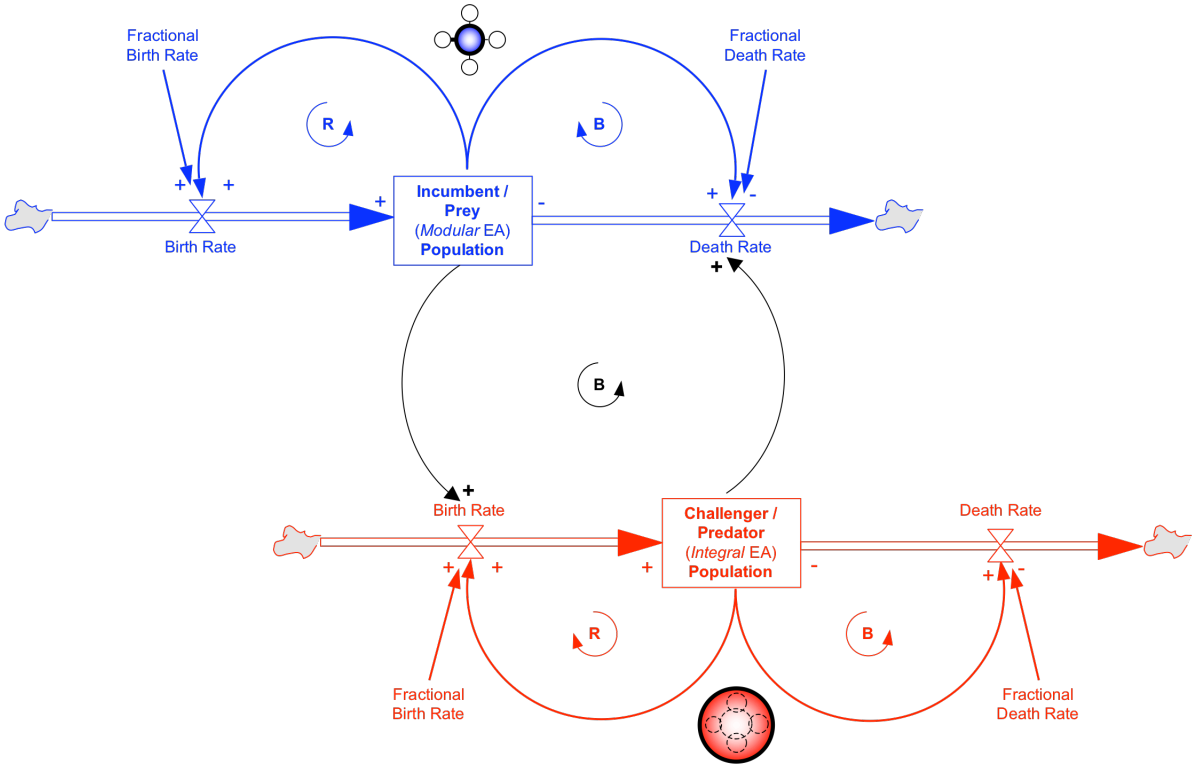


Figure 266: *Predator* (Integral) - *Prey* (Modular) Architectural Competitive Dynamics

6.20.4 *Evolutionary Oscillation of Enterprise Architectures*

> *"New patterns of behavior that emerge fall within **recognizable categories** – they are similar to but never the same as previous patterns of behavior. In this sense, **history repeats itself** but **things are never the same**."*[943]

A number of researchers have recently hypothesized the oscillatory dynamic evolution of product and supply chain architectures from integral to modular and back to integral (Schilling, 2000). Fine (1998) refers to this as the "double helix", Chesbrough (2003) alludes to "a cyclical model" of the dynamics of modularity, and finally Christensen et al. (2004) develop the theory of "Value Chain Evolution".

> *"Product architectures are **dynamic and unstable** as they continually migrate toward or away from increased modularity. Given the evolutionary nature of the relationships between technologies, firms and industries, changes in product architectures are both driven by and have significant repercussions on organizational and industry structures."*[944]

From system dynamics theory, this primary mode of architectural oscillation implies that there is a dominant mode consisting of negative or balancing goal-seeking behavior with delays.

Heuristic 3p:
The enterprise architectural forms (modular vs. integral) will evolve over time from integral to modular (i.e. the process of *disintegration*). The dominant architectural form from an industry population perspective will evolve over time from integral, to modular and back to integral – i.e. re-integration occurs at a population level, not at firm level.

> *"**Speciation** is a property of populations (organisms do not speciate), while **extinction*** [a sorting process] *is often a simple concatenation of deaths among organisms."*[945]

The capability of a firm to evolve (through strategic choice or environmental determinism) the architecture of its extended enterprise under competitive pressures from rival enterprises is governed by the amount of structural inertia it possesses.

> *"It should not be taken as given that the **strategic shifts required** to compete successfully in a **maturing industry** should be attempted at all, in view of the substantial and perhaps new types of skill that may be required."*[946]

The debate on whether or not it is possible for an enterprise's architecture to evolve is joined by the normative question of whether or not firm leaders *should* attempt the evolution.

> *"Industry leaders may or may not be in the best position to make the adjustments required by transition if they have substantial **inertia** built into their strategies and strong ties to the strategic requirements of the **growth phase** of the industry's development…a **new firm entering the***

[943] Stacey, R.D. (1995), pg. 483.
[944] Eytan Lasry (University of Toronto, working paper).
[945] Gould, S.J. (1989), pg. 122.
[946] Porter. M.E. (1980), pg. 246.

> ***industry during the transition phase**, possessing financial and other resources but no ties to the past, is often able to establish a **strong position**."*[947]

Figure 267 below illustrates the co-evolutionary feedback dynamics defined by the theory.[948] Note how the enterprise architecture drives the enterprise structure, which drives the firm performance, which shapes the evolution of the industrial environment. Also note how the feedback switches from integral to modular and back to integral again. This will be discussed further in subsequent sections.

