Gen. John M. Murray, commanding general of the U.S. Army Futures Command, gives remarks 7 December 2018 during the Army Capabilities Integration Center's (ARCIC) transition of authority ceremony held on Joint Base Langley-Eustis in Virginia. This ceremony recognized the transition of authority over ARCIC from the Training and Doctrine Command to the U.S. Army Futures Command. (Photo by Angel Clemons)

Proposed Army Futures Command Process Tenets

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This article recommends specific tenets for use in the U.S. Army Futures Command (AFC) development process. In order to fundamentally change the future force modernization process, both scientific research projects and technology development projects must be "codeveloped" by operational experts and technical experts. Additionally, these projects must be codependent with the Army's concept development, requirements determination, and capabilities integration functions.

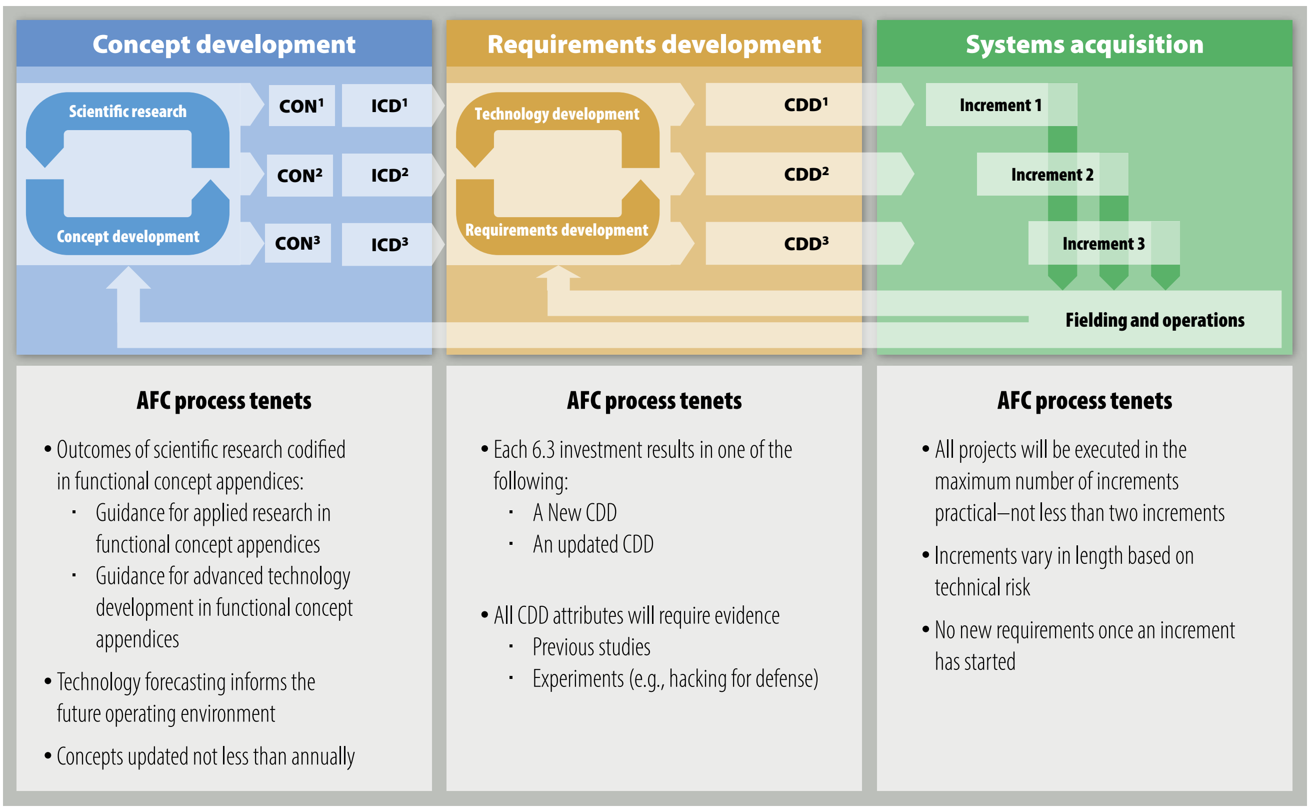
It can no longer be sufficient for Army scientific research investments or technology development investments to be guided and governed separately from capabilities development. Likewise, capability developers can no longer develop the Army's architecture while isolated from the knowledge generated by scientific research and technology development. The goal of AFC's processes should not be to *improve* "technology transition"; rather, the goal should be to *integrate* the Army's *processes* for discovery and innovation into a collaborative, iterative, and comprehensive Future Force Modernization Enterprise.

