International Society for the Systems Sciences
Proceedings of the 52nd Annual Conference of ISSS


EDITED BY
JENNIFER WILBY

ISBN 978-1-906740-00-9

## *Index of Papers*

# BUSINESS MODELS AND EVOLVING ECONOMIC PARADIGMS: A SYSTEMS SCIENCE APPROACH

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## ABSTRACT

For professionals at the beginning of the 21st century, much of the conventional wisdom on business management and engineering is founded in the 20th century industrial / manufacturing paradigm. In developed economies, however, the service sector now dominates the manufacturing sector, just as manufacturing prevailed over the agricultural sector after the industrial revolution. Simultaneously, as end products have transitioned from material outputs to information in digital form, traditional business models are under siege. The economic sociology in this new world challenges the integrity of models, methods and interventions successful in an earlier paradigm.

Since 2005, IBM has encouraged universities to develop a new field of Services Science, Management and Engineering (SSME). Researchers are responding with development of a new science of service systems, but mature foundations will require years of collaboration. In the absence of a well-established science from which educational curricula can be deduced, teachers can develop educational programs for joint learning, guided inductively by relevance and pragmatism.

A new seminar on business models – ways in which business organizations operate and evolve – is proposed. Complementing traditional management and/or engineering curricula, this course challenges students to reconsider contexts, surface assumptions and explore alternative approaches to business. With a domain that includes both human and technological parts, systems science serves as a skeleton on which content can be structured.

Keywords: service science, systems science, business models, economic paradigms

## 1. INTRODUCTION: WHAT CAN ENGINEERING AND MANAGEMENT STUDENTS LEARN AS A NEW SCIENCE EMERGES?

Since a National Academy of Engineering report was interpreted as a "failing grade for the innovation academy" for not meeting the needs of service businesses (Chesbrough 2004), IBM has encouraged the development of a body of knowledge on Service Science,

Management and Education (SSME). This has led to some formalization as steps towards a *science of service systems* (Spoher, Maglio et al. 2007), and a definition:

> A service system can be defined as a dynamic configuration of resources (people, technology, organisations and shared information) that creates and delivers value between the provider and the customer through service. In many cases, a service system is a complex system in that configurations of resources interact in a non-linear way. Primary interactions take place at the interface between the provider and the customer. However, with the advent of ICT, customer-to-customer and supplier-to-supplier interactions have also become prevalent. These complex interactions create a system whose behaviour is difficult to explain and predict. (IfM and IBM, 2008, p. 6)

Initial approaches to the engineering and management of service systems have built incrementally on existing disciplines. The disciplines include economics and law, operations research, industrial engineering, computer science, information systems, MBA and management consulting, management information systems and knowledge management, organizational studies and organizational learning (Spohrer, Maglio et al. 2008, pp. 6-7). Curriculum has been developed as courses inserted into existing programs (IBM 2006) and as the premise for a new program (Tukiainen, Takala & Ing 2006). While a new science of service systems is under development, a bottom-up approach to curriculum development has been practical.

As a complementary contribution to an educational curriculum, this paper proposes a seminar that embraces uncertainties as the science of service systems evolves. A course on business models – the way that businesses operate from a systems perspective – is targeted at graduate-level students in management and engineering. The challenge of multi-disciplinary thinking is dissolved through a foundation in systems science. Since much of our current thinking on services is anchored in industrial age management and engineering knowledge, an agricultural paradigm is added as an irritant to provoke deeper thinking.

The next section describes approaching an understanding of changes in the business world with technologies enabling and driving reflection of historical views of economies. As a path to structure discussions on features of the changes, an outline of topics selected from concepts in systems science is proposed. As a concrete demonstration of an alternative perspective, a reference framework of business models is described – not as an end point, but as a platform for conversation. The paper concludes with a discussion on pedagogy as a Singerian inquiring system, appropriate for the new body of knowledge on service systems emerging from multidisciplinary foundations.

