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THESIS

**TRANSFORMING DOD INTO A COMPLEX ADAPTIVE
SYSTEM BY MEANS OF THE MARKET**

by

Michael J. Castagna

September 1998

Thesis Advisor:

James C. Emery

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**TRANSFORMING DOD INTO A COMPLEX ADAPTIVE SYSTEM BY MEANS
OF THE MARKET**

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Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF SCIENCE IN
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Many organizations, including the Department of Defense (DoD), are struggling to make sense of the new demands placed upon them by an environment characterized by constant change. While working within a constraint-filled domestic milieu, coping with an unfamiliar national security setting, and adapting to a transformation in warfare, DoD must foray into yet another challenging environment: the knowledge economy. To explore the possibilities offered by the knowledge economy is a must if DoD is to remain a viable instrument of American foreign policy. Only the market can provide the cost savings and efficiencies that will preserve DoD's position as the supreme warfighter.

This work will use the language of complexity theory to describe both the nature of the knowledge economy and the subsequent organizational forms that will be required to cope with its demands. These information-intensive surroundings are creating a common set of requirements for success, and these are blurring the distinction between public and private sector organizations.

In order to withstand the rigors of the new realities, organizations will have to evolve emergent-like properties that are found in complex adaptive systems. One way to incorporate emergent-like properties is through the adoption of the price mechanism. This is demonstrated with the use of agency theory and transaction-cost economics. Finally, the work shows that only through the gates of a reformed acquisition process can DoD begin its journey to a more complex adaptive form.

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I. INTRODUCTION

A. AREA OF RESEARCH

This research explores lessons from the private sector that may assist the Department of Defense (DoD) in maintaining its status as the world's premier warfighter. Although, DoD has successfully defended American interests in numerous wars, it must prepare for domestic skirmishes that it is ill suited to fight. This conflict bearing down on DoD has been precipitated by fiscal constraints and the obscurity of the international security environment. Thus, in order to remain the effective instrument of American foreign policy, DoD will have to focus on its warfighting core competencies and leverage market forces for its peripheral economic activities.

B. OBJECTIVE

The objective of this research is to determine the extent to which DoD can use the market for its peripheral economic activities. This work will show that only through the cost savings made possible by the market can the military force remain a viable option for America's foreign policy. Some of the questions this research will answer include:

1. Primary Question

To what extent can DoD leverage the power of IT and market forces to allow it to focus on its warfighting core competencies?

2. Supplementary Questions

- a. According to contingency theory, endogenous and exogenous environmental forces determine strategy and organizational forms that subsequently follow. What are the endogenous and exogenous environmental forces shaping today's organizations?

- b. What are the characteristics of the new knowledge economy? What are the enabling technologies that are resulting in unprecedented global economic change and innovative organizational structures?
- c. What strategies are available to firms and public organizations to deal with uncertainty and change? How do private sector and public sector firms differ on this matter?
- d. How can information processing theory, transaction cost economics, and agency theory be used to help decision-makers organize for the future?
- e. Are more firms using outsourcing and transfer pricing to benefit from the innate efficiencies of the market?
- f. What are the principles of organizing in this market driven-environment? What are the implications for DoD?

C. DISCUSSION

Environmental factors are forcing the Department of Defense (DoD) to take a fresh look at the market. As funding decreases and missions increase, the use of the market will allow DoD to do more with less.

From all directions DoD seems besieged by forces of change. The international security environment has transformed from the predictable and stable order of the Cold War into a more diffuse and unpredictable form. Change has also swept across the face of warfare, creating an information-intensive form of conflict that cannot be ignored, but is yet to be fully understood. In addition, the domestic milieu has experienced fiscal constraints that have combined with the public's changing opinion on the use of military force to make DoD one of the most targeted agencies for cuts in the federal government.

Under this severe strain DoD must find a way to remain a viable instrument of America's foreign policy. This work suggests that at least part of the answer may lie in that which DoD so valiantly fought to defend during the years of the Cold War: the market system. The hypothesis advanced by this study argues that: the changing international security environment, nature of warfare, and domestic milieu will force DoD to focus on its warfighting core competencies while use the market for its peripheral activities and/or requirements. The market is the only mechanism that will produce the

cost savings to ensure that DoD remains the premier warfighting organization in the world.

In addition to the cost saving possible by adopting market mechanisms, the market may also produce a somewhat more nimble organizational structure. As DoD recalibrates its balance between “markets and hierarchies,” it will create a less bureaucratic support structure better able to serve the warfighter.

However, adopting market mechanisms must be approached prudently in order to ensure that DoD, if called upon, maintains its operational capacity to strike. This process will undoubtedly lead DoD through uncharted waters. Thus this work employs the language of complexity theory not only to describe the knowledge economy, but also to highlight the organizational changes required to facilitate market adoption. The complex landscape of the knowledge economy will prove just as challenging and demanding as DoD’s current environment.

Today’s market place has been revolutionized by information technology, resulting in a global, hyper-competitive, and electronically linked market place. Liberated from the temporal and spatial constraints of yesteryear, increasingly economic activity is conducted at unprecedented speeds via electrons and light pulses rapidly moving among the world’s largest banks. These electrons and light pulses are carrying the new lifeblood of this altered market place: knowledge.

This technology-driven market place is reducing market transaction costs, portending an even greater use of the market. The low-transaction-cost environment affects all organizations, both private and public, creating information management demands that force organizations to shed layers of hierarchy in favor of the market’s power. These variants of “complex adaptive systems” are able to “sense and respond” infinitely better than their “Weberian” counterparts and thus are able to evolve successfully on the “knowledge landscape.”

Two adaptive phases, drawing upon agency theory and transaction cost economics, will facilitate this transformation. An explanation of these theories and a general discussion on how they can be used to transform DoD will be presented below, followed by a more concrete attempt at reengineering the acquisition process.

D. METHODOLOGY

The methodology for this work is the application of economic theories to increase the efficiency of a public sector organization (DoD) and the conduct of an extensive literature review. The literature examined includes that of organization theory, complexity theory, economics (transaction cost economics and agency theory), and defense acquisition reform.

E. SCOPE OF THESIS

This research explores lessons from the private sector that will allow the Department of Defense to maintain its viability as the premier warfighter. This thesis is focused on the use of the market by DoD and the subsequent organizational forms that result.

II. THE CHANGING ENVIRONMENT AND THE NEED FOR THE MARKET

The Department of Defense (DoD), an organization that is still trying to orient itself after the disintegration of its communist rival, is being confronted by unprecedented challenges. Rarely has a military force been so burdened with responsibility, fettered by fiscal constraints, and limited by domestic demands. Yet, while entangled in this difficult environment, DoD must successfully navigate through a technological revolution that will redefine the nature of warfare.

To succeed in these trying times, DoD may have to focus on its warfighting core competencies and turn to the market for its peripheral economic activities, for it is only the market that can deliver the requisite efficiencies to mitigate the consequences of budget reductions of the past, present, and future. In the past, attempts have been made by DoD to leverage the market, but these have experienced only limited success. Today, the dramatic changes that information technology has wrought in the economy has made market adoption a must. The information revolution has begotten an interconnected global economy experiencing large reductions in transaction costs. This low-transaction-cost environment is more conducive to small, agile organizations able to leverage the power of the market. Therefore, the economy seems to be entering a period in which the coordination cost associated with market activity is declining relative to the costs of organizing internal activities. This will result in economic activity shifting “from hierarchies to markets.”

It may be in DoD’s best interest to follow this trend. The market will enable the maintenance of a strong national defense at a much more acceptable cost. Hence, a more market-friendly DoD will not only experience efficiencies and cost savings, but also a reduction in its bureaucratic hierarchy. If one views markets and hierarchies as polar alternatives along a continuum, the reduction in transaction costs portends a shift towards a leaner organization built around its core competencies. In this day and age, multiple layers of hierarchy are of little benefit to organizations that live and die by their ability to move information. Nowhere is this more evident than in modern warfare. As warfare’s emphasis shifts from “bullets to bytes,” (Campen, 1992, p. ix) efficient information flows may mean the difference between success and failure. An embrace of the market will not transform the rigid operational command and control structure of DoD, but it will create a more flexible and responsive support structure. This more agile, less bureaucratic

organizational structure, better suited to supply the warfighter's requirements, is another considerable benefit to adopting market mechanisms. Therefore, today's transformed market place may prove to be just the right weapon to bring the lumbering bureaucratic mastodon to its knees.

It is imperative that organizations understand the demands, constraints, and opportunities that exist within their environment (Nadler and Tushman, 1997, p. 29).. In this regard, DoD is similar to the many organizations trying to make sense of an environment marked by relentless change. As will be discussed below, organizations are influenced by multifaceted, complex, and increasingly evolving environments. Environmental stimuli are thus filtered by an organization's strategic alignment, producing actions consistent with the organization's global objectives. The stimuli of a changed environment beseech change.

Setting aside the economic and organizational benefits possible with the use of the market, this chapter will focus on emerging domestic and international factors forcing DoD to take a fresh look at the market. These catalysts include the changing national security environment, nature of warfare, and domestic milieu.

A. NATIONAL SECURITY ENVIRONMENT

The international security environment has been altered considerably since the collapse of the Berlin Wall. An uncertain and precarious international security environment has supplanted the predictive and stable nature of the Cold War's bipolarity. The world that was once neatly bifurcated into spheres of influence and protected by the unthinkable horrors of nuclear catastrophe has given way to an unstable "trisected world." This trisected world is born of a "clash of civilizations" (p. 21) in which the remnants of the agrarian age and the industrial age coexist with the more progressive elements of the information age. (Toffler and Toffler, 1990, p. 20)

Alvin Toffler states that "the first [revolution can] still be symbolized by the hoe; the second by the assembly line; and the third by the computer" (1993, pp. 21-22). Put in terms of warfare, DoD faces a security environment in which it could encounter daggers of the agrarian age, tanks of the industrial age, or hackers of the information age.

The threat posed by an agrarian culture has been experienced first hand by America's neighbor to the south. The recalcitrant actions of the PRI in Mexico to

maintain power could cause further uprisings of its agrarian population, as was recently seen in Chiapas.¹ Also, the “agrarian” products cultivated in unstable countries like Columbia have prompted the current administration to declare a war on drugs.

Industrial-age warfare is still a staple of the modern age. The tanks of Iraq’s Republican Guard could threaten American interests in the strategically important Persian Gulf. Even more alarming is the spread of weapons of mass destruction, including chemical, biological, and nuclear weapons. Many predict that an attack on the U.S. by some type of weapon of mass destruction is very likely in the not-too-distant future.

Finally, the first hints of war in the information age are beginning to appear. While weapons of greater technological sophistication are proliferating, a well-planned series of data packets sent over the Internet may prove the most deadly. The recent reports of the Pentagon besieged by hackers could be the harbinger of conflicts to come.

Neither is there a clear line that separates these conflicts nor a clear way to deal with them. The agrarian-based guerillas in Chiapas successfully used the Internet to sway the world’s opinion to their cause. In fact, it is often the case that the narco-terrorists are equipped with the better command and control gadgetry than the nations that begrudgingly host them. Furthermore, the Gulf War has sent all nations seeking ways to incorporate the power of information technology in their military forces.

However, these threats lack the seriousness of a monolithic communist power deterred only by Armageddon. This threat pitted the Western ideas of democracy and capitalism against the oppressive, totalitarian communist ideals. Thus, the communist menace enabled a focused and determined policy that was for the most part backed by the American people. In contrast, today there is no major foreign menace that motivates the American people to action. Because the current threats are diffuse, DoD is essentially operating in what many would call a “threatless” environment. The outcome is an ambiguous and desultory foreign policy.

While severe budget and force structure reductions have plagued DoD, the deployment of American troops abroad reaches levels that would have been deemed extreme even during the Cold War.

¹ The rebels in Chiapas have successfully used the Internet to sway world public opinion towards their cause.

B. TRANSFORMATION OF WARFARE

Another environmental factor for DoD is the changing nature of warfare. Here, both new missions and a “revolution in military affairs” can be used to illustrate this point. First, the post Cold War period has engendered new missions for DoD. To its vast repertoire, DoD has added peace keeping and peace enforcement operations. These missions evoked mixed feelings from an American public that has questioned the costs of engagements in Somalia, Haiti, and Bosnia.