The AFC development process should be comprised of three major activities:

- Concepts development
- Requirements development
- Systems acquisition

The proposed tenets of this process are grounded in proven industry best practices, which will ensure that scientific research and technology development efforts are nested within the Army's architecture and are focused on value (see figure 1).

The overarching principle tying these tenets together is the ability to "consume innovation." Innovation is disruptive and disruptions destroy the delicate balance required to manage an Army Program of Record (PoR). To truly break the paradigms limiting Army acquisition processes, innovation must be more than just allowed, tolerated, or incorporated. It must be sufficiently necessary for the survival of the new system that innovation must be sought out and *consumed*. The current Army acquisition system embodies principles that were right for their time, namely the Total Quality Management (TQM) principles circa 1987.[1] The Achilles's heel of the Army's implementation of TQM is that the process ignores the speed of global technological change. TQM is about getting the *product right* before metal is bent so that defects in manufacturing processes never emerge. These principles are time tested and work



AFC—U.S. Army Futures Command
CON—Concept
ICD—Initial capabilities document
CDD—Capabilities development document
6.3—Research, development, test and evaluation (RDTE) budget activity 3 funding (advanced technology development)

(Figure by author)

Figure 1. Proposed U.S. Army Futures Command Modernization Process

well today in U.S. industries that design and build products for soldiers. But the Army does not design and build products for soldiers. The Army determines the capabilities soldiers will need and relies on U.S. industries to build the eventual end products for soldiers. For this reason, the Army requires a process focused on the activity of getting the right *product* as opposed to the activity of getting the product *right*.

Getting the right product begins with understanding that scientific research is a fundamentally different activity than technology development. Because the Army's processes do not distinguish scientific research from technology development, the Army cannot consume innovations produced by either. Scientific research discovers the existing laws of the known world. Technology development applies the laws of science to produce designs for end products. These disciplines are not sufficient in and of themselves to create value for the warfighter; they require collaboration with the warfighter to get the right product.

An improved AFC process will accomplish three objectives:

1. properly nest scientific research with concept development,
2. establish an evidence-based process to nest technology development with requirements development, and
3. require a modern agile acquisition process of multiple development increments that will allow for the consumption of innovation.

Concept Development and Scientific Research

Army concepts today describe the capabilities the Army expects to have six to eighteen years in the future.[2] Similarly, discoveries from scientific research will take six to eighteen years or more to result in Army capabilities. The current Army process for concept development does not consume any knowledge from scientific research; instead, the process waits until there is a product ready for a technology demonstration.[3] Failing to inform concept developers of advances in modern science limits these developers to forecast future capabilities based on what they observe today and imagine for tomorrow. Similarly, scientific research conducted without the regular engagement of concept developers yields scientific discoveries that are not nested in the Army's desired future capabilities. In order to outpace ever-changing technologies and advancing threats, the Army must be able to consume scientific knowledge as it is discovered. Scientists and concept developers must continually engage to discover breakthrough science that is relevant to the Army.

To achieve a fundamental change in the Army's concept development processes for realizing future capabilities, AFC should implement the following tenets:

Outcomes of scientific research codified in Functional Concepts. The current structure of the Army Functional Concepts directs an Appendix C: "Science and Technology." Currently, these appendices list capabilities the concept authors desire for the science and technology enterprise to provide. A better use of these appendices is to provide separate guidance for the Applied Research and Advanced Technology Development efforts necessary to realize the Functional Concept.[4] Each entry in an Appendix C must contain three elements: a specific description of the scientific investigation/technology development required; a specific statement of supported operational effect; and a reference to the publication/technical paper establishing the validity of the potential scientific/technological breakthrough.

- *Guidance for Applied Research in Functional Concept Appendix C.* Applied Research is a "systematic study to understand the means to meet a recognized and specific need."[5] An example of how such guidance for Applied Research

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would appear in the Movement and Mobility Functional Concept would be: science for two-dimensional thermal photovoltaic materials for increased power density in order to significantly extend the flight time of unmanned aerial vehicles.[6]

- *Guidance for Advanced Technology Development in Functional Concept Appendix C.* Advanced Technology Development "includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment."[7] An example of how such guidance would appear in the Fires Functional Concept would be: technologies based solely on the polarization state of light in order to compensate for the physical and operational environmental effects on fires.[8]

Technology forecasting informs the future operating environment. Conducting scientific research requires each scientist to have knowledge of the breadth and depth of a given scientific field. That knowledge is useful not only for scientific investigations but also for forecasting the technologies that can be developed based on known science. Army scientists should provide an annual technological forecast to support a continually updated future operating environment (FOE). This technology forecast, when coupled with the FOE, will provide leaders with better information to prioritize investments for the future force.

