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USING PUBLIC COMPETITIONS TO HELP DESIGN MILITARY GROUND VEHICLES: LESSONS LEARNED FROM THE DARPA FANG PROGRAM

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ABSTRACT

In January 2013, the Defense Advanced Research Projects Agency (DARPA) embarked on a public design competition for a heavy, amphibious infantry fighting vehicle, using new design and simulation tools intended to revolutionize the product development process for future complex defense systems. A $1-million prize was awarded for the winning design, which was ultimately built, tested, and evaluated. This paper will provide an overview of the planning and execution of the FANG Mobility/Drivetrain Challenge, insight into lessons learned for future ground vehicle development, as well as for other programs and organizations that are considering using prize competitions.

INTRODUCTION

Beginning in 2009, the Defense Advanced Research Projects Agency (DARPA) embarked on Adaptive Vehicle Make (AVM), a portfolio of programs intended to enable a five-fold compression of development timelines for military vehicles and other complex systems. Based upon the idea that the classic systems engineering V model of development has collapsed under the weight of exponential growth in system complexity, and inspired by the integrated circuits industry's successful approach to maintaining Moore's Law timelines through VLSI (Very Large Scale Integration), the AVM portfolio included several key programs and performers:

- META (Vanderbilt University) – An open source, system design and simulation tool chain. The cornerstone of AVM, META was intended to raise the level of design abstraction, enable rapid exploration of design trade-space, and verify first-order performance characteristics across all relevant physics domains (see Figure 1).
- C2M2L (Ricardo) – Component, context and manufacturing model libraries for use within the META tool chain. The "Camel" component models were intended to provide a building-block approach to vehicle design, and an open-source catalog of off-the-shelf components and sub-systems.
- iFAB (Penn State University) – A virtual foundry capability, used both for the automated assessment of manufacturing feasibility and attributes of new designs, and their eventual physical fabrication.
- VehicleFORGE (Vanderbilt University) – An open-source web-based collaboration environment used to enable crowdsourcing of physical systems.
- FANG (Ricardo) – Fast, Adaptable, Next-Generation Ground Vehicle, an exercise of the AVM capabilities at scale and in the context of a relevant military system. [1]

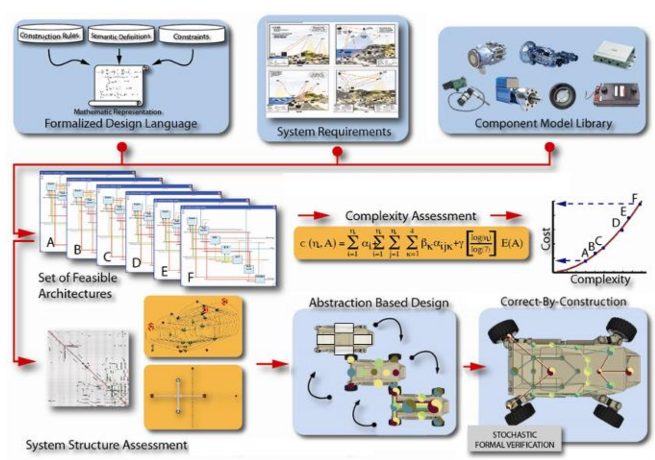

Figure 1: Notional META design flow [2]

Use of Prizes to Stimulate Innovation

While the five-fold compression of development timelines was the *raison d'etre* of AVM, there was a significant secondary element of maximizing innovation. This was predicated on the idea that the number of innovators applying their ideas to new complex defense systems could be increased from the current dozens to future thousands by reducing barriers to entry. The use of prizes to stimulate innovation has increased in recent years, enabled in particular by the ability of web-based social media technology to reach potential participants, although the approach has arguably been used for hundreds of years, including the British Government's 1714 Longitude Prize. [3] The Longitude Prize is also notable historical example of a prize-based challenge, using a large monetary award (£20,000) as a form of motivation.

DARPA has supported a number of prize-based challenges. Prior to AVM, these included the prize-based Grand Challenges and Urban Challenge for autonomous vehicles, as well as the Network/Red Balloon Challenge. Also supported by DARPA was the development and use of Foldit, an online game based on the challenge of protein folding, which uncovered the existence of outlier protein folding savants. AVM's experimentation with public feedback began with the XC2V Design Challenge, a prize challenge for the design of a tactical vehicle body (see Figure 2). While XC2V did not use AVM tools and processes, the successful use of a social network and public feedback to yield viable and innovative designs was seen as demonstrating the applicability of such techniques. [1]

Figure 2: XC2V was an initial effort to use public feedback within the AVM portfolio of programs [2]

FANG (Fast, Adaptable, Next-Generation Ground Vehicle)

While the VLSI revolution was effective in proving AVM's approaches for homogeneous systems like integrated circuits, the challenge remained for proving their use on more heterogeneous systems like military ground vehicles. In addition, these tools and processes needed exercising at scale, in the context of a relevant system, and as an integrated tool chain. These tasks fell to FANG. Specifically, FANG aimed to produce a new heavy, amphibious infantry fighting vehicle (IFV), mirroring the requirements of the Marine Corps' Amphibious Combat Vehicle (ACV).

