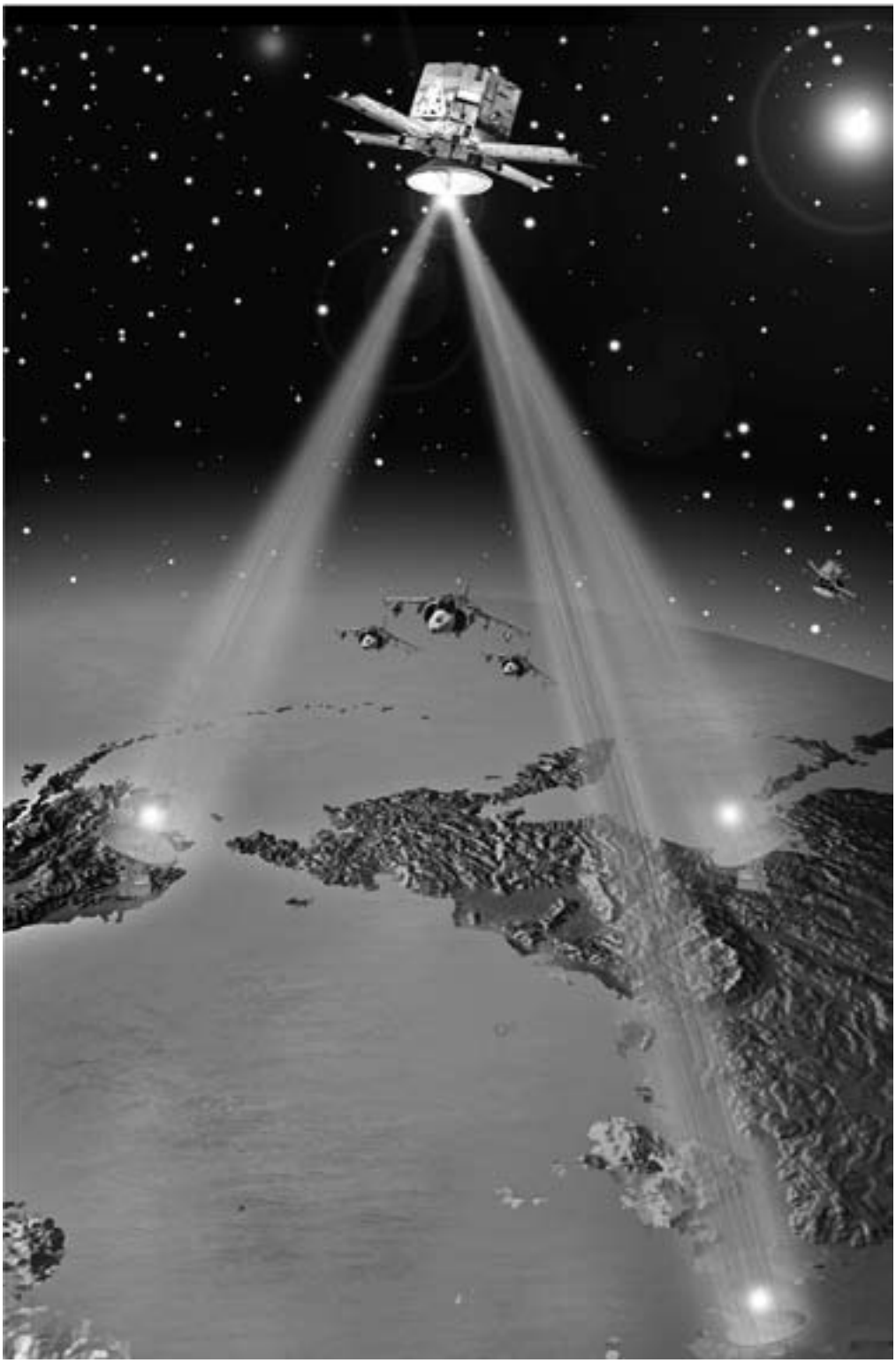

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A BUSINESS MODEL FOR DEFENSE ACQUISITION UNDER THE MODULAR OPEN SYSTEMS APPROACH

Eugene Gholz

This article briefly describes a business model that companies may apply to develop, produce, and sell avionics to the Department of Defense under a Modular Open Systems Approach (MOSA). Recent acquisition reforms have encouraged the use of MOSA, and the defense industry will need to adapt to the new style of acquisition. A business model summarizes the way a firm earns profits sufficient to remain in business: it describes core competencies, principal activities, cost structure, and expected revenue stream. The model proposed here suggests that firms can succeed under the new framework, but that MOSA entails some drawbacks for both industry and the government that may limit its applicability to a relatively small subset of programs.