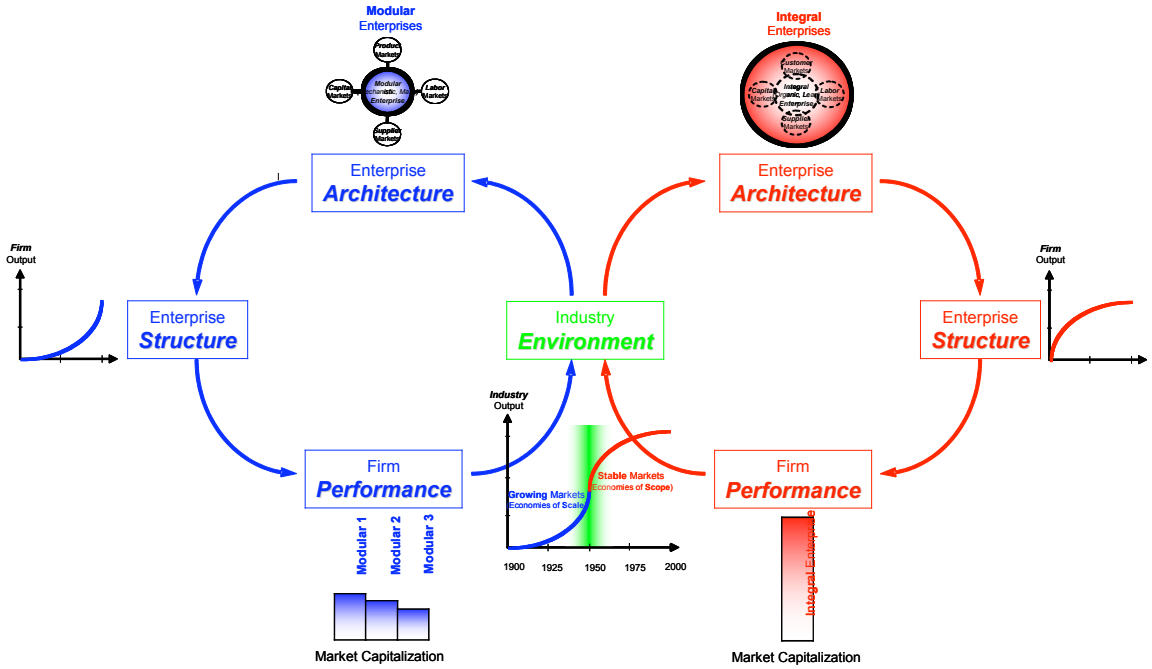


Figure 267: Co-Evolutionary Feedback Dynamics of the "Double Helix"

[947] Porter. M.E. (1980), pp. 246-247.
[948] Kunc, M. and Morecroft, J. (2004).

6.21 Chapter Summary

This chapter was the third of three essays which forms an integrated framework which attempts to explain long-term firm performance. In this chapter, we defined the construct of industrial evolution, and how it co-evolves with the performance of firms.

The context for this construct within the framework is shown below in Figure 268. Going back to Essay #1, we can now begin to see how different enterprise architectures are born or created in different states of the environment or industrial evolution.

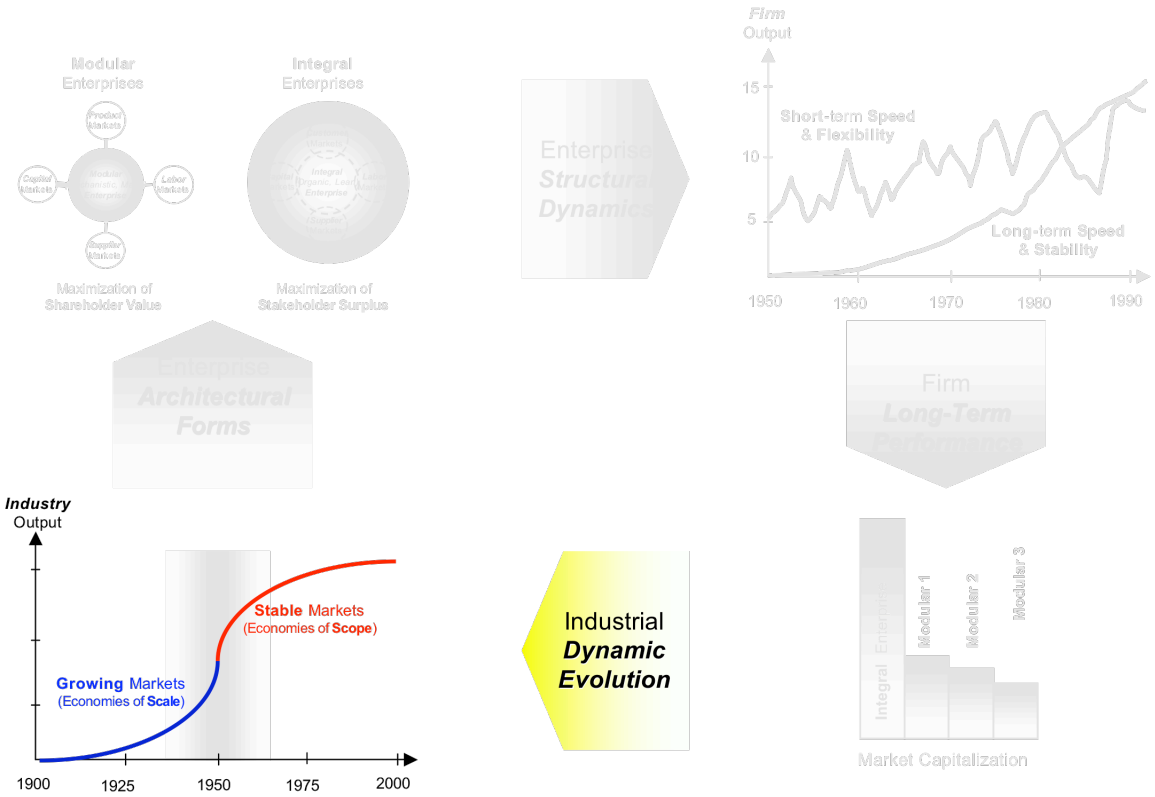


Figure 268: Enterprise - *Environment Evolution* and *Co-Evolution* within Framework

Part III: INTEGRATING THE THEORY

Chapter 7 Formal Mathematical Model and Numerical Simulation

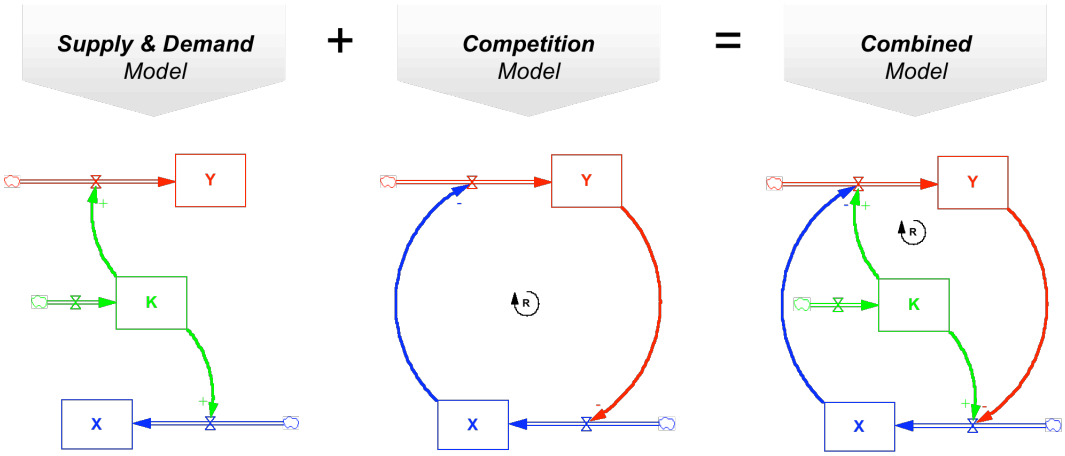
Equations of Motion. The evolution of business ecosystems will be expressed formally by a system of *coupled simultaneous nonlinear* differential equations,[949] where the state variables, X_n are stocks which accumulate net flows (dX_n/dt) over time.