The FANG Mobility/Drivetrain Challenge, the subject of this paper, offered a $1M prize for a single winning team. The focus of this competition was the use of AVM tools and processes for the integration of automotive systems necessary for the FANG IFV, including (see Figure 3):

- Powertrain
- Driveline
- Ground interface (suspension, wheels, tracks, etc.)
- Amphibious propulsion
- Powertrain cooling
- Hydraulics
- Controls
- Structural elements specific to mobility [4]

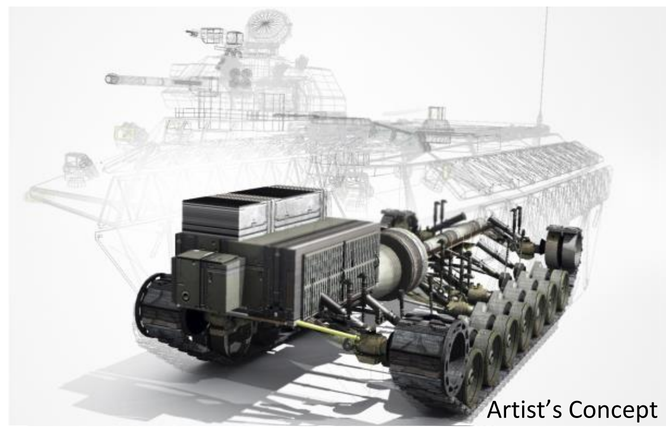

Figure 3: Rendering of the drivetrain and mobility systems that were the subject of the FANG Challenge [5]

The objective of this paper is to provide an overview of the planning and execution of the FANG Mobility/Drivetrain Challenge, and insight into lessons learned from the use of public competitions.

CHALLENGE STRUCTURE AND DEVELOPMENT

A diverse range of disciplines are required for the successful planning and execution of a large-scale prize challenge. As will be outlined in the following sections, this includes technical expertise in the products being developed and the software tools being used, people skills for the management and support of participants, media savvy for public relations and recruitment, and program management skills to integrate the efforts of a disparate range of performers. Figure 4 shows connections between a range of tasks and performers for FANG and AVM.

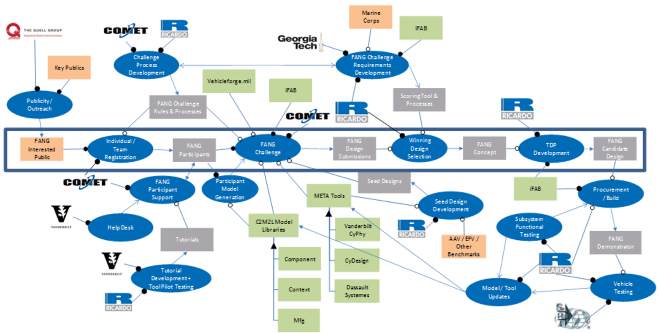

Figure 4: Schematic of FANG program inter-relationships using OPM (Object-Process Methodology)

As with any other systems engineering effort, there are many compromises and tradeoffs that must be made in order to prioritize the program objectives. The FANG Challenge was unusual and perhaps unique in that the exercise of tools and processes was first and foremost, while the utility of the end product was secondary. This is an overriding context and should be considered when judging the applicability of these approaches to future competitions.

Another overriding element of the approach for FANG that should be considered for context is the goal of objectivity. While selection of designs using panels of judges or subject matter expert ratings can be a valid and advantageous approach for a number of reasons, the FANG Challenge was intended to be a strictly tool-based approach. This was not only consistent with the theme of testing tools above all, but stems from the intended capability of the tools to produce hundreds or thousands of design configurations, each with dozens of competing attributes.

System Requirements

Requirements development is at the core of public design competitions, particularly efforts with a prize basis, as adherence to requirements will ultimately be the basis for the selection of a winning design. Requirements development in general is a well-established discipline within the field of systems engineering, with numerous publications and resources available for best practices. However, in terms of managing prize challenges and the specific demands of FANG, there were some nuances that should be considered.

Requirements need to be as comprehensive as possible, as participants that address unwritten requirements are likely to introduce compromises to those attributes that are actually being scored or assessed, and decrease their chances of winning. Conversely, if participants are rewarded for addressing unwritten requirements, then issues of competition fairness are introduced, along with the specter of potential disputes. This needs to be balanced against over-constraining designs with excessive or overly specific requirements that restrict the solution space.