Over the past several years, the Department of Defense (DoD), the military services, and the defense industry have sponsored a good deal of research about the technical aspects of a Modular Open Systems Approach (MOSA) to the acquisition of avionics.[1] The results have shown that while some technical hurdles still remain, business issues may be bigger barriers than technical ones to the implementation of MOSA.[2] Advocates of MOSA must show that the new approach will solve some problems for the defense industry as well as for its military customers and that the companies can be at least as profitable under MOSA as under traditional acquisition strategies. Firms in the defense industry are relatively comfortable with their traditional business model, and they require business analysis to give them an incentive to aggressively pursue change. They are generally quite ready to cooperate

with their customers' initiatives—in fact, responsiveness to the unique military customer is a hallmark of successful defense companies (Gholz & Sapolsky, 1999-2000)—but the customers need to put their request for such cooperation in the business language of company decision makers.

A business model summarizes the way a firm earns profits sufficient to remain in business: it describes core competencies, principal activities, cost structure, and expected revenue stream.

This article briefly describes a business model that companies may apply to develop, produce, and sell avionics to the DoD under MOSA. A business model summarizes the way a firm earns profits sufficient to remain in business: it describes core competencies, principal activities, cost structure, and expected revenue stream. Defense firms organized for "business as usual" will find a transition to MOSA difficult, and they may prefer to create new MOSA-oriented divisions rather then attempting to transform the culture of established organizations (Christensen & Raynor, 2003). Even if the military adopts MOSA for many acquisition projects, the traditional approach will remain in force for many high-value projects to which MOSA is not well suited; defense firms should maintain their existing structures to pursue non-MOSA acquisitions. But defense firms also stand a reasonable chance to do profitable business on some avionics projects under a MOSA business model. In a capitalist economy, a reasonable chance of profitable business, and not a guarantee, is exactly what investors and CEOs hope to find.

THE TRADITIONAL DEFENSE INDUSTRY MODEL

During the post-World War II era, the American defense industry developed a specialized business model, especially for prime contractors (Gansler, 1995; McNaugher, 1989). Generally speaking, today's defense companies closely follow directives from their military customers, developing customized products with attributes specified in advance by the buyer. The buyer pays the development costs up front or in stages during the development process. Because defense firms primarily invest the customer's money rather than their own in research and development, the firms have a limited role in choosing the technological trajectory that they will pursue (Dombrowski & Gholz, 2006). Consequently, they have relatively less skill in technology management than companies in other industries that emphasize innovation to a comparable extent. The most responsive defense companies tend to

be the most successful: executives and managers constantly reassure their customers that the customers' interests are the firm's top priority and adapt the firm's business processes to remain relatively efficient while following complex and intrusive acquisition regulations.

In the traditional defense business model, firms (especially prime contractors) are rewarded with a relatively stable income stream. Their close relationship to the military customer gives them a relatively low level of risk, comparable to the steady, low-risk business of a regulated public utility (Gholz & Sapolsky, 1999–2000).

MOSA AND ITS GOALS

As the American military increasingly relies on information technology in its new weapon and support systems, the traditional business model seems less appropriate than it used to. Advocates have proposed MOSA for avionics acquisition to adapt to the military's plans for network-centric warfare, to take advantage of technological opportunities that have developed in the commercial information technology business, and to improve the sustainability of military equipment as the product cycle for avionics has raced ahead of the long life cycle of the military's platforms. They also hope that MOSA can exploit the advantages of competition to control the soaring costs of systems acquisition.

Under its current business model, the defense industry tends to customize products on a platform-by-platform basis, but with transformation, each firm's proprietary technical solutions need to interface with other firms' proprietary products.

The shift to network-centric warfare is one of the major drivers for MOSA. The American military expects to use the next generation of equipment to share information across the battlespace more than ever before. Under its current business model, the defense industry tends to customize products on a platform-by-platform basis, but with transformation, each firm's proprietary technical solutions need to interface with other firms' proprietary products. Even if firms do not share the technologies that underlie their products' internal performance and only the interface designs are widely disseminated, defense systems as a whole will become less proprietary. This trend emphasizes the "open systems" part of MOSA: open systems are "integrated from elements provided by multiple sources" based on

"nonproprietary interface standards" (Committee on Aging Avionics in Military Aircraft, 2001, pp. 32–33). At the technical level, MOSA requires decisions about what those interface standards should be. Meanwhile, MOSA calls for defense industry design teams to focus on learning open interface standards and to contribute their expertise to the process of choosing and updating the standards.