Second, the revolution in military affairs portends the arrival of a new information-intensive warfare. This new form of warfare would be built around concepts like Admiral William Owens’ “system-of-systems.” Essentially, the dominance in firepower with which American forces have been privileged to march into battle would be augmented by an equally dominant “awareness of the battlefield” (National Defense University, 1997, pp. 273-274). The question remains as to whether the dominant battlespace knowledge will result in evolutionary or revolutionary changes in warfare and subsequently in the way militaries organize. Although still in a nascent stage, this revolution has pushed all four services to reevaluate their warfighting structure, resulting in programs like the Army’s Force XXI and the Marine Corps’ Sea Dragon. Precisely to what extent information warfare will alter the nature of warfare is still years from discovery.

Yet with tangible evidence of change all around, DoD, propelled by its bureaucratic momentum, maintained its current course after conducting the most recent Quadrennial Defense Review (QDR). Ignoring a changed world, DoD characteristically voted for the status quo. The serious issues of information warfare and weapons of mass destruction were ignored in favor of aircraft carriers and jet fighters.

Therefore, an already stressed budget and force structure is having to contend with changes that, although important, have not been afforded the proper funding and support. Some of these changes (e.g., information warfare) will prove cost-saving in the long term, but first require an appropriate level of current funding.

C. DOMESTIC CONSTRAINTS

While contending with a trisected, unstable world and adapting to drastically different missions, the military is confronted with some debilitating domestic constraints.

These constraints stem from an altered perception of power, budgetary reductions, and intolerance for military casualties.

First, the way in which power is perceived is changing, and thus its application is also transforming. Toffler boldly proclaims that “the control of knowledge is the crux of tomorrow’s world-wide struggle for power in every human institution” (Toffler and Toffler, 1990, p. 20). In a similar vein, Joseph S. Nye has written that “Soft Power” is on the rise, in which economic, diplomatic, and cultural issues have taken center stage in the world arena. He states that “[p]ower is becoming less fungible, less coercive, and less tangible” (Nye, 1990, p. 188). This results in the use of traditional military power becoming more difficult and more costly to wield (p. 180). Taken by itself, this trend does not bode well for major long-term increases in defense funding. As this new form of “Soft Power” continues to take hold, some argue that future defense cuts are inevitable.

This transformation of power has made budgetary considerations in a fiscally tight environment even more complex. Since 1985 the military has experienced a real 40% reduction in its budget, and now the budget totals only three percent of the gross domestic product. (Kutner, 1998) In fact, one may argue that without the occasional feint by Saddam Hussien, cuts would have been even more severe. In this regard, Hussien may be one of the few issues keeping the importance of defense in the forefront of Americans’ minds, and thus keeping defense budgets afloat. Some even argue that the budget is too high relative to the changes that must be made in the force to remain viable into the next century. For instance, Lawrence J. Korb (1997) argues that DoD’s current budget is too high and points out that DoD’s modernization budget “is 40% more than all of our allies combined, 75% more than either Russia or China, and 90% more than Iraq and North Korea combined” (p. 27). He claims that a more realistic assessment of the threat environment will inexorably lead to greater reductions in the defense budget.

Another domestic constraint finds its origin in the almost bloodless, for Americans, execution of the Persian Gulf War. The low casualties suffered have become the de facto standard for the conduct of military operations. Lawrence Freedman claims that “the perception that public opinion will not accept great sacrifices is now firmly embedded” (Freedman, 1998). This increasingly results in decisions that favor means other than military force. If this perception persists, further budget cuts will be inevitable as funds are allocated to means other than military force. The threat that this perception poses is yet another reason for the military to take pause and find ways to become more economically palatable.

Although there are certainly threats in this more complex and convoluted international environment, the question remains as to whether the threats are registering as important enough for the American people to support the required sacrifices. If the Ohio State town hall meeting was an indication, the use of force even in what is undoubtedly a strategic concern for the U.S. will be contested with great fervor. “The public’s readiness to sacrifice almost certainly depends on the issues at stake and has always been limited in the absence of direct threats to state and society or to cherished values” (p. 55). The military’s challenge is to survive intact during this environment so that it can successfully meet tomorrow’s threats.

D. DANGERS OF ESCHEWING THE MARKET

The various challenges mentioned above are producing a fiscally constrained environment that is demanding the military not only to adapt to a vastly different milieu, but also to make a transition to a yet undefined form of warfare. This seemingly impossible task will be accomplished only with the adoption of market forces. Eschewing the market may produce detrimental results to America’s national security. Here a hypothetical scenario is offered to demonstrate the dangers of shunning the market. Inevitably, the public’s perception of a benign security environment and its intolerance of causalities will interact with the mounting efforts to limit the funding of the federal government. This may result in a negative and harmful downward spiral in which the lack of will to commit American forces can then call into question the current level of funding provided to an infrequently utilized military. This could create a spiral of a dwindling force structure and withering budgets.

Of course, the counter argument to this proposition is that the military is really a deterrent force and to measure its utility by the frequency of its use is not only unfair, but also dangerous. The real danger is that this counter argument could be lost in political wrangling, which is not unprecedented in this century (e.g., military cuts after WWI, WWII, and Korea). In fact, political pressure for cuts could drastically intensify with an armistice being reached by North and South Korea (this seems highly likely) and/or the

displacement of Hussein in Iraq (this seems unlikely).² Is the military prepared for cuts resulting from one or both of these events?

Ultimately, it is incumbent upon the military professionals of this nation to stand prepared to defend the nation when the negative downward spiral of budget cuts is abruptly halted by a newly arisen threat. They should be the strongest supporters of adopting market forces since national security rests firmly upon their shoulders. When this threat arises, no matter what form it takes, it will be the men and women of the armed forces who will be called to action. Budget cuts or not, the military will be expected to perform successfully, and vital strategic interests may be at stake.

Today the conventional military superiority of American forces is unquestioned (p. 59). However, budgetary limitations are already beginning to affect the precise mechanisms of the military machine. The use of the market for its peripheral economic activities may provide the cost savings required to maintain the military's preeminence even in an environment marked by an elusive security environment and budgetary reductions.

² Some would mention the threat that Iran poses in the Persian Gulf, but Iran seems to be making diplomatic gestures to mend its relationship with the West. After all, Iran stood with the United States and other Gulf nations in CENTO and was at the time a staunch ally.

III. EXAMINING THE KNOWLEDGE ECONOMY

The previous chapter described an environment that requires the efficiencies of the market for proper organizational alignment. The adoption of these market forces may be the only way to maintain the military as an efficacious instrument of American foreign policy. Thus this chapter will suggest areas in which DoD can most effectively introduce market mechanisms while ensuring the protection of its current and future warfighting capability. As DoD begins to move in the direction of markets, a greater understanding of the market environment's demands and constraints will be required. Thus, this chapter will also examine the knowledge economy and reveal those characteristics most likely to impact the Defense Department. This examination will be aided by the use of metaphors from complexity theory because only they are suited to describe the economy's transformation into a "complex landscape." Finally, in keeping with the complexity literature, patterns will be elucidated from the seemingly chaotic and protean environment to facilitate a keener understanding of today's market place.

A. PRUDENT MARKET ADOPTION

DoD's transition from its current hierarchical structure to a more agile market oriented organization will afford it many opportunities. However, a clear delineation must be established between instances where market forces may prove efficacious and where they may be precluded by operational necessities. This is particularly important at the initial stages of the transition, because change is a disruptive process that will require the support of DoD's senior leadership. This support will prove fleeting if operational readiness is as much as perceived as being negatively impacted. Therefore, these senior leaders must be shown that measures taken to engender future cost savings through market mechanisms will not impinge upon their ability to meet current operational commitments.

In response to this concern, the Major Force Programs (MFPs) of the defense budget may prove the appropriate place to introduce market mechanisms. The budget is subdivided into eleven MFPs and they can be divided into operating forces and support forces:

Operational

- Strategic Forces
- General Purpose Forces
- Guard and Reserve Forces
- Special Operations

Support

- Intelligence and Communications
- Airlift/Sealift
- Research and Development
- Central Supply and Maintenance
- Personnel Activities
- Administration
- Support of Other Nations

This bifurcation provides a logical place to introduce market forces. Experimentation with market forces can be conducted in the support area, while providing a suitable cushion to ensure the continuing effectiveness of the operating forces.

B. THE COMPLEX LANDSCAPE OF THE KNOWLEDGE ECONOMY

Once the areas for market reform have been clearly circumscribed, DoD must reconnoiter the landscape of the knowledge economy. This is essential to gain the proper alignment with the market environment. This task will provide DoD with greater insight into how its current relationship with the market will evolve and expand to allow it to realize the requisite cost savings.

With competitive advantage shifting from tangible economic inputs to an elusive and immaterial form, the description of the knowledge economy itself has proven difficult. The terrain of the knowledge economy is so varied and demanding that the language of complexity theory is being adapted to facilitate its description. (Ditlea, 1997) Peter Drucker (1993) has identified the metamorphosis engendering this new economy: “the real, controlling resource and the absolutely decisive ‘factor of production’ is now neither capital nor land nor labor. It is knowledge.” (p. 6) Or as Paul Romer, a Stanford economist, notes, “the new economy is one of ideas” (1993).

The fleeting nature of the knowledge economy also lends itself to explanation through what evolutionary biologists call “fitness landscapes.” These landscapes are analogues to those found in nature. Here a Darwinian competition reigns in which organisms compete to occupy the highest peaks of the landscape. The “global maximum” of a single or multi-peaked landscape denotes the highest fitness. Fitness can be said to decline with a decrease in altitude. However, the global maximum is not always apparent, and organisms can quickly find themselves climbing to sub-optimal peaks. Thus a constant search is conducted to transition to peaks of higher fitness.

To complicate matters further, the interdependency between organisms causes peaks to shift and the terrain to deform each time one of the organisms on the landscape moves. A shift in position of an organism inevitably effects the choices of others on the landscape. Thus competitive and cooperative maneuvering is required to reach higher altitudes. The deforming nature of these landscapes, and the limited range of vision that this deformation begets, results in a high degree of uncertainty.

Complexity theorists such as Stuart Kauffman (1995) of the Santa Fe Institute have co-opted the theory to demonstrate that the evolution of a species, technology, and/or organization depends not only on natural selection but also on the emergent properties of self-organization. (pp. 183-189) Kauffman has developed a model of “correlated fitness landscapes” known as the “NK model”. Its name derives from its

ability to measure epistatic coupling, the ability of genes to affect the fitness of genes on other parts of chromosomes. (pp. 169-189) Thus NK refers to the fact that a species has N genes and each of those genes depends on the interaction with K genes for its fitness.

The NK model can also be used to understand the economy. “Alternatively, you can think of the model as an economy where each firm is free to organize however it likes internally, but where its relationships to other firms are fixed by a network of contracts and regulations” (Waldrop, 1992, p. 310) In this case N may represent the number of firms while K denotes the number of conflicting constraints or tradeoffs (e.g., limited resources, patented technology, etc.). Thus the NK model forms an interconnected web of dependencies in which the actions of one organism or economic agent alter the landscape for its counterparts. Kauffman and Macready note:

Real fitness landscapes in evolution and economies are not fixed, but continually deforming. Such deformations occur because the outside world alters, because existing players and technologies change and impact one another, and because new players, species, technologies, or organizational innovations enter the playing field. (cited in Lissack, 1996)

The deforming character of the knowledge economy can be attributed to a high degree of epistatic coupling. In fact, the model reveals that the higher the K (conflicting constraints or tradeoffs), the more rugged and multi-peaked the landscape becomes (Kauffman, p. 173). Thus, economies with numerous conflicting constraints will produce rugged mountainous terrain.

The constant deformation of the landscape is only one reason that navigation is difficult. The difficulty of movement increases proportionally with an increase in altitude. As each upward step is taken, the number of routes that continue to move upwards decreases. In fact, the model shows that each step up a given peak doubles the search time that is required to find the next higher fitness level while the number of options that lead upward are cut in half. Moreover, it is difficult to tell whether one is moving up to the global maximum, or merely a local peak. Thus the effort can lead to a less than desirable outcome. This is analogous to attempts at innovation in which the process starts out with an abundance of ideas and possible approaches, but ideas wither and the process becomes more restrictive as time passes. In addition, one cannot be sure that each step towards progress will lead to the desired solution.

