Report
HIGHLIGHTS
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The Role of Experimentation Campaigns in the Air Force Innovation Life Cycle

The U.S. Air Force (USAF) has always sought to improve its speed, effectiveness, and innovation in order to accomplish its missions in air, space, and cyberspace. Historically, the USAF's technology leadership has been inextricably intertwined with "experimentation campaigns," sets of related experiments intended to prove or disprove the validity of promising innovations. Such efforts led to the Bell X-1 aircraft that first broke the sound barrier; the X-15 rocket plane that led the way to space; and the stealth experimentation campaign that produced the F-117 Nighthawk Stealth Fighter and the B-2 Spirit Bomber. Notwithstanding this longstanding success, support for experimentation campaigns within the USAF has waned. At the request of the USAF, the Air Force Studies Board (AFSB) of the National Academies of Sciences, Engineering, and Medicine studied the current state of experimentation within the USAF in order to recommend ways to support experimentation throughout the innovation life cycle. The report finds that the culture, flexibility, leadership, and resources required for experimentation-driven innovation are not in place in the USAF. In the future, the USAF should take action to encourage a culture of experimentation and risk taking and make sure innovation is supported at all levels of leadership.

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EXPERIMENTATION CAMPAIGNS AND FEAR OF FAILURE

Finding: Well-designed and executed experimentation campaigns are critically important drivers of innovation. Experimentation plays the largest role in innovation and is arguably the single most basic innovation driver. Within today's USAF, the scope of experimentation needed to address an increasingly demanding set of missions with increasingly tight resources is lacking.

Finding: When it comes to experimentation, a fear of failure is crippling the Air Force today. Experimentation campaigns can be principal drivers of innovation, but as part of the process they need to be allowed the room to fail. The study

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committee interviewed Air Force speakers and panelists who attested to a culture of standardization and compliance at odds with innovation and experimentation. In particular, one of the greatest barriers to successful experimentation campaigns and innovation in the USAF is a lack of appreciation for productive failures. The current Air Force work environment is so risk-averse that it discourages the risk of failure even when there is an opportunity to learn from it. This is partly because the USAF fails to distinguish between two very different types of failures: minor failures in well-designed experiments that are inevitable and necessary in the discovery process, and harmful failures due to poor planning that threaten the organization's ability to fulfill its mission. In innovative organizations, failure is appreciated as an expected hurdle to be quickly evaluated and fixed before proceeding. A disappointing result from a well-designed experiment is not viewed as a failure – it is viewed as progress because knowledge is gained even though the result did not meet the expectation.

Finding: There is too little space for experimentation-driven innovation in today's Air Force. A few organizations such as the Rapid Capabilities Office (RCO) and Combined Air Operation Center – Experimental (CAOC-X) have created successful innovative environments, but these isolated pockets are insufficient to meet the mission needs of the AF as near peers become increasingly competitive.

Finding: The culture in today's Air Force is not one supportive of widespread experimentation, especially those leading toward disruptive innovations. In highly innovative organizations, innovation is a by-product of a reward structure and work environment in which innovations and innovators are valued as precious resources - leaders and organizational systems are all aligned to encourage innovation through experimentation. Currently, Air Force leaders oversee an organization that makes experimentation and innovation difficult for many USAF personnel.

Recommendation: Senior leaders should establish a clearer set of messages and incentives encouraging a culture of experimentation and risk-taking. These messages would strongly encourage innovation and cultivate innovators by providing appropriate rewards, recognizing the advantages of an innovation culture, and making deliberate and strategic efforts to leverage all influence channels to foster a culture that embraces innovation, experimentation, and risk-taking.