Functional Concepts updated not less than annually. Threats change rapidly and science advances continually. While it is impractical to conduct a full update of each Functional Concept annually, it is possible for the Army to consume knowledge gained from scientific research into the Appendix C of each concept on an annual basis. Transitioning this knowledge annually will allow all activities in the capabilities and requirements development processes to make decisions based on cutting-edge science.

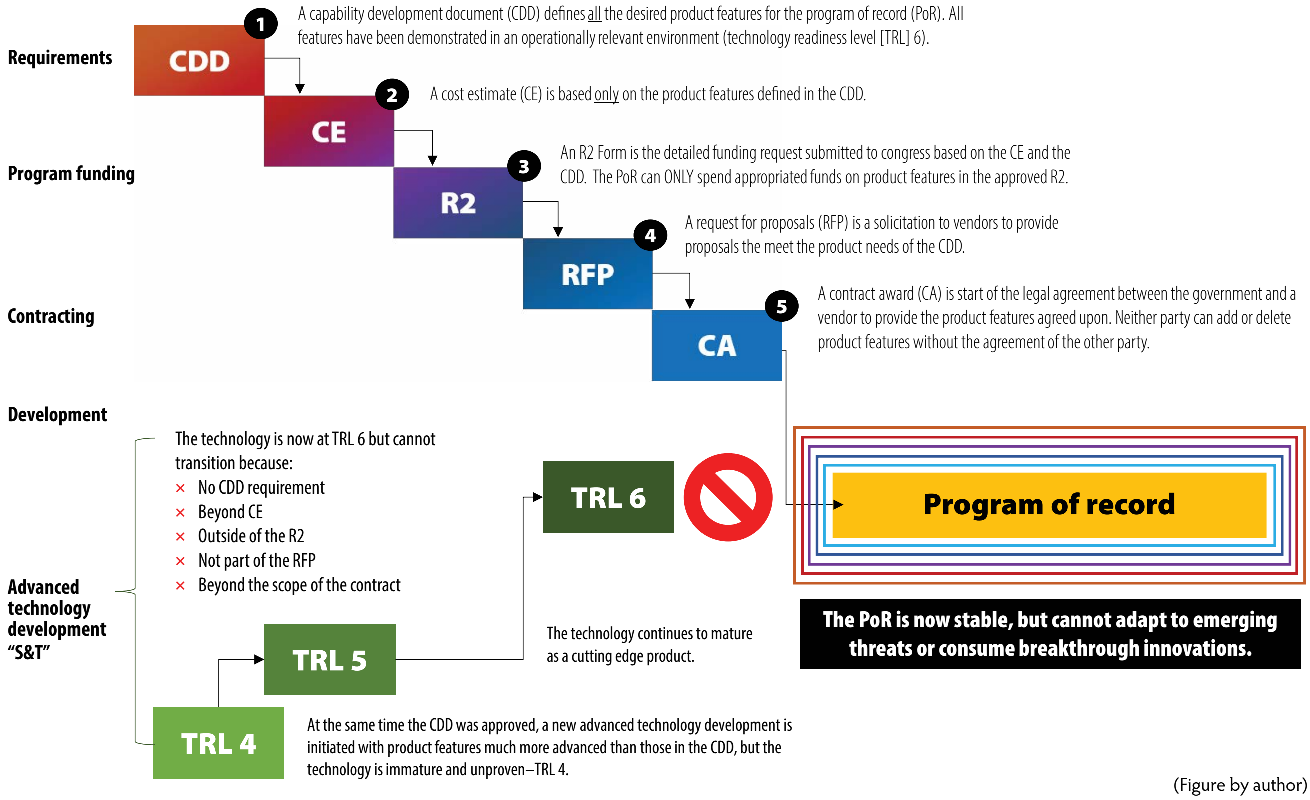
Consistent and iterative engagement between the concept developers and the scientific community will result in Functional Concepts that get the right product. Incorporating knowledge gained from scientific research into Functional Concepts and specifying pathways for technology development will enable the Army to show how its investments are leading to future capabilities.