The increasing military interest in information technology (IT) has also naturally drawn attention to the commercial IT industry. Since the 1990s, many people have observed that commercial IT tends to be more advanced than military IT. Commercial businesses also offer nearly continuous innovation to their customers (Alic, Branscomb, & Brooks, 1992), enabled by modularity of commercial products. Commercial customers can replace parts of their systems when new component technologies become available rather than paying to replace the entire system. Internal changes can increase a module's capabilities or simply reduce the cost of production or operation of a module at the same level of performance (Committee on Aging Avionics in Military Aircraft, 2001).

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In the new language of defense acquisition, modular design facilitates spiral development. Because modules can be replaced one by one and can be taken from existing systems and combined in new ways to produce new systems, the customer need not define all of the performance requirements for a system in advance. Instead, the customer can experiment with an initial version to reveal which modules most tightly constrain overall system performance. That experience will then allow the customer to define reasonable performance requirements for the next iteration of equipment and to focus resources in the next development spiral on improving key modules without redesigning the entire system.

In the same way, modular design also facilitates technology refresh, reducing the need to maintain obsolete parts in legacy systems. If a system is designed to be modular, obsolete parts can be thrown away and replaced with newer, cheaper, more capable parts. As long as the new module has the same external compatibility, it will not matter whether the internal components are the same as the old ones. The military will no longer need to stockpile replacement parts or maintain production lines that freeze technology at a particular point in time. Recognizing the fast rate of improvement in computer hardware and software and other electronics, many modular components can be designed with the assumption that they likely will be replaced through a technology insertion program. This design change will have the

added benefit of eliminating the need for expensive efforts to guarantee performance through years of use, because many parts will be "disposable" after relatively short life spans.

The combination of modularity with open systems may gain additional benefits of competition, spurring innovation, and controlling costs. Under the traditional defense acquisition approach, the customer is often locked in to buying parts from a sole source (the original producer). Some of the high cost of maintenance—probably a substantial fraction—is driven by the real overhead cost of maintaining inventories and keeping old production lines open. But many politicians, military leaders, and analysts fear that the cost is driven up a significant additional margin by the reliance on a monopoly supplier (Kovacic, 1999). Even though government auditors try hard to monitor actual costs, have tremendous access to the firm's cost data, and strive to avoid paying "too much," the lack of competition once a supplier is guaranteed a long-term market, especially for sales of replacement parts, makes the buyer vulnerable. Whether or not defense firms truly exploit their customers, American political and economic leaders distrust monopolies. The potential to eliminate monopolistic spare parts sales is a significant symbolic benefit of MOSA.

INTUITIVE SUMMARY OF THE BUSINESS MODEL

The MOSA redraws the division of labor between the government and industry in military systems development: industry will lead the relationship to a greater extent than in the traditional model. Instead of announcing detailed performance requirements for major systems acquisitions or upgrades, under MOSA the customer will only publish "roadmaps," general descriptions that link the performance characteristics of new systems to the military's evolving strategy and doctrine. Firms will create the detailed specifications and develop systems and modules that might interest the customer.

Companies will be able to propose improvements to modules or systems whenever they have a new product ready, developed on the companies' preferred schedule—influenced, of course, by contacts with the military buyers. This company-led proposal process will not work for platforms or major avionics systems that Congress must fund on a line item basis, but it will be easier to implement for smaller systems and system components. The MOSA will be easiest in the maintenance and upgrade budgets, which rarely attract the attention of political leaders and already are supported through a process that delegates more discretion to program managers.

To maximize the advantage of MOSA for technology insertion and spiral development, the military will buy small batches of parts or systems. From time to time—perhaps on a regular schedule, perhaps when installed equipment breaks, or perhaps in response to unsolicited offers from defense firms—companies will be able to bid on a batch of sales. For each bid, the companies will have to provide a complete description of the performance characteristics of their products, a unit price, and a number of units for which that price will be valid. Firms will have the option to offer the same equipment that they offered in the previous iteration of competition

(at the same price or a new one), or they may offer a new product that incorporates additional technological progress. The customer might purchase the new batch from the incumbent supplier, or the customer may buy the new batch from one of the incumbent's competitors. The only advantage that the incumbent will enjoy in the competition would come from whatever benefit it had gained from learning-by-doing or economies of scale on production of the previous batch.

The government may ask for minor modifications of the product as part of the contracting process, but the more that those modifications are requested, the less the customer will be able to benefit from MOSA. Ultimately, if the customer requires too many modifications, it should apply the traditional acquisition model rather than the MOSA for the project in question.

