Simplicity and National Security

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INTRODUCTION

Excessive complexity in the Pentagon's processes, organizations, and technologies creates a wide range of problems, including cost overruns, schedule delays, and unsolvable technical issues. This has a negative effect on our national defense posture, both from a military and economic perspective.

Unfortunately, these issues are often accompanied by an assumption that complexity is inevitable and must be simply tolerated. Fortunately, this is not the case.

While a certain degree of complexity is unavoidable and even useful, the data suggests that military technology programs do not have to be so complicated. In the vast majority of cases, simpler alternatives are readily available and highly effective.

Accordingly, this paper highlights the impact of complexity in government-led technology development programs and illustrates the benefits of adopting simpler alternatives. It then introduces a tool called The Simplicity Cycle which aims to help decision-makers manage complexity.

FASTER, BETTER, CHEAPER – AND SIMPLER

In the 1990's, NASA launched a series of missions as part of their Faster, Better, Cheaper (FBC) initiative. Nine of the first ten FBC missions succeeded, accomplishing such difficult feats as placing a rover on Mars (Pathfinder), intercepting an asteroid (Near Earth Asteroid Rendezvous), and bringing particles from a comet's tail to earth (Stardust). However, in 1999, four out of five FBC missions failed. Two years later, the method was abandoned.

"All of the more complex projects failed or were impaired…"

Professor Howard McCurdy researched NASA's experiments and published his findings in a book titled *Faster, Better, Cheaper: Low Cost Innovation In The US Space Program*. He demonstrates that success or failure was largely determined by the project's complexity:

> *Low-cost missions of the lowest complexity… did very well. As projects moved up the cost/complexity curve, failures occurred. It did not matter whether the more complex "faster, better, cheaper" projects sat above or below the adequate—spending line.*
>
> ***All of the more complex projects failed or were impaired, regardless of whether their managers spent too little or too much**. (McCurdy, 2001:27)*

While speed and thrift were key elements to the Faster, Better, Cheaper methodology, complexity was the primary differentiator between the successful missions and the failures. One of the main lessons of NASA's FBC experience, therefore, is to constrain a project's complexity. Doing so increases the likelihood of successfully accomplishing even the most difficult, unprecedented missions.

COMPLEXITY AND COMBAT READINESS

Defense analyst Chuck Spinney examined the impact of complexity within the DoD and concluded "the benefits of increasing complexity are clearly neither self-evident nor clear-cut." (Spinney 1985:85). He points out "reliability is more difficult to predict for complex systems than for simple systems, because complexity increases the uncertainty surrounding interactions between components… Moreover, as the complexity of a weapon increases, its number of failure modes increases." (Spinney, 1985:91).

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Spinney goes on to investigate whether increasing a system's complexity increases or decreases its capability. His conclusion is that "Increasing weapons complexity reduces combat readiness" (Spinney, 1985:11) in the following ways:

- Degrades combat skills by causing inadequate and unrealistic training
- Increases reliability and maintainability problems

- Increases cost of maintenance
- Increases dependence on large vulnerable support base
- Increase economic inefficiency of plans
- Slows modernization by increasing development/procurement lead times
- Multiplies magnitude and likelihood of disaster
- Increases vulnerability to countermeasures
- Cuts forces, supplies and munitions to inadequate numbers

In a similar vein, researcher Sheila Tobias writes "Expensive airplanes are complex airplanes, and complex airplanes, over the past ten to fifteen years, have been the bane of our existence. The costs of keeping a stable of these complex machines in fighting trim is astronomical." (Tobias et al, 1982:369) Tobias and her co-authors summarize this into a simple rule: "as weapons increase in complexity, their reliability declines." (Tobias et al, 1982:369)

"The evidence suggests that complex technology is usually relatively ineffective."

The cover story in Time Magazine's March 7, 1983 issue paints a similar picture. In an echo of McCurdy's commentary on NASA, a preference for complexity gets much of the blame for a variety of failed military technology projects. Quoting a Heritage Foundation report, the article points out "The evidence suggests that complex technology is usually relatively ineffective." (Isaacson, 1983:4).

It also cites Spinney's 1980 *Defense Facts of Life* report, which "argued that the pursuit of complex technology has resulted in the production of weapons that are high in cost, few in number and questionable in effectiveness." (Isaacson, 1983:3). The article supports the position of reformers who "argue that in many cases the simpler weapons are actually more effective." (Isaacson, 1983:7).

SIMPLICITY & AVAILABILITY

The clear implication of the aforementioned studies is that complexity is neither inevitable nor desirable. Simpler alternatives exist and outperform their more complex counterparts. The US Air Force's A-

10 Thunderbolt is one such example. It was developed with a healthy appreciation for the value of simplicity and has proven to be one of the most effective aircraft in the fleet.

