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KEEPING PACE: ORGANIZATIONAL BARRIERS TO COMMERCIAL PRODUCT USE IN DOD

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ABSTRACT. As a result of the technological boom of the past several decades, high-tech computer and aerospace products are readily available commercially. Typically less expensive and easier to obtain than custom design-and-build products, their value for the Department of Defense (DOD) has become evident. Less accustomed, however, to acquiring high-tech off-the-shelf, the organizational change required to facilitate "commercial-off-the-shelf" (COTS) acquisition has been sluggish and problematic. This paper examines the organizational barriers that have hindered the DOD aerospace transformation from a "design-and-build" acquisition philosophy to COTS. Three barriers were identified from this study: *misaligned reward systems, entrenched networks,* and *historical precedent.*

INTRODUCTION

In the middle of the twentieth century, aerospace and computer technology (an essential component of aerospace) were in their infancy, and such high-tech products were not available off-the-shelf. These technologies were sponsored in the US largely by the Department of Defense (DOD) and the National Aeronautics and Space Agency (NASA), and at the time were all but feasibility studies. In the post WWII era, the war-fighting benefits of air superiority were clear and the potential of the use of space for defense purposes was considered. The United States government pursued these avenues to maintain military technological superiority. While there was much debate as to what agency would be tasked with military associated space ventures, it was

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concluded that the newly create Air Force would be charged with the bulk of *aerospace*; a term created to define the atmosphere, with no clear boundaries as to which was for aircraft and which for spacecraft. Meanwhile, NASA evolved as the agency tasked with civilian space ventures. The term aerospace is now common usage, and the computer revolution and aerospace strides would have never happened without the work of the DOD and its industrial partners (Spires, 1998; Ceruzzi, 2000).

As aerospace and technologies developed, the design-and-build philosophy was an essential methodology for these feasibility studies. Then young contractors could not assume all risk for such projects that were largely experimental, and the management methodologies associated with this made perfect sense (Carter & Perry, 1999). However, many of these methods survived well beyond their usefulness – some even to this day – over 50 years later. Now, in the 21st century the feasibility of aerospace has been well established. The viability of integrated circuits, computers, software and related technologies have kept pace with Moore's law.[1] What had once been a purely government domain is now deeply rooted in the private sector.

Still, much of DOD acquisition methodologies have been geared toward the "design-and-build" approach, even though similar and superior products are available off-the-shelf. Enter the present dilemma: with a system whose organizational practices have long favored a design-and-build approach, and commercial product technology inexpensive and available, how does a massive bureaucracy such as the DOD change rapidly to incorporate COTS products that are superior to design-and-build?

Eisenhardt (1989, 1990) and her colleagues (Brown & Eisenhardt, 1997, 1998; Galunic & Eisenhardt, 2001) have long studied the issues surrounding organizational change in a "relentlessly shifting environment." Their findings have shown that this is a common and difficult problem, and the solutions are more difficult in a large rigid structure. Brown and Eisenhardt (1998) found that competing in a high-tech and high velocity environment, balance is key. In their studies, they asserted that successful continuous change organizations are adaptive, complex systems characterized by *semistructures*; that is, structures that are neither too rigid to impede innovation and flexibility, nor too nebulous so as to impede progress or lose sight of core competencies. Striking a balance between a chaotic structure and a rigid, hierarchical

structure is key to success. While Brown and Eisenhardt (1997) note that previous research suggest that *organic structures* (characterized by firms with fluid job descriptions, loose organizational charts and few rules) may foster innovation (Burns & Stalker, 1961; March, 1981), their study of six firms shows that the *semistructure* is optimal.

> For organizations with successful product portfolios, we found that semistructures emerged in each time frame. For example, the effective management of current projects lay between very structured, mechanistic organization in which bureaucratic procedures were tightly determined, and very unstructured, organic organization in which there were few if any rules, responsibilities or procedures. They neither rigidly planned nor chaotically reacted (Brown & Eisenhardt, 1997, p. 28).

Over the years, the DOD acquisition process has evolved to a highly structured hierarchical system characterized by laws, rules, and inflexibility. The ongoing transformation has been an attempt to bend this system to a more flexible system.

Eisenhardt (1990) distinguished that keeping pace with the environment means tracking real-time information rather than focusing on futuristic information. Similarly, in their study of a multidivisional corporation, Galunic and Eisenhardt (1996, p. 280) concluded that its hallmark was the "strategic use of charter changes to align and realign on an apparently continual basis." While the DOD has changed over the years, its inertia has prevented its keeping up with the high-velocity of private sector technology. Though change indeed occurs, it occurs incrementally.

Knowing when to pursue new technology and new ideas is easier said than done. Tushman and O'Reilly (2001) assert that the *ambidextrous organization* is one that is able to do both well. They use the example of RCA in the 1950s. The company debated whether or not to pursue new and risky transistor technology, which would likely cost them advances in the proven vacuum tube technology. The authors suggest that one was precipitating evolutionary change—a sure thing—while the other was revolutionary and risky. One manager at RCA said that it would be riskier to *not* pursue it if it became successful. So, RCA survived by learning to be ambidextrous (Tushman & O'Reilly, 2001). It is easy to look back and know that they did the right thing. But this is the nature of judging by hindsight, which has inherent biases.