Technology Development and Requirements Development

The Army's technology development processes take place in the Defense Acquisition System between Technology Maturation and Risk Reduction, and Low Rate Initial Production.[9] These processes have two consistent flaws: the initial development efforts ("6.3" funding) focus on producing a prototype that no one can consume, and the final development efforts ("6.5" funding) are commonly based on desired product attributes that were defined absent any evidentiary basis (i.e., there is no proof the Army actually needs the product feature being developed).[10]

These flaws flow from the root cause of a tunnel vision focus to accelerate a product through Technology Readiness Levels quickly and get the product right instead of a *fail fast* mentality focused to get the right product (see figure 2, page 5).[11]

- **6.3 investments result in requirements.** The Army's current doctrine is to invest its science and technology dollars in order to produce a prototype for transition to a project manager (PM). This nonsensical notion is often reflected in the statement, "We do some 6.1, then, 6.2, 6.3, and 6.4 then send a prototype over the wall to a PM."[12] The new AFC process must recognize why this paradoxical notion consistently fails and then, put an end to it for good. Recognizing the problem begins with understanding that the actual hardware (prototype) produced by a 6.3-funded effort has no value to a PM.
- **Every PoR exists to align the funding, requirements and development of an end product.** The funds that a PM manages were appropriated with very specific and narrow language that only allow those funds to be spent on attributes detailed in a capability development document (CDD). Further, attributes a PoR is developing/procuring today were technically mature (i.e., Technology Readiness Level 6) several years ago when the CDD was approved. The idea of technology transition of 6.3-funded prototypes to a PM is therefore nonsensical for either of two reasons: (a) if the prototype is a solution to a CDD attribute then, the 6.3 funds have been spent on a technology that was mature several years ago (e.g., "investing in the past"); or (b) if the prototype is not a solution to a



(Figure by author)

Figure 2. The Waterfall Method of Technology Transition Failure

CDD attribute, the PM is legally prohibited from allocating appropriated funds to receive it.

The solution to this dilemma is for 6.3-funded projects to produce knowledge (technical data) that can be consumed by requirements developers as opposed to PMs. Initiating or updating a CDD is the demand signal for Army resource programmers to update budget requests. So, no matter the value of the knowledge gained in a 6.3 project, if it does not result in an updated CDD, it will be virtually impossible for a PM to every have the resources or authority to further develop the product. If every 6.3-funded project must initiate a new requirements document or update an existing requirements document, then requirements development resources must be assigned to each 6.3 investment at its inception.

All requirements document attributes require evidence. Army CDDs define the features of a desired end product in lists of Key Performance Parameters, Key System Attributes, and Additional Performance Attributes. Currently, there are no footnotes, endnotes, or external references of any kind required for these features to be defined in a requirements documents. Any given product feature listed in a CDD may very well be based on extensive research and logical analysis. Unfortunately, it is equally true that any given product attribute in a CDD may also be based on a negotiation with a persistent action officer who would not allow the CDD to be staffed for approval without the inclusion of an attribute the action officer insisted was necessary. The lack of evidentiary reference in CDDs leaves no clue as to the validity or origin of a product attribute. There are two significant impacts to the lack of evidence in the process:

1. the Army budgets for, buys, and pays to maintain product features that soldiers never use; and
2. staffing CDDs takes far too long because every stakeholder can rightly claim that their desired product feature is as valid and necessary as all the other nonevidence based desired product features.

In the past, the U.S. companies determined product features the same way the Army does today. "Industry experts" would determine what customers/soldiers needed. This process is known as the

"BOGAT" (or "bunch of guys/gals around a table") method. U.S. companies in all industry sectors recognized the consistent failure in this method several decades ago but the Army still relies on it. U.S. companies use in-person surveys, blind sample tests, focus groups, and a myriad of other coordinated experiments to test hypotheses about product functionality. These experiments allow U.S. companies to get the right product and not waste money designing and building features customers do not use. The Army must first modernize to an evidence-based requirements process if it is to modernize the future force.

There is an extensive body of knowledge codifying early hypothesis testing as an imperative for innovation and agile product development.[13] This knowledge has been distilled into a specific doctrine the Army should implement called hacking for defense (H4D).[14] The essence of H4D is to test hypotheses about the need for individual features of a product *before* the initial design is begun and then also throughout the continual development process. Successful U.S. companies realized decades ago that no small group of user representatives could accurately predict and advocate for what the customer requires. However, the Army's current user representatives can have great value in an H4D-based doctrine as they are ideally suited to learn to apply hypothesis testing methods to continually gather evidence and update requirements. Changing the Army's processes so that 6.3 resources are spent engaging large samples of users to get the right product will be far more effective than continuing to spend those resources on a process that structurally prohibits technology transition.