Requirements also need to be verifiable, which was a particular issue for FANG as a purely virtual product development competition and entirely dependent upon AVM tools. This meant that the $1M prize purse would be awarded based on what modeling and simulation reported as the optimum design, without physically testing a down-selection of top-scoring designs. This also meant a compromise to the aforementioned desire for requirements to be comprehensive. Given the limits of time and resources, AVM tools could only be developed to assess a small number of key attributes, which in the context of the end product being secondary, was seen as acceptable.

FANG system requirements could be subdivided into three main categories: automotive performance, configuration, and programmatic. Automotive performance requirements were straightforward examples of typical vehicle technical requirements like payload, gradeability, and ride quality, while programmatic requirements covered metrics like acquisition cost and manufacturing lead time. Configuration requirements were meant to represent vehicle features or functions that rather than being a tradable performance metric (e.g. top speed), were instead basic expectation for a vehicle. For example, one FANG configuration requirement stated that “fuel tank(s) shall be provided with drain plug(s) to provide means of removing contaminated fuel.” So while a vehicle designer might typically make tradeoffs between top speed and cost, the inclusion of fuel drainage is a basic expectation and therefore a configuration requirement. [6]

Scoring/Winner Selection

Closely related to the topic of requirements development is competition scoring and selection of a winning design. It is essentially the challenge of determining which design has the highest potential utility to program stakeholders based on multiple competing requirements. A competition with purely objective scoring such as FANG required the explicit definition of scoring algorithms for pre-defined requirements, and considerations for fairness dictated that the scoring approach was entirely pre-determined. The FANG Challenge scoring was built upon a process of stakeholder outreach with the military services. The outreach included enlisted and officer personnel involved in both the use of the current amphibious vehicles and in planning for future programs. DARPA stakeholders were also included for elements specific to their vision for FANG.

In order to weight the importance of system requirements, preferences had to be gathered and calculated from each of the stakeholder representatives. Based upon the Analytical Hierarchy Process (AHP) overseen by the Aerospace Systems Design Laboratory at the Georgia Institute of Technology, weightings were computed from a series of pairwise comparison questions asked during the stakeholder workshops (which included methods for anonymous voting in order to minimize influences of group dynamics and authority figures). The weights were then aggregated through a number of different methods for comparison, including giving preference to voters or groups who responded with higher consistency (see Figure 5).

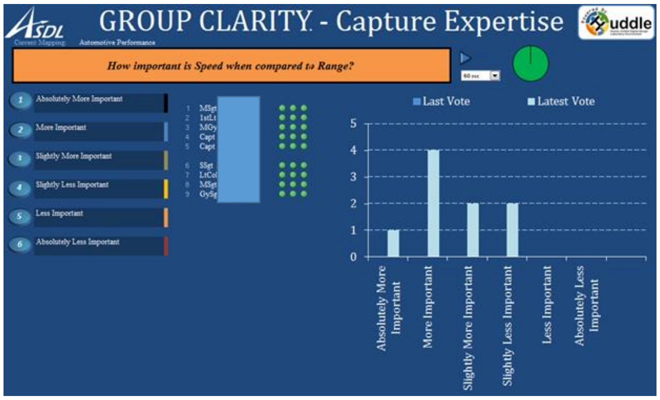

Figure 5: Group clarity exercise visualization for stakeholder preference-gathering workshops. In general, a response that shows agreement is characterized by a mesokurtic or leptokurtic histogram.

Additionally, a Single Requirement Preference Function (SRPF) was developed for each requirement. These utility curves utilized exponential functions and describe how much better the objective of a requirement is when compared to its threshold and midpoint. As shown in Figure 6, this translates to the rate at which increasing product performance results in diminishing returns in utility.

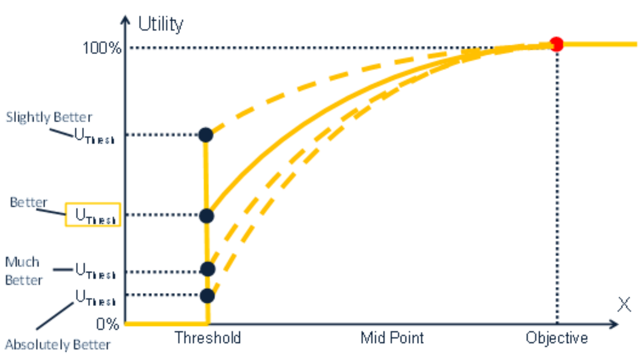

Figure 6: Shapes of a utility curve for different utility values at threshold

These scoring functions, including a hierarchy of requirements, were all aggregated into a Multi-Attribute Utility Function (MAUF) (see Figure 7). A number of methods for aggregating the MAUF were evaluated, including:

- Additive
- Shortfall
- Additive with Shortfall
- Multiplicative
- Euclidian Distance
- TOPSIS

Validation exercises were held with the stakeholder groups utilizing hypothetical vehicle designs indicated that the additive (or weighted sum) method most closely matched the stakeholder preferences. [8]