Recall that the landscape deforms because of the interconnectedness of each organism, resulting in the action of one affecting the choices and/or circumstances of others. Thus in the “knowledge landscape” firms are faced with a continuously more demanding struggle to fitness peaks which are not only difficult to locate, but deform with each increase in altitude. (Roos, 1997)

The deforming character of fitness landscapes is similar to the constantly changing nature of the knowledge economy. These conflicting constraints or tradeoffs are not new to students of economics. As Paul Krugman (1996), a professor of economics at MIT, notes:

If economists do understand one thing much better than the lay public, it is the sheer complexity of the economic system and the importance of feedbacks. After all, what is general equilibrium theory but a formalization of the proposition that everything in the economy affects everything else... (p. 2)

C. FORCES OF STABILITY AND INSTABILITY

One reason the knowledge economy forms a rugged landscape is that it harbors both stabilizing and de-stabilizing forces, found in the form of diminishing and increasing returns. “Mechanisms of increasing returns exist alongside those of diminishing returns in all industries” (Arthur, 1996, p. 101). However, diminishing returns are more common in the industrial sector, while increasing returns are more prevalent in the knowledge sector. Thus Stanford economist W. Brian Arthur states that the “[m]odern economies have bifurcated into two interrelated worlds of business corresponding to the two types of returns” (p. 101).

An examination of the two returns is necessary. The demands of the knowledge economy have resulted in an augmentation of classical economic thought with theories better suited to explicate some modern day economic activity. The fathers of classical economics were enamored by the simple, and yet powerful, price mechanism. The price mechanism of traditional economic theory provides a predictable equilibrium by abiding by the laws of diminishing returns. Arthur notes that diminishing returns result from “products or companies that get ahead in a market [and] eventually run into limitations, so that a predictable equilibrium of prices and market shares is reached” (p. 100).

Diminishing returns is at the heart of the perfect competition model, allowing for expansions and contractions in economic activity.

In this world, the powerful coordination mechanism of the price system engenders an unparalleled equilibrium between producers and consumers. Through the transparent mechanisms of supply and demand, the aforementioned environmental factors of demand, constraints, and opportunities are parsimoniously synthesized into a single summary statistic: price. The price mechanism allows disparate, self-interested individuals with only knowledge of their “particular time and place” to formulate decisions that will result in macroeconomic harmony (Hayek, 1948, p. 84). In their aggregate, these decisions ultimately effect the allocation of resources throughout the entire economy.

Fredrick Hayek, arguably one of the most prescient economists of this century, claims that the market is a “marvel.” He comments on the power of the price mechanism:

The most significant fact about this system is the economy of knowledge with which it operates, of how little the individual participants need to know in order to be able to take the right action. In abbreviated form, by a kind of symbol, only the most essential information is passed on and passed on only to those concerned. It is more than a metaphor to describe the price system as a kind of machinery for registering change, or a system of telecommunications which enables individual producers to watch merely the movement of a few pointers, ... in order to adjust their activities to changes of which they may never know more than is reflected in the price movement. (pp. 86-87)

Although diminishing returns is still prevalent in the knowledge economy, increasing returns may become more useful in describing economic activity in the growing information sector. “Diminishing returns imply a single equilibrium point for the economy, but positive feedback – increasing returns – makes for many possible equilibrium points” (Arthur, 1994, p. 1). Moreover, the potential equilibrium points are highly dependent upon initial conditions. Once random forces select a given product or company it could become locked in, resulting in the attainment of dominant market share. Where one would expect marginal cost to increase with each unit produced under the old theory, increasing returns actually results in an asymptotic decline in marginal costs for some goods (e.g., software, biotechnology). This decrease in costs results because knowledge, rather than tangible assets, makes up the preponderance of the product’s

development costs. Arthur writes, “Increasing returns are the tendency for that which is ahead to get further ahead, for that which loses advantage to lose further advantage” (1996, p. 100). He goes on to note instability is a by-product of this positive feedback mechanism.

Where diminishing returns may engender equitable market share for two competing technologies, such a situation would cause instability in an increasing returns environment. Essentially a zero-sum game develops between the two technologies because of “up-front costs, network effects, and customer groove-in” (p. 103).

The products developed within the knowledge sector require massive research and development cost. However, these “up-front” costs decline with each unit sold. Thus if the price is held constant, marginal net revenue increases as marginal costs decline. This may also allow for downward pressure on the price of the product as production costs fall to negligible levels. In a competitive environment, a benefactor of increasing returns could continue to lower prices, making the high, up-front R&D costs a huge barrier to entry. This could stifle competition. At the same time, consumers also experience powerful positive feedback effects as their investments in equipment and personnel “groove” them in to a given product. This is compounded by the need to maintain compatibility and the fact prices for compatible products are falling. This revolutionizes what it means to gain “first mover advantage.”

For instance, if technology A is superior to technology B and each begins with an equal share of the market, the winner will not necessarily be predetermined by the product’s quality. The winner will emerge from a random change in initial conditions that slightly favors one technology over the other. This slight shift compounds through the positive feedback mechanisms described above, ultimately producing dominant market share for the victorious technology. The success of the VHS format over the superior Beta format can be explained by increasing returns; so can the meteoric rise of Microsoft.

Where classical market theory created a relatively flat landscape shaped by the prescient price mechanism, increasing returns has “deformed” the terrain into a complex landscape. In fact, the price mechanism may send inaccurate signals in determining what, how, and for whom goods should be produced. For instance, the price mechanism may signal the availability of profits, thus attracting entrepreneurs, but if positive feedback mechanisms have already taken hold, their efforts may be for naught. Increasing returns requires that firms be proactive in assessing the technologies that may barely be visible

over the technological horizon. Thus firms need to understand the different forces engendered by the two returns.

However, even the economic activity governed by the classical model has been affected by the technological revolution. This revolution makes firms innovate constantly just to maintain products that are competitive in the marketplace. Competitive firms must respond to change just as quickly as the market. The interaction of these two forces has prompted corporate leaders like Andrew Grove to proclaim that “only the paranoid survive.”

D. TOWARDS AN UNDERSTANDING OF TODAY’S MARKET

Thus as DoD begins to utilize the market to a greater degree for its peripheral economic activities, it must pay heed to the rules of the complex economic landscape. This is especially true when DoD begins to shed hierarchy and expand its role as a consumer of market goods and services.

The instability that has been introduced into the equilibrium-prone classical economy by the destabilizing nature of increasing returns has lead many to label the modern economy as chaotic. The landscape has certainly changed and both opportunities and constraints lurk behind each crag of the rugged terrain. Navigation through the protean knowledge landscape can be summed up by a remark that Mitchell Waldrop made concerning deforming landscapes: “It’s as if everyone were walking on rubber” (p. 310) This would definitely produce paranoia even in the fittest of firms.

The uncertainty that Waldrop alludes to has become part of the quotidian reality of business. However, from the seemingly abstract randomness of the knowledge economy, patterns begin to emerge. In discussing the similarities between self-organizing systems like “embryos, earthquakes, and economics,” Krugman remarks that even when these systems “start from an almost homogeneous or almost random state, [they] spontaneously form large-scale patterns” (p. 3). Thus an examination of the knowledge economy reveals three major patterns: technology is the enabler, knowledge is the driver, and change is constant.

First, today’s market place has been utterly transformed by information technology. This has resulted in a global, electronically linked, and hyper-competitive market place. Liberated from the temporal and spatial constraints of yesteryear, increasingly economic activity is conducted at unprecedented speeds via electrons and

light pulses rapidly moving among the world's economic entities. Technology is the enabler of the information revolution.

The dramatic societal changes will continue with technologies that Soon-Yong Choi, Dale Stahl, and Andrew Whinston (1997) claim will lead the revolution into the future. According to them, the technology areas which will "shape the future include computer processing, storage, communication, and presentation" (p. 545). They claim that within twenty years processing will advance to a point in which its speed will approach that of the human mind (10 – 1000 trillion operations per second). In addition, storage capacity will continue to advance producing faster more efficient storage devices. Communication networks will become more robust and solutions to the "last mile" conundrum will make big bandwidth omnipresent. Furthermore, the differences will diminish between local switching telephone networks, mobile phone networks, long distance carriers, digital data service, and the Internet" (p. 547). Finally, presentation technologies will approach the clarity and reality of real life (545-547).

Technology has been an agent of change throughout the ages. How is today's technological upheaval different from the technological changes that ushered in the agrarian and industrial age? There are three main differences. Firstly, the progenitor of knowledge, information, is becoming digital. With this transformation the bit is rapidly replacing the atom. (Negroponte, 1995, pp. 11-18) Digital-based information is superior to the atom-based information in that it is easier to access, manipulate, share, transfer, and store.

Nowhere is this more evident than in the economy in which atom-based money is being supplanted by digital money. To replace its now antiquated ancestor, various species of money are evolving to such forms as DigiCash, E-Cash, and CyberCash, each currently struggling on a complex landscape for market share. However, these forms of digital money are already pervasive and circumnavigate the business world at light speed. Once standards are established, and the proper level of security is provided, digital cash will be ubiquitous.

Second, technology can produce greater levels of control by automating processes and procedures typically conducted by human capital. This was as true during the industrial revolution as it is today. However, modern technology also produces information on the processes and procedures that have been automated. "It provides a deepened level of transparency to activities that had seemed either partially or completely opaque" (Zuboff, 1988, p.8). Shoshana Zuboff calls this attribute of modern technology

“informating” (pp. 8-9). This allows, as Drucker has noted, the application of “knowledge upon knowledge,” ultimately, producing an interconnected mesh of man and machine (1993, p. 188).

Third, these interconnections are causing the “death of distance” combining into ever-increasing numbers of networks that span the globe. Philip B. Evans and Thomas S. Wurster (1997) note that advancements in technology have allowed greater “richness and reach” in modern communication. The authors note that a “sea change” has occurred with the “emergence of universal technical standards for communication, allowing everybody to communicate with everybody else at essentially zero cost” (p. 74). This greater reach has been engendered by the profusion of networks and networking technologies. This now allows a reach of global proportions that continues to expand exponentially. The richness measure reveals that the quality and quantity of information that can be shared in a timely fashion over networks has experienced order of magnitude improvements. (pp. 73-76) These networks can be expected to continue growing exponentially well into the future.

Richness and reach is creating a truly global economy. Thomas Davenport and Lawrence Prusak (1998) claim that this economy “gives consumers an unprecedented choice of goods and services and an endless cavalcade of new and better offerings from global companies” (p. 13). Therefore, competition is increasingly defined in global terms, and this is forcing all organizations to acquire the fitness level of a globally competitive corporation.

If technology is the enabler, then knowledge is the driver. The second pattern that reveals itself is that competition is increasingly defined in terms of knowledge. Toffler’s prediction that “the control of knowledge is the crux of tomorrow’s world-wide struggle for power in every human institution” is true today (Toffler & Toffler, 1990, p. 20). Knowledge has undoubtedly become the driver of economic activity. Competitive advantage is shifting to those nations, corporations, or individuals that can quickly and efficiently transform information into knowledge and apply it in the form of innovation. Therefore, innovation becomes a measure for the successful use of knowledge by information-age organizations.

The realization that knowledge has become the key economic resource has given rise to the intellectual-capital movement. It is not merely fortuitous that the intellectual-capital movement arose concomitantly with the Internet. The development of the Internet, and its related technologies, has provided a means to analyze, codify, and utilize

information in ways that would have been impossible less than five years ago. This technology suggests that the greatest gains are made when knowledge is engendered through a synergistic process in which the experience and intuition of human capital is combined with the tremendous information processing capacity of information technology.

Finally, the third pattern reveals that change has become the central theme of today's market place. "Rapid, relentless, and uncertain change is the most unsettling marketplace reality that companies and people must cope with today" (Goldman, S., Nagel, R., and Preiss, K., 1995, p. 3).