## 2. CHANGES IN THE BUSINESS WORLD ARE BETTER APPRECIATED FROM AN OUTSIDE PERSPECTIVE

> "It's like the fish in water. We don't know who discovered water but we know it wasn't a fish. A pervasive medium is always beyond perception." - Marshall McLuhan

Establishing new perspectives on engineering and management as a new science of service systems emerges presents a legacy challenge. Current practices, experience and education are anchored on sciences with a long history of development over the past half century. We bring predispositions and assumptions from an era that may or may not continue to be valid. As an example, how should we measure business performance? Many service businesses count hours of labour (e.g. billable utilization) as a key measure of productivity. Service businesses centered on expertise and skills often find that measurement logic can encourage to dysfunctional behaviours. Profitability and the quality of customer deliverables are not always improved by more working hours. While looking forward in time to plan absences precludes wasting resources, recording and reviewing hours worked and not worked (e.g. vacation) adds administrative overhead unnecessary to the senior business professionals (Belson 2007). Counting hours in a service business may be as nonsensical as a standard 9-to-5 schedule to a farmer who tends to fields and livestock from sunrise to sunset.

In the section that follows, challenges in understanding the "new" economy with definitions from the "old" economy are reviewed. Then, systems science is proposed as a common point of reference for both engineering and management education. Advances in technology are posed as a primary driver changing the economics of a business. Business models are then proposed as a focal point for discussions on changes to the business world.

### 2.1 Discussing a "new" economy leads to reifying distinctions in the "old economy"

In defining a new *science of service systems*, the meaning of *service* is problematic. In government statistics worldwide, categorizations of economic *outputs* have standardized on a three-way distinction: an agricultural sector, a manufacturing sector, and a service sector (Wölfl 2005). International studies on economic *inputs* have determined that Information and Communication Technology (ICT) capital has become sufficiently significant to be recognized alongside labour inputs and non-ICT capital (OECD 2000). Deeper examination of labour inputs makes a further distinction in talent recognized in creative-class occupations as something different from manual jobs in lower-paid service businesses (Florida 2002, 2004).

Presuming that students in graduate engineering and management programs will eventually become leaders in society, they should recognize that the drivers of value creation in the next 25 years will likely to change from those in the past 25 years. As they accumulate

experience in business organizations – either in for-profit or not-for-profit designations – they will shape and be shaped by the work they do. Learning business history provides a viewpoint on how organizational practices have come to be. As their careers require these professionals to look forward, however, they should take advantage of opportunities to understand potential directions that their business may take as the economic and technological contexts change.

## 2.2 Systems science is a common ground for systems engineering and systems approaches to management

The motivation to view business through a lens of systems science is practical. The new *science of service systems* is driven by a "new" *service economy* in which definitions and theories are still evolving. This is a scientific revolution (Kuhn, 1967/1996). At this time, *systemics*, -- as "an open set of concepts, models and practical tools useful for a better understanding and eventual management of complex situations or entities of any type" (François 1997, p. 362) – enable a rich vocabulary and set of concepts for discussion.

Linkages of system science can inferred from the applications. In engineering, the body of knowledge is known as *systems engineering* shares concepts and definitions from systems science. In management, the body of knowledge is distinguished as a *systems approach*.

Definitions of *systems engineering* emphasize interdisciplinary / multidisciplinary features to varying degrees. The IEEE defines systems engineering as "an interdisciplinary collaborative approach to derive, evolve, and verify a life-cycle balanced system solution which satisfies customer expectations and meets public acceptability". An alternative concise definition sees systems engineering as "a multidiscipline that addresses a system from a life-cycle, cybernetic and customer perspective" (Tien & Berg 2003, pp. 22-23). Although some would perceive engineering as based primarily in hard science, the systems engineering literature recognizes natural and human sciences:

> [A] system [can be defined as] an assemblage of objects united by some form of regular interaction or interdependence ... A system can be natural (e.g., lake) or built (e.g., government), physical (e.g., space shuttle) or conceptual (e.g., plan), closed (e.g., chemicals in a stationary, closed bottle) or open (e.g., tree), static (e.g., bridge) or dynamic (e.g., human). In regard to its elements, a system can be detailed in terms of its components, composed of people, processes and products; its attributes, composed of the input, process and output characteristics of each component; and its relationships, composed of interactions between components and characteristics. (Tien & Berg, 2003, pp. 23-24)

The lineage of engineering as an applied science serviced from theoretical knowledge is obvious.