$$dX_1/dt = f_1(X_1, X_2, \ldots, X_n)$$
$$dX_2/dt = f_2(X_1, X_2, \ldots, X_n)$$
$$\vdots$$
$$dX_n/dt = f_n(X_1, X_2, \ldots, X_n)$$

Note that such equations form a feedback system that generates system dynamics endogenously, via information from the various state variables, which feed back to influence their own rates of change.[950] When formulating these equations of motion, we aim for parsimony, i.e. the least amount of causal structure to explain the most salient features of the dynamic behavior of the evolution of business ecosystems. Clearly more detailed models can (and eventually hopefully will) add more precise insights into this dynamic phenomena.

Conceptual Formulation. The combined model represents a predator-prey interaction, with two firm "predators" in interspecies competition for a market "prey" evolving into two niches. The organization-environment ecosystem model will consist of four primary state variables. The market environment K will be represented in the two dimensions of quantity (i.e. the state of *diffusion*) and quality (i.e. the state of *commoditization*). The competitive environment will be represented in two dimensions representing species archetypes of early entrant "market-maker" X and later entrant "market-taker" Y. The basic ecological interactions between organization and environment are shown in Figure 269 below.

Figure 269: Constituent Elements of Conceptual Model



[949] In the traditions of the general system theory (e.g. Von Bertalanffy, 1950), cybernetics (e.g. Ashby, 1952), system dynamics (e.g. Forrester, 1961); as well as organizational ecology (e.g. Hannan and Freeman, 1977).
[950] System dynamics has been used for many years to model firm competition - See Appendix G for a brief summary. Most formulations are made with operational managerial decisions, while this research uses a higher-level ecological system formulation.

First, we present a model of supply and demand interaction. Most theories of the firm are unsurprisingly firm-centric and take the product/service offering as representing "supply" to a market of customers representing "demand". This ecosystem model focuses its lens on the carrying capacity of the market as representing "supply" of revenues to a market of competing firms representing "demand" for that revenue. Crucially, by allowing the market K to vary over time in terms of amount and type of product/service demanded/supplied, we lay the theoretical foundations for the emergence of heterogeneous competing organizational species X and Y. Note that the market K size (a stock) positively affects the growth rates (flows) of the competitors.

Second, we present a model of inter-species competition. Here we note simply that in a market of finite carrying capacity, one firm's amount of market, say X (a stock), negatively impacts or reduces the growth rate of its competitor's (a flow), in what is known in the ecological sciences as "exploitation" (as opposed to) "interference" competition. This simple formulation endogenously links the competitor organizations with their environment in closed-loop feedback. Unlike the classic Lotka-Volterra predator-prey equations in which the closed loop is negative or balancing and which generates oscillations, here the feedback is positive or reinforcing, resulting in the unstable "principle of competitive exclusion." We seek however, a nonlinear parametization of the model which will enable the inter-species dominance-switching that we observe empirically.

Model Build-Up. In the following sections, the model will be constructed progressively, each time adding a higher level of sophistication in order to more clearly understand the underlying assumptions, parameters, structure and behavior of the model at each stage of complexity. The following partial models will be analyzed and discussed sequentially:

Section 7.1
- *Constant* (Unchanging) Market
- *Intra*-species Competition in a Constant Market
- *Inter*-species Competition in a Constant Market

Section 7.2
- *Diffusing* Market (Quantity)
- *Intra*-species Competition in a Diffusing Market
- *Inter*-species Competition in a Diffusing Market

Section 7.3
- *Commoditizing* Market (Quality)
- *Intra*-species Competition in a Commoditizing Market
- *Inter*-species "Competition" in a Commoditizing Market

Section 7.4
- *Diffusing, Commoditizing* Market (Quantity and Quality)
- *Intra*-species Competition in a Diffusing, Commoditizing Market
- *Inter*-species Competition in a Diffusing, Commoditizing Market

Section 7.5
- Advanced Topics
- *Firm*-sector Topics
- *Market*-sector Topics

7.1 Competition in a *Constant (Unchanging)* Market Environment

7.1.1 Single Firm Growth in an *Infinite* Market

First, we assume a monopolist operating under increasing returns to scale. This assumption captures a variety of business phenomena including economies of scale, learning curve effects, etc. Under this reinforcing feedback, the more market the firm accumulates, the faster it continues to be accumulated.

Second, we assume initially that the firm exists in a market of unlimited growth potential – unlimited carrying capacity. The firm then is able to grow at its maximum fractional rate, r which is assumed to be constant and is determined by a number of goals and constraints which might include the rate of return on residual cash flows promised to risk bearers.[951]

Most models in organizational ecology focus on population size or density - expressed as number of organizations - as the primary state variable, which accumulates net flows of organizational entries and exits (e.g. Hannan and Freeman, 1977). Population size is of lower importance in these formulations. This paper however focuses instead on organizational size as approximated by the amount of environmental resources an organization accumulates, or more specifically in the case of business ecosystems, the amount of a market a firm possesses. In this way, a population could consist of a spectrum of organizations ranging from a large number of equally sized firms, each possessing the same percentage of the total market; to a single firm operating as a monopolist possessing the entire market. We will derive equations of motion for a firm accumulating market, X over time.[952]

The following differential equation captures this simple reinforcing feedback:

$$dX/dt = AR_X = r_X X \quad (1)$$

Where:

- X = firm X's acquired market
- dX/dt = the rate of change of firm X's market acquisition
- AR_X = firm X's acquisition rate of market (the inflow into X)
- r_X = firm X's maximum fractional acquisition rate of market

Constants. The model has one active "constant", r_X which is undoubtedly a time-dependent variable. This will be enforced in the next formulation.

[951] This is actually the fractional net growth rate, and has the units of percent of market growth per unit of time.
[952] For the present discussion, we assume that the firm converts demand into supply instantaneously or without any delays associated with order backlogs, inventory backlogs etc. Such delays in a balancing loop can account for cyclical oscillatory behavior. As the time horizon of interest in this evolutionary research is measured in centuries, the oscillations which manifest themselves over timeframes of decades are of secondary importance.