One important change is that the new environment requires both competition and cooperation. Recall that the rugged, deforming landscapes were a result of a great number of conflicting constraints and that to some extent the level of fitness achieved by a given organism (or firm) was also contingent upon the fitness level achieved by its cohabitants. Thus even competition has evolved into what Barry Nalebluff and Adam Brandenburger (1997) have labeled "co-opetition." The term describes the juxtaposition between the forces of competition and cooperation that have become a mandatory element of the knowledge economy. In addition, Eric Clemons and Michael Row have been persuaded that "[c]ompetitive, exploitative, and unnecessarily antagonistic relationships are increasingly giving way to more cooperative longer-term associations" (1992, p. 10). In fact, Peter Keen writes, "The growth of this new economy depends on mechanisms for ensuring trust" (1997, p. 80). So competition is being fettered by the need for trust and cooperation, especially as companies become more and more interconnected through information technology.

The most profound changes are just beginning to be seen in the economy. Information technology allows for the reduction of both internal and external coordination costs. However, information technology has been utilized principally for internal coordination, because of sundry limitations in technology that have only recently been surmounted. This limitation was overcome by the introduction of the Internet as a medium for conducting business transactions. Now that efficient transactional relationships are a reality, transaction-cost economics, a theory that elucidates economic organization, can be used to portend the displacement of economic activity from hierarchies to markets. "An electronic market not only offers a cheaper, more cost-effective way to transact business, but also brings about a more efficient market-clearing mechanism, because it is not limited by spatial constraints or inefficiencies in conducting

transactions” (Whinston, et al., p. 576). This may not only engender the “friction-free capitalism” mentioned by Bill Gates in “The Road Ahead,” but also have a profound effect on the way firms organize.

IV. HARNESSING EMERGENT PROPERTIES

The previous chapters outlined some reasons and ways by which DoD can harness market forces. The efficiencies and cost saving possible through the adaption of market mechanisms may prove critical for the military to remain a viable foreign policy option. The realization that the Defense Department must look more seriously at utilizing the market prompted a survey of the knowledge economy. This survey revealed a rapidly changing, interconnected economic order in which organizational success is tied directly to its understanding.

In a similar fashion to the discussion in Chapter II, Stan Davis and Christopher Meyer (1998) have characterized the economy's unprecedented rate of change as "BLUR."³ BLUR affects all organizations, private and public, resulting in each being forced to adapt to a starkly different global environment. This BLUR has blurred the distinction between private and public sector firms. It is creating a common complex landscape with a similar set of demands that govern the success of all organizations.

This chapter will examine the organizational characteristics that will enable successful adaption on such complex landscapes. Here the NK model presented in the previous chapter will be revisited to facilitate the identification of salient attributes of complex adaptive systems. Finally, these theoretically derived attributes will be translated into steps that modern-day organizations can take to begin the transition to a more adaptive form.

A. WHY THE PRIVATE SECTOR WILL LEAD

An assumption must be advanced prior to exploring the organizational characteristics best suited to meet the demands of the knowledge economy, namely that the innovative organizational structures beginning to take form in the private sector will ultimately be spun off to the public sector. Such a process has historical precedent. Prior to the 1970s, DoD led in technological innovations and, where appropriate, these innovations were spun off to the private sector. However, the rate and complexity of

³ BLUR is a function of "Speed x Conectivity x Intangibles" and represents the hyper-rate of change in today's economy.

technological innovation eventually overcame the ability of government to lead the dynamic and expanding field of high technology.⁴ Today technological innovation is led by the private sector and is spun off for use by the various departments of the federal government, including DoD.

In fact, the White House has essentially acted in accordance with the proposed assumption. It has stated that “The private sector should lead” in the development of electronic commerce. (1997, p. 4) This technology will more than likely prompt a rethinking of current organizational structures, thus giving the private sector *carte blanche* in designing new organizational forms.

An analogous situation to that mentioned above may exist with organizational structures. Peter Drucker notes, “[w]hen modern organizations first arose one hundred and thirty years ago, they were modeled after the first, and at the time the most successful, of the new organizations: the army” (p. 105). The command and control structure that was adopted still permeates much of the corporate world. However, many corporate mastodons, including IBM and the Big-Three automobile makers, have learned hard lessons about the inadequacies of their command and control structures. As technological innovation has shifted from the public to private sector, so too will the responsibility for designing organizational structures more conducive to the new age.

Yet another argument supporting the aforementioned assumption is that the information revolution has created a common competitive arena for all organizations (i.e., private and public). This common field of competition has been engendered by the redefinition of competition. As was mentioned in Chapter II, competition is now information-based, and in this environment the victors will be those that can rapidly convert information into knowledge. As a result, the private and public sectors will be submitted to similar information-related pressures. However, the public sector, for the most part, has been shielded from the pressures that have already forced the private sector to change. When this changes, the public sector will rush to adapt more suitable organizational forms. Thus the organizational innovations of the private sector will eventually be adapted by public sector organizations seeking to streamline their anachronistic structures. Hierarchical bureaucracies, *ipso facto*, cannot compete with the more innovative, flatter organizational forms beginning to emerge.

⁴ This may also be understood as a matter of scale. The emphasis on high technology innovation swelled the private sector to a point in which its IT investments/expenditures dwarfed those of the public sector.

The key point is that a knowledge-driven environment is creating a common playing field for all type of organizations. As the private sector leads in the exploration of organizational forms best suited for this environment and the public sector begins to adapt these organizational designs, the difference between private and public organizations will begin to wither.

How will these differences narrow? In considering this question, it is important to recall that all organizations are influenced by their environments. In fact, organizational success is often dependent upon the creation of a seamless environmental fit. Therefore, as the environment becomes more knowledge intensive it is placing similar demands on all organizations. Thus the narrowing will be precipitated by the common environment that will affect all organizations with its demands for rapid information processing and knowledge creation. Shortly it will be shown that these demands require organizations to transform into complex adaptive systems. With this common playing field articulated, all references to organizations that ensue will apply equally to private and public firms (including DoD).

There are various ways to organize so as to achieve alignment with the environment. However, the recognition of the intricacies of organizational design has led to the realization that there are certainly some forms of organization that are clearly better than others, but there is no “one best way” to organize. (Nadler and Tushman, p. 53) This methodology resulted in Paul Lawrence and Jay Lorsch (1986) developing “contingency organization theory.” They state:

The basic assumption underlying such a theory, which the findings of this study strongly support, is that organizational variables are in complex interrelationship with one another and with conditions of the environment. (p. 157)

Thus the absence of a panacea for the organizational conundrum has led to the recent proliferation of organizational forms within the private sector. Some of the recent offerings include the Knowledge Organization, the Learning Organization, the Virtual Organization, and the Network Organization. This work intentionally ignores a comparison of these forms, because as just mentioned each form is situationally and environmentally dependent.

In sum, similar environmental demands are forcing all organizations, including the Department of Defense, to evolve into leaner, flatter organizations that can handle the stresses of rapidly converting raw information into knowledge that leads quickly to action.

B. THE NK MODEL

This section reintroduces the NK model from Chapter II as a theoretical aid in understanding organizational forms suitable in an age of information. This section will juxtapose the classical systems analysis perspective in organization theory with that of the complex adaptive systems view in complexity theory. The NK model will help to identify attributes of complex adaptive systems and those characteristics that today's firms must acquire to compete in tomorrow's milieu. The systems analysis perspective will be used because it provides a familiar vantage point during the transition to a more complex form.

A theoretical analysis may elucidate the major structural changes required by organizations contending with complex landscapes. Recall that in the previous chapter the NK model was used to depict the knowledge economy. "In the framework of NK landscapes, the optimization problem [was] to find either the global optimum, the highest peak, or at least excellent peaks" (Kauffman, p. 248). However, this "evolutionary search" is impeded by various factors, the most serious of which is the continually deforming nature of the "knowledge landscape." Thus the objective of today's organizations becomes the tracking of fitness peaks through suboptimization. This form of suboptimization can be understood as a variant of Herbert Simon's "satisficing." With that said, satisficing-like actions occur because global optima are extremely difficult to locate on constantly transforming, rugged landscapes. According to Kauffman, "Tracking peaks on deforming landscapes is central to survival" (247). Some examples of the peaks that may be tracked by modern organizations are technology, managerial innovations, and/or customer preferences.

Kauffman, Bill Macready, and Emily Dickinson have developed, through the use of the NK model, a "patches logic" which models an organization's attempt to track fitness peaks.

The basic idea of the patch procedure is simple: take a hard, conflict-laden task in which many parts interact, and divide it into a quilt of nonoverlapping patches. Try to optimize with each patch. As this occurs, the couplings between parts in two patches across patch boundaries will mean that finding a 'good' solution in one patch will change the problem to be solved by the parts in the adjacent patches. Since changes in each patch will alter the problems confronted by the neighboring patches, and the adaptive moves by those patches in turn will alter the problem faced by yet other patches, the system is just like our model of coevolving ecosystems. (Kauffman 1996)

At this point, the patches simulation seems similar to the systems analysis view of organizations which depicts organizations as environmentally responsive, inter-related elements aggregated for a particular task. Organizations can be both composed of subsystems and members of larger systems. Interfaces couple the system's interdependent elements and feedback mechanisms facilitate environmental alignment. The environment is "arbitrarily" defined by the selection of the system's boundaries. In this model the environment's ruggedness and unpredictability creates what Simon calls bounded rationality.

According to the systems analysis perspective, the use of hierarchical structures allows organizations to cope with the impediments of bounded rationality and to achieve their global objectives. These organizational systems use authority relations for coordination and control and rely on a hierarchical structure for its information-filtering characteristics. James Emery (1969) notes that "[o]rganizations, like all systems, have a hierarchical structure that results from the factoring of global objectives into a hierarchy of manageable subobjectives."

Analogous to the "patches logic," an organization's attempt to deal with complexity and uncertainty results in what Paul Lawrence and Jay Lorsch (1967) call disintegration and integration. "As organizations undertake more complex tasks, they tend to complicate internally by differentiating new organizational units" (p. 213). So disintegration results as a means to cope with complexity and uncertainty while integration is responsible for ensuring that the proper level of collaboration exists between the organization's disparate units to achieve successfully its global objectives. The extent to which an organization chooses to integrate or disintegrate results in a tradeoff between "independence and coordination" (Emery, 1969, pp. 29-31).

Keeping this limiting factor in mind, let's look at the patches simulation more closely. First, recall that the "patches logic" attempts to model an organization. The patches simulation can be manipulated to represent different levels of organizational centralization or decentralization. The model can be demonstrated with the use of a small 10×10 square. (Kauffman, pp. 254-257) Each square represents an "agent." A 10×10 square consists of 100 agents each capable of two states: 1 or 0. Thus the agents within the lattice can be configured $2^{100} = 1.3 \times 10^{30}$ different ways. Each agent is coupled with and is capable of affecting its neighbors. The square is divided into "nonoverlapping quilt patches of different sizes (Kauffman, pp. 255) and each agent is allowed to change to its alternative state if and only if its change results in a higher fitness level for the patch in which it is located (analogous to Pareto optimality).

Therefore, "quilt patches" can be used to model a centralized or decentralized organization. Patches can be thought of as the disintegration of the organization into various departments.

A centralized organization would consist of a single patch (i.e., department) that comprises the entire organization. A square consisting of 100 agents can be modeled into a centralized organization by combining all of the agents under the authority of a single patch. This construction creates an inflexible organization because individual agents can change only if it benefits the organization as a whole. In this case, each agent would be able to change its state only if the change results in the movement of the entire 10×10 square towards Pareto optimality. Although organizations must always proceed in the direction of Pareto optimality, thus improving the lot of the organization, organizations can fall short of Pareto optimality and then get caught in a suboptimal position. Here lies the danger for centralized organizations.

The requirement that individual agents change only if that change benefits the entire organization creates a paralysis-like condition because of the numerous conflicting constraints that must be managed. Imagine a huge organization like General Motors attempting to change itself (or move off its current position) if it were not divided into departments. Could General Motors be expected to change if each of its employees' capacity to initiate change was contingent upon the move of all other employees? Without decentralization, the organization quickly freezes into place because of the seemingly limitless conflicting constraints that govern change in this situation. This results in a rigid organization because an agent can change states only if it benefits the entire organization. Thus the adaptive walk of this organization is short lived because it

quickly settles on a position (suboptimal or optimal) whether on a “good” peak or not. As a result, state changes among agents are no longer possible for a centralized organization because no additional state change can bring the organization to a more optimal position.

In other words, centralized organizations are limited to one move because of the vast number of conflicting constraints encountered by an individual agent attempting to change its state. The agent must not only know how it will effect his lot but how the change will affect the lot of the entire organization. Because of the huge number of conflicting constraints that emerge, a move by a centralized organization is analogous to a spin on a roulette wheel. Once the wheel comes to a halt and the ball lands on its position, it is frozen in place.