PRIME CONTRACTOR CORE COMPETENCIES

The MOSA will require leading avionics companies to have two core competencies: technology management and portfolio management. Firms will still need to nurture skills in product design and manufacturing, just as they have under the traditional defense business model, but their current core competency in responding to intrusive government oversight and regulation will fade in importance.

Firms will use their core competency in technology management to decide how much to invest in research and development (R&D) and how much to charge per unit, given their products' performance specifications. This skill set is not entirely unfamiliar, as defense firms already project cost and performance when they make paper proposals early in competitive projects. But under MOSA, the firms will have substantially more discretion and will face significantly more complex technology management problems.

Most important, under MOSA the defense industry will choose what product improvements to offer and when those new products should be developed. Under the current system, warfighters sometimes suggest unrealistic hopes for new technology, because their expertise tends to emphasize the military arts rather than science and technology. The balance of emphasis in acquisition planning has especially shifted in favor of military rather than technical factors in recent years, as Combatant Commanders have gained a more prominent role in the process. This customer influence often drives the pace and direction of investment in ways that will not yield the greatest marginal research benefit, increasing R&D costs. Buyers also change their minds about what they want, leading to poorly planned investment programs or to the "hurry up and wait" syndrome that can sometimes plague systems development (McNaugher, 1989). Under MOSA, by contrast, the firms will decide on the trajectory of technological change that they should invest in, giving more influence to the "natural" direction in which technological improvements are available.

Firms should be more sensitive to the financial costs of lurches in their research program. Their decisions will not be driven purely by scientific estimates of which technical problems are most readily solved, because company executives are driven by the profit motive and because they will still have to consider what technological

improvements they think that their customers will want to buy. Prime contractors will also still consider their customer's social goals in their analyses of alternatives.[3] But ideally, defense firms, which often employ former warfighters in their business development departments, will be in a better position than the military customer to understand simultaneously both the technical and warfighting influences on weapons development. As a result, the MOSA business model should increase the technical payoff and reduce the cost of R&D investment.

For the defense industry, the increased control of R&D investment comes at a price. First, the military customer will not always be interested in the technological improvements that the defense industry develops and offers. Firms will do their best to understand the military's needs, and under MOSA the military will work with industry to develop roadmaps that identify desirable product improvements. But forward-looking roadmaps will always imperfectly predict warfighters' needs and political leaders' budget priorities, so the customer may decline any particular product-price offer that a firm makes.

Second, because the companies gain control of investment decisions under MOSA, they will have to put their own money on the line. At least in the idealized MOSA business model, the companies will offer off-the-shelf products to the buyer—that is, products that they have developed on their own prior to offering them for sale.[4] Development cost will be figured into the price at which the new product is offered for sale, as it is in commercial markets. The buyer will bear little technological risk, because the basic performance characteristics of the already developed device will be well understood at the time of the sale; the remaining uncertainty will focus on how the warfighter will actually use the device. In essence, the MOSA model gives companies control over their investment decisions, allowing them to advance their technological core competencies, but it increases the technological and market risk that they bear.

To face the increase in risk that comes with the MOSA business model, firms will need to increase their financial competency to manage a portfolio of technology.

To face the increase in risk that comes with the MOSA business model, firms will need to increase their financial competency to manage a portfolio of technology. Firms should expect to lose most of the frequent competitions that they enter. These losses, though, will not hurt too much because each competition only offers the opportunity to sell a small batch of products to the military. Finance specialists in the defense industry will try to amortize the cost of R&D investment in *all* of the firm's new technologies into the prices bid on the competitions that the firm ends up

winning. The winning bids must pay for the successful product developments, the dead-end research projects, and the products that for whatever reason the customer has chosen not to buy. Because the customer will only buy a small batch at a time, the suppliers will not be able to earn a return on all of their investment on any individual sale. Instead, they will have to incorporate into their pricing strategies the probability that they will also win the follow-on contract. The pricing strategy and portfolio management decisions that MOSA asks of the defense industry are quite complex.

Through a combination of financial instruments, good market research, and sound competitive intelligence, defense firms under the MOSA business model should be able to bear the risk and earn a profit. When the current defense industry business model evolved during the Cold War, these techniques were less sophisticated than they are today. Today's firms stand a much better chance of succeeding at the complex business strategy decisions than they would have decades ago.

PRIME CONTRACTOR TASKS

Prime contractors' primary business activities will include routine collaboration with the customer on roadmapping the trajectory of technology, new product development that incorporates as many standardized modules as possible, and bidding on a plethora of small contracts to spread technology and market risk over a broad portfolio.