Figure 270 below illustrates the causal structure[953] of this *linear* first-order formulation, which results in unrestrained exponential growth of the firm's market acquisition.

Figure 270: Model Structure of Single Firm Growth in an *Infinite* Market

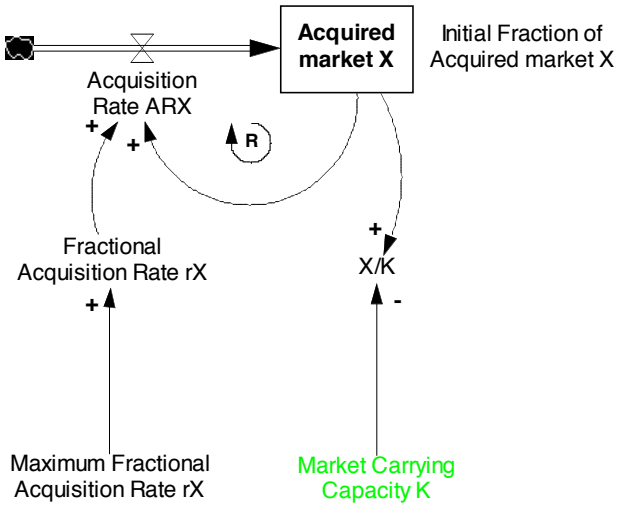
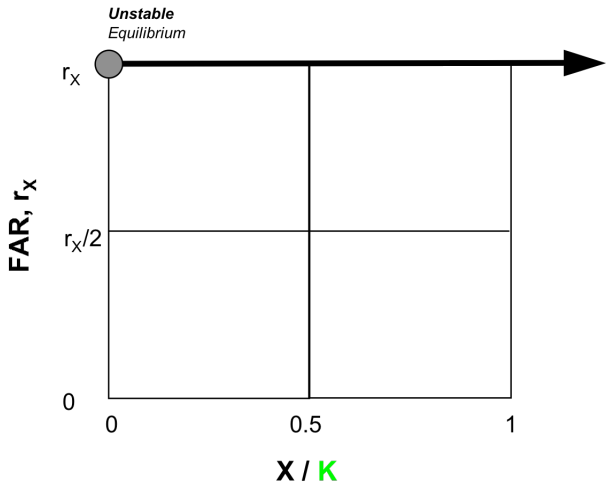


Figure 271 below shows the relationship between the firm's Fractional Acquisition Rate, r_X and the amount of the available market that it has taken. In this simple model of the firm, r_X is assumed to be constant and independent of the market availability.

Figure 271: Fractional Acquisition Rate of Firm in an *Infinite* Market

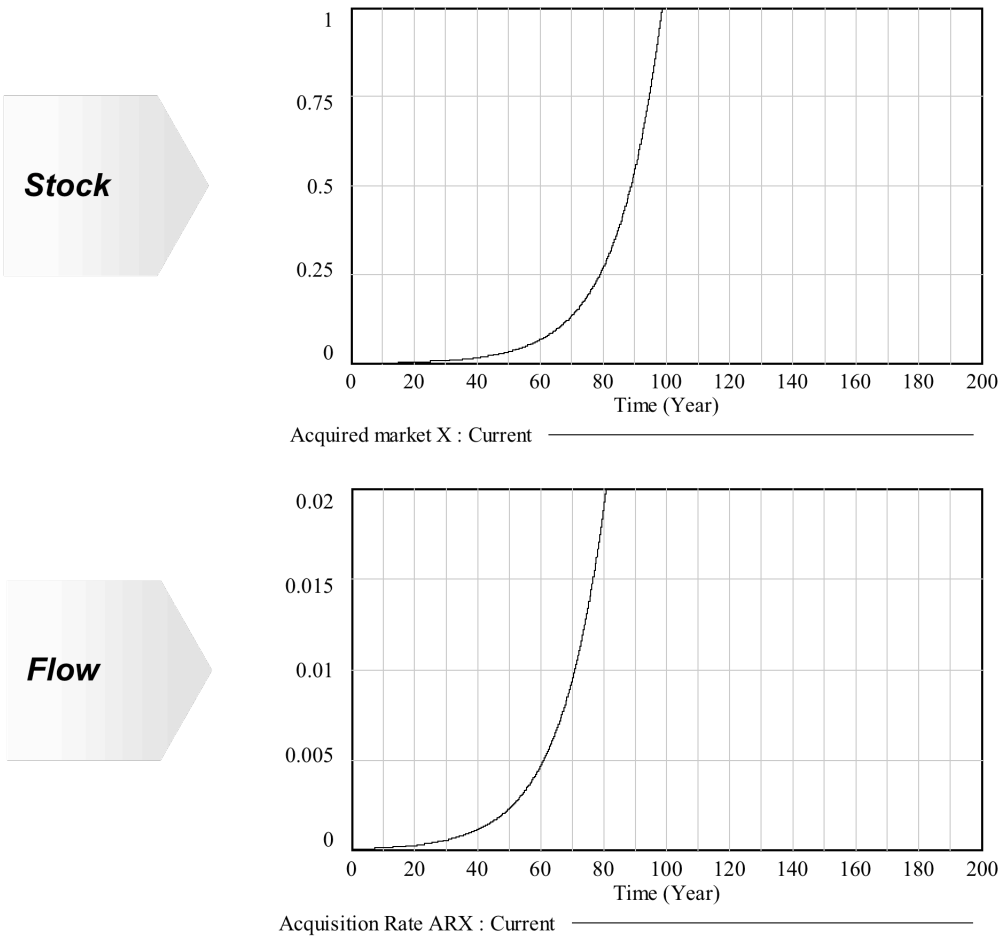


Organisms and organizations which maintain a constant r_X are known as "opportunist" species or r-strategists (Brittain and Freeman, 1980) that build – or take – ecosystems at high rates of growth and then exit them once the underlying growth opportunities diminish to find new opportunities in other ecosystems.

[953] In the diagrammatic representations of the differential equations, the "box" variables represent stocks or accumulations, while the variables below the "valves" represent rates or flows in and out of the stocks.

A firm starting out in a new ecosystem or market with constant r_X exists in an unstable equilibrium and exhibits unsustainable exponential growth that ultimately exceeds the carrying capacity of the ecosystem. The dynamic behaviour of such a firm is illustrated in Figure 272 below.

Figure 272: Dynamic Behavior of a Single Firm in an *Infinite* Market



One can either view this formulation as firm growth in an unlimited market, or as the early growth of a firm in a finite market, when its accumulated quantity of market, X is far from the carrying capacity of the market. What happens to this firm as it approaches the carrying capacity of the ecosystem will be covered in the subsequent section.