On the other hand, a decentralized organization is modeled by dividing the square into “multiple patches” or departments. In this scenario agents can change states as long as they are improving the performance of their patch (not the entire organization). This situation proves to be more flexible. Each state change within a patch is still required to move the patch closer toward Pareto optimality, but the coupling of the patches allows the organization as a whole to move both away from and toward a Pareto optimal position. This is possible because a state change which improves the lot of one patch may either improve or worsen the condition of its neighbors, and thus ultimately changes the state of the entire organization. This creates an organization in constant flux, and this flux is what permits the organization’s bi-directional movement on the landscape. The coupling between patches prevents all of the organization’s patches from simultaneously reaching a Pareto Optimal position and thus prevents freezing.

A decentralized organization is constantly affected by the interaction of its patches and so too is its position relative to a Pareto optimal measure. This proves to be advantageous because a decentralized organization is not limited to one move and is able to navigate up and/or down fitness peaks which prevents getting stuck on a low peak. For instance, if an organization reaches a low peak on its first move it is not “frozen” into place because some patches can still change states. As these patches change states, they affect their neighbors and thus change the entire organization. So if the organization moves away from a Pareto optimal position it can climb back down the peak and attempt a new ascent for a different location.

This results because the coupling between patches that change the state of the entire 10×10 square (organization) when one agent in any patch changes states because it

benefits its individual patch. Thus the system never freezes and instead becomes quite dynamic and adaptive.

The key then becomes to find just the right amount of disintegration that will enable an organization to lie in the fertile area between order and chaos: the phase transition. (Kauffman p.253) Here “good solutions” are found quickly. Disintegration within the model can take various forms. A more decentralized organization can be formed by taking the 100 agents and dividing them into four autonomous 5×5 patches. In other words the organization consisting of 100 agents would be divided into four autonomous departments. Furthermore, twenty-five patches divided into 2×2 squares can create 25 autonomous subunits within the organization. Sundry forms are possible with the limit of decentralization being reached when each agent represents an autonomous department.

The model reveals that the amount of fragmentation found in the system (the size and number of the independent patches) is determined by the amount of interdependency of the elements that make up the fitness landscape. Recall also that the amount of interdependency (measured by K) affects the ruggedness of a given landscape. The more rugged the landscape, the greater the disintegration (number of patches) required for proper adaptation. Since the disintegration produces autonomous patches, greater decentralization is also required. Thus the more rugged the landscape the greater the disintegration and decentralization needed to stay abreast of its constantly changing character. A flatter landscape (static environment) would allow for a single, large patch because there are fewer peaks to track or less change and uncertainty to manage.

Each of the model’s variations (from centralization to decentralization) uses limited hierarchy. One would especially expect a greater use of hierarchy for those situations where the organization is highly disintegrated. However, each of the models always has two layers of hierarchy. One layer would be analogous to senior management determining the proper global objective to pursue in a given environment, while the second layer would be comprised of employees. It is hard to imagine an organization that is completely flat (i.e., no hierarchy) that is not plagued with anarchy. On this count the patches model can also be said to parallel the idea of systems analysis. However, the model does not use hierarchy to factor global objectives to the extent found in systems analysis. The following quote will reveal that the theories begin to diverge when the interfaces of each individual subsystem are considered.

Each patch is an analogue of what we called a species... Each patch climbs towards fitness peaks on its own landscape, but in doing so deforms the fitness landscapes of its partners. As we saw, this process may spin out of control in the Red Queen chaotic behavior and never converge on a good overall solution. Here, in this chaotic regime, our system is a crazy quilt of ceaseless changes. Alternatively, in the analogue of the evolutionary stable strategy (ESS) ordered regime, systems might freeze up, getting stuck on poor local peaks. Ecosystems, we saw, attained the highest average if poised between Red Queen chaos and ESS order. We are about to see that if the entire conflict-laden task is broken into the properly chosen patches, the coevolving system lies at the phase transition between order and chaos and rapidly finds very good solutions. (Kauffman, p. 253)

Here lies the crucial difference between the current systems analysis perspective and the complex adaptive systems perspective. Where the adaptive variants rely on the abstract concepts of “self-organization” and “emergence” to coordinate its actions, the systems analysis view utilizes authority relations to conduct planning and control. For instance, Kauffman, speaking on emergence, notes that even with each individual patch attempting to reach its own optimal solution, an “invisible hand” intervenes to bestow order. Moreover, commenting on “self-organization” and “emergence,” Murray Gell-Mann (1994) notes that many scientists, including those at the Santa Fe Institute, “are trying hard to understand the ways in which structures arise without the imposition of special requirements from the outside” (pp. 99-100). Thus these ideas are certainly worth rigorous academic exploration, but they are not yet the organizational concepts on which one wants to stake one’s business.

So the systems analysis approach uses a more pragmatic method to coordinate organizational activities. According to Emery, planning is essentially the factoring of the global objective into a hierarchy of subgoals (pp. 118-119). Planning serves as a means of intra-firm communication and coordination and is a proven method to orchestrate organizational activities.

Here a question arises. Given that complex adaptive systems are the most likely to succeed in the dizzying environments noted above, does that preclude any organization from ever successfully adapting to its environment? Fortunately, the answer is no. Two techniques may be used to engender emergent-like properties. These techniques will only be mentioned here but will receive considerable attention in the next section. They are a

“declarative form” of planning that allows for “adoption through hierarchical planning”(pp. 125-126) and, what should be of little surprise by now, the adoption of market forces.

C. ENGENDERING EMERGENT LIKE QUALITIES

The lesson to be taken from the comparison of theories above is that the classical systems analysis model which many of today’s organizations are designed with can be modified to allow for emergent-like properties. But are there other lessons to be learned from the complex adaptive system model? The patches simulation reveals three principles that can facilitate adoption of emergent-like properties. These principles are: (1) organizations must become knowledge processors, (2) organizations must embrace the market for its internal as well as external coordination, and (3) disintegration and decentralization should be used so as to operate in the phase transition zone.

Each of these details should be considered in greater detail. First, if one thinks of the NK model as a knowledge landscape, organizations will be required to become knowledge processors. As a result, movement must be made away from conceptualizing organizations as mechanistic information processors (Galbraith, J., 1973; Arrow, K., 1974; Fitzgerald, L.). This is required for two reasons. According to Ikujiro Nonaka and Hirotaka Takeuchi (1995), the Western depiction of organizations as “machines for information processing” is not conducive to knowledge creation (pp. 9-10). This machine metaphor recognizes only the explicit dimension of knowledge, while ignoring its equally important tacit dimension. In addition, the process of innovation itself is chaotic. Thus, an overly mechanistic and systematic approach to this objective may prove counter-productive. In order to become more effective at generating innovations, firms must be thought of and designed as adaptive organisms that are processors of knowledge.

Second, all organizations hoping to transform into a more complex form must embrace the emergent characteristics of the market. Recall that Kauffman mentions an “invisible hand” brings order in the patches simulation. The market could easily be that invisible hand for organizations.

However, as Kenneth Arrow notes, organizations, in their attempt at collective action, put the price mechanism into abeyance (p. 33). Why then reintroduce market forces where the price mechanism was purposely rejected? The answer lies with the

increasing speed and the ever changing nature of the knowledge economy. The rate at which competitive firms must operate is approaching the speed at which the market performs. In an age where organizations are evaluated on the basis of their ability to convert information to knowledge and thus beget innovations, it seems logical that they should harness the benefits of the quintessential information processor: the market. In pondering how firms will achieve the level of innovation required in the modern economy, Tom Peters (1992) proposes “that giving the market free rein, inside and outside the firm, is the best—perhaps the only—satisfactory answer” (p. 480).

Recall the earlier quote from Fredrick Hayek in which he compared the market’s stock of information to that of a telecommunications system. This telecommunication system, as he fondly called it, communicates a large amount of critical information by condensing the message into the prices. With accurate pricing information the effective and efficient coordination of resources is made possible throughout the entire economy. In a similar fashion, the resources of an organization can be more effectively allocated by harnessing the communicative and the inexpensive bandwidth provided by the price mechanism. Organizations cannot afford to ignore the intra-firm coordination that this communications medium allows.

Remember that complexity theorists have classified the knowledge economy as “an example par excellence of a complex adaptive system” (Waldrop, p. 145). One way for organizations to become more like the complex adaptive systems that thrive on rugged landscapes is to adopt market forces.

Another idea from the complexity literature reveals the relationship that should be engendered between the knowledge economy and future organizations. The “fractal” has a peculiar characteristic of maintaining the same structure at different levels. Stan Davis and Christopher Meyer use the example of a “tree, branch, and twig” in that at each level the same branching structure is maintained. From this they posit that:

The methods for value creation must be the same at the macro- and microeconomic levels – the economy and the enterprise. The structure of the economic web should be the same as the structure of an adaptable organization web. (pp. 117-118)

Third, the “patches logic” clearly demonstrated that disintegrated, decentralized organizational subunits were more adaptive in rugged landscapes. In fact, the impetus for

the patches model was the observation that “[o]rganizations around the globe were becoming less hierarchical, flatter, more decentralized and were doing so in the hopes of increased flexibility and overall competitive advantage” (Kauffman, p. 245). Now with the aid of the model, the reason for the trend in greater decentralization is clearer.

D. FROM THEORY TO PRACTICE

It is crucial that organizations pay heed to the aforementioned lessons so as to emulate complex adaptive systems by acquiring emergent-like traits. It is only those organizations that can make the transition to a more complex form that will succeed in today’s demanding environment. The following will combine the above theoretical-based principles with recent private sector experiences to formulate a model approximating the characteristics of complex adaptive organization. The aim here is to translate the theory of complexity and its metaphors into pragmatic steps that practitioners can use in transforming their organizations.

First, complex adaptive organizations exhibit an ability to learn. They develop a constantly evolving schema that senses and reacts to the most minute environmental changes. This learning process constantly builds the schema by incorporating organizational experiences. This not only enables refinements to be made in its current operations, but also allows for proactive actions motivated by the schema’s predictive ability. (Waldrop, p. 145, borrowing from John Holland’s description of complex adaptive systems). Murry Gell-Mann comments that these adaptive systems

acquire information about [their] environment and [their] own interaction with that environment, identifying regularities in that information, condensing those regularities into a kind of schema or model, and acting in the real world on the basis of that schema. (p. 17)

A hyper-responsive schema is rapidly becoming a corporate necessity and is being made possible by the recent advancements in information technology. This schema serves as an organization’s brain (or as “level one” of the patches model) and nervous system. However, in this case, the brain of the organization does not sit atop a pyramidal hierarchy directing with a central planning script. Rather it is an environmentally

responsive, ever changing, diffuse, and collectively derived understanding of the organization's mission. Changes in any part of the organization are instantly communicated throughout, thus allowing the autonomous units to adjust dynamically in real time to any change in circumstance.

At the same time, this organizational mind provides for a distributed repository of corporate knowledge. This knowledge is essentially a codification of a firm's human and intellectual capital. This knowledge repository can both be accessed and to some extent modified by each of the organization's workers. This is then provided to every appendage of the organization by information technology which acts in a similar fashion to a "nervous system" (Emery, p. 34).

Second, this nervous system produces organizations that are comprised of multiple "agents" or workers networked together for the attainment of a common goal. Every node of the network is now critical. The growing number of knowledge workers being assimilated into modern firms and the rapid advances in information technology are drastically changing organizations. A firm's core competence is no longer a function of individual interactions but a product of a wholistic synergy made possible by networks.

Some claim that this network effect is spreading throughout an organization's value chain thus blurring the boundaries of individual organizations. However, circumscribing the exact bounds of an organization has always been problematic because systems boundaries are drawn "arbitrarily." (Emery, pp. 4-5) Certainly, the boundaries that separate one firm from another have become less distinct with the advancement of technology, but organizations will remain, despite those who claim they have been supplanted by a more ephemeral networked form. Drucker writes, "A good many writers, seeing all these changes and all this turmoil, are writing of 'the end of organizations.' That, however, is the one thing we can predict with certainty will not happen." (1997, p. 4)

Third, the nature of planning and control is changing. The hyper speeds and ceaseless demands of the new economy are forcing a reevaluation of planning and control methodologies. Planning and control is moving to a still yet indefinable form in which emergent-like qualities are made possible. Although, as noted above, the organization's brain provides guidance concerning its global objectives, the organization's true bearing is a collective by-product of the interaction of its knowledge workers.