Management – in itself, a multidiscipline – has hidden foundations from some leading thinkers who encourage a *systems approach*. While some see management as an art, others emphasize the science in management.

> [Amongst] Management Scientists … the systems approach to problems is fundamental and … organizations, a special type of system, are the principal subject of study.
>
> The systems approach to problems focuses on systems taken as a whole, not on their parts taken separately. Such an approach is concerned with total-system performance even when a change in only one or a few of its parts is contemplated because there are some properties of systems that can only be treated adequately from a holistic point of view. These properties derive from the relationship between parts of systems: how the parts interact and fit together. (Ackoff 1999/1974)

There is not a single systems approach in management. Generic methodologies have been constructed for a functionalist systems approach (with 7 categories of theories), an interpretative systems approach (with 7 categories of theories), an emancipatory systems approach (with 2 categories of work) and a postmodern systems approach, leading to development of a pluralist approach of critical systems thinking (Jackson 2000).

Since depth in at least one discipline seems to be a prerequisite for studying systems, a universal definition of systems science is an ongoing debate. However, systemicists would largely agree that systems science loses its value if it is seen as a discipline.

> Systems science is a meta- or trans-discipline (or possibly better, a meta-methodology) for everybody, and should not be simply reduced to a discipline status, even when and where it must be teached [sic]. (François 1997, p. 362)

For the interests we have at hand – bridging the language and concepts of engineers and managers so that discussions of analysis and design can productivity proceed – systems concepts and languages can aid in clarity. The alternative is for the quality of discourse to fall to a common level of a Grade 6 education.

At some time in the future, it's probable that the science of service systems will converge to become a normal science. Systems science will then recede into the background as a foundational body of knowledge, as it has with other engineering and management disciplines.

### 2.3 Advances in technology changes the economics of a business by loosen constraints

The reasonable of business directions is judged within paradigms. A paradigm is "a mode of viewing the world which underlies the theories and methodologies of science in a particular period of time" (New Shorter Oxford 1997). This definition recognizes that science has multiple branches. The new science of service systems is largely being

defined inductively from developments of society and business. In a practical evolutionary view, three stages have been proposed by "a nation's economic evolution" – mechanical, electrical, and information (Tien & Berg 2003). This thinking can be extended to recognize advances in science with technology along a non-exhaustive list of disciplines, e.g.

- mechanical,
- biological,
- material/chemical,
- electrical, and
- information / communications.

Within each of these fields, paradigm shifts occur. In biology, the discovery of DNA led to the advent of molecular biology. In material science, nanotechnology is new. As much as shifts occur within in these sciences, boundaries between disciplines are naturally redefined (e.g. biology and chemistry have led to biochemistry).

Business opportunities arise as paradigm shifts lead to technologies that change the possibility and feasibility of products and services.

> The effect of technology is -- and always has been -- to loosen constraints. As a result of technological development, what was not possible becomes possible. Or what was not economically feasible becomes so. (Normann 2001, p. 27)

By the late 1990s, one significant paradigm shift for the sciences and the business world was in information, as digital content became networked, i.e. the Internet. These advances not only impacted computer science, but also other fields (e.g. bioinformatics in the life sciences). The conventional wisdom on a science of service systems will take some years to work through definitions and distinctions.

### 2.4 The value that a business creates is defined in its business model

Businesses – or more generally, purposive social systems – create value as organizations collectively, in ways that individuals alone cannot. As enterprises are viewed less as monolithic entities and more as network forms, the coproducers of business outcomes are being recognized as a value constellation (Ramirez & Wallin 2000). A customer or client may be served by a lead organization that coordinates with or subcontracts to alliance partners or other third parties. Fluidity of organizational boundaries invites reflection of the business model.