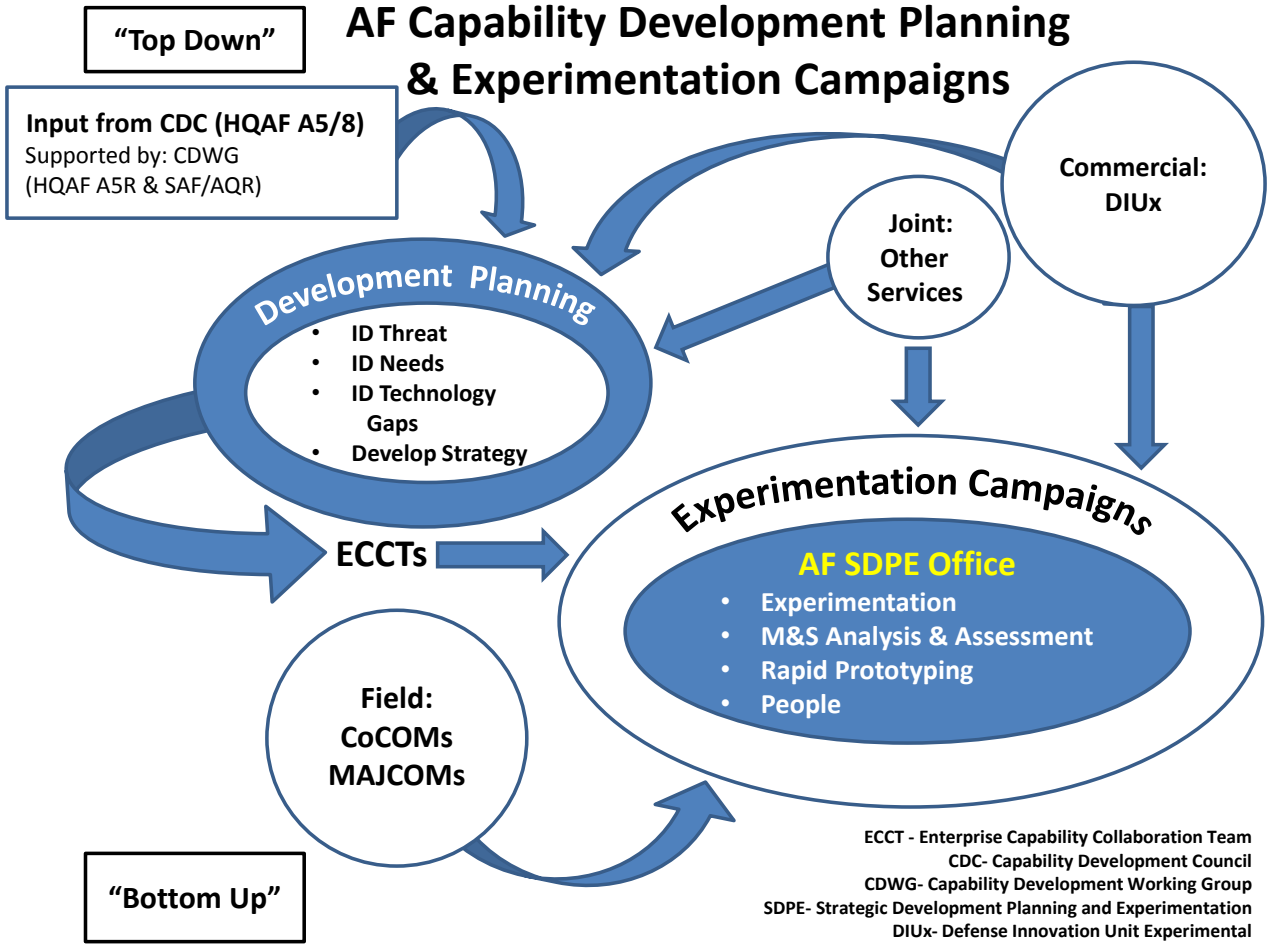
THE INNOVATION CATALYST

Finding: Dedicated leadership in the form of "Innovation Catalysts" is the essential foundation on which innovation through experimentation must be built, a foundation largely missing in today's Air Force. In highly innovative organizations, there is a single named individual who is responsible for working with other senior leaders to maintain the strategic technical vision and for leading campaigns of experimentation and innovation to fulfill those visions. The report refers to these individuals as "Innovation Catalysts". While the USAF has these individuals in a small number of isolated pockets, the organization primarily relies on innovation led by committee-based processes. These processes are not as effective at producing the disruptive innovations critical to long-term strategic success as experimentation efforts led by focused and empowered leaders.

Recommendation: The Air Force should determine where it most critically needs innovation, and establish Innovation Catalysts to help drive experimentation and innovation in those areas. This is the report's top recommendation. Innovation Catalysts would champion innovation and experimentation in the USAF and act as the primary mechanism for driving experimentation campaigns and technology advances. A well-placed Innovation Catalyst would be unambiguously in charge of guiding innovation through experimentation, have the authority to set priorities, discretionary control over an innovation fund, and a direct connection to top leadership.

