Data Verification, Validation, and Accreditation/Certification for Modeling and Simulation within the Department of Defense (DoD)

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Keywords: M&S, VV&A, DoD, data, verification, validation, accreditation, certification

1 INTRODUCTION

Modeling and Simulation (M&S) has seen a dramatic rise in importance in design and engineering in the last decade. Likewise, rising attention has been given to *Verification, Validation and Accreditation* (VV&A) which is a multi-disciplinary research field aiming at increasing the credibility, e.g. accuracy and validity, of simulation models. The data generated from M&S are invaluable to make procurement decisions, reduce risk, and contain development testing, and evaluation. Given the mounting use of simulation models and growing complexity of the models greater demands have been placed on VV&A. Because the VV&A topic is rather broad, this paper is focused on the verification, validation, and certification processes of *data*, specifically as it relates to DoD simulation.

1.1 BACKGROUND

In recent years, interest in data verification, validation, and accreditation and/or certification has increased dramatically. The relationship between good data and successful M&S projects is evident. Recent studies indicate the necessity for project team members to give considerable time, effort and resources to strengthening data collection integrity and processes. For example, a study, conducted by Gary Horne and Ted Meyer, demonstrated the profound need to devote more attention to this part of the modeling and simulation effort. The study discusses the concept of data farming. Data farming is defined as the opportunity to grow more data in a particular area of interest. If a modeler is interested in learning as much as he/she can about how certain factors react within specific scenarios and environments, then the individual will want to consider how data is generated, and how many permutations or combinations are possible for a specific planned objective. Therefore, having a solid knowledge of data "behavior" is absolutely crucial to the success of the modeling effort. One can only gain a keen understanding of data integrity if there is an awareness of the basic foundation of how data is verified, validated and accredited/certified [1].

1.2 THE ROLE OF DATA

The data collection processes within the M&S industry require a great deal of attention to detail. Data collection is one of the first elements in the VV&A process we must consider. It is vitally important to ensuring that all parts of the process have integrity. Factors such as *what is the intended model resolution* or *which technique will a modeler use in defining data parameters* must be identified during the initial stages of data collection. Once data have been collected, they must undergo vigorous testing for verification, validation, and accreditation/certification. Without this level of testing, data may prove to be faulty, or useless in terms of the overall purpose of the modeling and simulation project [2].

2 DEFINITIONS OF VV&A

As published in the DoD Instruction (DoDI) 5000.61 [3], VV&A are three discrete processes that are defined as:

- **Verification** – the process of determining that a model implementation and its *associated data* accurately represent the developer's conceptual description and specifications.
- **Validation** – the process of determining the degree to which a model and its *associated data* provide an accurate representation of the real world from the perspective of the intended uses of the model.
- **Accreditation** – the official certification that a model, simulation, or federation of models and simulations and its *associated data* is acceptable for use for a specific purpose.

2.1 PURPOSE OF VV&A

"To determine whether a model or simulation or federation should be used in a given situation, its *credibility* should be established by evaluating *fitness*

for the intended use. In simplest terms, *Verification, Validation and Accreditation* are three interrelated but distinct processes that gather and evaluate evidence to determine, based on the simulation's intended use, the simulation's capabilities, limitations, and performance relative to the real-world objects it simulates. The purpose of VV&A is to assure development of correct and valid simulations and to provide simulation users with sufficient information to determine if the simulation can meet their needs [4]."

3 DEFINITIONS OF VV&C

The following definitions are established in the DoD Directive (DoDD) 5000.59-P [5]:

- **Data Verification** – data producer verification is the use of techniques and procedures to ensure that data meets user specified constraints defined by data standards and business rules derived from process and data modeling, and that data are transformed and formatted properly.
- **Data Validation** – the documented assessment of data by subject area experts and its comparison to known or best-estimate values. Data user validation is that documented assessment of data as appropriate for use in an intended model. Data producer validation is that documented assessment within stated criteria and assumptions
- **Data Certification** – the determination that data have been verified and validated. Data user certification is the determination by the application sponsor or designated agent that data have been verified and validated as appropriate for the specific M&S usage. Data producer certification is the determination by the data producer that data have been verified and validated against documented standards or criteria.