> The *business model* defines the value-creation priorities of an actor in respect to the utilization of both internal and external resources. It defines how the actor relates with stakeholders, such as actual and potential customers, employees, unions, suppliers, competitors, and other internal groups. It takes account of situations where the actor's activities may

> (a) affect the business environment and its own business in ways that create conflicting interests, or impose risks on the actor; or
>
> (b) develop new, previously unpredicted ways of creating value.
>
> The business model is in itself subject to continual review as a response to actual and possible changes in perceived business conditions. (Wallin 2006, p. 12)

In the above definition, an actor may be an individual or an institution such as a firm. A supplier can assemble an offering for a specific set of capabilities appropriate to the client – possibly appropriate only for that client – in a value constellation (Ramirez and Wallin 2000). Broadening interactions beyond quid pro quo monetary exchange to include the resources and ethos of social relations and institutions moves shifts the styles from microeconomics to economic sociology (Swedberg 2003).

With systems science, advances in technology and business models described above as a starting point, the context of evolving economic paradigms comes to centre stage. In the pursuit of rich conversations on value creation, we'll now turn to a proposed set of system topics as platforms.

## 3. SELECTED TOPICS IN SYSTEMS SCIENCE PROVIDE LENSES FOR DISCUSSING CHANGES IN THE BUSINESS WORLD

For audiences of engineering and management students, education on systems science per se is not the primary goal here. Systems science is presented as a body of knowledge that can be applied. In this interest, ten topics are presented below to guide thinking and discussion about the business world. The number of topics is slightly arbitrary, but aligns with the practicality of teaching a seminar in a 10-week quarter or a 13-week semester. Systemicists are welcomed to develop their own lists suitable for their needs. The ten topics are:

- 1. Business models, value creation, and the "new economy"
- 2. Ignorance and knowledge
- 3. Boundary
- 4. Order, purpose, self-organization
- 5. Living, being, becoming
- 6. Energy and complexity
- 7. Form, networks and power laws
- 8. Information, communication and meaning
- 9. Coevolution, competition and variety
- 10. Aesthetics, ethics and morals

If these topics were to be pursued as a study of systems science per se, each topic could become a course by itself. As a way to better understanding business models, the content and references for each of these topics is described below.

### 3.1 Business models, value creation, and the "new economy"

The motivation and context for the seminar are outlined, following the content of this paper. It is important to distinguish between descriptions of business founded on rigourous definitions in systems science from those extending system metaphors.

### 3.2 Ignorance and knowledge

Despite the fact that we haven't fully defined business based on a science of services system – and knowledge on manufacturing systems and agricultural systems continually evolves – we can and should move forward. From a systems perspective, what can we know and what should we know? Are there things about the business world that are unknowable?

The key reading draws on competence development and ignorance (Ing, Takala & Simmonds 2003). This reading includes embedded references to the College of Medical Ignorance (Witte, Kerwin & Witte 1998), the unbounded mind (Mitroff & Linstone 1993), the design of inquiring systems (Churchman 1971) and ecology of mind (Bateson 1972).

### 3.3 Boundary

Pure services businesses, manufacturing businesses and agricultural businesses don't really exist. What are the boundaries of a business when viewed as a system? How do new informatic spaces (e.g. the Internet) impact social interaction in physical and social spaces? How does this relate to a business model? What are the considerations for inclusion or exclusion?

The key reading draws on viewing social interaction through mediating spaces (Ing & Simmonds 2002). This reading includes embedded references to business design (Ackoff, 1994) and pattern languages (Alexander, Ishikawa et al. 1977). Some definitional sources on *open* systems should be provided. Additional references include value constellations (Normann & Ramirez 1994) and critical systems theory (Jackson 2000).

### 3.4 Order, purpose and self-organization

Service businesses may or may not be different from manufacturing and agricultural businesses on unitary or plural directions and coordination. On which organizational dimensions should leaders set direction and/or bounds, and when should they let direction emerge? Which styles of coordination work in global businesses? What processes enable self-organization?

The key reading considers the balance between legal (rule-based) order and negotiated order in network form organizations (Parhankangas, Ing, et al. 2005). This reading includes embedded references to turbulent environments (Emery & Trist 1965) and

negotiated order (Strauss 1978). Additional references include goals, objectives and ideals (Ackoff 1981), context and coordination (Haeckel, 1999), the cathedral and the bazaar (Raymond, 2000), heterarchy (Hedlund 1986), and polycentric and geocentric organizations (Permutter & Heenan 1979).

