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*Formerly Booz & Company*

# *Design for affordability*

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# *Executive summary*

**Program managers** and defense manufacturers frequently are caught between opposing imperatives: deliver increasingly capable and complex systems while simultaneously reducing costs. In an era of uncertain defense budgets and a shrinking procurement base, the traditional approach of squeezing savings through incremental cost reduction initiatives no longer supports the targets required by Department of Defense (DoD) programs. In response, a few innovative programs have initiated a step-change in performance, delivering more effective systems at a dramatically lower cost to the customer. Manufacturers have taken a "total cost" perspective by systematically evaluating all cost drivers, starting with the actual platform design.

# *ISSR: What drives (your) program costs? Achieving step-change cost reduction on Department of Defense platforms*

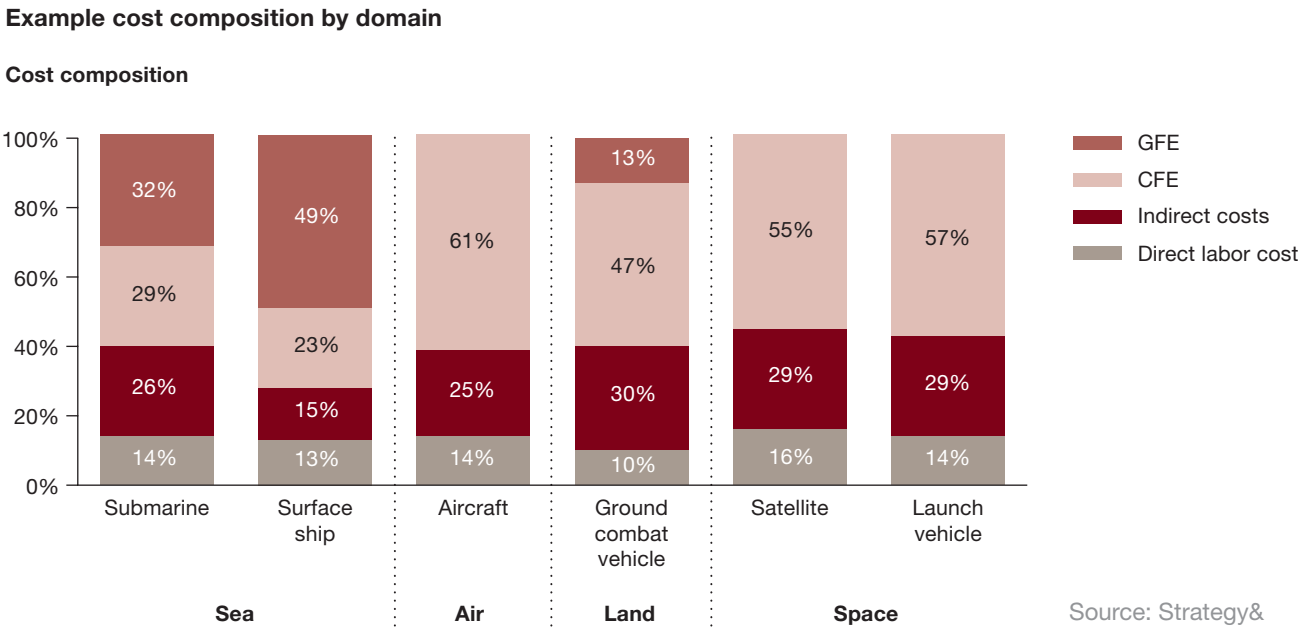
The need to reduce costs is not new to the defense industry. Like most industries, the defense industry historically has attacked costs by individual cost category: government-furnished equipment (GFE), contractor-furnished equipment (CFE), labor, and overhead. In managing costs, contractors typically have sought to make reductions on a category-by-category basis, focusing primarily on labor and overhead. As the most visible and controllable costs, these two categories are often considered low-hanging fruit that will have an immediate impact on the bottom line.

Unfortunately, direct labor and overhead (indirect) also are the smallest cost categories and typically offer the least opportunity for improvement *(see Exhibit 1, next page*). Direct labor, for example, comprises only 10 to 16 percent of total platform cost. Interestingly most of the Lean Six Sigma (LSS) initiatives we've observed focus on direct labor.