Not all DOD projects lend themselves to COTS use. Some products are simply not available off the shelf. Indeed, where would one purchase an aircraft carrier off-the-shelf? With other products, the decision is simpler. Computer workstations are readily and cheaply available off-the-shelf; though up until the 1980s the government designed and built custom workstations when they were not. But there is much gray area. Software, for example, has many unique issues which makes it difficult for program managers to determine what can be purchased off the shelf and what cannot. For instance, one characteristic of software is that it is intangible and as a result can be difficult to understand and determine usability in various projects. There are countless questions of integration, survivability and upgrade. This study asks the questions: when COTS products provide optimal performance at lower cots, why are they *not* used?

METHODS

This was a qualitative, inductive case study involving two Earth-orbiting satellite ground control stations and related DOD organizational data. As the study progressed, theory arose and was reprocessed in accordance with the data gathered. Data was re-gathered in many cases to clarify the evolving theory.

This case study compared two Earth-orbiting satellite ground control systems designated with the pseudonyms GAMMA and DELTA. Each was built with identical performance requirements, and during the same time frame. However, the GAMMA system was procured using exclusively COTS products with a streamlined management philosophy, while the DELTA system was built with only few COTS products and traditional management methodologies. This provided a unique study opportunity, as the only variant in the system comparisons was the management techniques and decision processes.

Eighteen unclassified documents were reviewed, including proposals, technical and financial data. I interviewed four people who were involved with the acquisition and operations of both systems, observed flight operations at the GAMMA ground control station, and talked with three operators on duty. All names and system identifiers have been changed. During the Air Force's mandated consolidation activities of the 1990s, a legacy system, which had been built in the 1980s, was being shut down in favor of a consolidated facility elsewhere

in the United States. The legacy system, though cutting edge when conceived in the 1970s, was outdated by the time it was completed, installed and operational in 1984 – at a cost of over $1 billion. Its shutdown had been postponed five years from the original expected date. In order to maintain this system, the Air Force was spending approximately $1 million per year just in maintenance costs. A mid-level Air Force officer suggested rather than maintain an archaic system, difficult to operate and costly to maintain, that they buy an inexpensive system using commercial-off-the-shelf (COTS) products. By taking advantage of the new broad market in workstations and commercial satellite systems they could maximize the use of COTS. After two years of pressing the concept, the Air Force Officer and his team were given approval to build this system in June 1999, and it was operational a record six months later.

The material collected from the acquisition of the two Earth-orbiting satellite ground control stations yielded is summarized in Table 1. For more high-level supporting data, thirty semi-structured and unstructured interviews were performed. These individuals who were selected based on their acquisition and DOD experience, and a balance was maintained between high-level personnel (such as those who make policy) with field personnel (those who enact policy). Interviewees came from diverse backgrounds and included both military and civilians, contractors and government. Most interviews were semi-structured and followed a set of questions, but a few were unstructured. As personnel showed their passion for this topic, several just started talking and did not stop. In these cases, I made a spot decision not to interrupt as the individual was providing me with valuable data. The shortest interview was 30 minutes and the longest was three hours. Four interviews entailed follow-up contacts, and ten involved follow-up e-mails and telephone calls.

Document review and analysis were also an important part of the high-level supporting data. Using all resources available (including DOD libraries, websites, and individuals), over 1000 documents were collected pertaining to acquisition, commercial products and procurement. Since COTS has become a hot topic, there are journals and websites dedicated to just that. Given the reams of writings available, many were dated and not related to the present study. As such, I selected 21 that were the most relevant to this study based on several criteria. First was impact on commercial product implementation, such as

TABLE 1
Data Comparison Between GAMMA and DELTA

	GAMMA	DELTA
Mission Requirements	Command and control of a government 80-satellite constellation	Command and control of a government 80-satellite constellation
Total Cost	$1.25M	$40.00M[a]
Annual Maintenance	$0.2M/yr	$2.0M/yr
Approval to Operational Time	6 months	32 months
Type of Contract	Fixed price[b]	Cost plus award fee
Ground Hardware	All COTS[c]	Custom and commercial
Procurement Strategy	Spiral	Waterfall
Software	COTS Windows-based – requires little training	Custom software – requires more training

Notes:

a. This included a matrix switching cost that was not included in GAMMA's total cost. Though it is a tool that improves operational efficiency, GAMMA procurement personnel determined that it was neither necessary nor feasible given their budget.

b. "Fly-before-buy" concept allowed all products to be tested and exact cost to be known before purchase.

c. Some products were modified.

mandates and laws. Mandates began with the "Perry Memo of 1994," authored by then Secretary of Defense William Perry. Others followed. As use of commercial products has increased, various changes have been realized as the process matured. As the government recognizes these necessities, studies are sponsored, and their findings presented in reports. Even as this paper was being written, new information and policy changes were reported daily. It was critical to keep up with these changes, and care was taken to ensure that all data analysis was done on the most current data available.

RESULTS AND DISCUSSION

With remarkable clarity and consistency, several themes emerged from the case study and supporting data. I distilled these into three major empirical themes. The most compelling organizational barriers to COTS

use are: ***misaligned reward systems, entrenched networks,*** and ***historical precedent***.

Background

As the *Perry Memo* of 1994[2] suggests, for procurement of COTS products, appropriate management is critical, or all efficiencies are lost. This rang true with the case study. With GAMMA, the management team eliminated old "design and build" inefficiencies, and with DELTA they did not. One of the keys to the success of the GAMMA project was information sharing. Both the government and contractor teams were completely empowered which is not the norm with traditional contracting. The team that assembled this was a true partnership, as all cost; schedule and budget information was shared freely, while changes and trade-offs were made on the fly with full concurrence only when necessary. Detailed, unnecessary requirements were minimized and resulted in a requirements set two pages long while requirements for similar systems with the same mission had been over 100 pages. Therefore, by working as a genuine partnership with complete information sharing, this team was able to optimize commercial products for their use, making changes only when necessary.