### 3.5 Living, being, becoming

Can service businesses, manufacturing businesses and agricultural businesses be described as *living* in similar or different ways? Businesses are not static entities, but evolve and change. Still, they may have functions and structures similar to other types of systems. While many business people don't think about the differences between system metaphors and systems models, they often lead to different conclusions.

The key reading draws distinctions between deterministic (mechanistic), animate (organismic), social and ecological models based on purposes in the parts and wholes (Ackoff & Gharajedaghi 1996). Three completely different approaches include living systems theory (Miller 1978), the viable system model (Beer 1972/1981, 1979) and anticipatory systems (Rosen 1985).

### 3.6 Energy and complexity

Natural science sees the world as matter, energy and information. If business assets are matter, can and should service businesses, manufacturing businesses and agricultural businesses expend energy into embodied forms? While Europeans and Asians caught on to the significance of petroleum and electrical costs in the 1970s, North Americans seem to have taken longer. Energy and complexity are related concepts, linked through hierarchy theory in ecosystem ecology. Businesses may gain a deeper understanding of capital as energy in a systems model.

The key reading makes an important distinction between complication and complexification (Allen, Tainter & Hoekstra 1999). This important distinction is more fully fleshed out in a later book (Allen, Tainter & Hoekstra 2003). The parallelism with energy is described in the mystery of capital (de Soto 2000). The centrality of energy is further defined in energy, power and society (Odum 2007). The entropy law is applied in innovations versus environmental protection presumptions (Hawk 1999), based on the entropy law and economic process (Georgescu-Roegen 1971). In regional development, it may be possible to design self-refueling systems as part of the nature of economies (Jacobs 2001)

### 3.7 Form, networks and power laws

The validity of the idea that form follows function can be challenged in information-intensive service businesses, and probably also contemporary manufacturing businesses and agricultural businesses. In systems theory, structure is an arrangement in space, and

process is an arrangement in time. In rapidly changing business environments, growing without bulking up can be a challenge. Organizing a system as a set of loosely coupled parts results produces different properties in the whole.

One key reading associated with arrangement in space the cellular form organization appropriate for the knowledge age (Miles, Snow et al. 1997). A key reading associated with arrangement in time looks at how buildings learn (Brand 1994). A cautionary tale on tightly-coupled systems is presented as normal accidents (Perrow 1984). Network forms as common in social structures (Barabasi 2000), and now technologies are changing the structure of production to in favour of wealth of networks (Benkler 2006). Digitalization further separating information content from tangible content is shifting targeting from the mass market to the long tail (Anderson 2006).

### 3.8 Information, communication and meaning

Service businesses may or may not be different from manufacturing businesses and agricultural businesses in the ways that information is embodied in individuals and shared in communities of practice. In social interaction, information serves a variety of functions (e.g. directing, requesting) and can be interpreted with different meanings according to the context of the listener.

The key reading draws from computer science to view offerings as commitments, approaching service systems from a language action perspective (Ing 2008). This reading includes embedded references to appreciate doing and speaking in the office (Flores & Ludlow 1980) and understanding computers and cognition (Winograd & Flores 1986). Criticisms of overt control can be dissolved with Banathy-style conversations, with a homeopoetic ethic for organizational change (Rowland 2004) and self-organization of public discourse (Walton 2004). The rise of information technologies leads to a deeper consideration of what computers still can't do (Dreyfus 1992) and learning, meaning and identity in communities of practice (Wenger 1998).

### 3.9 Coevolution, competition and variety

A business can choose to cooperate, compete or not engage with others. The dimensions of coevolving relationships amongst and between service businesses, manufacturing businesses and agricultural businesses will vary, each with merits and demerits. Competition may or may not result in conflict. Cooperation can be different from coordination, if increased variety is desired. The rise of open source as sharing in communities contrasts to views of private source and ownership.

Definitions of types of interactions between species (e.g. parasitism, mutualism) are categorized in basic ecology (Odum 1983). The benefits of cooperation may show up with positive feedback as increasing returns (Arthur 1996). Within or outside the relationship, coordination may follow the law of requisite variety (Ashby 1956).

Benefits may accrue from a design of diversity (Page 2007). If the relationship is not going well, partners may have to choose to express themselves through exit, voice and loyalty (Hirschman 1970). For large scale issues, however, there may be no exit, and action only as catastrophe looms large, as an upside of down (Homer-Dixon 2006). Reacting, rather than proactively or interactively dealing with these issues leads only to a post-normal science of precaution (Ravetz 2004).