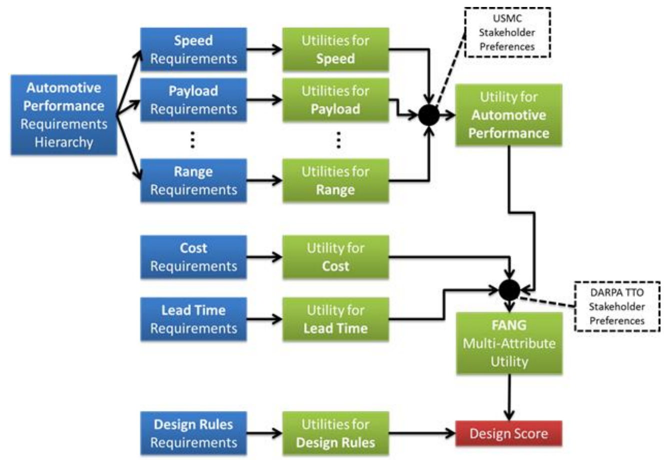

Figure 7: MAUF Hierarchy

There were a few key decisions made in defining the limits of the SRPF curves. First, there was the assumption that any result below the threshold would result in a score of zero for that requirement. This was based on the idea that a threshold requirement represented a minimum expectation and should include a substantial penalty for all failures to meet it. Compounding this penalty were instances where a requirement was defined as a key performance parameter (KPP). In this case, the requirement was considered to be of such overriding importance, that a failure to meet the threshold would result in a zero score overall, essentially disqualifying the design. At the other end of the SRPF utility curve was the assumption that any result above the objective would provide no higher score than meeting the objective itself. This was to guard against the potential of participants designing products that produced extreme performance in a single or very few attributes while sacrificing the minimums that should be met across the broader range of attributes.

An element of AVM model capability established within the Ricardo C2M2L models that was important to executing a purely virtual completion was the ability for META simulation tools created by Vanderbilt ISIS to report instances of components exceeding their limitations. If, for example, the torque limitations of a drive shaft component were exceeded, indicating a predicted breakage, the vehicle design would be considered invalid and receive a score of zero for that requirement.

The Configuration Requirements represented a special challenge for scoring. As was mentioned previously, the requirements were meant to represent basic expectations rather than part of a requirements tradespace. On the other hand, few of these requirements were justifiable as KPPs, so there was a reluctance to disqualify designs outright, particularly as failure to meet them would generally be more an issue of design immaturity than a poor design concept. These requirements were also a challenge, as the scoring weighting did not fit well within the aforementioned processes for stakeholder prioritization. The Marine Corps does not wish to trade an adequate bilge pump capacity against vehicle swim speed. The FANG program took an approach inspired by the Kano model for customer satisfaction, in which failure to meet basic needs results in dissatisfaction (negative points), versus the positive satisfaction resulting from increasing performance needs (see Figure 8). Exact values produced by these algorithms were, however, largely based on program team judgment and tuning during the test process.

Evaluation of a design's potential was conducted by a series of standardized simulations, referred to in the program parlance as "test benches." C2M2L component models were assembled into system designs using the META software, and then tested against specific FANG requirements. The results of the test benches were then fed into a VehicleFORGE-hosted scoring tool that assisted participants in visualizing the performance and tradeoffs of their design. Test bench results were also fed to the FANG administrators in order to track progress and problems, and top scores were posted to a leaderboard that all FANG participants could view. The expectation was that a public leaderboard would be a motivational tool, driving participants to obtain or maintain their lead.

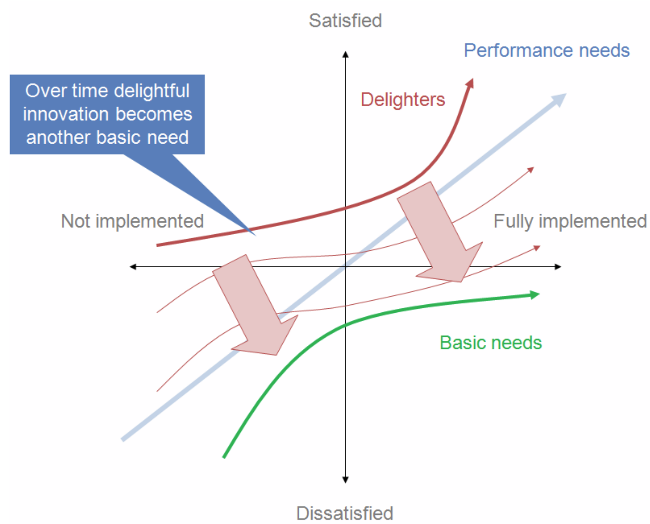

Figure 8: Kano model for customer satisfaction [9]

A number of pros and cons were considered regarding whether to have an open or closed scoring system. In the end, it was determined that a closed model would be the most effective risk reduction, while still allowing participants to gauge scoring sensitives by submitting designs as often as possible. Additionally, there was a desire to see a diverse set of designs from the competition participants, and there was concern that an open scoring model could have resulted in a rapid convergence on a single architecture.