There seem to be two ways in which organizations can engender emergent-like qualities. First, organizations can make greater use of the market, which was earlier

described as the epitome of a complex adaptive system. An example of how DoD may pursue this route will be presented in the next chapter. The ideas that will be expanded upon include core competence analysis, transaction cost economics, agency theory, and market transfer pricing. Second, an organization's planning and control system can be modified to allow for emergent-like properties. Recall that the crucial difference between systems analysis and the complex adaptive systems perspective was that the former lacked the emergent-like properties of the latter. However, there is a pragmatic way that emergent-like properties can be harnessed by a planning and control system.

The technique, a declarative form of planning that allows adaption through hierarchical planning, is one that has already been identified by Emery, and provides for the creation of an adaptive planning process that enhances organizational performance. A "declarative" form of planning, which demands that organizational directions are given only in the form of a "specified outcome," may allow the cultivation of emergent-like properties. In discussing the declarative form, Emery notes that after the "specified outcome," is given, it is "left to those executing it the responsibility for choosing the sequence of actions necessary to achieve it." (p. 110) Adaption through hierarchical planning results in performance improvements by way of iterative, micro-evolutionary changes to the various trade-offs of the constraints that are present in the planning processes. (pp. 125-126) These two ideas form the basis of an organization's organic efforts to produce emergent-like behavior.

Thus the organization's brain and nervous system engender emergent-like properties by providing only general guidance while creating a knowledge-saturated workspace that all agents can collectively exploit to achieve the organization's objective while providing only general guidance to organization. In addition, the adaptive planning process allows for a flexible plan that changes with new information or unexpected constraints. Thus, adaption through hierarchical planning and a declarative form of planning creates in human organizations a close representation of Kauffman's patches freely coordinating amongst themselves to achieve a firm's global objective.

In addition, a rapidly changing environment forces a redefinition of long-range planning. With a protean environment, one can expect greater organizations to make greater changes to their plans. The frequency of these changes would depend on the environment within which one is operating and what level of the hierarchy is affected. It may turn out that more energy should be directed to short range planning because of the environment's rapid and dramatic changes.

However, to create this patch-like activity two issues must be addressed. First, as previously mentioned, the organization's brain (level one in the patches simulation) clearly articulates, refines, and communicates the global objective of the firm. This message is delivered on an information technology backbone which acts like a nervous system connecting each subsystem in the organization. Because of the inundation of knowledge that is produced in this process, information technology must also be used to prevent information overload. This technology takes the form of smart agents that can facilitate the retrieval, parsing, analysis, and synthesis of information. Second, senior managers should become facilitators, not directors. Drucker offers an example by writing that corporate leaders must become more like orchestra conductors. They facilitate the making of music, yet maintain the ability to transform the piece if required. (1993)

Fourth, in order to remain responsive to an unforgiving environment, organizations must avoid bureaucraticization and instead construct decentralized, shallow hierarchical structures. This structure is demonstrated in the patches simulation with its two-layer hierarchy. Moreover, this structure is constructed with decentralized "building blocks" that are dynamically arranged to meet each given objective.

Thus, each subsystem of the organization becomes a specialized building block that, combined with the other subsystems, forms a firm's core competence. A possible organizational coping mechanism for dealing with a protean and demanding environment is to specialize. This is analogous to organisms on rugged landscapes in which specialization allows survival. In a similar fashion, modern firms have to focus on their core competences to succeed. Thomas Malone and John Rockart (1991) claim that the greater efficiency engendered in markets by information technology "implies that firms should focus more carefully on the few core competencies that give them strategic advantages in the marketplace" (p. 132).

This line of reasoning can also be extended to encompass an organization's "building blocks." These blocks can be thought of as highly specialized teams that are coupled and decoupled according to the task at hand. As before, the unit of analysis shifts from the individual to the team. These teams, as in the patches simulation, are autonomous units that can exploit "entrepreneurship" to optimize (or actually suboptimize because of the aforementioned constraints) and avoid unnecessary bureaucratization.

This collection of decentralized, independently specialized subsystems benefits organizations in that they not only provide for efficient information flows, but also allow

for the most effective use of human capital. This technology-enabled decentralization allows for the actualization of Hayek's principal of empowering those individuals with the information that is relevant only in a "particular time and place."

Fifth, like their protean environments, these organizations are constantly changing. Thus, John Holland writes, "complex adaptive systems are characterized by perpetual novelty" (cited in Waldrop, p. 147). This may be similar to what Peter Drucker calls "abandonment." He claims that every three years organizations need to reevaluate everything, right down to the very business they are in. (1995, pp. 32-33) It seems that today's organizations may have to reevaluate themselves at a faster rate. However, this is a difficult task and it remains to be seen if organizations can truly transform themselves at rate faster than is prescribed above.

In conclusion, organizations hoping to cope with the demanding knowledge economy must acquire emergent-like properties. In the following chapter, the two most salient actions an organization can take to this end will be expounded upon.

V. FROM HIERARCHIES TO MARKETS

At this point in our journey to transform the Department of Defense into a more effective organization for the 21st century, several environmental factors have been revealed that call for a more streamlined, market-driven organization. In addition, it has been demonstrated through theory and practice that an organizational transformation that embraces emergent-like qualities is a requisite for success in the new age. This transformation should be done endogenously with modifications to the planning and control system and exogenously through the incorporation of market forces. This chapter will focus on the latter, for that is the route that will lead to the greatest performance enhancements for organizations.

The Defense Department's adaption on complex knowledge landscape will be possible only through change that facilitates the use of emergent-like properties. The most effective route to this end is the incorporation of the market's complex adaptive traits into DoD's organizational structure. If pursued, this change will prove revolutionary. It will create an organization that can rapidly and accurately "sense and respond" and thus stay aligned to its protean environment. (Bradley, 1998)

The strategy of market adoption may also produce lasting change. In the opening pages of this work, it was mentioned that a shift in organizational forms is occurring "from hierarchies to markets." The market may serve to cleanse permanently DoD of some of its bureaucratic character by permanently shifting its peripheral economic activity to the market. Thus, integrating the market within DoD's structure may prove more effective than previous reform efforts that have sought to incorporate business practices into the Department's operations. The reason is that a complete reevaluation of the assumptions that drive reform is necessitated. From Robert McNamara's attempt to introduce Ford Motor Company's practices into the Defense Department to the present efforts by William Cohen, the bias has been towards hierarchy (internal rather than market coordination). This assumption has often allowed DoD's girth to persist even as means to improve its effectiveness were being diligently investigated. In fact, DoD has historically resisted efforts at reform; Cohen's laudable efforts to harness the "revolution in business affairs" have been primarily precipitated by a reduction in funding.

Past missteps aside, today's low-transaction-cost environment may provide an opportunity to leverage the market and truly reform DoD. Therefore, the question driving

change must be restated in a form that attempts to determine the extent to which DoD can use the market, rather than how to make a bloated bureaucracy more effective. Any reform should begin by examining DoD's vast requirements and then posing the following question: To what extent can the market be used to meet a given requirement? If and only if the market is seen as unsuitable to meet a given requirement should the question of effectiveness be broached.

With this new reform orientation in its arsenal, DoD will be able to redesign itself into an organization⁵ better suited to exploit the seemingly boundless opportunities of the information age. The time is ripe for this new orientation. As market transaction costs continue their asymptotic decline and electronic commerce continues its exponential growth, organizations will be forced to reevaluate their "market-to-hierarchy" ratio.

Thus this section will explore the use of two economic theories, transaction cost economics and agency theory, to show how they, along with electronic commerce, can be used to facilitate movement to a more agile and adaptive organizational structure. DoD's new organizational structure will be built solely around its warfighting core competencies, and the market will be leveraged for all of its peripheral economic requirements.

A. THE ECONOMIC THEORIES

Among the economic theories that have arisen to challenge the "classical" treatment of the firm as a profit-maximizing black box, two of the most influential are transaction-cost economics and agency theory. Although these theories differ in their attempted explication of the "nature of the firm," they do so in a complimentary way. Transaction-cost economics begins with the premise that the "markets and hierarchies" are alternative means of organization. However, markets suffer from various transaction costs that impede efficient coordination, thus resulting in the emergence of hierarchies (any form of organization that uses internal coordination instead of the market's price mechanism). Thus the growth of hierarchies can be attributed to their ability to "economize" on market transaction costs. This theory, in conjunction with core

⁵ Organization and firm are used interchangeably throughout the paper.

competence analysis, will prove useful in circumscribing the appropriate boundaries of DoD.

Where transaction cost analysis examines an organization's relationship to the market, agency theory delves deeper into an organization's internal mechanisms. From this perspective, organizations are thought to be a "nexus of contracts among self-interested individuals." Here, the myriad of relationships that comprise a firm are managed through contracts between principals (owners/managers) and agents (workers). This theory offers means to cope with the inherent friction found in principal/agent relationships known as "agency costs". These costs are then balanced against the costs of delegating decision rights within an organization. The balancing of these costs sheds light on the organizational tradeoffs that one must consider in designing a centralized versus a decentralized organizational structure.

Transaction cost economics was introduced in a 1937 article entitled "The Nature of the Firm." In this piece, Ronald H. Coase framed a question that gave birth to a new paradigm in understanding economic organization, namely, "why a firm emerges at all in a specialized exchange economy" (reprinted in Williamson and Winter, 1991, p. 20). In posing such a question, Coase, like Fredrick Hayek, had great respect for the price mechanism as a simple but powerful means to coordinate economic activity. Yet all around him were organizations. He argued that although the market was a coordinator of economic activity par excellence, a firm incurred transaction costs with its use. Thus, in certain situations, internalizing the coordination efforts within a firm's hierarchy could economize on transaction costs (here the price mechanism would be supplanted by internal coordination conducted by authority relations). Decisions between the two alternative forms of organization, markets or hierarchies, are made on the basis of minimizing coordination costs (internal or external). Coase states, "the operation of the market costs something and by forming an organization and allowing some authority ('entrepreneur') to direct resources, certain marketing [transaction] costs are saved" (p. 22).

With the emphasis on the costs incurred in transacting, the unit of analysis becomes the transaction. A transaction can be defined as a transfer of a good or service from one party to another. Therefore, transaction costs are all the expenses incurred in the execution of a given transaction. Transaction costs can occur endogenously as a result of internal coordination of a task (e.g., costs of coordinating a large group of people to achieve a global objective) or exogenously if the task is coordinated by means of the

market. Furthermore, these market transaction costs arise from operational and contractual circumstances. For instance, operational costs would include search costs, transportation costs, inventory holding costs, and communications costs, while contractual expenses accrue from the costs of writing and enforcing contracts (Gurbaxani and Whang, 1991, p. 64).

Transactions can also be evaluated on the basis of three “principal dimensions.” These dimensions include the frequency in which a transaction is executed, the uncertainty inherent in conducting a transaction, and a condition referred to as asset specificity (Williamson, 1996, p. 49). Although the first two are self-explanatory, the third dimension requires a brief explanation. Oliver Williamson claims that asset specificity is the most “important and distinctive” dimension (p. 45). A specific asset can be understood as having a higher opportunity cost in its current use than it would have in an alternative use.

For instance, if a firm requires a specialized part that can be produced only with investment in uncommon machinery by another firm, transaction costs will be high. This occurs because the production firm will be unlikely to invest in unique equipment if there is only one buyer. This results due to the leverage that the sole buyer would have over the producer whose machinery was inappropriate for any other use. Here the buyer can exploit quasirents, or the difference “between the amount which would be needed to justify an investment and the amount which justifies operating it after is undertaken” (Rubin, 1990, p. 3). Thus, in situations like the above, efficient transactional relationships are maintained by integrating the production of the part within the organization’s hierarchy (this can occur with the investment of specialized machinery and personnel or by means of vertical integration with another firm).