Regarding overhead, Strategy& has seen and participated in the restructuring of the DoD contractor base, with the objective to achieve "single-site economics" — following its evolution from single-site/single overhead (mid 1990s), to multi-site/single overhead (2000), to single division/single overhead (today). Although opportunities still exist for cutting overhead, a continuing reduction in the units that the DoD has procured places the defense industry in a challenging position as players struggle to hold costs constant against a shrinking procurement base.

In effect, strategies for reducing labor and overhead do not address where real opportunities lie — that is, how the system is designed and built. The "big elephant in the room" is the significantly increasing material cost. For most programs, material cost reduction is about

*Exhibit 1*
**Cost composition by domain**



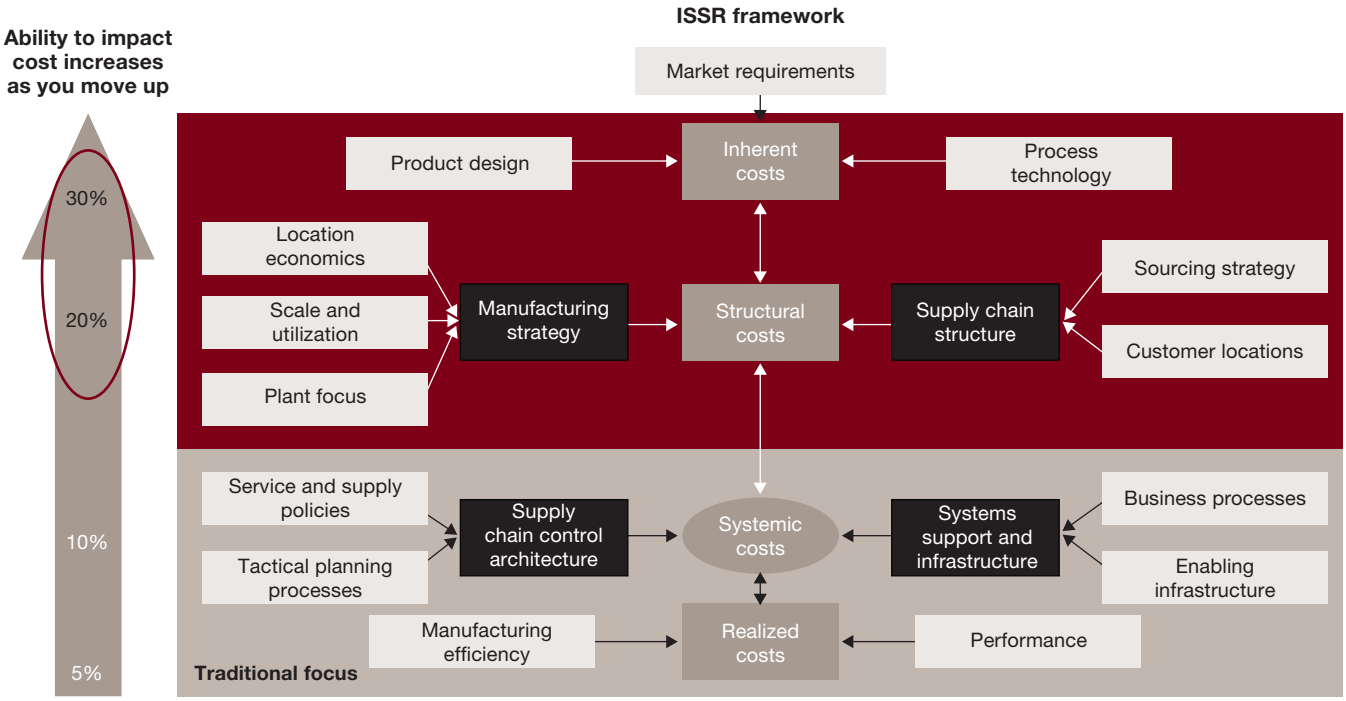

Source: Strategy&

beating or achieving negotiated future inflation indices. Therefore, as exhibited in Exhibit 1, 50 to 60 percent of the platform cost, once designed, is largely taken off the table. To achieve significant and enduring step-change cost reduction, several innovative DoD programs have taken a different approach to attacking material costs.