Technology roadmaps are essential to MOSA, because firms need a simple way to understand what their customers want from innovation. If firms are to choose how to invest their own R&D money, they will need a reasonable expectation that their customers will buy the products that result from any laboratory successes. Roadmaps provide broad guidelines and set headline goals but do not set particular investment priorities or product specifications. They draw on the military's operational experience, simulations that try to model the future strategic and tactical environment, and technical advice from military laboratories and defense contractors.

In the past, firms' principal contribution to their customers' technology planning was informal. Firms hired retired military officers who could interface easily with their active duty counterparts. Today, the firms' role in roadmapping is already expanding and becoming more formal. Some contractors have built sophisticated computer simulation systems that they use for strategic planning (and marketing). Under MOSA, a sale by a prime contractor will include a computer model of the product's behavioral characteristics, a model that can be plugged into future simulations and thereby contribute to future roadmaps. Some program offices (e.g., the Army's Future Combat Systems) have already used the contractors' simulation systems to better evaluate alternative project definitions and investment plans. This collaborative process will become routine under MOSA. Neither the customers nor the suppliers will be able to create sensible roadmaps on their own; collaboration on modeling and simulation will be a key task.

Prime contractors already advertise their main activity as systems integration rather than manufacturing, and MOSA will reinforce the importance of systems

integration (Gholz, 2003). In fact, the intellectual emphasis of the modular open system approach suggests that prime contractors should develop their products by incorporating as many already-developed component modules as they can, given technical constraints. Using such off-the-shelf contributions from Tier 2 suppliers will help reduce each prime's up-front investment in in-house R&D and tooling, and the incorporation of such off-the-shelf modules will also reduce total system cost by allowing the subcontractors to plan to spread development costs for their modules across several final product lines. Through this process, the primes' key proprietary knowledge will increasingly consist of their design team philosophies and their trade secret ways of drawing together subcontractors' modules into optimally designed systems (Drezner, et al., 1992).

Prime contractors will also be responsible for partitioning the functionality of systems into modules. If a system is a set of "black box" modules that work together, someone has to decide what functions belong in each black box, what processing has to be accomplished internally by modules and what tasks can be shared within a central processing unit, and when functionality that had previously been accomplished by multiple modules can be better accomplished in the next iteration by a single, integrated box. Under MOSA, prime contractors will make those decisions. However, this systems integration task will require especially close collaboration

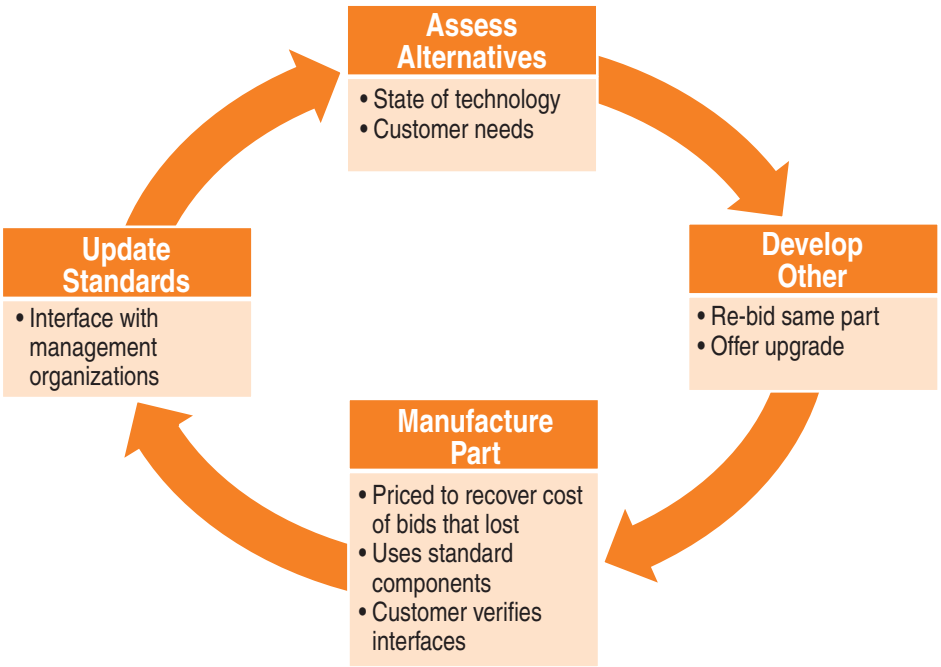

FIGURE 1. SUMMARY OF FIRMS' ACTIVITIES UNDER THE MOSA BUSINESS MODEL

between the prime contractors and their customers, because changing the boundaries of modules will complicate the customers' maintenance and upgrade plans; modules will no longer be as interchangeable. As a result, MOSA will emphasize the interface between primes and their military customers.