To further streamline the installation and testing process, they omitted unnecessary oversight and configuration control. The estimated cost was $1.25 million, with low yearly maintenance cost. The delivery was performed with a "fly-before-buy" approach." That is, the government *did not buy the system unless it worked.* This is also not standard operating procedure. For example, with the traditionally used cost-plus-award-fee (CPAF) contract, the government is responsible for the contractor's costs as well as their award fee (profit), customarily 10-15%. For COTS systems, using the CPAF does not make sense. To line item all costs associated with an off-the-shelf product is time-consuming and inefficient, and sometimes impossible. For instance with off the shelf software where all development costs are absorbed by the company, and is transferred by disc, the cost of the disc is nearly nothing, but the cost of the development could represent years of work and millions of dollars. Yet, the COTS software could easily be sold to the government for substantially less. GAMMA was a fixed-price contract. The government-contractor team accomplished this by allowing a prime contractor to test various COTS products prior to purchasing the best products. These products were integrated by the government/contractor/

vendor team; resulting in an Earth-orbiting satellite control facility that was the least expensive the government has purchased to date for this network of approximately 80 satellites. The system was brought online within budget in October 1999.

Meanwhile, DELTA was being procured with identical operational requirements as GAMMA. While the systems' missions were the same, their procurement philosophy and technical setup were quite different. DELTA's acquisition was done using the traditional *request for proposals* (RFP) and source selection. The program was approved in December 1996, and brought online and operational in July 2000. The government program office also had two private consulting firms as advisors, and a $20 million budget. About eighteen months into the program, the contractor was having technical difficulties, and estimated that they would need another $20M to complete the system, so they submitted an *engineering change proposal* (ECP) for an additional $20M, which was approved. Though initial DELTA requirements stated that COTS products would be used when possible and there would be a minimum of custom products, in reality, the government lost all COTS benefits by over integrating and using traditional management techniques. DELTA program managers were made aware of GAMMA; already successfully online and built using COTS products for $1.25 million, but they continued to invest in the DELTA contract. GAMMA started operations in July 2000; two months late, and at $40 million; twice the proposed budget.

It was clear from this case study that the DELTA project should have been halted once the GAMMA project had proven successful. Why was it not? What were the motivators that kept it going? With this data and information from the interviews and documents, the answers to these questions were distilled to the following.

Misaligned Reward Systems

Individuals typically identify with their organizations (Tyler, 1999; Weick, 2001), and seek approval (Tetlock, 1991). Tyler (1999) explains that formal organizations, such as places of employment, help define the identity a person, and thus induce cooperative behavior. While he notes that the motivation for this can be material rewards, his findings show that *status* is also a powerful motivator. Higher status induces higher cooperative behavior with organizational norms. In the military, organizational norms are very clear, strong and visible. Personnel wear

their status (rank) on the uniform. It is easy to identify, and recognition of upper rank by a lower ranking individual is not only a norm, but is required. In his theories of *sensemaking,* Weick (2001, p. 11) offers that individuals are in a constant search to fit into and find their place in their environment: "People attempt to create order: through social comparison, expectations and action, flows become stabilized momentarily." In order to make sense of their environment, individuals first need to interpret it: "Action is based on interpretation of cues: These interpretations are externalized by concrete activities" (Weick, 2001, p. 13). Culture and identity are very strong in the military. The DOD mission of protecting the U.S. and its citizens is a serious and difficult one that bonds military members and their families as well as creates strong networks. DOD personnel, therefore, create order by responding to the organization with which they identify. Status is gained by promotion through the ranks, and promotions are secured by following the rules. People are inherently approval seekers (Tetlock, 1991). Individuals develop a self-image, for which they seek legitimacy, followed by self-verification. Once this is established, they have an inherent need to be consistent with their established self-image, and then seek self-enhancing feedback, completing their self-image loop (Fiske & Taylor, 1991). Among other factors, behavior is determined by *cognition* and *motivation.* While cognitions are important in determining to what behavior a person will ascribe, motivations determine whether or not the predicted behavior will result. (Fiske & Taylor, 1991) Previously, it was noted that the military individual is cognitive of his or her preferred behavior, and with the proper motivation (in this case, an increased status) the predicted cycle will result. Once this occurs, the self-image is reinforced, and given the established need to be consistent (Weick, 2001; Cialdini, 1993; Fiske & Taylor, 1991) the forces against altering a chosen course are overwhelming.

This panned out during the interviews. Several respondents reported that there was no motivation or incentives to employ COTS products; often perceived as new and risky technology. On the contrary, there were strong incentives maintain tradition. During one of my interviews, I asked a mid-level officer who was working on a COTS-based program what his motivations were to use this concept, he replied that this was the better system, and as part of the COTS effort he intended to pursue it. "What's in it for you? A promotion? Higher pay?" He replied that none of those would come directly from these efforts, and to the best of his

knowledge, there was no motivation whatsoever to deviate from the traditional method of acquisition. With the individual reward system at odds with organizational goals, it reinforces the said behaviors and disallows the desired change.