First, rather than analyzing the impact of individual cost categories (e.g., depreciation or payroll cost), these programs have analyzed the impact of cost drivers (e.g., process technology or asset use). Second, the programs focused on the cost drivers that offer the greatest opportunity for savings, and they have challenged conventional ways of conducting business, all the way back to the design of the platform itself.

To identify, analyze, and address a program's cost drivers, Strategy& has applied its cost-driver framework based on inherent, structural, systemic, and realized (ISSR) costs (*see Exhibit 2, next page*). ISSR evaluates cost drivers based on four categories:

*Exhibit 2*
**ISSR cost driver framework**




Source: Strategy&

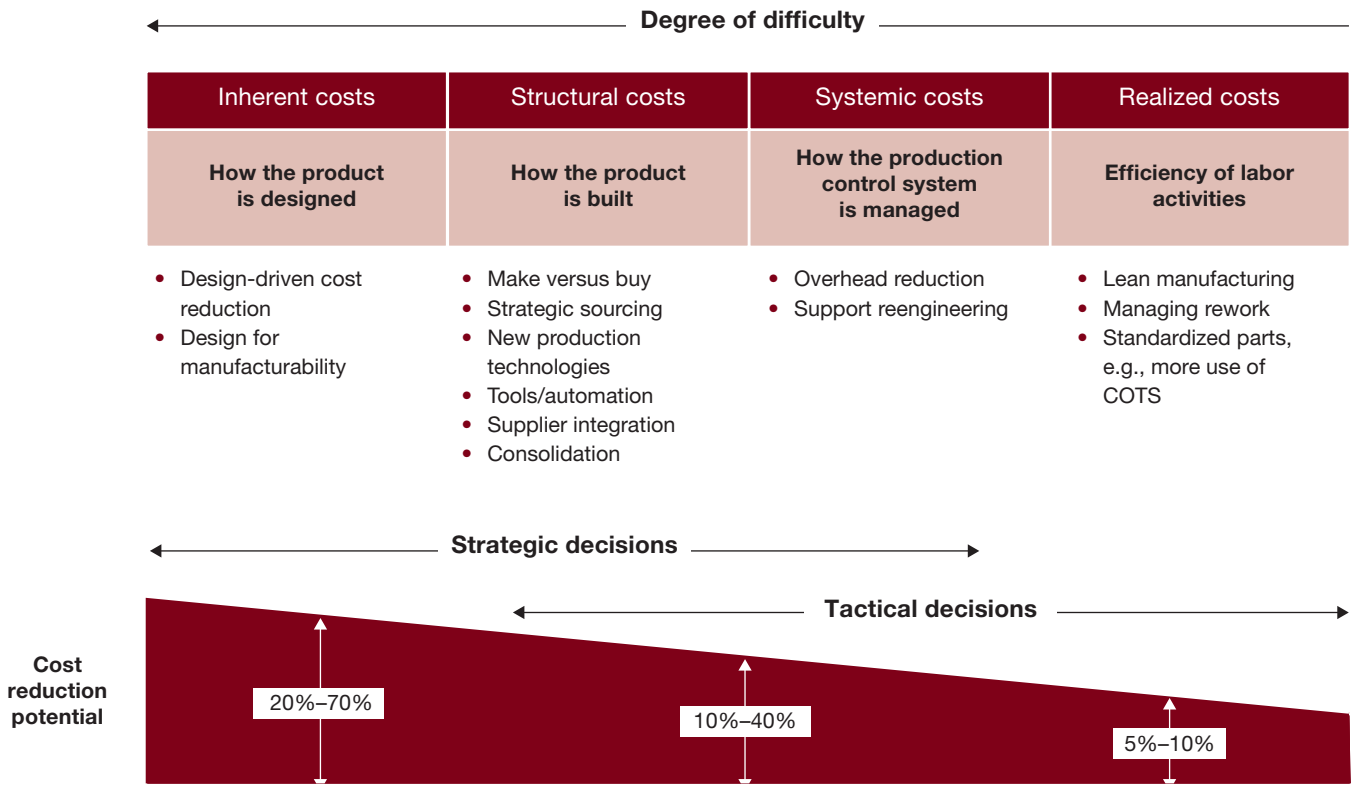
- Inherent costs, driven by the platform design
- Structural costs, driven by how the product is made
- Systemic costs, driven by how production is managed
- Realized costs, driven by the actual work practices.