Thus by assessing transactions for operational and contractual considerations, and evaluating each in terms its frequency, uncertainty, and asset-specific qualities, firms can choose a structure that economizes on transaction costs. The relative merits of conducting a given transaction internally (hierarchy) or externally (market) are weighed and the most cost-effective alternative is chosen. Organizational forms exist along a continuum with end points that are defined by market and hierarchy, with sundry organizational hybrids interspersed. Williamson (1996) notes, “Transactions, which differ in their attributes, are aligned with governance structures, which differ in their cost and competence, so as to effect a discriminating—mainly a transaction cost-economizing-result” (p. 12).

Whereas transaction cost economics enables an organization to determine its appropriate “environmental fit,” agency theory enables an organization to determine its proper “organizational fit.” Organizational fit can be defined as a process in which agency costs are weighed against “decision information costs” to determine incentive structures and decision rights within the organization.

One case of agency theory posits that the firm is a collection of self-interested individuals, all of whom have a contractual relationship with the firm. The self-interested nature of these individuals causes organizational misalignment between the objectives of the owner/managers (principals) and their employees (agents). In this model, “Employees can do any of the following: shirk, appropriate corporate goods, receive bribes for illegal favors, and abuse decision rights to their own benefit” (Gurbaxani and Whang, p. 61). Thus these various actions must be prevented, or at least minimized, by the principal attempting to achieve an organization’s global objective.

The differing interests between principals and agents form the basis of organizational friction that is encapsulated into the concept of “agency costs.” These costs come in three forms. First, there are monitoring costs for principals to check on the progress of agents in the execution of their assigned tasks. Second, there are bonding costs in which agents must report their progress to their principals. Third, there is a residual cost that is incurred regardless of the amount and success of the monitoring and bonding efforts utilized. The residual cost exists because the innate disparity between the interests of principals and agents will result in some loss in the firm’s value, despite efforts taken to countermand the other forms of agency costs. Agency theory proposes various methods to maintain the viability of a firm even though it is inflicted by agency costs. Some of these proposals deal with monitoring and bonding strategies, the establishment of incentive structures, and contracting techniques.

In addition to agency costs, firms are said to experience information-related costs that are incurred with the placement of decision rights within a firm’s hierarchy.⁶ Vijay Gurbaxani and Seungjin Whang have labeled these information-related costs as “decision information costs.” These costs come in the form of “information processing, costs of communication and miscommunication; opportunity costs that arise from delays in communication; and suboptimal decisions that result from a lack of information” (p. 62).

⁶ Vijay Gurbaxani and Seungjin Whang note that “decision rights” are synonymous with terms like “decision responsibility” and “decision-making authority.”

Thus in determining whether a centralized or decentralized organization is more effective, the decision information costs must be balanced with agency costs. For instance, information related costs increase as they are moved up the hierarchy of the organization, but agency costs are reduced. On the other hand, information-related costs decrease with movement down an organization's hierarchy, but agency costs increase. "Therefore, decision rights in an organizational hierarchy should be located where the sum of these costs is minimized." (p. 60)

B. FROM HIERARCHY TO MARKET

The application of transaction-cost economics and agency theory may facilitate the much-needed transformation of DoD into a complex adaptive organizational form. Here a two-phase process will be presented using the above-mentioned theories to incorporate the market's emergent characteristics into DoD's organizational structure.

This organizational metamorphosis can occur in two adaptive phases. First, transaction cost economics can be used in conjunction with a core competence analysis to circumscribe the boundaries of DoD. Gary Hamel and C.K. Prahalad (1994) define a core competence as "a bundle of skills and technologies that enables a company to provide a particular benefit to its customers" (p. 199). With DoD's customers being the American citizenry, it should focus on those core competencies that allow it to meet the requirements set forth by the national security strategy of the United States. Once an analysis of DoD's core competencies is conducted, then transaction-cost economics should be used to determine those non-core competencies which should be allocated to the market because they result in a husbanding of transaction costs.

This "environmental fit" will result in a leaner, more focused organizational structure that can more effectively carry out its warfighting mission. Having shed its peripheral economic requirements to the market, even greater agility can be engendered through a proper "organizational fit." Thus the second phase would attempt to create somewhat of a market environment within the structure that was deemed necessary by phase one. Where possible, the second phase will seek to use agency theory and market transfer pricing to create a decentralized, market-driven organization.

The shift of organizational forms from hierarchies to markets can be attributed to factors that parallel the lessons revealed by the patches simulation. Recall that these

lessons were: (1) organizations must become knowledge processors, (2) organizations must embrace the market for its internal as well as external coordination, and (3) disintegration and decentralization should be used so as to operate in the phase transition zone.

The first reason that organizations are moving away from hierarchies and to markets is related to lesson (2). The introduction of the Internet and electronic commerce is enabling a reduction in external coordination costs (transaction costs) similar to what information technology has already delivered for internal coordination costs. Information technology's ability to reduce an organization's internal coordination costs has been well documented, (Brynjolfsson, 1994) but because of technological limitations the reduction of external coordination costs has lagged behind. As predicted by transaction-cost economics, this relative decline of internal coordination costs versus external coordination costs has favored the adaption of organizational hierarchy. However, the effects of reduced external coordination costs are just beginning to be felt. Only with the recent introduction of the Internet has the business community contemplated the possibilities of a market-oriented organization. Organizational forms like the Virtual Corporation and the Network Organization are starting to emerge that exploit the benefits of low transaction costs.

The second factor leading to a greater use of markets can be related to lesson (3). A more extensive reliance on the market is allowing for the creation of flatter, less-hierarchical organizations that are more responsive to changing circumstances and thus can reduce their risk of environmental misalignment. But the speed at which the market operates and the greater reliance on greater decentralization creates a chaotic-like environment within the organization. This chaos occurs in the phase transition between order (complete centralization) and disorder (complete decentralization) in which organizations perform at their peak. A smaller, less bureaucratic organization that embraces the market will experience less resistance in making the changes necessary to stay abreast of a constantly changing environment.

The third factor, relating to lesson (1), is that rapid and effective use of an organization's knowledge is facilitated by a nimbler market structure. In addition, the market itself is an information processor that when woven into the structure of an organization results in the added benefit of the price mechanism's precient message. Hence, an organizational structure that has been pared of excess hierarchy will better withstand the information processing and knowledge creation requirements of a

knowledge economy. These factors may decisively shift the balance of organizational forms towards the market.

Underlying each of these shifts is the transformative power of information technology. Information technology has enabled the market based organization to reduce transaction costs. Recall that Philip Evans and Thomas Wurster showed that by revolutionizing communications, information technology has led to a dramatically transformed business environment. This transformed environment allows organizations to shed the temporal and spacial restrictions that have tipped the organizational equation from markets to hierarchies.

Since technology provides a vehicle to alter organizations, the two adaptive phases mentioned above could be initiated concurrently with DoD's efforts to establish an electronic commerce capability. In fact, DoD has been assigned the lead role in implementing the Federal Acquisition Streamlining Act's (FASA) Federal Acquisition Computer Network (FACNET), and thus can set the example for the entire federal government. Electronic commerce will undoubtedly create closer links to the private sector and thus could markedly change the government's relationship with the market. As this becomes a reality, even greater opportunities will present themselves for DoD to leverage the market and reduce its hierarchy.

Thus the steps required to institute electronic commerce will provide the ideal environment to determine what should be done by hierarchy and what can better be accomplished through the market. In addition to the improvements in efficiency and effectiveness that DoD will experience from its electronic commerce efforts, it will also create a real platform for change. Although DoD has aggressively pursued electronic commerce, it has experienced little success. Success has eluded DoD because it has focused on the technological nature of electronic commerce while ignoring the equally important fact of its impact on organizational structure.

In fact, Hock-Hai Teo, Bernard C.Y. Tan, and Kwok-Kee Wei (1997) have shown that the implementation of electronic commerce can provide a vehicle for organizational change. The authors conducted a case study of Singapore's Trade Development Board's (TDB) implementation of an EDI-based electronic commerce system known as TradeNet. This is a particularly interesting case study in that it documented a successful implementation of an electronic commerce capability for a public sector organization. The project's success can be attributed to its holistic approach. It used the opportunity not only to implement an electronic commerce system, but also to transform its

organizational structure, business processes, business network, and business scope (pp. 141-143). The case study uncovered four lessons learned from the TradeNet implementation: “change existing mindset, institute radical reform, leverage knowledge and technology, and foster win-win situations” (pp. 159-162).

In contrast, DoD has not only failed to realize information technology’s full potential, but has squandered an opportunity to transform itself. This lack of success can be attributed to the fact that DoD adopted information technology, specifically in its electronic commerce efforts, without initiating the requisite organizational changes. This certainly resulted because of the ineffective reform orientation mentioned earlier. The effort to implement electronic commerce failed to address the most salient issue, that of process reengineering. This all but guaranteed that there would be no improvement in effectiveness and/or efficiency. However, consideration was not paid to the first and most critical question, that which seeks to recalibrate the division of labor between DoD’s hierarchy and the market. Teo, Tan, and Wei stress that “[m]ost studies suggest that the use of information technology without concomitant organizational changes was unlikely to yield significant gains in terms of organizational performance” (p. 141).

Another example of misguided priorities can be found with DoD’s fixation on a “paperless” environment. Although this is a laudable objective, especially since it seeks to reduce the miles upon miles of stored paper files (Burman, 1998), focus on this objective has prevented a more holistic, transformative perspective. FACNET became merely a vehicle for reducing paper, rather than medium for dramatic change. Thus DoD has eschewed Michael Hammer’s (1990) advice to “obliterate rather than automate,” instead choosing simply to overlay the technology on top of existing processes. The Defense Department’s lead role in the FASA’s FACNET has been far from successful, primarily because information technology was adapted without a concomitant organizational redesign.

This has resulted in the General Accounting Office reporting that “less than two percent” of the federal transactions between the micro-purchase level (\$2501) and simplified acquisition threshold (\$100,000) are conducted via FACNET (Rodrigues, 1997). “Although FACNET is barely a couple years old, GAO noted that it already is out of step with newer, faster, and more cost-effective approaches to electronic commerce, such as the Internet or on-line catalogues” (Pushkar, 1997). Furthermore, various articles report that several federal agencies have begun a mass exodus from the poorly planned and executed FACNET. (Power, 1997; Author Unknown, 1997) However, even after 24

senior agency officials forced the executive branch to abandon FACNET (Messmer, 1998), it seems to be making a comeback. Thus current efforts to make use of the Internet by use of e-catalogs (E-cats) and purchase cards (p-cards) (Drake, 1997) is being muddled by the persistence of FACNET.

Electronic commerce is critical for the creation of a market-oriented organization. Thomas Malone and John Rockart note:

A surprising result of our research is a prediction that information technology should lead to an overall shift from internal decisions within firms toward the use of markets to coordinate economic activity (p. 131).

Due to electronic commerce's potential to transform DoD into a more effective and efficient organization, DoD's new Internet strategy should be pursued aggressively. However, since electronic commerce standards have yet to be established, the government should seek to implement only the most open standards: HTML/XML, ASCII, TCP/IP, SQL, and IMAP4. These open standards will create a more flexible implementation of electronic commerce that, combined with considerable organizational redesign will produce a leaner and more effective DoD.

Electronic commerce lies at the heart of the "friction-free" economy and will deliver the economy's low-transaction-cost environment right to its doorstep. However, its ability to leverage the potential of the market rests with the effective re-education of DoD's "doorman" to the market: the acquisition process.

VI. CONCLUSIONS

Before the benefits of the market can be realized, a fresh look must be taken at the acquisition process that serves to regulate DoD's role with the market. A plan for DoD acquisition reform will be offered to demonstrate what can be accomplished when the economic theories offered in the previous chapter are combined with the transformative nature of information technology. The end result will be that the acquisition process is transformed from a "rule driven to objective driven process" (Osborne and Gaebler, 1992).

A. APPLICATION TO ACQUISITION REFORM

As the DoD begins to exploit fully the transformative properties of information technology, less hierarchy and greater market utilization will result. However, prior to electronic commerce enabling organizational changes, the Department's means for interfacing with the market must be changed. Recall that the market's low transaction costs will enable a reduction in DoD's hierarchy only if it allows for an economizing of transaction costs. However, because much of DoD's interaction with the market is conducted through an acquisition process that is plagued with problems, the transactional benefits may not be realizable. This results because the acquisition process adds sufficient transaction costs to tip the balance of a transaction cost analysis towards hierarchy.