Finally, to supply a given number of systems, prime contractors will make more separate offers to their customers than they do under the traditional acquisition approach. Each successful bid will win a smaller batch of production, meaning that a string of successes would be required to yield the same production run as a single win would enable under the traditional system. Furthermore, because MOSA facilitates competition and each individual firm should expect to lose a higher proportion of the competitions that it enters, prime contractors will each need to bid on a broader array of systems to maintain their workload.[5] Bidding will have to become a more routine business practice, and perhaps well-defined interfaces and modular product designs will allow prime contractors to simplify the descriptions of what they are trying to sell to their customers. Moreover, if only a few modules of a system are changed from one generation to the next, a substantial fraction of a company's offer (especially an incumbent producer's offer) may entail reuse of part of the language of the previous iteration of competition.

Most importantly, the content of companies' offers will change under MOSA. Instead of explaining to the customer how the firm plans to develop a product to meet the customer's relatively detailed specifications, under MOSA a bid will offer a detailed description of the performance characteristics of a known product. Under the traditional system, the goal of a bid is to convince the customer that the firm is likely to be able to develop a system at a reasonable cost and on schedule. Under MOSA, the prime contractor need not explain the inner workings of the product in great detail, and at least some technical characteristics of the system will be described by references to widely known open interface standards. The much simpler goal of a MOSA bid will be to explain the features of a product and how it meets needs set out in roadmaps.

Figure 1 summarizes the cycle of activities under the MOSA business model.

THE MOSA BUSINESS ENVIRONMENT: WHAT THE GOVERNMENT MUST DO

The MOSA will require a substantial change in the military acquisition organizations' culture and activities. Specifically, the buyer will need to learn to trust competition to control prices and profits, replacing the current system's direct audits of program accounts. The buyer will also need different kinds of technical knowledge than it currently relies on to write specifications under the traditional acquisition system. There is little reason to believe that the American government can make these changes in its acquisition processes for large systems (McNaugher, 1989; Schooner, 2003), but the MOSA is more likely to work for avionics and other subsystems contracts, especially if the equipment is purchased in small batches.

To allow firms to amortize the development costs of their many products that do not win competitions for procurement contracts, the government will have to excise the profit limits from the Federal Acquisition Regulations. In essence, firms need to figure the development costs from their losing bids into their calculation of overhead costs on the production contracts that they actually win. The result will be that procurement prices will be much higher than the development and production costs of the particular equipment being purchased on a particular contract, making that contract seem tremendously profitable if it were examined under traditional cost and pricing rules.

Under the traditional acquisition model, the government faces tremendous political pressure to unilaterally renegotiate contracts that seem "too profitable": buyers informally impose profit limitations even on fixed-price contracts (Rogerson, 1994). If government auditors ask for too much product-specific cost data, the buyers will face political and cultural pressure to drive prices down. The buyer should not ask questions to which it cannot afford to know the answers. The MOSA contracts will be fixed-price with a different cost structure than under the current business model.

Firms will only have an incentive to invest in risky, innovative research if the buyer allows them to recoup their full portfolio of costs.

Firms will only have an incentive to invest in risky, innovative research if the buyer allows them to recoup their full portfolio of costs. For those products acquired under the MOSA business model, the government's interest in ensuring affordability will be maintained by competition. Furthermore, because the government will only buy small batches at a time, the buyer will not waste too much money by overpaying on any particular contract, if for some reason competitive pressures temporarily fail to limit the profit margin to a reasonable level. Any purchases on which the buyer accidentally overpays will be the contracts most likely to attract competitors for the next round of competition, driving the price back down.

The other big change in government activity under MOSA reinforces the recent trend away from issuing detailed specifications of technical requirements. Under MOSA, the buyer will simply solicit innovative proposals from industry, based on jointly developed roadmaps that cover broad areas of technology.

But the attenuated government role in technology management will not absolve buyers of all responsibility for technical understanding of military systems. Buyers will need two kinds of complex technical knowledge. First, government buyers will need more technical skill to compare offers and decide best value. Different companies may not offer products with the same features. For example, one bid

may offer exactly the same product that the government purchased in the previous iteration, perhaps at a lower price, while the competing bid may offer a new, upgraded module with extra functionality, presumably at a somewhat higher price. Program managers will need more discretion in their source selection decisions than is allowed by current practices to weigh the value of contractor-led innovations.