Several interviewees said that the problem was largely one of *attitude*. They explained that in the high-tech aerospace arena, DOD has traditionally been the leader, and private industry the follower. One interviewee said that many people [in the Pentagon] had trouble accepting that off-the-shelf products at a fraction of the cost of traditional products could possibly be better. I asked if they saw any improvement in attitude. One respondent said that the environment was becoming more COTS friendly, while others said that it would take a lot of retirements before that ever happened.

On the organizational level, the DOD budget system favors large budgets and large staffs. It also favors sub-organizations that spend their budget rather than save it. Here's how. Each fiscal year, programs are approved for a certain portion of the budget. The program is permitted to spend up to that given amount allotted for the fiscal year. Should they spend less, they are required to return the money to the DOD and are likely to have a lower budget for the following fiscal year – commensurate with their proven spending. Should they need more funding, they are likely given more. This author asked numerous acquisition officers about this system. One replied that since no one ever had enough money anyway, this was OK. Another replied that this gives DOD no incentive whatsoever to save money, and on the contrary, it encourages spending. If funding is saved, it will just be taken away, so offices are careful to spend it all by the end of the fiscal year. "The reward system is upside down!" said one interviewee, referring to this. Another interviewee pointed out that program managers are further motivated to increase budgets because the cycle for funding approval is so long. Should they run into programmatic problems (as with DELTA) and the program comes in late, it is a worse fate that having a large budget to start with. "This encourages us to pad the original budget. If we end up with more funding than necessary, we just spend it. If we end up with less, we are in real trouble because it can take up to two years to approve new funds. It's also embarrassing," said another interviewee.

In organizations, a "knowing-doing gap" often exists between what organizations know is the right path of behavior, and what they actually do (Pfeffer & Sutton, 1999). In their book, the authors discuss numerous

organizations where the organizational goals are at odds with the organizational behavior. Most interviewees agreed a gap existed on some, but not all levels. For example, the mere fact the DOD was pursuing COTS technology illustrated that a serious effort was underway. Consistent with my interviews at the top level, it was clear that commercial technology is a major part of the DOD transformation. Implementation, however, has proven more difficult.

While substantial efforts are being made toward changing the organizational culture and closing the gap both at the individual and organizational levels, the rewards system is still misaligned. Such a philosophical change in an organization's structure is notoriously difficult. In fact, imprinting in the early years of an organization typically lays the foundation for its entire life (Hannan, Burton & Baron, 1996; Stinchecombe, 1965). Such profound changes can be long in coming.

Entrenched Networks

Many of the tasks performed by the DOD are highly specialized – especially those in the high-tech arena. In the early days of aerospace, most of the work was experimental and many projects were feasibility studies. For example, in the mid-20th century, no one had shown that space flight was possible. As technologies became proven, a number of aerospace corporations emerged and bids for government contracts increased in number. As contractors and sub-contractors were selected, they became embedded in the DOD system.

Throughout the second half of the twentieth century as the interest in aerospace grew, DOD funding grew, and so did the number of firms offering services. Since the government was the single largest purchaser of aerospace technology, when a company – especially a struggling one – lost a bid, it could at best mean massive layoffs, and at worst, organizational death. Through the 1960s and 1970s, the industry matured, and so the number of large government aerospace contractors became smaller and those that survived the industry's shakeout enjoyed high profits, nearly guaranteed employment, and sparse competition. As this happened, the government skirted well thought-out competitive policies by citing that certain contractors had to be considered "sole-source;" that is; as the others fell out, the ones left were the sole producers of highly specialized technologies, and had no competitors. The government was then in a position of being committed to whomever

could produce a technology. Moreover, the DOD – an organization in and of itself with no competition – had little incentive to become more efficient and seek other sources. This shadows the market theory of the *fundamental transformation*, which states that: "Although a large numbers-exchange condition obtains at the outset, it is transformed during the contract execution in to a small numbers exchange relation on account" (Williamson, 1975).

And so, in many cases, the government has relied exclusively on single firms for specific technologies, and conversely specific firms relied heavily on the government. Thus, a network was established. Networks are typified by lateral or horizontal patterns of exchange and reciprocal lines of communication between actors or organizations (Powell, 1990). Both professional and personal social networks comprise a myriad of ties; both *cohesive* and *equivalent* (Burt, 1995). In his network theory, Burt defines *cohesion* as a direct connection and *equivalence* as an indirect connection formed by mutual contact. In the case of a DOD contractor, the prime contractor usually has the *cohesive* tie to the government, and the sub-contractor would have an *equivalent* tie. Whenever there is lack of *cohesion* in a network, there is an opportunity for a third party to benefit from making a connection (Burt, 1995). The term *tertius gaudens* (after Simmel, 1923) literally means 'from the third who benefits.' One of my interviews with a partner of a small (about fifteen employees) aerospace vendor revealed data suggesting that *tertius gaudens* exists in her government contracting experience. The interviewee noted that they were often "brokered" by larger, better-known defense contractors. She cited a contract in which her company did about 95% of the work, but were awarded only 50% of the monies. "It seems companies starting out need a big brother," she said. Other interviewees cited analogous situations.