Advertising, Publicity, & Social Outreach

An important element of prize challenges is the enlistment of participants in order to provide the greatest possible pool of talent and innovation. The FANG outreach effort, led by DARPA, focused on the use of digital media and media relations to disseminate messages by generating online content, interviews, and news stories.

As a first step, profiles were developed for the psychographics of the primary audience groups that were expected to generate participants, including students and universities, active and retired military personnel, small businesses, and other individuals.

Leveraging the VehicleFORGE web-based collaboration infrastructure, the FANG program set up a dedicated public-facing website with competition details and points of contact for directing public and media interest. The site was also set up to collect metrics for measuring the effectiveness of the outreach campaign, as well as assembling "hand raisers" by soliciting a sign-up for a FANG Challenge e-newsletter.

DARPA led the development of a series of videos meant to excite and educate prospective participants, including three long-form videos providing a high-level look at the competition (see Figure 9), and five 90-second "mini" videos with a deeper look at individual elements of the competition. These videos were posted on DARPA media channels. [6]

Figure 9: Screenshot of public outreach video produced by DARPA for FANG Challenge recruitment [10]

In order to promote media interest, the FANG team prepared a press kit of materials for reporters, including a backgrounder, FAQ, glossary of terms, and approved images. Later, a press event was hosted for reporters representing traditional print, broadcast, and online media, as well as influential bloggers. Media representatives were further targeted and engaged according to planning for long lead, short lead, and social media, as well attempting to reach design, defense, technology, and student/university audiences.

Analytics were a key element of managing publicity. VehicleFORGE visitor metrics, referral sources, and social media post metrics were all used, which allowed adjustments to outreach strategy according to the relative effectiveness of various media.

Rules and Processes

Central to planning for a prize-based design competition is the development of rules, documents, and processes for dealing with participants from the general public, to inform and manage their actions and expectations. These plans and documents included the Challenge guidelines, participant agreement, registration process, use of VehicleFORGE for team formation, and overall process and timeline for participation.

The Challenge guidelines were created to provide an overview of the Challenge and associated tools, processes, requirements and expectations for participants. These included everything from basic introductions to the software tools and competition objectives, to eligibility under ITAR regulations, treatment of intellectual property, design submission process, scoring process, and conditions for receiving the $1M prize purse. Documentation was intended to be both clear and comprehensive and the FANG team leveraged the benchmarking of guidelines from several previous prize competitions.

The development of competition rules and processes did require a myriad of important decisions intended to ensure:

- Security requirements associated with a military vehicle development program
- A fair and even playing field
- Ease of participation to the extent possible
- Measures to avoid malfeasance

The FANG Challenge registration and participation process was designed to manage a large number of participants in an online environment with little to no direct interaction with Challenge administrators. As a competition with a large prize purse and no cost to participate, it was anticipated that there could be participation in excess of available resources for manual handling of administration tasks.

Software Support

As the primary purpose of the FANG Challenge was to perform a large scale test and demonstration of the AVM software tools and processes, a critical element was the integration and support of those tools. Key aspects of this task included:

- Software beta testing
- Software release management
- Tutorial development
- FANG seed design
- Issue reporting & resolution

In order to prepare the competition participants for the challenge of designing an extremely complex product using a new set of software tools and design processes, a significant amount of training was necessary. While some of this training was covered through the delivery of documentation for all of the software tools and processes, the cornerstone of participant preparation was the Mass Spring Damper (MSD) tutorial, created as an introductory exercise (see Figure 10). The MSD tutorial was intended to guide participants through development of a damped spring-mass system, a simple dynamics model utilized in most engineering classes. As an extremely simple system, it would allow users to focus on the basics of using the tools, and was broken down into stages for preparation, building, and testing the system. [6]

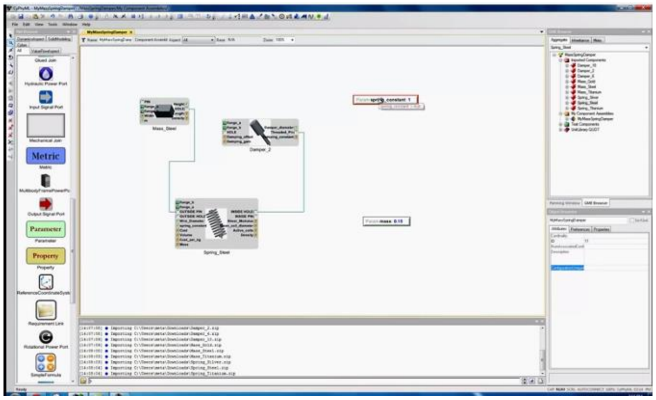

Figure 10: Mass Spring Damper (MSD) tutorial using Open META-CyPhy tools [11]

A second element of participant support and training were the "seed designs." These were pre-assembled AVM models, provided to the participants to give them an example of a functional FANG design, and help bridge the gap between modeling the very simple MSD and a very complex IFV. Competitors started with the "5-Pack" seed design, made up of drivetrain components (engine, crossdrive, power take-off module, driveshaft, & final drive) of a conventional architecture for a tracked amphibious vehicle. There were additional "surrogate" components that represented connections between these functional components and other components necessary to comprise the full vehicle design (see Figure 11). Participants were later provided with the "Amphibious Vehicle" seed design, which was a functional AVM model that represented the same level of completeness as was expected from the participants.