The rigorous and comprehensive nature of the ISSR approach triggers the identification of all improvement opportunities. The framework is explicitly designed to attack material and manufacturing build costs. Further, ISSR offers a collaborative approach that draws in government stakeholders and suppliers, ensuring that all cost-cutting measures have been explored and vetted for the maximum benefit to the platform and government program. By this virtue, the ISSR framework provides government agencies and contractors with a comprehensive approach to measure and validate their cost-saving strategies.

As the ISSR framework clearly shows, not all costs are created equal. Consequently, the programs on which we have worked directed their efforts toward addressing two primary drivers of platform cost: inherent costs (driven by the design of the platform) and structural costs (driven by how the platform is built). For DoD programs, these areas almost always offer the greatest opportunities for gain (*see Exhibit 3*).

The sections above present not only a breakdown of the inherent and structural costs and how they can be used to drive savings across a major program, but also a review of critical factors for creating a successful ISSR program in the defense industry.

*Exhibit 3*
**Inherent and structural cost drivers' potential for cost savings**




Source: Strategy&

### *Inherent costs — designing for affordability*

Inherent cost drivers are fixed in the platform design and production process. Although reducing inherent costs requires upfront time and investment, it offers the greatest payoff by designing the most costly components out of the platform. The resulting cost savings cascade throughout the platform, from materials costs to labor costs.

Designing for Affordability redefines how project costs are analyzed and how stakeholders interact from the project's inception. It addresses fundamental design questions: Can system designs be simplified while maintaining state-of-the-art capability? Can components be standardized across the platform? Can less expensive alternatives be substituted for expensive parts without compromising quality?

Addressing questions like these offers the greatest opportunity for cost reduction. Moreover, it brings to the forefront tradeoffs and decisions that should be made during the innovation window, when product design and schedule can still be altered to deliver savings (*see Exhibit 4, next page*). Therefore, stakeholders gain more control over requirements from the start.

Reducing inherent costs also has the potential to yield savings across the lifecycle of current and future platforms:

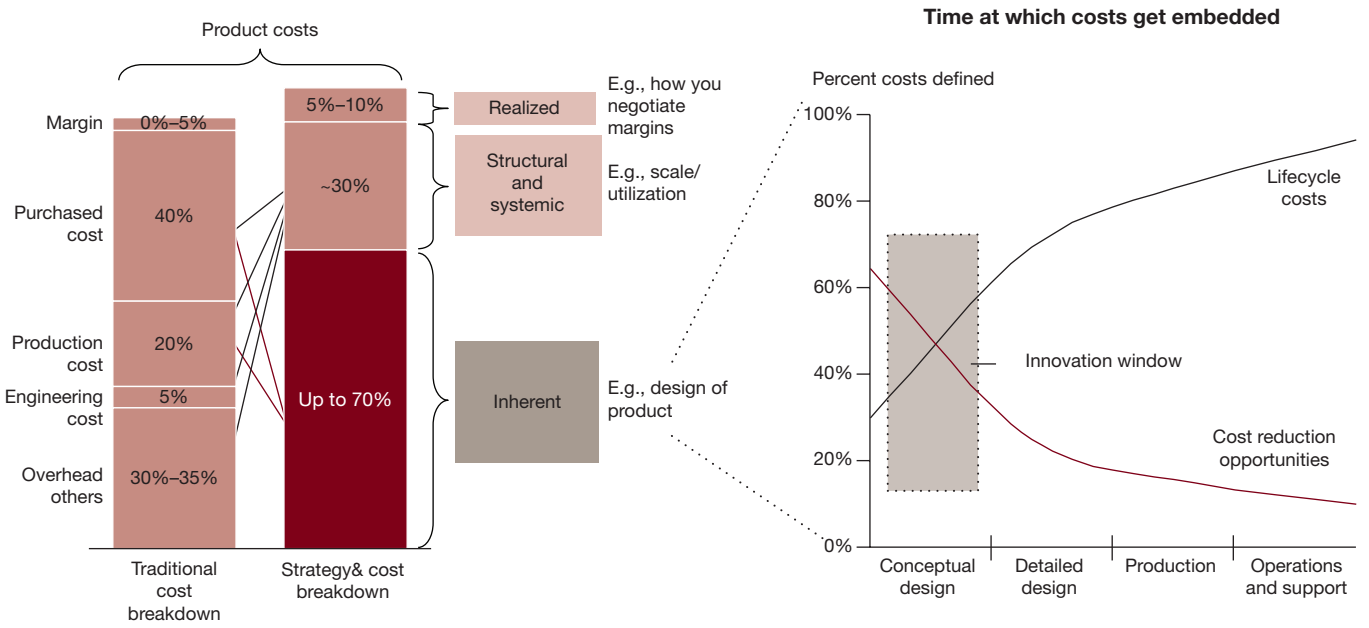
- **Production savings**. Redesigning portions of the platform can generate substantial savings over the production run of the product. Reductions in production budgets will sometimes pay for the initial investment in redesign.

- **Lifecycle cost savings**. Lifecycle costs extend beyond production costs to include operating costs (e.g., fuel, payload, and personnel), maintenance, modernization, and disposal costs. A Design for Lifecycle effort has the potential to generate tremendous savings when total lifecycle costs are optimized, revealing additional opportunities such as improving platform availability and reliability.

- **Future program cost savings**. Cost savings efforts on current programs may have a long-term impact by applying these same strategies on future programs. This impact may become the difference between a larger DoD procurement of units versus a smaller-than-expected procurement of units.

General Dynamics Electric Boat's recent success story with designing for affordability illustrates the cost savings that can be captured through the process of redesign. The program eliminated significant costs in materials and manufacturing, including redesigning the bow on the

*Exhibit 4*
**Inherent and structural cost drivers' potential for cost savings**




Source: Strategy&

U.S. Navy's SSN-774 Virginia-class nuclear attack submarine. For example, replacing the original sonar sphere with a hydrophone array saved millions of dollars per sub by eliminating the excessive penetrations required by the sphere. The original design also required about 1,000 transducers, each of which had only a 17-year life. In contrast, the hydrophone array's hydrophones cost far less as an initial production cost; with a lifespan equal to the sub's expected 33-year life span, they offer added lifecycle savings.

## *Attacking structural costs — building for cost savings*

Structural costs are related to how the platform is built in relation to the inherent design. For defense programs, these costs often are tied to decisions about which contractor builds which component, how much modularity is designed into the platform, and how manufacturers approach their production scheduling. Next to inherent costs, structural costs offer the greatest potential for costs savings on weapons platforms.

As one component of its focus, attacking structural costs addresses the issue of level loading capacity — a common mistake in the defense industry, but if corrected, an opportunity for substantial cost reduction. Drawing out unit production schedules to level load capacity is an attempt to smooth out workload peaks and valleys in an environment in which the DoD has decreased the number of units it procures. Rather than stabilizing profits, however, this approach often substantially increases platform costs for the following reasons:

- **Higher level-of-effort support**. The longer a unit remains in production, the more attention it consumes from management and support functions. Often, platforms in production require maintenance and preservation activities to ensure that critical components do not degrade.

- **Increased risk of change**. The longer a unit remains in production, the more likely it will be subject to change. Complex military platforms are constantly being upgraded, often with new electronics and software. Although change may result in increased short-term sales and profit to the prime contractor, it leads to higher platform costs longer term.