This is not to suggest that the prime contractor (or third party) never adds value to a project. Indeed, the prime contractor often has the task of integrating highly complicated systems. When the systems were younger and had highly complex interfaces, the job of integration was equally complex and risky – especially before anything was standardized. But as systems become more or less a *black box*, the job of integration dwindles. In his studies on the search and transfer problem, Hansen (1999) found that less complex technology (codified and independent) is more easily transferred over weak ties; and that weak ties also facilitated information search with this type of technology. Strong, thick ties, on

the other hand, were able to handle more complex technology (non-codified, dependent) transfer, but less able to handle information search, as the ties were few. Therefore, knowledge that could stand on its own – the so-called *black box* – was easily transferred. In the case of the DOD, the more independent the information, such as COTS products that stand alone, the easier integration becomes. For example, GAMMA purchased a proven off-the-shelf product that had already been verified and needed minimal integration. The entire search and transfer process took less than six months, even with the necessary government regulations and other prerequisites.

Similar to Granovetter's (1973) study of *weak ties*, Podolny, Stuart and Hannan (1996) found that *cohesive* ties could be more damaging to an organization's status and therefore life prospects. A *cohesive* tie indicates that an organization shares the same or similar technologies and contacts with other innovators; thus rendering the organizations redundant and competitive with one another. Moreover, if an organization (in this case a company) shares technology as well as a *cohesive* tie with a competitor, that bond signals legitimacy and therefore heightened status to the market. Conversely, if the company shares only an equivalence network relation, it can compete more keenly with the other companies possessing the same technology as they will have broader networks and not enhance competitors' status. This is well supported by Granovetter (1973) in which he showed that a small, *cohesive* network of strong ties is limiting and can lead to "overall fragmentation." This surely panned out as the defense contractors of the early 1990s became redundant, large and sluggish. After the merger the network is still strong and *cohesive*. Meanwhile smaller (but arguably) more efficient companies with newer technologies and more ties with the commercial world are beginning to emerge into the defense theatre through numerous weak, but equivalent ties.

For example, three years ago, Raytheon, one of the largest DOD contractors, completed a prototype for the "Land Warrior," the infantry battle gear of the future. After spending $2.1 billion developing their prototype, it was a disaster. It was "a 40-pound monstrosity," according to the Government Accounting Office (GAO). Worse yet, the high-tech portion for this system, part of its key revolutionary component, failed in every way. It was well over its original $1.4 billion budget, it simply did not work. Nonetheless, Raytheon claimed success: "We fulfilled our contractual obligation, and designed what the government requested,"

said a spokesperson for Raytheon. It was for cases such as this that the first mandates for change authored by then Secretary of Defense, William Perry did away with *milspecs* in favor of operational requirements, that is, so that the contractor could take more responsibility for the success or failure of a product, and not just claim that it met the *milspecs*. To save the "Land Warrior," in 1999, Army Colonel Bruce Jette, an engineer and MIT physics Ph.D., after some searching, hired *Pacific Consultants*, a small Silicon Valley firm who claimed that they could build a prototype in six months for $2 million. By using truly off-the-shelf products – *really* off the shelf: from well-known electronic retailers *Fry's* and *Best Buy* – the company delivered as promised. They developed a twelve-pound unit that uses Microsoft Windows 2000 software. Their vest and body armor were snug and lightweight, and most importantly passed field tests. While there were a few kinks to work out, the Pacific Consultants' "Land Warrior" was $30,000/unit, while the Raytheon unit was over $60,000. Army and DOD managers involved in this have commented on the lessons learned. "The Army may have led the world in solid-state electronics in the 1960s, but today, our technology expenditures aren't even one high-tech company's R&D budget. … We have to use technologies in the commercial sector to our advantage," commented Colonel Jette (Iwata, 2002).

Though small vendors have high potential, overcoming barriers to entry into the network is considerable. As suggested earlier, corporate ties with the DOD are well entrenched by individuals who were former DOD employees, and others who have grown to rely on specific companies. In their study of volunteer organizations, Popielarz and McPherson (1995) had similar findings. This study focused on niches and niche position, and how this affected membership of voluntary associations. They found that persons close to the center of the niche tended to have few, homogeneous ties with those also in the center of the niche. In an earlier study, McPherson, Popielarz, and Drobnic (1992), findings were similar, and they also noted that weak ties proved to be less redundant as they are more likely to transmit new information.

Krackhardt and Kilduff (1990) studied social networks and discovered that persons shared only a limited number of constructs, and that friends share similar constructs. They were able to judge and assess the organizational culture given these scenarios. In the workplace, they said, people evaluate beliefs by comparing their opinions with others in their social network that were already known to share similar constructs.

This system is an application of Festinger's (1954) *social comparison* theory, as well as an extension of *social proof* (Cialdini, 1993). It seems that they have shown a system that is somewhat incestuous. That is, a supervisor who shares a similar construct with a subordinate will be less likely to hire someone who does not share his or her construct, limiting the diversity of his or her group. The net result shows that social networks within define organizational culture, and have an impact on organizational outcome. This study presents a bridge between micro- and macro social network and organizational behavior theory as evaluations are made at the individual, cognitive level, but affect the organization and its behavior. Therefore, it is not only important to have a powerful and balanced network, but it is also important to be cognizant of others' networks. In Brown and Eisenhardt's (1997) study of the *semi-structured* organization, one of the six computer companies they studied reported to have coffee bars throughout the development areas to encourage informal networking and high, fluid communications to encourage brainstorming during breaks. Their later writings offer that the optimal organization balances structure structured planning with less structured flow.