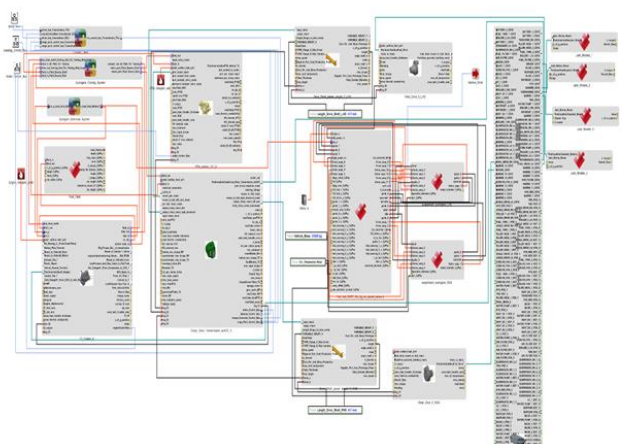

Figure 11: Block diagram of "5-Pack" seed design for FANG within Open META-CyPhy tool

It is worth noting that the MSD tutorial was also used as a means of screening participation in the competition. The use of the AVM tools for vehicle design was technically demanding, and there was significant concern that resources for participant support would be overwhelmed by users that had not invested sufficiently in the training that was provided. The MSD was of such simplicity that it was expected that any team that could not successfully complete it had no real hope of tackling more complex vehicle systems. MSD was therefore provided as a pre-competition exercise that was required before allowing participation in later competition phases.

One issue facing a drivetrain and mobility competition is the fact that vehicle drivetrain and mobility systems do not exist in isolation, but are very much driven by the needs and constraints of a full vehicle design. Packaging those systems into a wide-open space would have real risk of encouraging unrealistic or infeasible designs. Participants were therefore provided with a surrogate hull that provided the mounting points for the subsystems, as well as a mechanism for determining and adjusting the overall dimensions of the vehicle and assessing a variety of vehicle-level requirements (see Figure 12). [6]

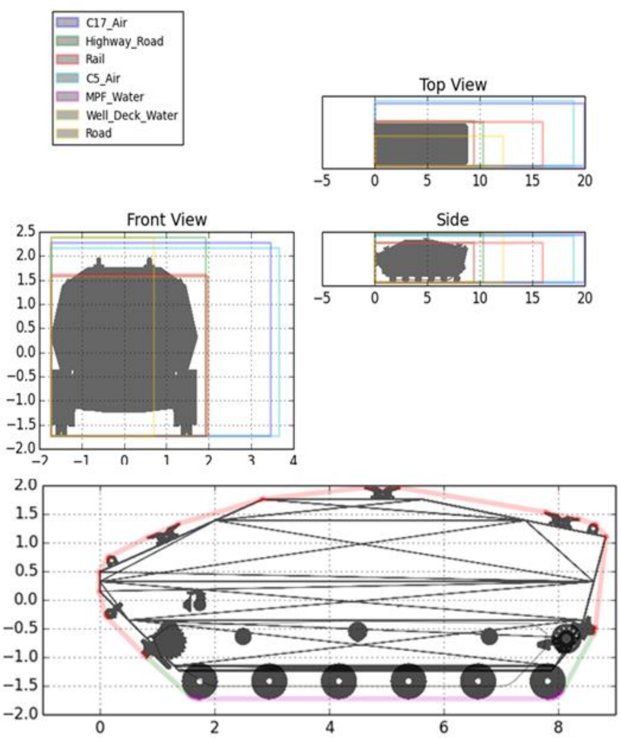

Figure 12: This transportability test bench required a vehicle hull design in order to make an assessment [12]

Issue reporting and resolution was another critical element of supporting the Challenge participants. The ability for participants to report issues and ask questions was solely contained within the VehicleFORGE host environment through the use of a help desk. The help desk was open 24 hours per day, 7 days per week, and was staffed by experts within each area of the Challenge. All issues were tracked and maintained in a searchable database, and an "issue library" was maintained and updated in response to incoming issues. The program target was for resolution of all issues within 48 hours after ticket posting, or provide clear communication for implementation timeframes if that was not possible. While specific technical issues were routed to subject matter experts from the range of AVM performer organizations, the Challenge Manager had overall responsibility for all communications.