Systems Acquisition

Systems acquisition in the context of this article refers to acquisition projects that have an approved Milestone B decision and are thus PoRs. This is the phase of development where the emphasis shifts to getting the product right. A myriad of acquisition statutes and regulations exist to mitigate technical risk, but they do so by constantly extending the development timeline in a single-minded focus to get the product right. This approach relies upon one faulty assumption and ignores one catastrophic risk.

The faulty assumption is that the requirement is completely "right." Even the most precise and expansive evidence-based requirements determination effort will only ever be a series of estimates based on relatively small samples. The Army cannot know if it has the right product until the first products are fielded and employed by soldiers. For these reasons, the Army must employ the agile development methodologies that implement pre-planned product improvements (P^3I) based on user feedback of fielded systems.

The catastrophic risk ignored by a process focused solely on design stability (i.e., getting the product right) is the risk of obsolescence. Technical obsolescence is realized when product development timelines are so long that the subordinate technologies in the design are displaced by newer technologies. Operational obsolescence is realized when a product development timeline is so long that threat capabilities change so as to make the end product of no value before it is ever even fielded. The risk to design stability varies inversely proportionally to the risk of obsolescence. Decision makers must balance the time required to decrease design stability against the increased risk of obsolesce that grows with development time. Adopting the following two tenets will help consistently achieve the necessary balance:

1. All projects will be executed in no less than two increments. A multiple increment approach allows for development based on stable requirements while simultaneously allowing for the consumption of innovation. Fielding technologies before all attributes of the requirements document are developed also allows for updated requirements based feedback from soldiers. Every major weapons system in the Army ends up undergoing an incremental approach (e.g., the M1A2V3 SEP, the M109A7, the AH-64 Block III, etc.). Planning for these updates in advance will allow the Army to regain and maintain overmatch on the battlefield of tomorrow.

2. No new requirements once an increment is started. An increase in product requirements ("scope creep") is directly related to project failure.[15] Often, project failure is preceded by the addition of new requirements to an existing development effort. This reality presents a paradox for Army Future Force Modernization efforts: consuming innovation means transitioning knowledge into new requirements, *but* changing requirements in existing programs significantly increases the risk of program failure. For this reason, the "no less than two increments" tenet and the "no new requirements" tenet are symbiotic.

In summary, realizing advances on the battlefield requires comprehensive, coordinated changes in the entire acquisition system. Doing away with the failing, stovepiped requirements development process and materiel development process is the key first step to catch up to successful industry innovation methods. Recognizing that scientific research produces *knowledge* that should be consumed by concepts developers is a critical element to modernization. Likewise, recognizing that technology development produces *knowledge* (not prototypes), which should be consumed by requirements developers, is also critical to modernization. Lastly, changing PoRs to be ready to consume innovation yet balance technical risk is the final necessary element to improve modernization. None of these changes require statutory changes for implementation, but all of them require culture change within our Army. The AFC embracing the culture of change and implementing these proposed tenets now will jumpstart the changes our Army desperately needs. ■

Notes

1. Field Manual 5-1, *Total Army Quality Management* (Washington, DC: Government Printing Office, 1987 [obsolete]).
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5. Ibid.
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11. Assistant Secretary of Defense for Research and Engineering, *Technology Readiness Assessment Guidance* (Washington, DC: DOD, April 2011), 2-13–2-14, accessed 8 January 2019, https://www.dau.mil/cop/pm/_layouts/15/WopiFrame.aspx?sourcedoc=/cop/pm/DAU%20Sponsored%20Documents/TRA%20Guide%20OSD%20May%202011.pdf.
12. The Army used Research, Development, Test and Evaluation (RDTE) resources to develop products. RDTE is confusing as it is both a Major Force Program and an Appropriation Type. The "6" in "6.3" is the Major Force Program. The "3" in "6.3" is the Appropriation Type Budget Activity. Of the eleven Major Force Programs, #6 is "RDTE." There are seven RDTE Appropriation Type Budget Activities and #3 is Advanced Technology Development.
13. Eric Ries, *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* (New York: Crown, 2011).
14. Thomas "Bull" Holland, "How the Army Ought to Write Requirements," *Military Review* 97, no. 6 (November-December 2017): 104, accessed 19 November 2018, https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/November-December-2017/How-the-Army-Ought-to-Write-Requirements/.
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US ISSN 0026-4148