Recommendation: Wherever they are established, Innovation Catalysts should be directly linked to their senior leadership. An Innovation Catalyst can make important contributions at various levels of an organization. All the larger highly innovative organizations studied for this report had a very senior leader working as an Innovation Catalyst at the highest levels, usually with a title such as Chief Technology Officer (CTO), but always as a key member of the organization's "C-suite." These organizations also mirrored the corporate level CTO with similar positions at different levels and scales in a fractal-like pattern, across the organization. Given the size and complexity of the USAF, it is reasonable to expect the position of Innovation Catalyst to be replicated at several key locations. The success of existing isolated pockets of innovation in the USAF is strong evidence that Innovation Catalysts can be effective at a variety of levels and locations across the organization. Regardless of where they are located, all the individuals working as Innovation Catalysts should be engaged in development planning and the related experimentation campaigns spinning off from the developmental plan.

Recommendation: Air Force leadership should move proactively to create organizational space for experimentation-driven innovation. One of the primary responsibilities of an Innovation Catalyst is to identify, manage, and protect strategically important initiatives leading to disruptive innovations. Balancing sustaining versus disruptive innovations is a critical part of the Innovation Catalyst's job. In the USAF, the pendulum appears to have swung far in the direction of normal production over disruptive innovation. Therefore,



This figure illustrates the connection between experimentation campaigns and development planning in the USAF and shows the relationships among the new organizations established by the Charter for Air Force Capability Development in HQ USAF, SAF/AQ and AFMC, and the "bottom up" operational community.

most Innovation Catalysts will likely be needed to help shore up the level of disruptive innovation. In order to accomplish this, the Innovation Catalysts must have the authority to set priorities and control over a significant innovation fund; lest they become "toothless tigers".

Finding: The tools and processes essential to Air Force success with innovation through experimentation are not in place. Except in a few notable areas, current USAF tools and processes for experimentation and prototyping are ineffective at producing rapid innovation on the scale needed by the USAF.

Recommendation: The Innovation Catalyst should establish a portfolio of proven management tools and disciplined approaches for experimentation based on established best practices. The report identifies several of the best practices of highly innovative organizations most salient to the Air Force. The tools and processes most relevant for the USAF include:

- Sandboxes – Protected space in which it is safe to experiment (The new Strategic Development Planning Experimentation is an example.)
- Classic experimentation tools – Including scenario planning, hypothesis testing, analysis, modeling, simulations, prototyping, and gaming
- Makerspaces – Do It Yourself space for discovery by hands-on building
- Partnerships – Especially those involving end-users and highly innovative contractors

Finding: Metrics need to be carefully tailored to specific situations or they can do tremendous harm. Within the highly innovative organizations studied for this report, there was not a single set of metrics that was widely used across the board. Instead, these organizations carefully select metrics that fit their particular circumstances. The power of metrics is widely recognized, but metrics need to be carefully tai-

lored to specific situations or they can lead to unintended consequences and do tremendous harm.

Recommendation: The Air Force should carefully and cautiously consider metrics, as bad metrics could quickly derail any effort to stimulate greater experimentation and innovation. Metrics need to be established wherever an Innovation Catalyst is established; they need to reflect the particular strategies and organizational circumstances facing that particular Innovation Catalyst; and every metric should take into account the potential for unintended consequences if it is taken to its extreme.

There are a broad range of factors that come together to form a culture that discourages risk-taking, experimentation, and innovation within the USAF. Therefore, there is no one quick fix solution for implementing a robust experimentation program within the USAF. Addressing this issue will require a multi-pronged approach of appointing Innovation Catalysts closely linked to senior leadership, creating more space for experimentation, using a proven portfolio of tools, carefully choosing metrics, and providing clear messaging and incentives.

THE WAY FORWARD

Given the varied, complex, and growing USAF mission, the need for experimentation, experimentation campaigns, and innovation within the Air Force has never been greater. As a historic global leader in military technology innovation, the USAF has proven it can successfully manage experimentation campaigns. However, while best practices are currently used successfully in isolated pockets in the USAF, these innovative pockets lack the scale and scope necessary to spur advances across the USAF. Without overcoming the obstacles constraining innovation, the USAF will find itself less and less relevant. Promoting innovation across the entire USAF will require proper leadership focus, organization, resources, and a supportive culture. While the focus of USAF leadership must meet the needs of today, it is also important to build future capabilities.

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