A particular issue for prize-based competitions is the provision of participant help while maintaining a level playing field. This was particularly relevant in the FANG Challenge, where there was a fine line between software assistance and providing an advantage toward winning the prize purse. This was managed through guidelines for the interactions between the help desk personnel and Challenge participants, particularly avoiding either coaching participants or debugging their models, as well as careful management of issues by the Challenge Manager. There was strict use of written communication, which while often slowing the help process, was necessary to allow the monitoring of support and communications.

Public Challenges and Data Restrictions

A major security-related issue for the AVM tools and FANG program was the public nature of the design competition. One of the intended advantages of the AVM approach was the use of the C2M2L component models as the building blocks of any new design. This model library was meant to act as a virtual catalog of the off-the-shelf components that were available for vehicles in this class, which could then be assembled into a variety of system configurations within the META software and tested against the program requirements. Use of this approach within a public competition led to three primary issues:

- International Traffic in Arms Regulations (ITAR)
- Distribution Statement D restrictions
- Proprietary data

An IFV is of course a military vehicle, and the export of its technical data is restricted under ITAR. FANG therefore had to take some measures to meet U.S. Government requirements. First of all, this meant that participants could only be U.S. persons. In a virtual competition, verification of U.S. citizenship can be difficult, but DARPA allowed a process of self-certification (as part of the Participant Agreement), coupled with measures that VehicleFORGE took to restrict access from users located in foreign countries.

Some of the components intended for use within the C2M2L component library were sourced from currently fielded military vehicles, whose Government-owned technical data packages were labeled not for public distribution. That meant that Challenge participants could not have access to these components. This was resolved through the deliberate "genericizing" of models. The models followed the basic form and function of the actual components, but dimensions and performance were adjusted with random factors. This meant that a completed winning design would require rework, but in the context of using the competition to test the tools, this was seen as acceptable.

Perhaps even more difficult was the issue of enlisting the supply base to provide high-fidelity data for their products, knowing that the data would be publically released and available to their competitors. This issue drove a number of compromises into the library, including fewer component options than might otherwise have been available, and lower data fidelity as components were populated with values based on engineering judgment, or genericized.

CHALLENGE EXECUTION AND RESULTS

This section focuses on Challenge timing, participation statistics, vehicle system design results, and the transition of the winning design for building, testing, and evaluation.

Challenge Timing

The timing of the FANG Challenge can be divided into several primary phases:

- 5 months – Publicity and media outreach
- 3 months – Open registration period
- 3 months – FANG Challenge
  - 2-week MSD exercise
  - 7-week preliminary vehicle design period, with bi-weekly releases of new vehicle systems and test benches
  - 4-week final design period with finalist participants

Participation Statistics

- Total registered teams: 261
- Total registered participants: 1060
  - Registered with a team: 428
- Teams passing MSD exercise: 34
- Finalist teams: 18

What is immediately noticeable about the participant statistics for the FANG Challenge is the split between the numbers of total registrants versus participants that were ultimately capable of making it through the MSD exercise. There were a significant number of parties that were interested enough in FANG to join, but were put off from seriously competing due to a mismatch with expectations, challenges of learning and using the software tools, or the difficulty of IFV drivetrain design. In fact, only a little less than half of the participants actually made it as far as joining or forming a team. It is also notable that, as shown in Figure 13 below, teams with a single member far and away dominated the registration for participation, while teams with multiple members had a much higher rate of survival into the Challenge finals.

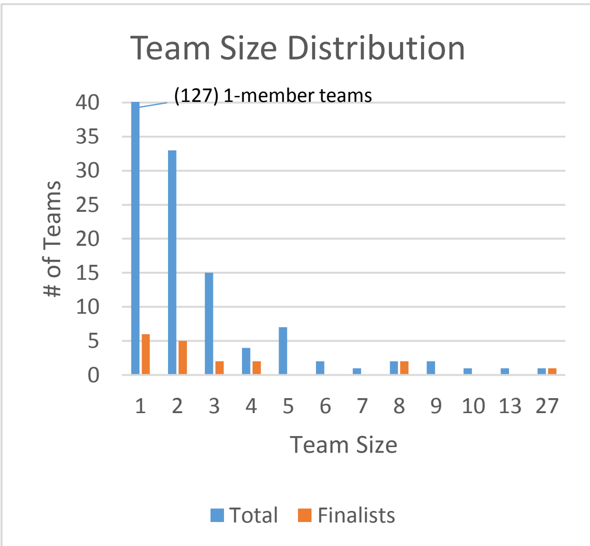

Figure 13: Distribution of team sizes, both for total registration and for finalist teams

Vehicle Design Results

As is shown in Figure 14, the winning team was able to finish with a decisively greater score than the rest of the finalists. It is also notable that fully half of the finalists were unable to submit a design with a non-zero score, illustrating the challenge of both mastering the tools and creating a vehicle design that did not violate any threshold for all KPP requirements. [6]