7.1.2 Single Firm Growth in a *Constant, Finfite* Market

As no firm exists in an infinitely rich resource environment, we next constrain the model by imposing finite but constant market carrying capacity, K, which might represent the size of population of potential customers or sales. The model now needs another feedback, this time a balancing loop which enables the firm growth to begin to slow down as it approaches the ecosystem's carrying capacity.

We therefore extend the previous differential equations to capture the mode-switching from reinforcing to balancing feedback as the firm approaches the carrying capacity of the market. This new logistic equation is shown below:[954]

$$dX/dt = AR_X = r_X X\,(1 - X/K) \qquad (2)$$
$$= r_X X - r_X X^2/K$$

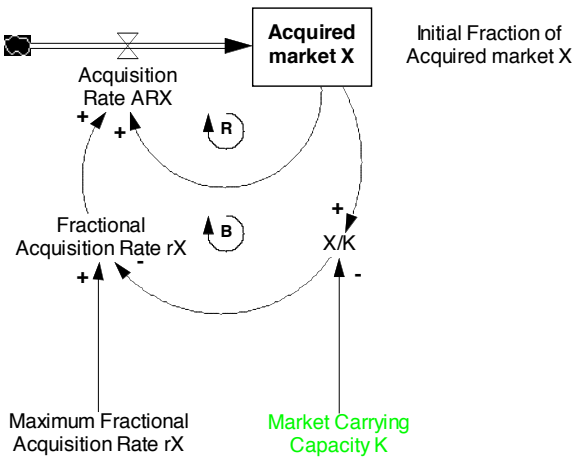
Where:

- K = the market carrying capacity of the ecosystem[955]

Constants. The model has two "constants", K and r_X which are undoubtedly time-dependent variables. For example, exogenous factors influencing the market carrying capacity K are consumer population size and wealth per capita, both time-dependent variables. A firm's maximum fractional acquisition rate r_X is also influenced by exogenous factors like stakeholder goals, resourse access, etc. each of which may also be time-dependent variables.

Figure 273 below illustrates the causal structure of this *linear* first-order formulation, which results in logistic growth of the firm's market acquisition. Note that since there is only in inflow to the stock of Acquired market X (which is controlled by both reinforcing and balancing loops) the value of the stock can only ever increase.

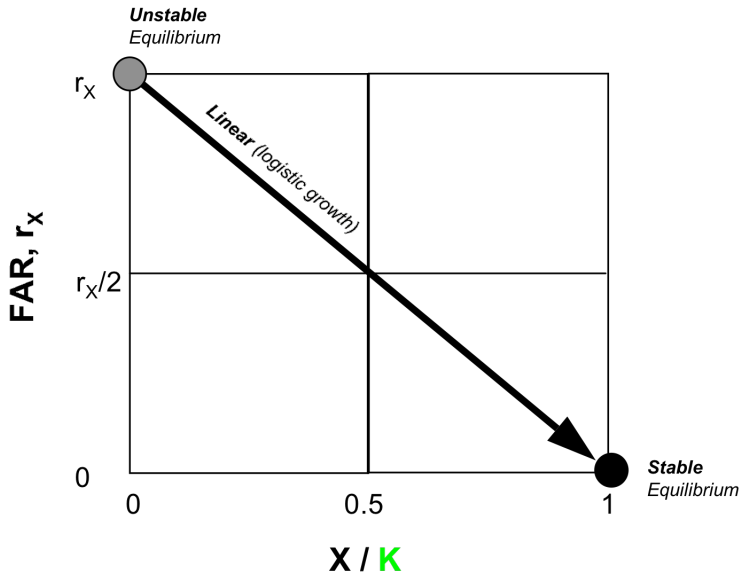
Figure 273: Model Structure of Single Firm Growth in a *Constant* Market



[954] This was first formulated in social systems by Verhulst (1838) in his logistic population growth model.
[955] Note: K need not be constant nor homogeneous. We will explore each in subsequent sections.

Figure 274 below shows the relationship between the firm's Fractional Acquisition Rate, r_X and the amount of the available market that it has taken. In this simple model of the firm, r_X is assumed to vary linearly with the the market availability. The assumption here is that, as the firm acquires more of the finite market, K, the rate of firm growth, r_X begins to reduce linearly[956], making the organization's rate of growth dependent upon the proportion of the carrying capacity that remains unexploited[957].

Figure 274: Fractional Acquisition Rate of Firm in a *Constant* Market



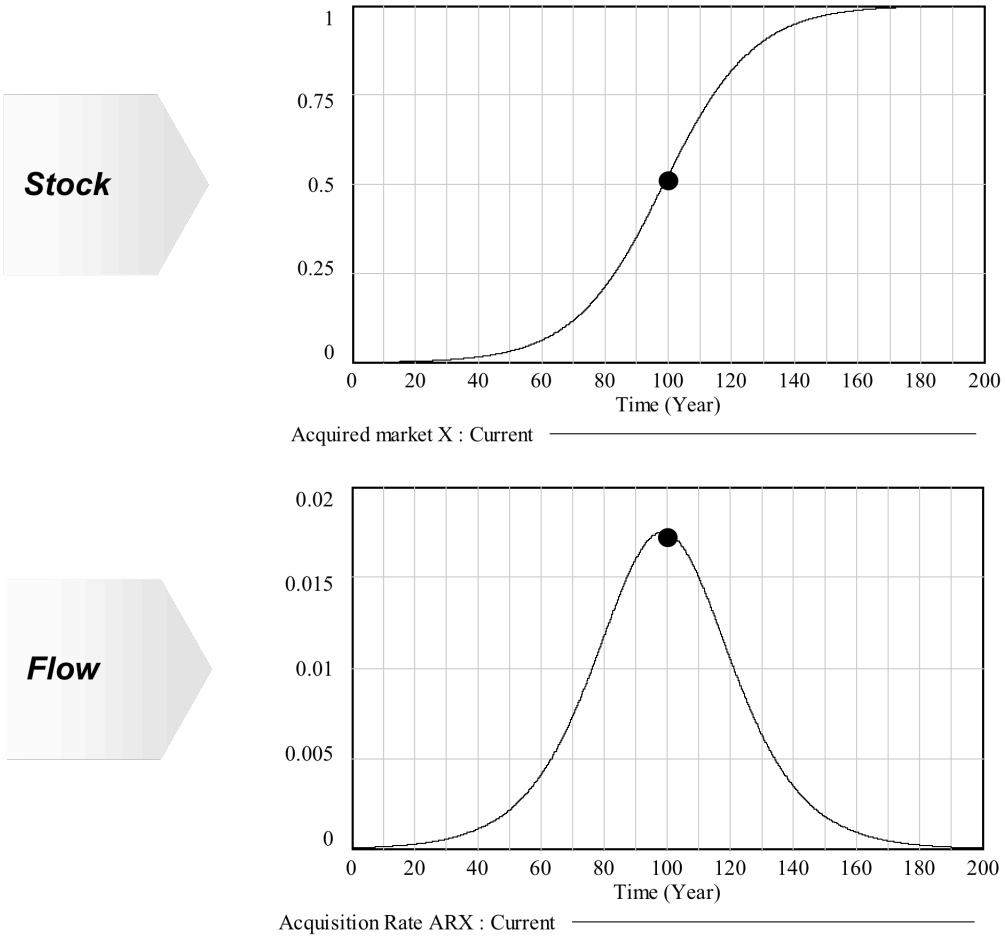
Organisms and organizations which vary their underlying growth rate r_X in response to the market carrying capacity, K are known as "equilibrium" species or K-strategists (Brittain and Freeman, 1980) that build – or take – ecosystems at slower rates of growth and then await for other ecosystems to be built by r-strategists before they move into that new market.