### 3.10 Aesthetics, ethics and morals

Most of the business interest in systems science is oriented more towards economics and design. Working down from philosophy, however, there are some helpful systems approaches to the classical ideals of aesthetics, ethics and morals. In bridging across services businesses, manufacturing businesses and agricultural businesses, these systems concepts may be helpful.

Readings in this are should draw on the systems approach and its enemies (Churchman 1979), the four enemies being politics, morality, religion and aesthetics. Coming from a different perspective is the appreciative systems of Sir Geoffrey Vickers (Checkland, 2005). Both of these have influenced more recent work on systemic governance and creative problem solving through critical systemic praxis (McIntyre 2005). Contributing an understanding of commercial and more syndromes is systems of survival (Jacobs 1992)

### 3.11 From these topics, a system of concepts is coproduced inductively with each student

This seminar is designed not as a deductive manner where the textbook has been written. It has been designed as an inductive process, where a student with peers and a facilitator coproduce insight into business models. Each student will gain different insights, with a trajectory according to his or her personal interests. In this respect, the seminar follows a systemic philosophy where the structure of a system of system concepts will develop coherency within the mind of the student.

## 4. A DEMONSTRATION: BUSINESS MODELS APPROACHED FROM A SYSTEMS SCIENCE FOUNDATION

The seminar is more focused on process than an outputs, since each participant will take enrich his or her knowledge from his or own foundation of experience. For those individuals with an orientation more towards ends, this section demonstrates how systems concepts could produce a different view of the business world. This view is not intended to close off discussion, but to provoke conversations in yet another ways that the world could be seen.

The essential challenge, as a new science of service systems is being developed, is to rethink the distinctions of agricultural, manufacturing and service sectors, as well as the resources of land, labour and capital. As an example, three categories of resources are crossed with three categories of ethos to create a matrix of nine categories of business models.

### 4.1 The resources essential to the business define key functions

From a systems perspective, resources are inputs to business that largely define their contribution to society. Classical economics has recognized the inputs of land, labour and capital. Following the shifts in the economy, let's consider three major types of resources:

- (1) renewable resources,
- (2) appropriable resources, and
- (3) cultural resources.

Renewable resources are replenished by nature. Human beings can offset the depletion of the resource through consumption by enabling replenishment or through conservation. Businesses based in renewable resources include farming and fishing. Major activities within such businesses include cultivation and harvesting.

Appropriate resources are generally non-renewable. They accumulate properties through manufacturing processes, where energy is expended to create forms recognized as man made materials and equipment. Businesses based in appropriable resources include extractive activities such as mining and petrochemical refining, and manufacturing activities such as building automobiles. Major activities within these businesses include acquisition and processing.

Cultural resources originate from human interaction. They are embodied in human beings and shared in practices of everyday life. Cultures include language, artistic expressions, rituals and behavioural norms. Cultural practices are reproduced with shared experiences and predispositions through family ties, social networks, history and institutions. In today's world, human beings may adopt aspects of culture from regional domiciles, workplaces, generational cohorts and/or shared interests. Participating in these businesses includes affiliating with the culture (e.g. being accepted as legitimate by the community) and practicising the skills (e.g. being a player rather than an observer).

Describing a business by its essential resources is only a partial analysis. As a renewal resource, it's different to grow vegetable on a farm from growing them in a hydroponic skyscraper. The mass production of automobiles is different from an antique restoration. Shooting a major motion picture is different from capturing home videos. This leads to another dimension: ethos.

## 4.2 The ethos of a business structures action in practices

An ethos is "the characteristic spirit of a culture, era, community, institution, etc., as manifested in its attitudes, aspirations, customs, etc." (New Shorter Oxford, 1996). A business is social system, so there are varied and alternative structures of actions to produce similar types of outputs. From a systems perspective, ethos is part of the operation of the system. Let's consider three types of ethos:

- (a) an organic ethos,
- (b) an industrial ethos, and
- (c) a service ethos.

Each feeling of each ethos comes through in engaging with an individual from that profession or community.