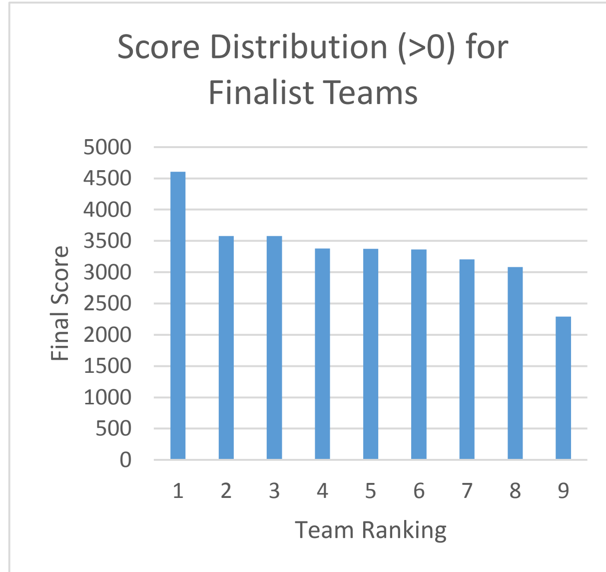

Figure 14: Distribution of FANG Challenge final scores for teams scoring greater than zero

The winning design from team "Ground Systems" is shown in Figure 15. The Ground Systems design offered significantly improved powertrain performance over the legacy vehicle fleet, while primarily utilizing many tried and true components and could be built with a minimum of development time and cost.

Figure 15: Rendering of the winning design for the FANG Challenge from team "Ground Systems"

Building, Testing, & Evaluation

While largely outside the scope of this paper, it should be of interest to readers that the winning FANG design was built, tested, and evaluated as follows:

- The Ground Systems design was developed by the FANG team in ~3 months from the post-Challenge concept model to a fully functional and manufacturable technical data package (level 2+)
- The manufacturing of the FANG mobility test rig was completed by the iFAB program at Rock

Island Arsenal, with final inspection ~11 months after the conclusion of the FANG Challenge
- Powertrain dynamometer testing was completed, along with automotive testing at Camp Grayling and Keweenaw Research Center

The FANG test rig was designed and built to be as consistent as possible with the Ground Systems design, differing largely in terms of the detail required for a manufacturable and functional vehicle, as well as the additional of various systems not related to powertrain and mobility that were necessary for safe and drivable operation, (e.g. operator controls, fire suppression, lighting, etc.). [12]

Figure 16: Completed FANG Automotive Test Rig at Ricardo facility

CONCLUSIONS

The planning and execution of the FANG Mobility/Drivetrain Challenge was a unique opportunity to engage in a large-scale, prize-based design challenge using leading-edge design and simulation tools. The Challenge provided an intersection of public education and outreach, software development, vehicle design, modeling and simulation, and decision analysis.

Program Successes

FANG was successful by a number of measures, including:

- The program produced a tracked vehicle demonstrator, from Challenge kick-off to final inspection in only 14 months
- FANG encouraged AVM researchers and developers to conform to a strict timeline
- Many non-traditional participants and teams were able to successfully participate, including the winning team, which was only three persons and geographically distributed
- FANG successfully used common tools and objective scoring to provide an even playing field for participants

This last point of success is worth elaborating. Many competitions for designs or innovations have the issue of how to make fair and objective comparisons of virtual designs, which is why most progress from a wider virtual field to a down-selection for physical testing. FANG, however, took the approach of using a common toolset for modeling and simulation. There is potential value in the opportunity for the Government to establish new standards for modeling and simulation so that design concepts can be compared on an “apples to apples” basis. This would be similar to what was accomplished with NRMM (NATO Reference Mobility Model), but across a wider range of attributes.

Program Issues

FANG also helped define a number of challenges inherent in the program’s approach, including:

- Constraints on the availability of components for amphibious IFVs limited the diversity of the design space
- The difficulty of simultaneously maximizing innovation and accelerating adoption of new engineering tools
- The difficulty of balancing helpful communications and assistance to competitors while maintaining a level playing field

Recommendations for Prize Challenges

Prize challenges can bring in a diversity of ideas and talent, particularly when there is a significant prize purse. It may be most effective when there are no strict limits on which toolsets may be used or what designs may be deemed acceptable. Use of a prize purse can be a double-edged sword, as it can reduce cross-team interaction and cooperation. If cross-fertilization of ideas is seen as an important source of innovation, this has to be traded against the participation benefits of a large prize.

Public competitions, particularly those involving highly complex processes or subject matter, demand an emphasis on communication so that participants can understand what is expected of them and how the process is intended to work. This includes clear and comprehensive documentation, and opportunities to obtain help and direction.

The views, opinions, and/or findings contained in this article are those of the author and should not be interpreted as representing the official views or policies of the Department of Defense or the U.S. Government.

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