A firm starting out in a new ecosystem or market with linearly declining r_X exists in an unstable equilibrium and exhibits logistic growth towards the carrying capacity of the ecosystem.

Figure 275 below illustrates the dynamic behavior of this *nonlinear* first-order formulation, which results in sigmoid or S-shaped growth of the firm's market capture.

[956] This linear relationship, which produces logistic growth, will be relaxed in subsequent sections which explore interspecies competition.
[957] This is called "mass dependence" in the organizational ecology literature.

Figure 275: Dynamic Behavior of a Single Firm in a *Constant* Market



Note that *differentiation* of the stock (i.e. the slope of the line tangent to the curve), yields the flow or rate values, with the maximum rate (i.e. steepest slope) occurring at year 100. Conversely, note that *integration* of the flow (i.e. the area under the curve), yields the stock values, with the maximum stock occurring at year 200.

7.1.3 *Intra*-species Competition in a Constant Market[958]

In most markets, no firm exists without competition; we therefore need to next introduce competition between firms for customers in a common market. At this point, we assume two identical isomorphic competitors, X_1 and X_2 having homogeneous enterprise architectures occupying the same mathematical point niche. We therefore extend the previous differential equation (2) to account for the simple fact that the addition of sales to either competitor decreases the rate of growth of the other competitor.[959] Both competitors are now connected via a reinforcing loop that amplifies differences in market share resulting in an unstable equilibrium.[960] The new, coupled system of differential equations is shown below:[961]

$$dX_1/dt = AR_{X1} = r_{X1}X_1\,(1 - X_1/K - X_2\,\alpha_{12}/K) \qquad (3a)$$
$$= r_{X1}X_1 - r_{X1}X_1^2/K - r_{X1}X_1X_2\,\alpha_{12}/K$$
$$dX_2/dt = AR_{X2} = r_{X2}X_2\,(1 - X_2/K - X_1\,\alpha_{21}/K) \qquad (3b)$$
$$= r_{X2}X_2 - r_{X2}X_2^2/K - r_{X2}X_2X_1\alpha_{21}/K$$

Where:

- α_{12} = firm X_1's competition coefficient
- α_{21} = firm X_2's competition coefficient

The competition coefficient defines the intensity of competition. If firm X_1 competes directly in the same market or niche as firm X_2, then its competition coefficient $\alpha_{12} = 1$. This is the implicit assumption of the model formulation at this point. Later, we will explore the opposite case, where the competition coefficient $\alpha = 0$, that is competition in heterogeneous (commoditizing) market environments, in which niches develop that are suited to different species of organiztions.

Figure 276 below illustrates the causal structure of this nonlinear *second*-order formulation, which results in sigmoid or S-shaped growth of each competitor's market capture. Provided that both firms have identical forms and occupy the same market niche, no two-firm (or more generally, two-population) equilibrium can be stable – any exogenous shock to the system will result in the elimination of one of the firms (or populations).[962]

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[958] By definition, in *intra*-species competition each stock represents a firm (or collection of firms having similar growth rate characteristics) but not an entire species.

[959] In ecology, this is called "exploitation" (vs. "interference") competition (Brian, 1956). Other dynamic models formulate competition using more operational variables (Sterman, Henderson, Beinhocker and Newman, 2007).

[960] This severe "winner-takes-all" competitive assumption is akin to Bertrand (price) competition, rather than the weaker form of Cournot (quantity) competition where the market is shared in proportion to relative firm growth rates. Under this assumption, the "competition coefficients", α_{12} and α_{21} equal 1.

[961] This system of equations formed the basis for modeling competition within the seminal organizational ecology framework (Hannan and Freeman, 1977: 942). It is based on the classic Lotka-Volterra equations for *competing* populations, after Lotka (1925) and Volterra (1931). Note that this is different from the classic Lotka-Volterra equations for *predator-prey* populations which generate chaotic oscillation due to a central *balancing* loop.

[962] This is known in ecosystem theory as the "principle of competitive exclusion" (Gause, 1934).

Figure 276: Model Structure of *Intra*-species Competition in a *Constant* Market

