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DETROIT ARSENAL DIGITAL ENGINEERING IMPLEMENTATION & WAY FORWARD

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ABSTRACT

This GVSETS paper outlines the strategy for integrating Digital Engineering (DE) practices into the Detroit Arsenal (DTA) acquisition, engineering, and sustainment communities. A DTA DE Community of Practice (CoP) is being led by Program Executive Office (PEO) Ground Combat Systems (GCS), PEO Combat Support & Combat Service Support (CS&CSS), Combat Capabilities Development Command (DEVCOM) Ground Vehicles Systems Center (GVSC), and Tank-Automotive & Armaments Command (TACOM). In addition, Program Management Offices (PMOs) will document their DE implementation plans as part of all planning documents per Assistant Secretary of the Army for Acquisition, Logistics & Technology (ASA[ALT]) guidance [1]. In this paper, each of the DTA organizations will address the following: Ongoing DE Related Efforts; Upcoming / Planned Efforts / Opportunities; Lessons Learned; and Challenges / Issues / Help Needed. Additionally, each DTA organization explains its current and future states along with its corresponding gap analysis which contains its respective near-, intermediate- and long-term DE goals.

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1. INTRODUCTION

Due to the common influences of the Department of Defense and the Department of the Army on Digital Engineering Strategy, DTA senior leaders encouraged a common strategy for the Ground Community on DE implementation. This resulted in the formation of a draft DTA DE Strategy and ultimately a DTA DE CoP, where all interested parties from across the DTA community can share lessons learned,

challenges, and shape common goals on DE implementation. A unified approach on DE across the ground community is a desired end state; however, gaps in existing tools and infrastructure have caused varying approaches to current state DE implementation across the ground community. A key focus on data sharing and open architecture with respect to all current and future state DE implementations is essential.

2. DEVCOM GVSC

In July 2021, DEVCOM GVSC stood-up a GVSC DE Integrated Product Team (IPT) with membership across 17 GVSC organizations/competencies. The IPT's mission is to transform GVSC business processes through people, processes and technology and the vision is for a common DEVCOM DE implementation supporting all Army Ground Systems. GVSC has been an active, collegial participant in US Army Futures Command (AFC), ASA(ALT), Office of Chief Systems Engineer (OCSE) and other DE working groups and forums. GVSC is fully collaborating with AFC HQ and other DEVCOM Centers to help shape the enterprise DE Strategy.

The GVSC DE IPT's goal is to transform GVSC's business processes towards an integrated DE approach. The IPT utilizes a bottoms-up approach, leveraging lessons learned from ongoing and planned DE-related projects across GVSC. Key projects include Virtual Prototyping and Virtual Experimentation, Simulation Data Management Digital Thread, Model-Based Definition, Model Based Trades, among others.

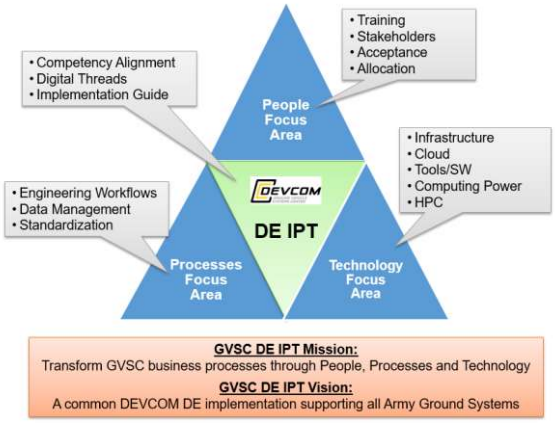

Figure 1 - GVSC DE IPT Mission, Vision, & Focus

2.1. Ongoing DE Related Efforts

The IPT developed an Engineering Tools Repository (ETR) that revealed ~243 tools used across GVSC. The GVSC DE IPT ETR is currently being migrated to DEVCOM Analysis Center's (DAC) tool repository. The DAC repository also includes tools from across other DEVCOM Centers. GVSC was requested to brief-out its ETR to the AFC DE CoP on December 16, 2021 since it was deemed a value-added work product to model related efforts at the AFC level as they capture enterprise statistics on tools and licensing information.

The DEVCOM GVSC DE IPT also conducted a DE Maturity Self-Assessment using the US Air Force DE Maturity Model as a baseline that was then refined to include the additional stringent requirement to identify rationale justifying maturity metric scoring. Once again, GVSC freely shared its [sanitized] DE Maturity Self-Assessment with AFC that included a presentation to the AFC DE Maturity Model Working Group on October 28, 2021, that is under consideration for utilization throughout AFC.