One commercial vendor interviewee suggested that some of the lack of use of COTS is a result of government personnel's lack of knowledge of the market. As markets become entrenched, knowledge of other markets become weak, as individuals can only have a limited number of constructs (Krackhardt & Kildiff, 1990). In the interviews, government personnel generally agreed with this. While a market survey is required prior to awarding contracts, how broad its reach is a matter of judgment. The government person making the judgment, largely a product of the government system as well, may not be capable of reaching beyond his or her known constructs, as Krackhardt & Kilduff suggest. Those in the center of the network are most likely to stay there, but are also less likely to have knowledge of organizations outside the network (Popielarz & McPherson, 1995). Meanwhile, individuals on the periphery of their organization are less likely to remain in the organization largely because of their ties to the outside world. The mid-level Air Force manager who had championed the all-COTS GAMMA system said that he was treated badly for his efforts. He was nearly passed over for a promotion and considered leaving the Air Force. While the behavior of his superiors seemed incomprehensible to him, it is consistent with other findings.

Since the DOD has dedicated contractors for custom designed systems, and what was once cutting edge technology is now commonplace, the notion of using COTS products is a relatively new idea, and has not gained full acceptance for various reasons. The DOD is accustomed to working with a fairly set group of contractors who hold clearances and are well *embedded* (Granovetter, 1985) in the network. Amongst the DOD, it is widely known that new contractors are victims of discrimination when a new contract goes out to bid. Taking business away from traditional contractors—an existing network—not only breaks professional ties, but social ties as well. Many high level personnel at these companies were former DOD employees. Blending in the center of the network; where ties are few, thick, and cohesive is more likely to earn a promotion than being at the periphery of the organization where ties are numerous, thin and equivalent. Yet, according to past studies, those on the periphery are most likely to gain access to new information through weak but plentiful ties, but are less likely to earn status via promotions than those at the center.

The military system does not permit much cross-fertilization between the DOD and the commercial world simply by the career system. When one either enlists or is commissioned as an officer, it is normally for the long haul. Up until 2002, when the government approved the "Thrift Savings Plan" for military personnel (similar to a 401K), an officer who resigned prior to retirement eligibility would receive no benefits, thus motivating them to complete a nominal twenty-year career. Unlike private industry, where employees readily move from company to company (usually taking retirement benefits with them), the service is more stove-piped. Resignations are less the norm, and after getting out, a person rarely returns – the system simply does not allow it. The maximum age for joining the service is 35 (this can vary depending on the field). So, while cross-fertilization occurs constantly in the private sector, the military service tends to be less so. Further, those who come from the service academies have even fewer ties with non-service academy people. By charter, the service academies educate men and women who intend to be career officers. Their DOD contacts tend to be even more *cohesive* with other service members than those coming from other college campuses. The academies have the benefit of commissioning their graduates sooner so that their date of rank comes before officer commissioned in other colleges. This affects an officer throughout his or her career as date of rank is how future promotions are

paced, giving them a slight edge over those coming from other colleges. The net result is that those who have thick *cohesive* ties enjoy higher status, but perhaps fewer ties with outsiders, making their market knowledge more limited.

In summary, entrenched networks are the result of an organization that has held on to decade-old ties with known contractors. It is a system that encourages thick, *cohesive* ties, limiting the search capabilities to other markets. While this type of network has worked well in certain cases, it doe not work well for acquiring new technologies from lesser-known commercial industries.

Historical Precedent

Getting stuck in the past: it is very easy to become accustomed to following a certain pattern and continuing that pattern regardless of potentially better solutions. In a large bureaucracy such as the DOD, following past patterns can be a result of organizational inertia. When all the regulations, rules and culture favor a given business philosophy and certain contractors, to overcome this requires more energy than to remain with the status quo.

There are four important degrees to organizational commitment: *explicitness, revocability, volition,* and *publicity*. With each level of commitment, the actor or organization becomes further committed to the act (Salancik, 1995). The first, *explicitness,* is the degree to which an act is known to have taken place, or is known to be true or viable. The second, *revocability,* is the degree to which the act is reversible. The third, *volition,* is the degree to which the act can be linked with an individual or group of individuals, and the fourth, *publicity,* is the degree to which an act is publicly known. In the case of DELTA, commitment to the behavior had reached *publicity,* making it difficult to backtrack. The group of individuals who had the power to rescind the original action would have been going against powerful cognitive forces. The contract budget had not only passed the necessary cuts at the lower levels, but as required, had been approved all the way to the top of the chain of command. The project became an accepted and integrated part of the highly complex system of ground stations, and to revoke it would not only have been difficult from a commitment standpoint, but also would have gone against group pressures. Group pressures have long been known to distort individual judgments to the point where a people

have been shown to go against their better judgments to favor group consensus (Asch, 1951).

From the inception of the highly technical fields of integrated circuits and aerospace, the DOD's acquisition philosophy has been to build custom technology from scratch. In the early years of aerospace, this technique was inevitable, as most technologies were not available. This process, though expensive, was necessary and successful at the time, as many studies were technologically risky. Nonetheless, these practices became part of the DOD historical precedent. The DOD had publicly committed itself to this proven way of business, and such procedures became part of the management architecture. Entire divisions were created to help manage contracts in this fashion. As a result, changing this way of business, though mandated, has been a long arduous process – as with the individual difficulties of revoking a commitment, so it is with the organization. It has meant unpleasant procedures like downsizing and layoffs in both the government and among the government contractors. Moreover, it meant retracting what was publicly axiomatic previously, as discussed, a direction that goes against the grain of commitment and consistency; two very strong human tendencies (Cialdini, 1993).