An organic ethos may be described as one that appreciates and nurtures the local bounty. An Amish farm may be the ultimate reflection of an organic ethos in agriculture.

> What is underway on an Amish farm does not involve single purpose. The farms are not regarded as economic units, although the Amish make sound economic decisions. What we observe on the Amish farms is similar to what we observe on a natural ecosystem – homeostasis. Purpose and mechanism are transcended.
>
> …. [The Amish] are interested in profit and high yield, but neither concern drives them as a single purpose. Had the Land Institute's newly acquired 160 acres been an Amish farm, it would have been highly diversified … The living riparian community on each side of the two streams would have been a habitat for an abundance of wild species, including quail, pheasant and deer. It would have been a source of fuel, a boundary dividing the farm into smaller fields. It would host some predatory birds and insects. The smaller fields would have suited a horse- or mule-powered agriculture. The larger cottonwoods would have provided shade for grazing animals or for a resting team and driver. The fallen hackberry limb would have been converted into firewood. The straw that we plow under or burn would have would have become bedding for livestock and thus become a way of holding urine and manure, and all three would have returned to the fields from which they came. Some of the grain would be fed on the farm, some would be sold, depending on need.
>
> Because the emphasis for the Amish is not exclusively on production, mass production of food on the farm is incompatible with their sense of how to live in the world. (Jackson 1987, pp. 128-129)

The description of an organic ethos in the context of business isn't necessarily meant as an anti-technology bias; it's meant as a way seems more natural to the community. Thus, photography on film holds an organic ethos for those from an age of chemistry in a way that digital photography does not.

An industrial ethos is associated with efficient machinery, and describes much of the modern world. Machines extend the capabilities of human beings, replacing social functions with automated mechanisms -- either as improvements or degradations, depending on the point of view. Much of the business world implicitly takes the industrial ethos, from the days of Henry Ford's Model T, to the current day.

> Competitive advantage cannot be understood by looking at a firm as a while. It stems from the many discrete activities a firm performs in designing, producing, marketing, delivering, and supports its products. Each of these activities can contribute to a firm's relative cost position and a basis for differentiation. A cost advantage, for example, may stem from such disparate sources as a low-cost physical distribution system, a highly efficient assembly process, or superior sales force utilization. Differentiation can stem from similarly diverse factors, including the procurement of high quality raw materials, a responsive order entry system or a superior product design (Porter 1985, p. 13)

The industrial ethos has a predisposition for finding more efficient ways of getting work done. It can be dispassionate about tradition, and thus surfaces advocates and resisters. The industrial ethos occurs not just in manufacturing businesses, but also in public enterprises. It is closely related to Weber's idea of a machine bureaucracy, which served to eliminate nepotism in German civil service of the early 20th century.

A service ethos is associated with humility. Humility is the quality of having or showing a low estimate of one's own importance. It is reflected in the person providing the service recognizing the wants and needs of the customer / client / citizen above his or her own position. A service ethos does not mean a lower societal rank, as can be demonstrated in the spirit of servant leadership.

> The servant-leader *is* servant first.… It begins with the natural feeling that one wants to serve, to serve *first*. Then conscious choice brings one to aspire to lead. That person is sharply different from one who is *leader* first, perhaps because of the need to assuage an unusual power drive or to acquire material possessions…. The leader-first and the servant-first are two extreme types. Between them there are shadings and blends that are part of the infinite variety of human nature.
>
> The difference manifests itself in the care taken by the servant-first to make sure that other people's highest priority needs are being served. The best test, and difficult to administer, is: Do those served grow as persons? Do they, *while being served*, become healthier, wiser, freer, more autonomous, more likely themselves to become servants? *And*, what is the effect on the least privileged in society? Will they benefit or at least not be further deprived? (Greenleaf 1977, p.13)

The service ethos is commonly associated with service professions such as the clergy and nursing. This does not mean that for-profit businesses can not place value on serving customer and other constituents.

Engineering and management professionals choose organizations with whom they associate, just as those organizations select the individuals. The ethos of an organization contributes to whether an individual does or doesn't fit with its character.