The IPT is presently defining key DE requirements to help shape its implementation approach and tailoring guidance for S&T projects. It's noteworthy to mention that the GVSC DE Lead and

GVSC DE Deputy provide a bimonthly status update to the GVSC Director and Executive Committee which illustrates that while the IPT is founded on a bottoms-up methodology, it simultaneously receives top-down guidance and support. Focus on how software ties into Digital Engineering is of key interest in the overall DE Vision at the leadership level. GVSC Software Engineering Center (SEC) is implementing a Software Factory framework that is based on a DevSecOps methodology that will allow GVSC to move faster without sacrificing quality.

GVSC is conducting a Digital Thread Tool Study with Intercax Syndeia that entails evaluating this software on a collaborative effort with DEVCOM Armaments Center (AC) in partnership with Strategic Technology Consulting (STC). Utilizing the STC test environment and tool stack, GVSC and AC are able to evaluate digital thread capabilities between SysML and CAD, utilizing MagicDraw/Cameo with a Teamwork Cloud and a Creo model with PTC Windchill. Integrating digital thread capabilities for MBSE into the Enterprise Product Data Management (ePDM) environment on cArmy is the grand vision as GVSC moves towards a unified DEVCOM MBSE/DE approach.

GVSC Web Enabled Services (WES) has been leading ePDM for GVSC which is a critical effort to consolidate instances of Windchill across DEVCOM Centers, to a single cloud hosted Windchill within the cArmy environment. The ePDM will be the backbone of a DEVCOM GVSC DE implementation. On the horizon is the challenge to integrate M&S tools into ePDM. On this front, PTC has strategically partnered with Ansys and is demonstrating a viable path forward for Modeling, Simulation, and Analysis (MS&A) integration into PTC Windchill via their tech stack. GVSC will continue to work with industry partners to identify how to fill this critical need for ePDM on MS&A integration within the ePDM environment.

2.2. Planned Efforts & Opportunities

GVSC's upcoming planned efforts include coordinating with AFC HQ on cloud migration for critical DE tools such as Windchill, MagicDraw/Cameo, DOORS, etc. The GVSC DE IPT is also working across DTA and DEVCOM to collect key requirements for a DEVCOM or Army wide Digital Engineering Ecosystem to help shape technology investments, scope pilot projects, and capture stakeholder needs across the Science & Technology (S&T) and Acquisition communities. An opportunity exists for GVSC to enhance its virtual prototyping and additive manufacturing processes utilizing DE capabilities. GVSC fully plans to partner with industry and academia to enhance its DE capabilities. Moreover, a GVSC DE objective is to drive culture change in PMs to embrace DE to support acquisition reform as GVSC strives to become more efficient within government program offices.

2.3. Lessons Learned

Along the way in the DEVCOM GVSC DE journey, there have been many lessons learned. Implementing digital thread software requires a unique skill set. Working with industry partners that have expertise in these tools is critical for success. It's imperative to use the right tool for the right job; not everything needs to go in a single model. It is prudent to remember that MBSE doesn't imply that we should put all data into a single tool. For example, there is still utility in using robust requirements management tools such as the Dynamic Object Oriented Requirements System (DOORS) and integrate data to the authoritative system

model as needed for analysis. To be sure, industry has a lot of DE and MBSE expertise that GVSC can learn from vice prescribing methods and processes for internal work.

2.4. Challenges and Gaps

When it comes to challenges, issues and/or help needed, not unexpectedly, DEVCOM GVSC has encountered some significant obstacles and anticipates more of the same as GVSC DE matures in the future. IT/G6 security and networking constraints will make tool integrations a challenge, but not impossible. Cloud management for MBSE tools such as Cameo and DOORS will require solutions for local admin controls over project spaces, while maintaining placement in the enterprise cloud. Modeling, Simulation, & Analysis (MS&A) tools must be integrated within the product lifecycle management (PLM) software to establish scalable Authoritative Source of Truth (ASoT) and digital thread capabilities. GVSC needs to better understand how to support PMs with DE as a unified capability which is something being addressed in the GVSC DE IPT. Another challenge is accessing common tools from multiple networks. Project teams are often distributed across NIPR, DREN, SIPR, etc. which means an added burden should users need to use two computers to do their job. While the need for security is understood, getting approval for new tools to put on a government network can take a very long time.

3. PEO GCS

PEO GCS has several program offices currently evaluating the guidance from DoD and ASA(ALT) on DE against their unique programmatic conditions. For new start programs, DE seems to be an easier fit as there is greater opportunity to implement DE aspects early in the lifecycle without a lot of rework. For enduring platforms on the back half of the lifecycle, implementation of DE can be more of a challenge in how to optimize the current state without reworking previous program deliverables.

3.1. Ongoing DE-Related Efforts

The largest DE-related effort in PEO GCS currently resides within the Optionally Manned Fighting Vehicle (OMFV) program office. OMFV is seeking to implement a digital acquisition approach to support modernization. Key tenets of the OMFV DE include heavy focus on MBSE, MS&A, PLM, Digital Thread, and Cloud technologies to create a fully integrated Digital Acquisition Environment (DAE). The DAE, hosted in the cArmy cloud, will be the ASoT for all programmatic data (see figure 2.