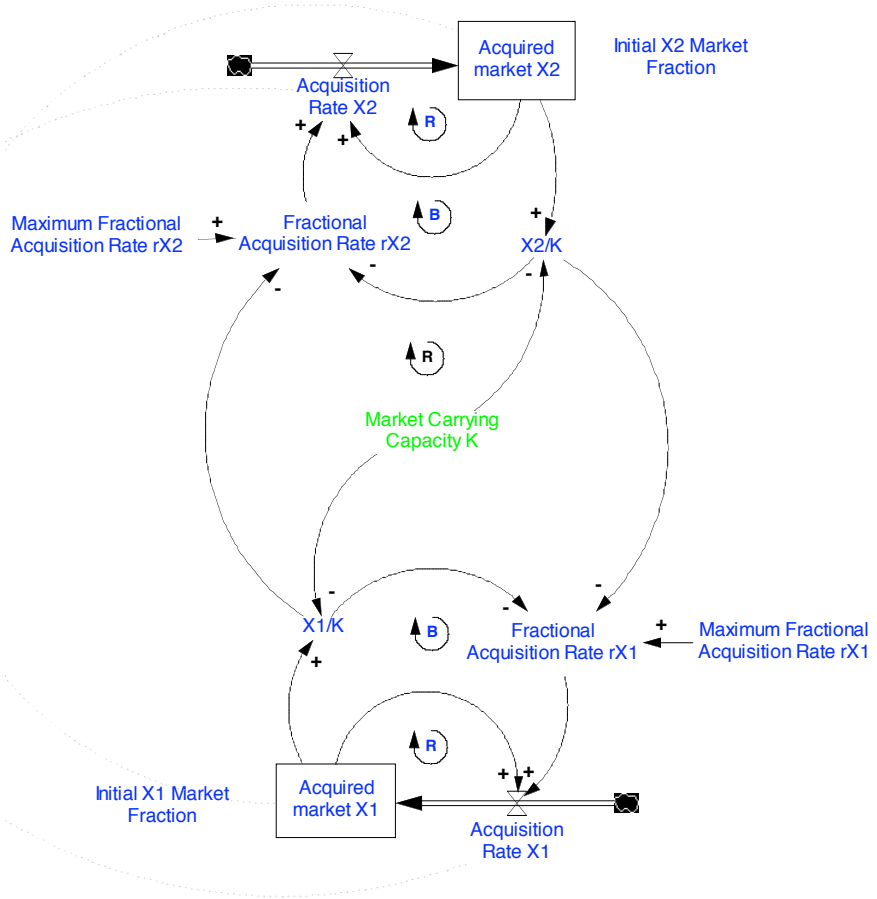


Figure 277 below illustrates the relationship between the competing firms' Fractional Acquisition Rates, r_{X1} and r_{X2} and the amount of the available market that they have collectively taken .

Figure 277: Fractional Acquisition Rates of *Competing Firms* in a Constant Market

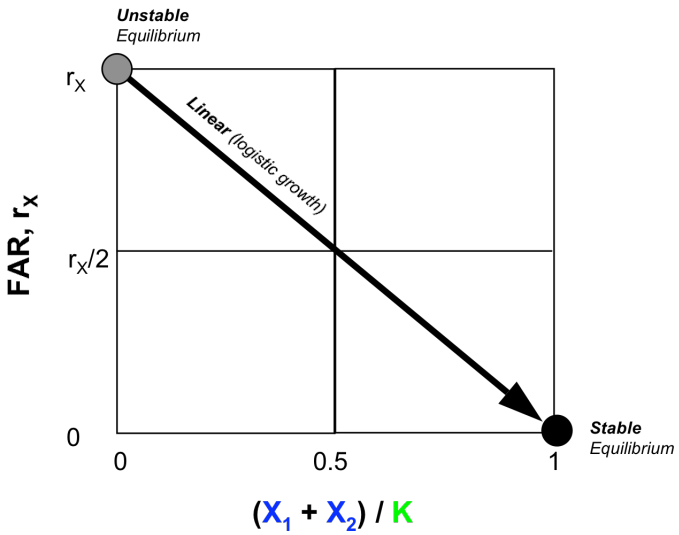
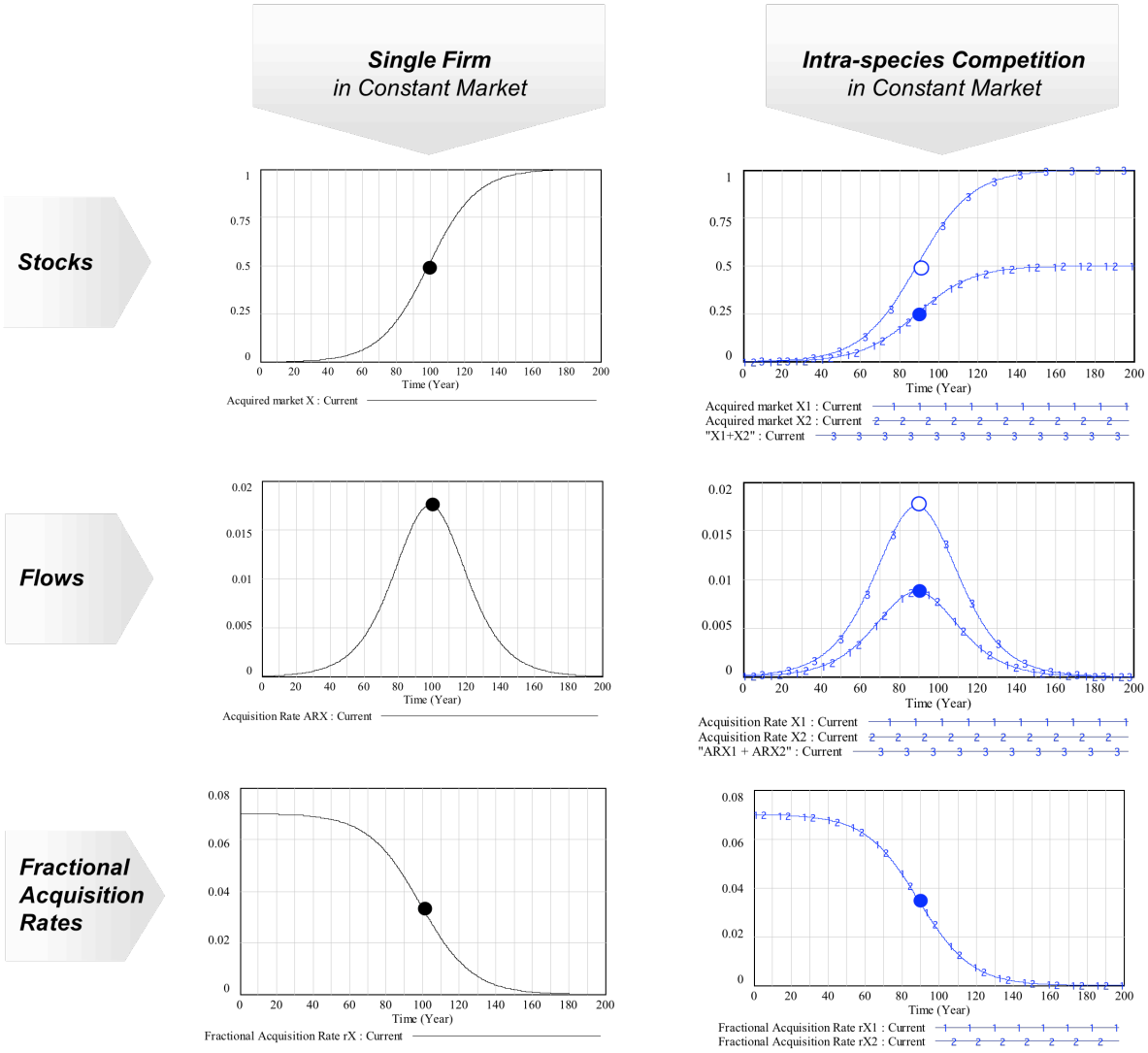


Figure 278 below illustrates the dynamic behavior of intra-species competition between homogeneous firms in a constant market. In this case, both firms unsurprisingly split the market 50%-50%. Their peak acquisition rates are also unsurprisingly half the acquisition rate of a monopolist. What might be surprising is that the peak aqusition rates of the competitors occurs before that of a single monopolist, due to the fact that each acquisition impacts both the firm and its competitor, i.e. the reinforcing loop that now links competitors.