To earn that discretion, acquisition officials will need the technical capacity to do more than compare proposals to the specification or statement of objectives in the request for proposals. It may be hard for the operational side of the military to delegate important choices about technical performance to civil servants and uniformed military acquisition officers. Military leaders already chafe at decisions by politicians that trade off performance against cost, but they accept that determining the defense budget is a fundamentally political decision, and military professionals respect civilian control in the United States. Un-elected acquisition officials, however, may be more vulnerable to criticism and pressure from warfighters, if they choose not to buy the most advanced technology available. Acquisition is an inherently political as well as technical process (Dombrowski & Gholz, 2006), and that fact constrains the government's ability to implement MOSA.

The government will also retain an important role in helping to set the open interface standards—a second core technical capability. With defense firms increasing their strength in technology management, they naturally will have more technical advice to offer on the open interface standards. While the government should pay attention to firms' good advice, it also needs an accountability mechanism to guard against contractors' natural—perhaps even subconscious—attempts to seek competitive advantage and higher profitability by steering the evolution of the standards definitions in favor of particular technologies.

Furthermore, the organization empowered to set modular interface standards will need its own acquisition budget. When it determines that a technical standard should change, presumably based on an innovation created by a single firm, that firm's proprietary technology will have to transfer into the public domain.[6] The standards body will need to pay to purchase that intellectual property. More than just buying a new system, the customer in this case would be buying part of the competitive advantage that the firm expected to enjoy in future rounds of competition.

CONCLUSION: IS MOSA A GOOD IDEA?

The idea of using a modular open systems approach to buy military avionics is relatively new, so at this point assessing its benefits and costs is a fairly speculative exercise. It would certainly be easy to oversell MOSA, and overselling is often an important part of policy advocacy. Convincing politicians, military leaders, and the acquisition bureaucracy to sign on to a new approach will require considerable leadership and salesmanship. But real analysis should support the public approach.

Work on MOSA for military avionics began in the engineering community, where many of its technical advantages "just made sense." Digging deeper into the technical issues raised important business issues: how will defense companies operate under

the MOSA, and can they be induced to support MOSA by offering them a reasonable chance to earn profits? This description of a possible MOSA business model suggests that businesses can adapt to MOSA, at least for some military avionics projects. But getting past the business problems only reveals political and organizational questions that need to be answered, too, before significant acquisitions will make sense under the new approach. Moreover, MOSA will surely involve a good deal of painful reorganization and overhead investment in creating the standards body—costs that need to be considered carefully compared to the limited volume of MOSA projects that will be available for bidding even under a fully implemented MOSA acquisition system.

The MOSA offers some clear advantages for both the DoD and the defense industry. Systems designed for modular maintenance and upgrades should be able to resolve some of the obsolescence problems of today's equipment, and technology refresh opportunities should facilitate spiral development, allowing equipment to better serve warfighters' needs. The frequent competitions to sell small batches of modules and systems should also allow sensible, flexible decision making to trade off maintenance and acquisition spending. Firms will be eager to take control of their technology management decision-making and to rely on their own strategic decisions about investment priorities.

On the other hand, MOSA must overcome some real limits. The appeal of open standards and the analogy to the world of commercial information technology are frequently used to support casual claims about gains in interoperability. While increasing interoperability is surely an extremely important goal for military acquisition organizations in the new era of network-centric warfare, it is easy to exaggerate the interoperability benefits of MOSA. Not every commercial IT product really "plugs and plays"; hard work is still required, not only to define the interface standards but to maintain them in the face of technological change and mission creep.

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The organization in charge of maintaining the open architecture standards, supported by government project managers, will need to decide the extent to which the detailed designs for each new product purchased by the military will pass into the open architecture. If too much technology remains proprietary, then the MOSA business model will not reduce costs to the extent that it should, i.e., competitive firms will still have to re-invent the wheel over and over again. But each innovation that changes the standards definitions must be fully paid for at the time that it

is shared with the rest of the defense industry, meaning that incorporating new technologies into the standards definitions will be expensive. Moreover, changing the standards too frequently will set back the gains in interoperability that MOSA is intended to bring and will attenuate the learning-by-doing benefits that designers would otherwise gain by repeatedly using the same architecture.

For other reasons, too, the cost advantage of MOSA may not be large. Buyers will still insist on dictating the technology trajectory, so MOSA will not allow for innovation to move in its most "natural" direction. Appeals to national security and the needs of warfighters carry a tremendous amount of weight, especially in times of war, and technology experts and business strategists will struggle to make their views heard in the roadmapping process.

Furthermore, MOSA requires a delicate balance between the costs and benefits of competition. Development cost savings under MOSA come from getting modules into multiple systems: winning bidders need to succeed repeatedly. At the same time, the margin between price and cost is only controlled by competition, and each competition to sell a batch of equipment will have many losers. Somehow, the acquisition system needs to pay the development costs of all of those losing bidders to keep them in the defense business. The more firms that bid on each increment of technology, the more total development investment that has to be spread across the production runs of successful bids. If too many bidders are attracted to the MOSA market, MOSA could actually increase system-wide costs.