Numerous academic studies have been written on the theory of *escalation* (Staw, 1976; Fox & Staw, 1979; Staw & Ross, 1989; Staw & Hoang, 1995), but the nature of escalation is as old as written history. In 1620, Bacon criticized the human tendency to cling to, and invest in a previously held notion in spite of better ideas. Twentieth and twenty-first century theories impressed the profound value that these studies may have on organizations. Publicizing actions often contributes to making them more and more irrevocable, as individuals feel the need to explain or rationalize former actions; which then strengthens the beliefs of the organization or organizational actor (Weick, 2001). *Escalation* has shown to be common behavior in numerous types of organizations and organizational actors. Anyone who has studied basic engineering economy, knows the fundamental rule of *sunk cost*. That is costs already incurred (sunk cost) should not influence a decision, and the in *sunk-cost trap* this fundamental rule is ignored. Staw (1976) showed how investors would likely 'throw good money after bad.' In this series of role-playing studies among business students, he further showed that the more an individual had at stake (high responsibility), the more likely they were to *escalate* their resources than those with less at stake (low responsibility).

The implications of such a study, Staw asserts, is that individuals are likely to act in self-justification by rationalization. After Festinger (1957) he notes that individuals have a strong need to maintain the appearance of rationality. In turn, in order to self-justify, they will *escalate* resources. In his discussion of this study he proposes that when an individual is uncertain of his or her status; such as in a government organization, an ambiguous social structure, or a bureaucracy, he or she is more likely to fall into the trap.

In the case of the DELTA ground station project, the original cost of the system was budgeted for $20 million. The contractor, (who was theoretically using a COTS based system) realized that they would need another $20 million to complete the ground station. Consistent with their well-publicized, original commitment, the DOD awarded the money even though they knew a similar system (GAMMA, with the same operational requirements) had been successfully built for substantially less.

Expanding on Festinger's (1957) self-justification theories, an examination of the 'Trapped Administrator' is consistent with previous findings that self-justification is a source of commitment to a course of action (Fox & Staw, 1979). In this study, however, the theorists asserted that not only internal, self-justifying factors lead to escalation, but also an *external* threat could be stronger than internal. Job insecurity and policy resistance are examples of external pressure. The results showed the administrator who has concerns about job security as less flexible in decision-making, and is therefore more likely to continue a course of action that he or she began, and less likely to embrace new ideas or change of any sort. Further, the *threat rigidity theory* (Staw, Sandelands & Dutton, 1981) showed that groups as well as individuals faced with a threat became *rigid*. That is, they revert to behavior with which they were most comfortable, rather than looked for new solutions to avert the threat. A threat could take on almost any avenue: a job, a promotion, an investment, or even the physical environment (Staw, Sandelands & Dutton, 1981). In the case of DELTA, once the system build did not live up to expectations, the government managers reverted to their most comfortable and trusted methods of committing more funding to bail it out. Rather than reaching out toward newer technologies, and searching for other options, the system became less flexible more *rigid.* Whether it is those faced with a physical threat (Weick, 1993) or the threat of spoiled identity (Sutton & Callaghan, 1987), it appears that individuals

revert to their most comfortable, primal behavior. In the case of the trapped administrator, the threatening environment is the administrator's job; which ultimately threatens his or her livelihood, not just career. Most people depend on their jobs for food, health insurance and shelter; basic needs critical to physical well-being. In the service, losing one's job means forfeiture of all benefits accrued. Moreover, it can be mightily embarrassing.

Resistance to change can be a result of many interacting and complicating factors. Ironically, the more there is at stake, the more organizations tend to cling to old ways of operating. Through self-justification, organizational actors have the need to rationalize their previous behavior and continue on a chosen course of action in spite of information to the contrary (Staw, 1976). Another study (Lord, Ross & Lepper, 1979) showed that for those who hold strong opinions become even stronger when presented with contrary information. The organizational actor tends to assimilate the new information with ingrained bias so as to attribute the newly gained knowledge to support his or her cause rather than contradict it. The authors conclude that these individuals process the data relative to a strong partiality to fit into their schema. An individual would then read contradictory information as *contributing* to their already-held belief system, rather than detracting from it; further lending credence and further justifying their commitment to the previously determined course of action. As such, the power of consistency is formidable, (Cialdini, 1993) but initial commitment is key. Once an individual has committed him or herself to a course of action, then the need to be consistent is overwhelming (Freedman & Fraser, 1966). These situations have panned out in the DOD. As Weick (2001) noted, the acts of individuals comprise the behavior of the organization. As had happened with other organizations, the DOD has, in many cases, clung to old ways of business in spite of better systems – even when these systems are proven and risk is low.

The DOD is a massive organization; about 1.4 million active duty personnel, and 1.2 million reservists, and a $291 billion budget,[3] where decision-making is complicated by technical, financial and political challenges. The science of decision-making has long relied on *utility theory* as a tool for selecting optimums. *Utility theory* is a methodology by which the decision maker objectively compares as many known aspects of a decision with the as much knowledge that he or she has at the time. The options are weighed against outcomes and their probability

of occurrence. Decisions; especially those that could result in potentially large gains or losses are more complicated. *Prospect theory* is an alternate model that is based on the now robust premise that people prefer certain outcomes. (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). The tendency to prefer certain outcomes (aptly called the *certainty effect*) when losses loom large logically contributes to *risk aversion*; as the decision maker becomes less likely to seek a course in which the outcome is uncertain, since the potential for large loss exists; even though the potential for gain could be higher.