- **Lack of urgency**. When many units are in various production stages, urgency is often lost. In these situations, productivity and accountability are quick to erode.

- **Higher working capital costs**. Extended production schedules tie up cash in inventory. Again, this issue may be profit neutral to the prime contractor through reimbursement by the DoD with progress payments. However, factors such as cost of capital tied up in inventory, risk of obsolescence of raw materials, and cost of warehousing will still drive an increase in platform costs.

Establishing a comprehensive program to reduce production schedules can provide substantial cost savings for many DoD programs. In this effort, programs should set cost reduction targets ranging from 20 to 30 percent. Focused teams should analyze critical path, resource, as well as product capacity and other constraints. Supplier and customer participation should be elicited to discuss contingency and flexibility to improve the overall production schedule.

Often the schedule reduction program will lead to design-driven ideas, such as making systems more modular or easier to test. For example, the physical space constraints of submarine design increases the amount of time required to complete a given task the closer to final assembly the task is planned. By scheduling key tasks (e.g., test activities) earlier in the process, the amount of time and cost spent on this task can be reduced substantially.

### *Attacking systemic and realized costs — material procurement and labor efficiency*

Systemic costs are driven by how material (i.e., CFE and GFE) is procured and how business processes are employed for measuring and accomplishing the work. Labor practices and human resources drive realized costs. In the defense industry, these areas typically receive the most attention, but they usually offer the fewest opportunities for cost savings.

Strategy&'s approach to systemic costs addresses material costs across the entire platform. This dimension of the framework emphasizes consolidating buys across platforms and sites and working with suppliers to identify and attack common drivers of cost. Suppliers are encouraged to source and price their components more competitively to drive down costs throughout the value chain.

Although they offer the least potential for savings, realized costs are where contractors employ the most time and resources across a cost reduction program. This effort often comes at the expense of more important drivers — namely, inherent and structural cost drivers. In the long term, even a 20-percent improvement in realized costs (labor and overhead) typically results in only 4- to 8-percent reduction in total platform costs.

Furthermore, variable costs such as medical benefits continue to outpace inflation, making gains in this area fleeting at best. Lean Six Sigma and other labor efficiency programs can prove effective, but only if these programs are implemented after inherent and structural costs have been addressed.

### *Creating the right environment for step-change cost reductions*

Various cost reduction strategies have been attempted with degrees of success in DoD programs. The ISSR framework and approach substantially increases the size of the opportunity and probability of success.

Even an ISSR program, however, must overcome several challenges: "selling" the idea of investing for long-term gains, bringing together and managing multiple stakeholders, and integrating and managing disparate sets of data. Although these challenges are not unique to the defense industry, they often are magnified in the industry as a result of tight margins and a fear of schedule cost overruns. Addressing these concerns systematically and strategically are critical for creating the right environment for cost reduction.

*Developing the business case for investment*

If implemented correctly, Designing for Affordability and the ISSR framework can fundamentally transform how an organization considers cost reduction. This change in culture can then be scaled across the enterprise, resulting in further benefits.

An ability to realize the full range of design-driven cost reduction opportunities, however, requires an upfront investment to redesign portions of the platform. For many stakeholders, the idea of investing time and money into redesign can be a tough sell. In our experience, it is critical to understand and address objections over investing in redesign early in the process. An independent third party can be invaluable in helping navigate this part of the endeavor.

The key is demonstrating how the upfront redesign generates ongoing savings across each unit procured and across the program's entire lifecycle. The "moment of truth" typically comes when stakeholders realize that the initial redesign investment can be paid for directly by reductions in production budgets. That alone often justifies the investment. Even more compelling, frequently an order-of-magnitude increase in savings potential occurs when costs are considered across the program lifecycle (Design for Lifecycle methodology). Often, cost savings from the original program can be applied to future programs.

*Managing multiple stakeholders*

To be effective, the ISSR process requires the collaboration of multiple stakeholders, including the Government, prime contractor(s), and suppliers. Individuals at all levels must be encouraged to channel their talents, expertise, and creativity toward developing innovative cost-saving strategies. Typically, this effort will result in dozens, or even hundreds, of suggestions that must be compiled, evaluated, and prioritized. With all the moving parts of the ISSR framework, initiatives will have very different timeframes, costs, risks, and benefits that need to be identified and managed.