Figure 278: Dynamic Behavior of *Intra*-species Competition in a *Constant* Market

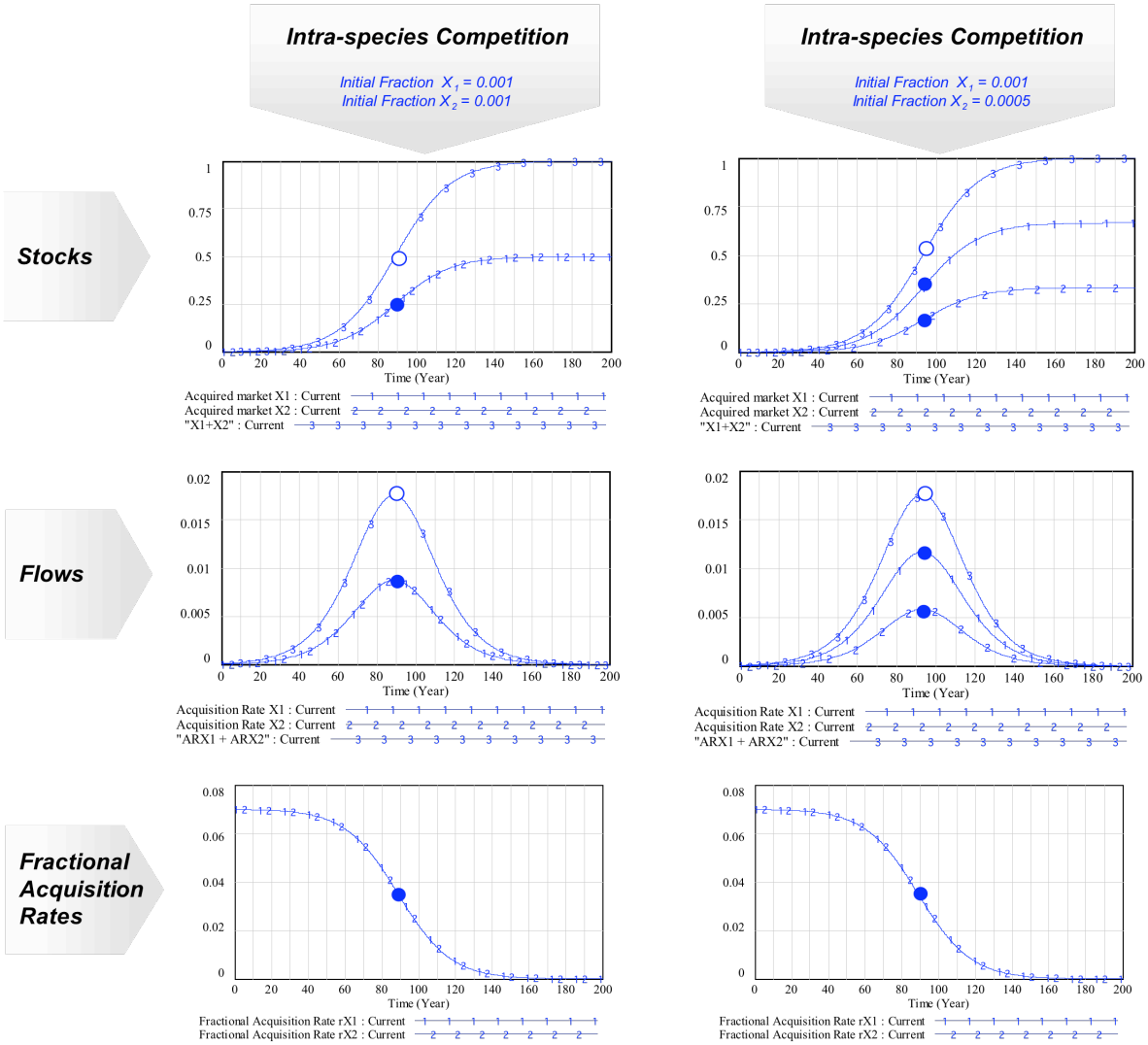


7.1.3.1 Parametric Study: *Initial Conditions*

Figure 279 below illustrates the dynamic behavior of intra-species competition between two firms having differing initial acquired markets – one firm having twice the initial acquired market than the other. This formulation assumes that both firms are equally efficient, however one firm has greater luck or initial endowments.

Here, a simple linear relationship exists between the initial endowment of a firm (as expressed by its initial acquired market) and its success. Specifically, a doubling of the initial fraction of acquired market, results in a doubling of the acquired market – here a 67% to 33% split of the acquired market.

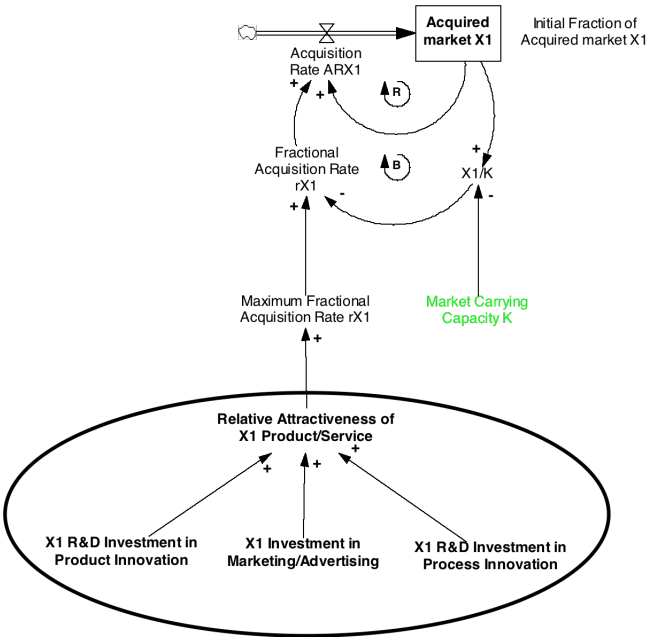
Figure 279: Dynamic Behavior of of Competing *Initial Acquired Markets*



7.1.3.2 Parametric Study: *Fractional Acquisition Rates*

Next, we explore intra-species competition between two firms having different efficiencies, which is reflected in their maximum fractional acquisition rate, capturing the relative attractiveness of a firm's products and services (see for example, Paich & Sterman, 1993). Although not explicitly part of the model presented herein, a number of operational factors can impact a firm's efficiency or maximum fractional acquisition rate, including its investment in R&D in product innovation, process innovation, or its investment in marketing/advertising as illustrated in Figure 280 below.

Figure 280: Model Structure of Relative Attractiveness of a Firm's Products/Services



The relationship between competing firm's fractional acquisition rates and their acquired market relative to the market carrying capacity is illustrated in Figure 281 below.

Figure 281: Fractional Acquistion Rates of Firms in Intra-species Competition