### 4.3 Categories of business reference models aid reflection on distinctions

As a demonstration of an alternative view on business models, the three types of resources are crossed with three types of ethos to produce business model reference points. These are intended neither as practical nor complete, and seminar participants are encouraged to develop their own views.

**Table 1. Business model reference points**

| | *(a) Organic ethos*: local bounty | *(b) Industrial ethos:* machine efficiency | *(c) Service ethos:* humility |
|---|---|---|---|
| *(1) Renewable resources:* Cultivate and harvest | (1a) Agroecological business model<br>• (Amish) family farms | (1b) Materials refining business model<br>• Food processing<br>• Pharmaceuticals | (1c) Physical wellness business model<br>• Health care |
| *(2) Appropriable resources:* Acquire and process | (2a) Handcrafting business model<br>• Fashion apparel | (2b) Lean production business model<br>• Petrochemicals<br>• Automobile | (2c) Security business model<br>• Insurance<br>• Banking |
| *(3) Cultural resources:* Affiliate and practice | (3a) Performative experience business model<br>• Concerts<br>• Live theatre | (3b) Media publishing business model<br>• News<br>• Television and movies | (3c) Intellectual development business model<br>• Education |

Each of the nine business model references points described in Table 1 has unique features as systems.

The (1a) *agroecological* business model, as illustrated by family farms but exemplified by the Amish, are designed around renewal resources, operating with an organic ethos. Diversity of crops, livestock and byproducts enables near self-sufficiency, with local trade supplementing family efforts.

The (1b) *materials refining* business model begins with similar resources to the agroecological, but takes an industrial ethos with the use of machines. Examples include food processed are superhuman speeds, or pharmaceutical development of plant and animal extracts. Corporate agribusiness also follows this type of model.

The (1c) *physical wellness* business model takes natural living beings (i.e. human beings and animals), and applies a service ethos. Health care services in the spirit of nursing are of this type.

The (2a) *handcrafting* business model starts with appropriable resources but applies an organic ethos. Fashion apparel, where uniqueness and custom fit are important, places a high value on craftsmanship.

The (2b) *lean production* business model is based on appropriable resources, and the industrial ethos is a direct descendant of the mass production style of Henry Ford. Petrochemical and automobile production clear follows this type of business model.

The (2c) *security* business model takes appropriate resources – possibly slightly abstract, as in property rights – and applies a service ethos. Insurance means that if an insured item is lost, it can't be lost again. Banking enables funds to be channeled from those who have plenty to those who have short-term obligations to meet.

The (3a) *performative experience* business model is founded on cultural resources (e.g. musical scores, actors) working in an organic ethos. Concerts and live theatres are valued for their immediacy, and the immersive experience has value to "being there".

The (3b) *media publishing* business model takes the cultural resources (e.g. concert performances), and applies an industrial ethos. Live events (e.g. news as it happens) can be reproduced at lower fidelity and bandwidth for viewers with a lesser interest in the content.

The (3c) *intellectual development* business model starts with cultural resources (e.g. high school graduates) and applies a service ethos. Education is delivered through pedagogy.

The above nine business model references are provided as a foil against which the traditional three-sector categorization of agriculture, manufacturing and services is contrasted. Each of the references would be impacted to a varying degree by changes in a technology – that may or more not be relevant to the core resources or ethos. The goal for the seminar is not to validate this business model reference, but for each participant to develop a perspective helpful and valuable for his or her own domain of focus.

## 5. EDUCATION IN ENGINEERING AND MANAGEMENT AS A SINGERIAN INQUIRING SYSTEM IS APPROPRIATE FOR AN EMERGING SCIENCE

The fifth way of knowing (Mitroff & Linstone 1993, Churchman 1971) is a Singerian inquiring system. It is an open system where features of inductive-consensual, analytic-deductive, multiple-reality and dialectical thinking are all included, and new ideas are continually swept in. In contrast to viewing disciplines having closed and fixed boundaries (e.g. this idea belongs to economics, that idea belongs to sociology, and the

other idea belongs to political science), a systems approach to engineering and management is appropriate for future-facing perspective.

In time, a science of service systems will mature, and manufacturing and agricultural businesses will continue to evolve. This seminar is designed to welcome and embrace the ambiguity of an emerging science.

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