Internally, a comprehensive ISSR program represents a big shift in behaviors in most organizations. Many employees will only dare to consider initiatives that improve processes in their narrowly defined department or scope of work. The ISSR approach helps mitigate this by allowing central management to better organize and encourage employee involvement beyond the department perspective. Once those employees are engaged and contributing, central management will be positioned better to coordinate resulting initiatives.

Not all ideas will fit the bill. A rigorous assessment process is critical, and ideas must be fully vetted based on performance and cost-savings potential. This process often is emotionally charged, and the ability to demonstrate impartiality is crucial. As with creating initial stakeholder buy-in, a third party with prior experience in this type of a cost reduction program can provide the objective and independent perspective required for managing the process with credibility.

*Integrating disparate sets of data*

The ISSR framework examines different slices of the total platform cost — by system, area, cost type, and process. When done correctly, the framework offers a like-for-like comparison that eliminates unnecessary, overdesigned, and overpriced components, processes, and systems. The ISSR framework incorporates all costs into a common, integrated picture so that the program manager is able to compare and make tradeoffs across cost reduction opportunities (*see Exhibit 5, next page*).

Achieving these results requires an ability to access and integrate government, contractor, and supplier data into a carefully structured database. This complicated ISSR aspect can be costly if not done correctly; little margin for error exists because all design and manufacturing decisions will be based on the data from this database.

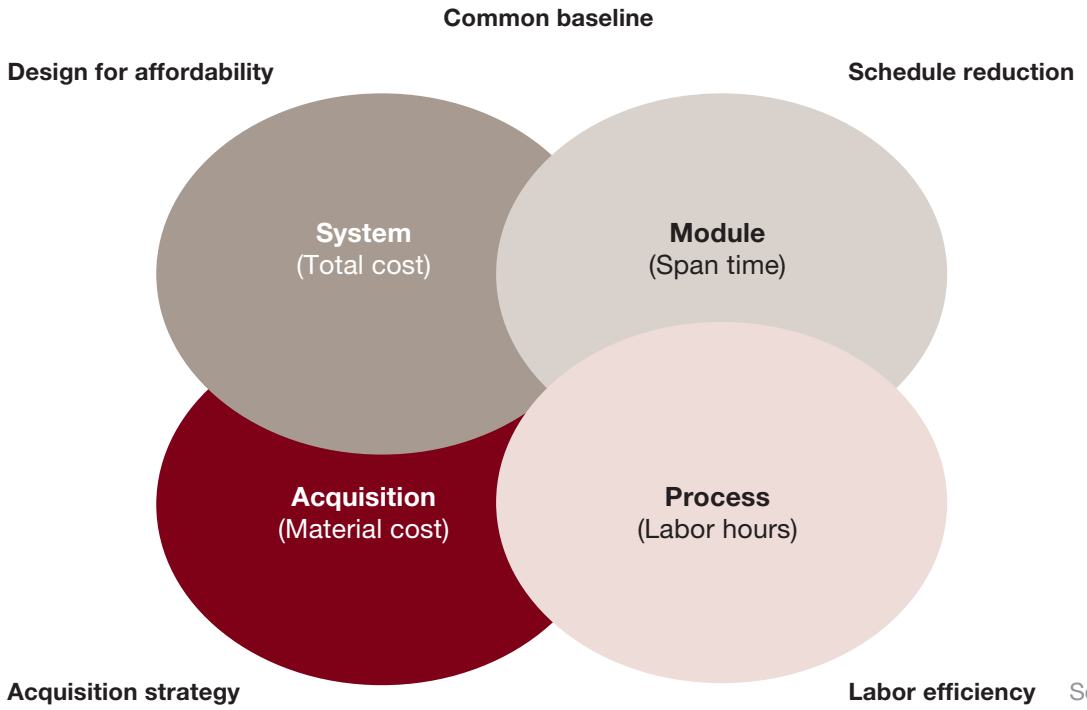
Because it is a nonrecurring action, the database needs to be created only once. As such, it may be cost-effective to work with a contractor that has experience with integrating this level of detail. Having the know-how and experience to not only organize this data but also use it to identify opportunities and frame decisions is critical to the success of the cost reduction program.