From the start, project leaders deliberately pursued a simple approach. As researchers at the Air Force Institute of Technology explain "… it was intended that simplicity of design would lead to a shorter development time, lower life cycle cost, reduced maintenance times, increased sortie rates and the ability to operate from austere bases." (Jacques & Strouble, 2008:22) These benefits were indeed realized.

"…complex aircraft required more maintenance per flight hour than simple aircraft do, which leads to increased availability and decreased costs for simpler aircraft."

Simplicity also has a strong direct correlation with operational availability. As Jacques and Strouble point out, "… there was an observed ratio of 3:1 in MMH/FH [Maintenance Man Hours per Flying Hour] between the most complex and the simplest strike aircraft." (Jacques & Strouble, 2008:23) That is, complex aircraft required more maintenance per flight hour than simple aircraft do, which leads to increased availability and decreased costs for simpler aircraft.

The history of the F-16 Falcon's development tells the same story. In an interview, one project leader explained "We were perceived as being anti-technology. Our slogan was 'make it simple…' We used the technology available to drive the given end, that is, or was, to keep things as simple and small as we could. Our design was a finesse approach." (Hehs, 1991).

The results: the F-16 went from Milestone B to First Flight 8 months faster than the F-15 Eagle, which was developed in the same era. The Falcon achieved its Initial Operational Capability four months faster than the Eagle. According to the USAF F-16 Fact Sheet, nearly 40 years after its first flight, "…the F-16's maneuverability and combat radius… exceed that of all potential threat fighter aircraft."

The value of simplicity is not a new discovery. In WWII, the P-51 Mustang was praised for its simplicity:

> *"The record of North American's P-51 Mustang fighter proves, however, that* ***it is both possible and practical to create a single basic design that can be modified, as military needs dictate, to keep abreast of requirements****…*
>
> *These achievements are, from an engineering standpoint, remarkable—because they were accomplished by a plane that does not to any extent embody previously unknown engineering features, but rather employed refinements of known accepted practices." (Nelson, 1944)*

In 1942, a Colonel in the Army Air Corps wrote that the P-51 is "…an extremely simple airplane and has such perfect handling qualities as to put a smile of joy on the face of any fighter pilot." (Sanders, 1942)

CONCLUSIONS

Recent and distant history alike show that high levels of complexity are neither inevitable nor unavoidable. Further, the data clearly shows that complexity reduces reliability, maintainability and operational relevance. Simplicity on the other hand helps constrain cost and schedule while still delivering systems that put "a smile of joy on the face of any fighter pilot."

Since complexity has such a significant negative impact on operations and technology, a serious effort ought to be made to prevent and remove unnecessary complexity. Project leaders could hold up simplicity as an enduring value and use it to guide their decision-making and problem solving. Academic instructors could emphasize the importance of simplicity, and source selection activities could place a premium on simpler approaches as well as simpler technologies. Technology development programs should track and analyze metrics that assess the complexity of their processes and technologies alike, with the purpose of identifying opportunities to simplify.

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One specific way to foster this shift towards greater simplicity is to use the Simplicity Cycle. As explained in the book by the same name, this tool highlights common complexity-related pitfalls and introduces a several techniques for increasing quality by reducing complexity.

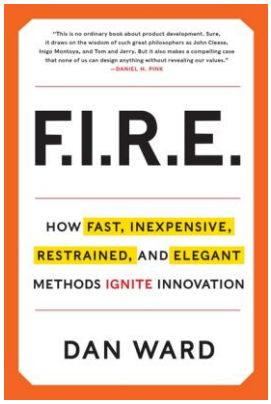
First introduced in 2006, the Simplicity Cycle is a visual tool designed to help people recognize, grasp, and discuss issues related to complexity and simplicity in a wide range of situations, to include defense technology development projects. A number of military acquisition programs have used it to facilitate effective simplification efforts, both technical and organizational. Seminars and workshops on this topic are available through Dan Ward Consulting LLC.

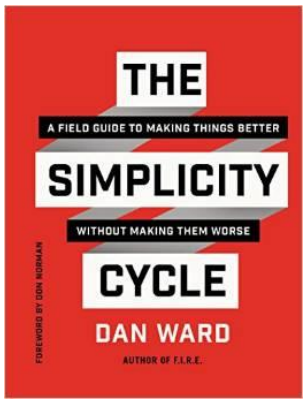
ABOUT DAN WARD CONSULTING, LLC

DWC was launched in 2015 to help corporate and government organizations reduce the cost, time, and complexity associated with delivering innovative new products and services.

Dan Ward is a retired USAF lieutenant colonel who holds three engineering degrees and multiple military certifications. He is the author of two books published by HarperBusiness *FIRE: How Fast, Inexpensive, Restrained and Elegant Methods Ignite Innovation* and *The Simplicity Cycle: A Field Guide To Making Things Better Without Making Them Worse*. Dan is a Cybersecurity Fellow with the New America Foundation as well a Senior Associate Fellow with the British Institute for Statecraft.

For additional information, visit TheDanWard.com.





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