Chasing new ideas can be risky, and failure rates can be high. (March, 1991; Brown & Eisenhardt, 1998) According to Beer and Nohria (2000, p. 133): "The brutal fact is that 70% of all change initiatives fail." In March's studies of *exploration* versus *exploitation*, he asserts that organizations that follow a path of *exploitation* – characterized by the refinement of existing technologies – are less vulnerable in the short term (and therefore there is a low failure rate early on) than those that follow a path of *exploration*—a trait that is characterized by inventing new and creative technologies—who are plagued by a high failure rate early on. Though with *exploration* short-term failure rates can be high, March's (1991) findings show that in the long run, it increases knowledge, increasing the competitive edge over time.

Over the years, the DOD has been on the cutting-edge of many new and risky initiatives, and many have been successful, while others have failed. Meanwhile, as March (1991) and Brown and Eisenhardt (1998) suggest, the DOD has balanced such ventures against their then core competencies. It is somewhat ironic that at the dawn of the 21st century, the DOD is slow to grasp newly available cheap technologies. While COTS products are viewed by some as new and risky, the fact is that most COTS products are proven technologies and less risky. But as one interviewee put it: "People reach a certain comfort level and don't want to leave it. Commercial products do not seem comfortable for some people in such positions." The Air Force Scientific Advisory Board (2000, p. 2) on COTS determined:

> The cultural differences between a traditional custom MilSpec and a COTS intensive environment are enormous for both contractor and government personnel. COTS demands new skills, knowledge and abilities. The traditional skills that are acquired over many years do not require an adequate

> understanding of to address the additional complications in selecting, specifying, buying and using commercial products for military applications. Roles and responsibilities change dramatically… The ramifications of these shifts are enormous. … Many feel job insecurity and a loss of control.

Ironically, while COTS products are often perceived as risky, as most new methods are considered risky, they are theoretically less risky than building custom technology as COTS products have been tested and proven. The Air Force Scientific Advisory Board (2000, p. 2) has claimed that [COTS products have a] "Reduced development risk: Since the commercial product market is proven, the risk of providing its intended function in the system is mitigated." Yet, as prospect theory states, people often view anything new as riskier than tried and true way. Therefore, it is the *perception* of risk that the DOD needs to overcome.

As in the beginning of this section *prospect theory* states that people prefer certain outcomes, especially when losses loom large. In the aerospace community, not only are the monetary stakes high, but the careers in the military are also at high risk. This makes decision-making difficult and the tendency toward what is comfortable is greater. In the case COTS product and technology usage, a relatively new concept in DOD, historical precedent has provided powerful inertia for the program manager to overcome.

EPILOG

While in hindsight it is painfully clear that in the case of the two Earth-orbiting ground control systems, the COTS system was far superior to the more expensive and cumbersome non-COTS system, this was somewhat more obfuscated in foresight. Especially with remarkably complicated systems such as these, the tendency to revert to primal behavior is rational. That is, even after the DELTA team realized that they could build a better system for less, they acted rationally according to the motivators and doctrine of their organization. One high-level DOD official said: "We get exactly what we deserve." She was referring to the well-studied premise that personnel behave in accordance with a clear rewards system, which is precisely what the DELTA procurement team did, even though it did not make sense.

The problem is the organization. The DOD acquisition process has suffered from years of regulation piled atop laws that no longer make

sense, and well-meaning personnel have been stifled by the rules binding their organization. This is not unique to the DOD, and many companies suffer the same plight. (Pfeffer, 1998).

While this study has pinpointed three organizational barriers to change, it is only the first step in eroding them. "It's like a gigantic organism that has developed an immune system to COTS products," said one interviewee. Indeed, when a system that has been imprinted from inception with a given pattern of operation, the organization tends to hold onto those early patterns and rules, thus change is difficult (Hannan, Burton & Baron, 1996). Future studies will need to examine *how* to chisel away at this enormous glacier of entangled and archaic practices. Though it is critical to re-emphasize that COTS product use is not always an optimal solution, the services need to reach out into the market and find commercial, cutting-edge, perhaps unique solutions. Though there have been many cases where this has happened successfully, it has frequently been a battle against the organizational norms. The visionaries in the services have taken the lead on this, and will need to continue to grind away at outdated existing practices, while paying attention to the wisdom of young service members who have not yet become ingrained in old methodologies; a practice called *reverse socialization* (Sutton, 2001).

The present study revealed that many service people and contractors at all levels are aware of these important issues and anxious for change. This, of course, is encouraging.

NOTES

1. *Moore's Law*, the theory that chip density doubles every 18 months, was stated in 1964 by Intel CEO Gordon Moore, then of Fairchild. (Ceruzzi, 2000).
2. The 1994 Perry Memo was the initiation of the present COTS revolution. It was published as a memo six days after Perry took office in 1994 and was followed by the "Acquisition Reform – Mandate for Change" memo of June 29, 1994. This memo specifically gave direction to the use of *milspecs* (military specifications). That is, milspecs were to be replaced by *performance specifications*, thus allowing the contractors more latitude in project design by allowing them to adhere to performance goals, rather than line-by-line specifications. The Secretary of Defense emphasized the need for a cultural change to accompany this business

philosophy. Both of these memos were enacted into law by the Federal Acquisition Streamlining Act (FASA) on October 13, 1994.

3. From the *World Almanac and Book of Facts*, 2003, page 207.

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