## *The drive to evolve*

As the DoD changes how it procures new platforms, defense industry players must evolve to meet the new expectations. Shrinking production groups, tighter government budgets, and lower procurement levels are necessitating an adjustment in how industry designs and manufactures weapons platforms.

Making these changes will not be easy. Contractors are being asked to trim platform costs at an unprecedented scale while simultaneously maintaining or improving system capabilities. The most cost-effective, strategic means for achieving this effort is by attacking inherent and

*Exhibit 5*
**Common baseline for ISSR data**




Source: Strategy&

structural cost drivers. This comprehensive and focused approach for systematically attaching all cost drivers — focusing first on inherent and structural costs — will capture cost-savings at a level that incremental reductions simply cannot achieve.

For contractors that employ ISSR, step-change improvements in cost savings are not only reachable but also profitable. For DoD agencies, the employment of ISSR framework on a platform is a key indication that all possible costs have been reduced from a platform. In today's political and financial environment, defense industry stakeholders cannot afford to not evolve to the next level of efficiency and cost-effectiveness in its platform development.

## *ISSR process enables Virginia-class submarine to hit cost target*

*Strategy& delivers a ground-breaking cost reduction approach applied to building submarines in the Navy's Virginia-class (SSN-774) program, a new class of nuclear-powered attack submarines designed for the Navy's evolving post-cold war requirements.*

### *A new class of submarines*

The affordability of ships is a key concern of the Navy if it is to be successful in its plan to recapitalize the fleet. The Virginia-class submarine program, which delivered its first ship in 2004, represents a successful partnership between the Navy and industry in achieving the affordability goal for the procurement of a planned SSN-774 class of 30-plus submarines through 2020. To support the acquisition of these submarines within its budget plan, the Navy set a target unit cost of US$2 billion (2005 dollars) per submarine as a condition for meeting its goal of increasing production from one to two boats per year starting in 2012. This goal represents a unit cost reduction of nearly 20 percent.

Complicating the cost-reduction mandate was the new, joint production arrangement for building the Virginia-class submarines. The submarines are built jointly by General Dynamics Electric Boat Corporation and Northrop Grumman Shipbuilding under an arrangement in which each shipyard builds portions of each boat, and then the yards take turns assembling and delivering the final boat. Because it represented a departure from traditional Navy submarine construction, the joint production method would require fresh perspectives and innovative approaches to achieve the aggressive cost-reduction goals.

### *A ground-breaking approach*

Electric Boat, the prime contractor for design and construction of the Virginia-class submarine program, brought on the strategy and technology consultants at Strategy& to develop a comprehensive, long-term plan for permanently reducing costs of each submarine to $2 billion per boat (2005 dollars).

Working closely with program executives from the Navy and Electric Boat, Strategy& developed a unique approach to Design for Affordability (DFA) based on its ISSR cost-driver framework of Inherent, Structural, Systemic, Realized (ISSR) costs. This organic, rigorous cost-reduction approach leveraged Strategy&'s experience across numerous industries to attack inherent and structural program costs in all major areas, including design, cycle time, acquisition and sourcing, organizational structure, and labor efficiency. Navy officials approved the plan in April 2006 and Electric Boat selected Strategy& as the lead consultant for the effort.

Within 10 months, Strategy& experts, working side by side with senior leaders from the Navy and Electric Boat, charted a course that fundamentally transformed the entire submarine acquisition process, from design to sea trials. The result was a comprehensive set of improvements in management, acquisition, production, and technical processes that have enabled PEO-SUB to reduce estimated program acquisition costs by $3.8 billion. Equally as important, the Virginia-class cost reduction effort enabled the Navy to accelerate its plan to double the construction rate to two boats per year — a significant savings to US taxpayers and a needed boost to our national security.

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