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Future of Product Development in the FA&D Sector - Now!

Brent Baker

Alexander Daly

WHITE PAPER

The Dream of the End State

It can be unrealistic and even dangerous to dream about the future, but then again you can't afford not to either. That about sums it up in all walks of life: family, business, education, politics, conflict, etc. What was the dream of the Internet itself when its promises were far on the horizon 25 years ago? Back then the 'Information Superhighway' promised to dramatically change our lives in fundamental ways with monochrome PCs connected through telephone networks. A generation later, despite the many drawbacks, was the dream worth it? Most would argue that the upside of newfound capabilities has more than offset the downside: instantaneous personal and business communication as well as the ability to trade stocks, shop, share ideas, telecommute, pay bills, and even watch newly released films - all from home. Was it dangerous to be the early adopter and herald in these fundamental changes years ago? Yes, but the reward was well worth the risk.

We are at another crossroads. On the horizon today there is an evolving 'dream' about the impact the Internet of Things (IoT), Artificial Intelligence (AI) and other emerging tech will have on our daily lives in future years; and as a subset – how technology platforms could be used inside the DoD and the defense industrial contractor base. Given the risks involved on this front, the difference between reasonable planning and engaging in utopian fantasy is razor thin. Take any high-profile aircraft program as an example. Given the projected maintenance costs over the lifecycle, is it unrealistic to imagine the beneficial impact on availability and cost of the following types of use cases?

- **Diagnostics and Remediation** - A landing gear could diagnose its own problem and order a replacement part, or at least alert ground crews of an impending breakdown before it happens.

- **Knowledge Management** - Tribal knowledge type insights and gained expertise unique to the maintainer of one aircraft could be verified with empirical data, and then shared through Augmented Reality (AR) with

other maintainers across the fleet.

• **Use of Legacy Data** - Historical flight data coming from sensors could be automatically analyzed to create the basis of new mission profiles.

• **Spares Optimization** - A set of optimal sparing scenarios could be created given unique parameters for aircraft availability for specific mission profiles or combat deployments.

• **AR for Maintenance** - Using a tablet or wearable device (such as an AR headset) maintainers could determine where the malfunctioning part is, 'see' it in context, then be guided step by step through its repair procedure.

All excellent ideas, but the interactions between the DoD and the defense industry OEMs have been somewhat like a junior high school dance; lots of interest on both sides, but neither making the first move. On one side is the DoD, still recovering from the readiness impact of sequestration years ago yet eager to use the recent uptick in spending to counter near peer threats in hypersonics, cyber, and AI. And on the other, industry is trying to be as proactive as possible in bringing new capability concepts to the DoD but still needs enough guidance to de-risk R&D expenditures, which directly impacts M&A posture.

In the meantime, clearer demand signals are often coming from non-government customers, where cost of sale is lower and acquisition timeframes faster. Thus, FA&D (Federal Aerospace & Defense) is underserved for many emerging technologies relative to other sectors of the economy. This is ironic as it was the Pentagon that gave the world technological marvels like GPS and 'electronic mail' decades ago. But both sides are highly interested and will make a move - more likely with toe-in-the-water steps rather than through one galvanizing, catalytic event. That said, there are green chutes emerging that will spur adoption.

Near-Term Horizon Product Development Trends

So many people are justifiably reluctant by the prospect of emerging technologies in the DoD that they are only speaking about them in the abstract. But to adopt faster than near-peer competitors, we must have the collective courage to speak about them in the specific. Below are a few

specific trends:

Real Time CAD Simulation - One emerging trend is the concept of real-time simulation inside CAD systems. Up until very recently, most of the structural, thermal, modal analysis for new products happened only after porting CAD data into a simulation system, then back again post analysis; an error prone and clumsy process. Those days are ebbing away now, with simulation that is happening inside CAD itself. This sounds like a minor technical distinction, but it will have significant impact on quickening product development by narrowing the feedback loop. It will also mean a migration away from physical prototyping to purely digital simulation. There has been much talk of the so-called 'CAD Renaissance' of late and real time sim inside CAD will clearly be an engine fueling that renaissance.

Digital Twins - Many players in the FA&D sector have been amplifying their portfolios with a capability that allows data flow between physical products and their digital equivalent (a 'digital twin'). The DoD is actively exploring the use of Digital Twin type capabilities from industry. This tightening of the feedback loop will help the DoD and defense industrial base reduce costs for design, manufacture and support as well as open up new landscapes for invention and growth. As a demonstration of the demand strength in this nascent area of enterprise software, Digital Twin software is currently a $1.8B market, expected to grow at a 35% CAGR between 2019 and 2024.[1]

AI for Design and PLM - Another concept on the near-term horizon is 'generative design', in which AI algorithms - not human beings - will be designing the products of tomorrow. A design engineer will determine design requirements and intent, and the AI will create multiple, optimized solutions based on those requirements. The AI has no human biases, which will mean a step function for innovation with designs that meet requirements in entirely new ways. This will ultimately drive the need for enhanced PLM capability through linkages to additive manufacturing (certified 3D parts libraries, blockchain for custodial chain). When generative design is eventually coupled with real time simulation and digital twins, the impact on product development will be immense, both for the defense industrial base and inside the DoD.