Another key tenet of the OMFV Digital Acquisition approach is the Modular Open Systems Approach (MOSA), enabled by the usage of the PEO GCS Common Infrastructure Architecture (GCIA). Utilizing GCIA and a DevSecOps approach will allow for rapid upgrades to the OMFV and mitigate vendor lock.

The GCIA is a key enabler of the MOSA strategy for not only OMFV, but for all ground systems. Future implementation of GCIA within other platforms will be a key objective of PEO GCS – Product Lead Capability Transition and Product Integration (CTPI).

Another program office implementing an internal DE capability is the Self-Propelled Howitzer System (SPHS) on their Extended Range Cannon Artillery (ERCA) program which is leveraging expertise from DEVCOM Armaments Center and DEVCOM GVSC to produce a SysML model of their architecture.

PdM Robotic Combat Vehicle (RCV) is implementing MBSE as well, utilizing a SysML model to guide their requirements and architecture refinement as OMFV has done.

3.2. Planned Efforts & Opportunities

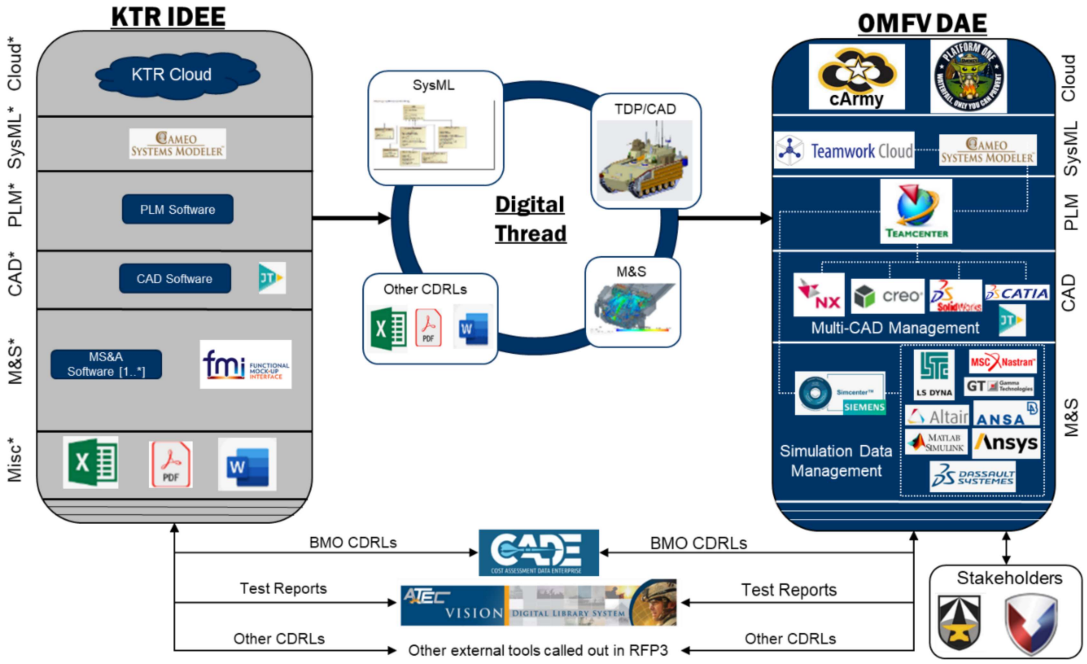

Figure 2 - OMFV DAE Tech Stack

Some key planned efforts for PEO GCS include the migration of the OMFV tech stack onto the cArmy cloud, implementation of GCIA to support MOSA for PEO GCS platforms, RCV Software Factory efforts, as well as modernizing the workforce to adopt DE best practices. Many opportunities exist to use DE to modernize the way programs manage large data sets, especially in the logistics and sustainment domain. Integration of data across various tools and environments will be a key enabler that has yet to be solved.

3.3. Lessons Learned

Some key lessons learned have taken place as programs begin to embrace DE. On the OMFV program, it was learned that DOORS is still a very useful tool to manage large sets of changing requirements. Initially, it was thought that MagicDraw/Cameo could be used as both a requirements management and requirements analysis & traceability tool. OMFV learned that keeping the requirements management aspect within DOORS, and syncing DOORS to MagicDraw via ReqIF or DataHub was a much more efficient way to utilize the workforce and tools.

Some overarching lessons learned from across the enterprise are that consensus on a common DE environment, set of tools, and processes is difficult. This is a result of a large range of DE maturity and appetite from program-to-program. Program lifecycle, complexity, and acquisition strategy all factor into the level of DE implementation that makes sense for each program.