Ultimately, MOSA may be a workable way to solve a number of technical and business process problems for the acquisition of military avionics.

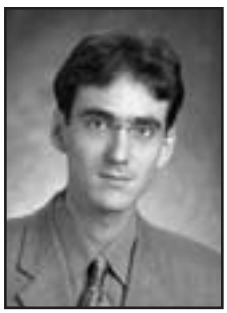
Finally, firms should not necessarily trust the government. First, the ultimate buyers of military systems, Congressional representatives, may not allow firms to set prices high enough to cover their total costs of bidding for MOSA contracts. Politicians are likely to "renegotiate" profit when it seems too high on an individual product. Contracts for subsystems and small modules are likely to be "too far in the weeds" for politicians to notice, but to make a big difference in interoperability, spiral development, and cost savings, MOSA will have to apply to some relatively visible products, too. The only hope is that sales can be packaged in small enough batches not to attract politicians' attention to the profit margins. But the small batches are a double-edged sword for firms trying to manage their portfolio of risk: the smaller their guaranteed production runs from each contract win, the higher the risk the firms

will have to bear. For MOSA to work, batch sizes need to be set pragmatically (not too small), and that will require a good political solution.

Ultimately, MOSA may be a workable way to solve a number of technical and business process problems for the acquisition of military avionics. But "workable" does not mean that MOSA is a *good* way to solve those problems. Unfortunately, by its very nature, it will probably not be possible to implement small-scale "proof of concept" tests of the modular open system approach: it inherently relies on spreading risk and investment cost across a broad array of projects all at the same time. The DoD Open Systems Joint Task Force is working to implement MOSA, and recent reforms of the defense acquisition process make MOSA a default approach for some systems. With that in mind, defense industry executives and the government acquisition workforce need to understand the business issues, as well as the technical and political ones, in the Modular Open Systems Approach.

AUTHOR'S NOTE

The author would like to thank the members of the Modular Open Systems Approach to Interoperability Initiative working group, convened under the Aerospace Vehicle Systems Institute (AVSI), for their comments and suggestions in developing this business model. Key members of that effort included Carl Heck, Parl Hummel, Fred Kuhn, David Lund, Pravarna Mamidi, Spencer Rawlins, Dan Slick, Ben Watson, and LCDR Michael Whelan. A previous version of this model was developed under a consulting contract with the Boeing Company as part of the AVSI effort. The views expressed here are those of the author.



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ENDNOTES

1. A broad selection of this research can be accessed on the web site of the DoD's Open Systems Joint Task Force at http://www.acq.osd.mil/osjtf/index.html.

2. The MOSA also faces political barriers. While the Department of Defense can (and already does) include a preference for MOSA in its acquisition regulations, and Congressional leaders in principle support the idea of efficient acquisition and can understand the arguments that have piqued the military customers' interest in MOSA, political leaders nevertheless have good reasons to perpetuate the traditional style of acquisition for the vast majority of defense projects. The traditional acquisition system did not evolve by accident. The MOSA advocates should conduct a separate analysis of the political case for MOSA and should develop a political strategy to broaden MOSA's application in parallel with their technical analyses and the business analysis reported in this article.

3. There is no obvious reason why MOSA would require any shift in the small business set-asides in defense contracting. Prime contractors will simply continue to include small business content as one of the factors to optimize in their trade studies during system development. Meanwhile, the buyers will continue to include small business content as one of the desirable factors that they weigh in determining whether to pay the asking price for a system offered by a prime contractor. As a result of this continuity, the overall shift to the MOSA business model is unlikely to require substantial changes to the business models followed by defense-oriented small businesses.

4. Some products may be too complex and some systems may require too much up-front investment for firms to bear the costs alone. For those systems, the government and the defense industry may continue to use the existing weapons acquisition model.

5. Assuming that the introduction of MOSA does not increase the total amount of equipment that the military demands, any new suppliers that are drawn into the military market by MOSA will have to take work from established suppliers. Presumably, many of the new entrants that MOSA advocates hope to bring into the defense industry will offer modules rather than systems, meaning that they will compete more directly with Tier 2 subcontractors. But established defense firms at all levels of the industry should wonder if one result of the new acquisition approach would be to shrink the per capita market size, hence shrinking their expected business volume, revenue, and employment levels (thought not necessarily their rate of return).

6. "Public" in this context does not mean freely available to anyone. It means open to firms allowed access to classified technical standards available for use by firms in the defense industry.