But design isn't the only arena of product development that will be using AI. Think about the implications for AI on PLM itself. It will mean a capability to comprehensively validate large PLM data sets in seconds or do natural language processing in searching though unstructured data. Another

capability could be to quickly assess risk within a PLM system and make proactive, remedial decisions.[2] Such smart PLM systems will have an awareness built-in that quickens product development times.

When we move to an era of 'explainable AI' from the black box systems of today, users will also be given a traceability tree to determine how those AI results were derived, further enhancing value. The DoD's budget for AI is skyrocketing. According to Bloomberg Government analysis, AI funding will be increasing from $1.4B FY 2019 to $4.0B in FY 2020.[3] In addition to exploring AI for predictive maintenance, network mapping, 'maneuvers and fires' and other warfighting and humanitarian capabilities, the DoD will likely be looking at applying AI to product design and PLM as well.

Migration from Documents to Models - Ever since the DoD issued a groundbreaking policy directive for Digital Engineering adoption in 2018, there has been a push among the services to migrate from a document-centric approach to product data to adopting a models-based approach. The idea is to view engineering as a continuum across the product lifecycle vs. merely existing in one early phase of it. This also applies figuratively to product support models, design models, and management models.[4] PLM is at the core of the Dept of Defense Digital Engineering Policy. In the last year since the policy was released, the Air Force and Navy have both made broad-sweeping moves toward enterprise-level PLM acquisitions, partly to meet the requirements laid out in the policy directive.

Augmented Reality - The DoD is starting to make decisive moves in adoption of Augmented Reality (AR) as well. In 11/2018, the Army awarded a $480M contract to Microsoft for up to 100,000 HoloLens headsets to be used for both personnel training and in live combat missions. Among the Army's stated goals for AR include night vision and thermal sensing, measurement of vital signs, concussion monitoring and hearing protection.[5] This will be the tip of the adoption iceberg as the Navy and Air Force will ultimately be making similar moves. In a program called 'Optical Dominance' the U.S. Special Operations Command (SOCOM) has also been considering combining AR with AI / machine learning and other technologies for rehearsal and targeting before missions as well as telemedicine.[6]

Using AR for Maintenance is another consideration. As of last count in 2016, there were 617,000 military and civilian maintainers in the DoD.[7] Many of these maintainers will be leaving the workforce soon. Could AR be a means capture

the expertise of maintainers to train the next generation? In 6/2018, the Air Force Research Laboratory (AFRL) issued an RFI for virtual, augmented and mixed (VAM) reality technologies specifically for aircraft maintenance.[8]

A forcing function on the industry side of AR adoption has to be Foreign Military Sales (FMS) of U.S. defense equipment to U.S. allies, primarily in Europe and the Middle East. Due to a policy change lowering the cost of these transactions[9], deals skyrocketed 33% to $55.6B between 2017 and 2018.[10] Most of those contracts require the U.S. firm to provide equipment maintenance as well as in-country offsets for economic development, including workforce training. In order to de-risk the delivery of these contracts, many of the U.S. firms must be considering technologies like AR to help quickly train their own maintainers or bring in-country maintainers up to speed.

Conclusion

Today's aerospace and defense leaders must work harder and faster than ever to meet the increasing demands of their missions, constituents and markets. Smart warriors adapt. The prospect of FA&D sector readiness improvements and efficiency gains from emerging technologies like Digital Twin and AR is quickly shifting from theory to legitimate use cases and acquisitions.

But the threat surface from these technologies is expanding so rapidly that it now includes what used to be safe ground under your feet. From the designer's desktop, to the factory floor, to operating environments on land, air, sea and space - the digital thread is being stretched across the entire product lifecycle. How shall we meet this challenge? There are no easy answers, but in general start fast and secure, fail small, then scale what is working. Induce tight feedback across multiple OODA loops. Your near peer competitors are doing the same. Can you afford to stand still?

Authors

Brent Baker, Sr., Maj Gen (Ret), USAF is Vice President, Federal Aerospace and Defense of PTC, Inc. General Baker was previously Vice Commander, Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio. The command employs some 80,000 people and manages $60 billion annually in research, development, test and evaluation, while providing the acquisition management services and logistics support required to develop, procure and sustain Air Force weapon systems. In his role at PTC, he is responsible for strategic planning and business development in the worldwide FA&D market vertical with a specific focus on gaining first-to-market competitive advantage in the adoption of technology and smart, connected enterprise solutions.

Alexander Daly is Director, Federal Aerospace and Defense of PTC, Inc. He leads PTC's Federal Aerospace and Defense efforts for DoD programs to government and industry customers. In this role, he creates strategies for improving processes around product design, manufacture and support through the application of software platforms from PTC. Mr. Daly also leads PTC's government relations efforts on Capitol Hill.

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PTC, Inc.

October 2019

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