Only with a changed acquisition process will DoD be poised to take advantage of the phenomenal opportunities available to organizations that leverage the marketplace. These efforts will not prove easy because the government has been attempting to reform the acquisition process for the last 220 years (Frank, 1997, p.286). For instance, despite a "parade" of eleven major initiatives dating from 1961 to present, "the acquisition system continues to function under a heavy burden of regulation and bureaucratic inefficiencies" (p. 282). However, changes in today's marketplace will add considerable firepower to the government's reform efforts.

Today's acquisition process still stands as an obstacle to greater market utilization. As DoD turns to the market for its peripheral economic activity, a

streamlined acquisition process becomes critical. This effort to streamline the acquisition process lends itself nicely to the two adaptive phases mentioned previously.

The first phase calls for both a core competence and transactional analysis. What does a core competence and transaction cost analysis reveal? Jacques Gansler (1998), Under Secretary of Defense Acquisition and Technology, thinks that he has pinpointed DoD's core competencies as management, policy, intelligence, and combat. He goes on to say that DoD must

look to the private sector to compete for a wide range of goods and services –housing, logistics support services, transportation and delivery services, data management, medical supplies and health maintenance services – many of which can be delivered faster, better and cheaper. (Gansler 1998)

In a similar fashion, the head of Business Executives for National Security, Retired Lieutenant General Thomas McInerney, believes that “Cohen should divest entirely such commercial functions as business travel, data processing, and housing” (Crook, 1997). It is not surprising that there are many opportunities for DoD to make better use of the market and subsequently improve its efficiency and effectiveness as an organization.

In maintaining the theme set early in this work, only those areas of acquisition reform that affect DoD's peripheral economic activity will be further investigated. Thus the areas of the acquisition process that affect DoD's core competencies, as delineated above by Jacques Gansler, will be ignored. Also, the process for acquiring major weapons system will also be intentionally overlooked. These will be ignored not because they are not in need of reform, but simply because reform in this area is beyond the scope of this work. Former Secretary of Defense William Perry clearly believes that the whole acquisition process needs to be reformed, saying:

DoD has been able to develop and acquire the best weapons and support systems in the world. DoD and contractor personnel accomplished this feat not because of the acquisition system, but in spite of it. And they did so at a price... the nation can no longer afford to pay... (Frank, p. 280)

However, even with this bifurcation of acquisition process a true transactional analysis to determine what should be produced by hierarchy and what should be delegated to the market will still be impeded by the current acquisition process. Hence, due to the rule-laden and politically-driven environment of the government, agency theory may have to be used to reduce the bureaucratic inefficiency preventing the use of transaction-cost economics.

According to Deborah Frank, the main impediment precluding a successful reform of the acquisition process is its heavily politicized nature. With the crux of the reform effort identified, she recommends a quixotic, but necessary step towards realizing an effective acquisition process. She turns to an earlier work by W.H. Gregory (1989) in which he recommends that Congress distance itself from the acquisition process and take on the role of board of directors. Extrapolating from this point, the American citizenry can be thought of as shareholders and military officers can be thought of as managers.

Now with this scenario, there exists fertile ground for the use of agency theory. In fact, one of the main applications of agency theory is to understand the conflicting interests between shareholders and managers in their pursuit to maximize the value of the firm. But how can one define the value of an acquisition process? The elements that create the value of acquisition process are three-fold: the acquisition process provides a means to manage and control the appropriation of government funds, provides for a mechanism of “fairness” by promoting “competition,” and provides for the purchase of high-quality goods and services.

Agency theory can maximize the value of the acquisition process while reducing the friction (agency costs) that may arise between Congress acting in the role of board of directors (principals) and military officers (and government employees) that run the acquisition system (agents). If the senior leadership of DoD translates Congress’ broad intent into a declarative acquisition plan which is then effectively communicated to all subordinates, decision rights can be altered to produce fundamental change in the acquisition process. As a result, a patch-like, decentralized structure will supplant the ineffective bureaucracy that now exists.

Here agency theory will be used to demonstrate how it can positively affect each part of the value definition mentioned above. First, control in the system is maintained by limiting agency costs, at the expense of information costs. Recall that decision rights within an organization should be placed where the sum of agency and information-related costs are minimized. The current system limits agency costs somewhat, but does so with

unacceptably high information costs. These information costs result in poor decisions that cost taxpayers money. Thus, these agency and information costs must be better balanced. This can be accomplished by relocating decision rights.

Since agency costs and information costs are inversely related, as decision rights are moved down the hierarchy, agency costs can be expected to increase. However, information technology “provides the ability to improve monitoring and performance measurement, reducing agency costs and thus inducing the decentralization of decision rights.” For instance, p-cards can be programmed with certain spending limits and/or smart agents can be devised to allow purchases on only a certain category of goods or services.

This decentralization of decision rights allows the maintenance of control while information costs are reduced. This allows for the maximum empowerment of an organization’s human capital, which in turn allows for the utilization of information most relevant in a “particular time and place.” (Hayek, pp. 79-81) Agency theory and information technology will beget the much-needed efficiencies heretofore unrealized in the acquisition process.

In addition, in the case of DoD control is built into its military hierarchy. With budgetary authority pushed to the lowest levels, the already existing military hierarchy can be used as a control mechanism. By use of commander’s intent, superiors can ensure that funds are used appropriately and effectively. To ensure compliance with the commander’s broad guidance, a performance block should be added to an officer’s evaluations to reflect his/her ability to effectively manage his/her allocated budget.

Second, with clear guidance and the proper incentive structures, budgetary authority can be delegated to the lowest level possible. Once this occurs, the need for the acquisition system to provide fairness is diminished. This results because the delegation of budgetary authority increases the number of purchasing agents who attack the market like the self-interested consumers they are. Fairness was an issue when the government was a monolithic purchaser of goods and services, but once it is broken down into a multitude of self-interested buyers, centralized decision making can be replaced by the more flexible price mechanism. Economies of scale need not be sacrificed as each individual government agent would still benefit from any government rates. In sum, guided by a clearly communicated intent and limited by well-thought-out incentive structures, the individual agents are afforded the opportunity to act in a way best supported by their information.

Third, the delegation of purchasing authority will also allow for the purchase of high-quality goods and services. Individuals will be empowered with the means to make decisions quickly with information relevant for a particular “time and place,” thus ensuring the items needed are the items bought. The creation of a close link between consumer and producer is especially important since DoD is moving toward performance-based specifications. Ultimately, individual agents will be empowered with the capacity to purchase rapidly those goods or services they require.

Rather than rules and regulations obstructing the purchase of goods or services, a set of well thought out incentive structures could facilitate the acquisition process. For instance, today a service member must submit his requirements through a bureaucracy-laden process that ultimately serves to distort or misinterpret his initial requirements. Clearly the service member has the greatest knowledge of the requirements that will allow him to meet his assigned mission. Instead of this convoluted and unproductive process, a service member should be delegated the authority to manage his own budget and make purchases as he sees fit. This service member can be further guided by incentive structures like rewards for cost savings and positive fitness reports. In addition, simple rules can be issued to control purchases. For instance, rules can be promulgated to ensure information technology purchased is compatible with currently used systems (i.e., Microsoft Office or Intel-based architecture). Finally, the military hierarchy that serves as the ultimate form of control also serves to guide the service member in making his purchases. Thus acquisitions can take place without the cumbersome and bureaucratic process that currently exists.

In sum, agency theory has enabled the decentralization of the overly centralized acquisition process into “patches” that by way of their own independent actions achieve the acquisition system’s global objective in a more efficient manner. Fairness is facilitated by the breakdown of DoD into a vast group of individual buyers governed by the market, rather than a rigid, centralized acquisition system controlling access to the market. Control is simply shifted to the extant military hierarchy and the constantly evolving security measures in the field of information technology. Finally, high-quality goods and services are a by-product of the markets, and need not be managed by a cumbersome, bureaucratic organization that adds no value to the process. Ultimately, the decentralization possible through the application of agency theory pushes the acquisition process closer to the phase transition zone where organizational performance is improved.

Now that the inefficiency has been squeezed out of the acquisition process while its value has been maximized, transaction-cost economics can be used more accurately to determine those efforts which will produce cost savings by using the market. The core competence analysis above determined those critical skills and technologies that are required for DoD to accomplish its mission. On the other hand, a transactional analysis will determine the economic viability of using the market instead of DoD's hierarchy. This process should begin in those areas identified as non-core competencies and over time may actually be able to be extended into the core competence area. An analysis of this sort will undoubtedly demonstrate that the use of the market will produce efficiencies and cost savings for DoD.

In many ways, the acquisition community acts as the liaison between the federal government and the market. If the efficiencies of the modern market place are to be realized by the defense community it must have an efficient conduit in the acquisition process. Therefore its reform is pivotal in realizing the gains this work has shown possible.

Thus by reducing some of the burdensome control mechanisms of the acquisition process it is pushed closer to the phase transition zone where organizational performance is enhanced. Ultimately, a reformed acquisition process will result in a leaner, more effective organization that can lead DoD in harnessing the power of the market. The cost savings accrued by the Defense Department allow it to remain a potent instrument of America's foreign policy.

B. CONCLUSION

In hindsight, this thesis has sought to target the three fringe groups that intentionally or unintentionally hinder the process of reform in DoD: skeptics, proselytizers, and sycophants. These individuals can be found in every facet of the industrial-military complex, some in uniform, some not, but each holding views that are detrimental to the greater use of the market and the subsequent lasting reform that will result. The skeptics of reform condemn even the slightest mention of the market as heretical, using as a shield their government identity to proclaim "we are different" and to justify their quick dismissal of ideas supporting the use of the market. The proselytizers, on the other hand, are always ready with a paean for the market. Whether appropriate or

not, the market is touted as the snake oil for DoD reform. The sycophants, meanwhile, probably the most dangerous, seek an advantage with a ready embrace for whatever idea is the reform plan du jour. They are particularly dangerous because their seemingly passionate acceptance of an idea leads to only a well-calculated barrage of lip service.

However, these groups constitute only a minority. So then, for the remaining majority of hard working, reform-minded employees of DoD it is hoped that this work provides an initial guide to true reform. It is incumbent upon us to pay heed to DoD's changing environment and to invoke reform to avoid the dangers mentioned in Chapter II. However, as reform begins to move us in the direction of the market, it is important to realize that a clear understanding of this new environment is necessary. As was shown in Chapter III, the knowledge economy poses its own challenges which, when understood and accounted for, allow for large opportunities.

What does this work offer as a guide to allow DoD to benefit from the opportunities of the knowledge economy? First, that change is possible if DoD adopts a new reform orientation. This reform orientation was covered in Chapter V and forces one to consider the trade-offs between markets and hierarchies prior to thinking about ways in which internal tasks can be executed more effectively. This consideration of the market early in the process will allow DoD a chance to focus on its core competencies and use the market where apposite.

Second, transaction cost economics was shown to provide a useful decision rule for the use of the market. An organizational structure allowing for the economizing of market transaction costs should be adopted. This would allow DoD to shed much of its hierarchy and in the process reduce some of its bureaucratic inefficiencies. Recall that in Chapter III the Major Force Programs were bifurcated into operational and support functions. This provides an initial starting point for the introduction of the market without hindering operational readiness.

Third, in addition to cost savings and efficiencies, the market also allows for an injection of "emergent qualities" into an organization. Chapter III explained complex landscapes and how complex adaptive systems are the most fit to achieve success in this demanding environment. Organizations that embrace the power of the market subsume to an extent its complex adaptive system properties.

Fourth, Chapter IV demonstrated that on complex landscapes decentralized organizations seem better suited to cope with the seemingly ceaseless demands of the environment. Agency theory was then introduced as a method in which DoD could

evolve into a more decentralized form by re-examing the trade-off between information costs and agency costs. This more decentralized structure would also allow DoD to handle more effectively the information management requirements endemic to the information age.

Fifth, just as information technology has been the enabler of the revolution that has swept society, it too is the enabler of true DoD reform. The case study presented in Chapter V of Singapore's Trade Development Board's implementation demonstrated the organizational reform that is possible with the adoption of electronic commerce. Thus DoD must learn from its mistakes with FACNET and use its subsequent attempt to initiate radical and lasting reform. It is hoped that this guide may initiate some of the changes required to maintain the effectiveness of DoD into the new millennium.

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