3.4. Challenges & Gaps

Some key challenges include a variety of terminology and ontology used across government and industry for DE. Development of a common ontology for Army and DoD should enable consensus which may lead to better contracting language for DE related efforts on programs. A common set of minimum viable tools required to implement DE could be another enabler of a common PEO GCS DE approach. Finally, definition of digital thread in a contractor DE environment is not easily transferrable to a government DE

environment. If this was possible, it may reduce re-work if the government wishes to maintain a digital thread between models and data in the government's DE environment.

4. PEO CS&CSS

In January 2021, PEO CS&CSS began its Digital Engineering initiative. The early stages of this initiative included networking and collaborative discussion with other organizations to further develop an understanding of this subject matter. After connecting with DoD partners, the next logical step was to meet with Industry partners and get an understanding about their Digital Engineering capabilities. With this baseline, the focus shifted towards developing a profile about what our organization does today. As part of building the Digital Engineering portfolio, areas have been identified where DE could be leveraged to improve the way business is performed.

4.1. Ongoing DE-Related Efforts

In order to baseline what DE capabilities of PEO CS&CSS looks like; a Digital Engineering Assessment is being performed. As part of this process, a questionnaire was sent out to the Lead Engineers from each PM. This questionnaire covers a wide range of DE related topics, such as requirements, data management, tools and culture. With an understanding of priorities, strengths, weakness, and commonalities, defining a path forward will be possible. It is also expected that by performing this assessment, there will be a better understanding about current capabilities.

Another part of the PEO CS&CSS DE initiative is to raise awareness throughout the organization. To ensure DE is adopted, it is paramount to have buy-in from the workforce. To improve the understanding of DE throughout the organization, a Digital Engineering 101 presentation has been created. The DE 101 material provides as a high-level overview of key definitions and concepts that surround Digital Engineering. The goal of this presentation is to socialize this subject matter with members of the organization, so they are situationally aware as to where to look for valuable DE opportunities.

Serving as a compliment to the DE 101 material is a Big Data 101 presentation. Given the vast amounts of data – ranging from business data to program data – understanding the techniques to harness and analyze this data is important for the organization. This presentation covers topics such as defining big data, data analytics vs data science, and business intelligence.

PEO CS&CSS began an Enterprise Architecture initiative in March 2021. This effort was aimed to establish an infrastructure that is conducive to enabling DE. Specifically, the intent of this effort was to develop an understanding of the current state of tools / applications that are in use across the organization. Through a series of interviews and working meetings with the PM's and APEO's, an understanding was achieved. Data exchange and tool relationships were mapped out in Magic Draw and a portfolio of the tools / application in use was captured in Power BI. With this stronger grasp on the Enterprise Architecture, the PEO is better positioned to understand tool commonality, home grown products, data flows, and where the need exists for new applications. As a follow on, there is an ongoing effort to develop policy that establishes business rules for the procurement of new tools / applications.

Lastly, an effort is being made to improve the resource management reporting for PEO CS&CSS. In the past, this type of information was captured in Excel and visualized in PowerPoint. This static process

left little visibility into the data, required several manual steps to build the finished product, and was susceptible to data that was stale. By utilizing Tableau (a business intelligence tool) and leveraging a server that hosts Tableau, the resource management reporting is prepared in a more accurate and timely fashion.

4.2. Planned Efforts & Opportunities

After establishing a baseline per the Digital Engineering Assessment, an upcoming effort will be to address PM identified priorities. Specifically, identifying appropriate DE activities that make sense for the PEO and provide a return on invest is the focus going forward.

In effort to bring consistency across PEO CS&CSS, an additional upcoming effort is to develop DE language to be used in strategy document; areas of interest are requirements, advanced manufacturing, and modular open system approach.

4.3. Lessons Learned

During this initiative, it has become clear that Digital Engineering is broad and it can add value in a variety of areas. Overall, it is prevalent within the organization, but at various maturity levels. Digital activities are all around; the biggest take away thus far though has been that it is necessary to understand how to take digital activities and create an integrated environment, where data is linked. Ideally, as a change is made to an artifact, those updates should propagate through the entire system.

4.4. Challenges & Gaps

There have been challenges when it comes to the portfolio. Programs are either more mature on the lifecycle or are non-developmental. Consequently, aligning DE activities to programs can be challenge. Given that there might be restrictions to the technical drawings, there are challenges when it comes to implementing DE activities. Due to there not being as many developmental programs, the opportunity to implement DE during the initial state of the lifecycle is not common. In the near term, the plan is to build out the organizations Digital Engineering profile; understand what is common / unique across the organization. From there, the next step would be to go from digital to integrated; having data that is connected across the organization. Looking longer term, the next steps would be to have an environment that is intelligent and capable of artificial intelligence and machine learning.

5. REFERENCES

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