3.1 DATA VV&C

According to DoD Directive 5000.59, it is mandated that each DoD component establishes VV&A policies, procedures, and guidelines for models, simulations, and their associated data. The application of M&S requires accurate and reliable data in order to define, for instance, a) doctrine, b) environments, c) scenarios, and d) weapon & system performance. In an environment that relies heavily on the credibility of M&S results, the quality of data is as important as the performance of the models and simulations themselves. However, unlike VV&A, which has been addressed in detail in the DoDD 5000.59, *Data Verification, Validation & Certification* (VV&C) is still not at a stage of general understanding and practical implementation [6].

4 THE TIGER TEAM

The *VV&C Tiger Team* (VVCTT) was founded in 1997 under the leadership of the VV&A Technical Working Group (TWG). The Tiger Team is a group of M&S practitioners from the military ranks (Army, Navy, Air Force), Office of the Secretary of Defense (OSD) representatives, as well as Modeling and Simulation Executive Agents (MSEA).

4.1 VV&C TASKS AND OBJECTIVES

The VVCTT was tasked to identify key issues and gaps that exist within the data verification, validation, and certification process, specifically as it relates to the DoD modeling and simulation methodology. Additionally, the VVCTT has been charged with examining and reviewing current processes, policies, and practices as they apply to the VV&C data activities. These include [6]:

- assess the current state of DoD VV&C products
- leverage relevant VV&C activities of the M&S community at large
- convert these activities into specific products
  - generic user template for VV&C
  - data user integrated VV&A/VV&C model
  - suggested topics for inclusion in the rewrite of the *VV&A Recommended Practices Guide*
- ascertain what remaining activities are needed to reach the desired technical end state and make appropriate recommendations

4.2 PROCESS DEFINITION

According to the VV&C Tiger Team report, four sub-groups were formed to identify individual elements and objectives. The associated tasks of the sub-groups were:

- **Leverage** – exploit the current state of VV&C resources, information and knowledge
- **Template** – create a user-driven template of data quality information
- **Model** – develop a data user integrated VV&A, VV&C model
- **RPG** – suggest topics for rewriting the VV&A Recommended Practices Guide (RPG)

4.3 PRODUCTS

As indicated in 4.2, process definition, the VVCTT was divided into sub-groups. Each of the four teams was challenged to develop a deliverable that either would a) improve existing product(s) or b) outline policies and/or guidelines that assist data producers in providing useful information to data users.

- **VV&C Bibliography** – the leverage group produced a bibliography of existing literature as well as a compilation of existing V&V tools.

Additionally, the publication includes references to pilot projects and their *lessons-learned* reports.

- **Data Quality Metadata Template** – the DQMT is a data user guide that provides methods and methodologies for identifying producer-generated Data Quality (DQ) information in support of VV&A activities.
- **M&S Lifecycle Process Model** – the team involved in this effort updated the existing M&S Lifecycle Process Model which was originally developed for supporting the development of the DoD VV&A RPG.
- **VV&C Content for the VV&A RPG** – the two recommendations that were updated included a) VV&A policy guidance documents, and b) the *VV&A Recommended Practices Guide.*

5 IMPORTANT DISTINCTIONS

It is important to note that there are clear distinctions between the manner in which the end user and the producer of data employ data in their work. Producer data is defined by a parameter called *data quality*, as outlined by DoD 8320 series. On the other hand, the user data V&V activities are typically inculcated into the M&S accreditation process. Further, the M&S life cycle plays an integral role in how data is defined. Data may have different meanings and levels of significance, depending on where the M&S project is in its life cycle. Similarly, data can be captured at various points along the life cycle, or continuum of the M&S process.

5.1 GAPS

In Major William Norton's study of VV&C with the Tiger Team [6], he points out that there are several gaps between current processes and desired long-term results. The study points to several opportunities for further research and/or improvement. They are:

- inconsistency within user application data V&V activities
- inherent disconnect between producer and user requirements
- no central resource data bank, or library for user data V&V information

5.2 EMERGING ISSUES

There are numerous issues arising from current studies of data VV&C. Since there is no real infrastructure in place to house any new knowledge with respect to VV&C, the case can be made that the industry should consider dedicating resources to developing a coordinated knowledge management program in a joint environment. Further, there are many business opportunities to study the role of intensive training and technical assistance that focus on providing DoD with cutting edge technological tools that capture the true value of having accurate, verified, validated data on time, at the right time. Additionally, the need for data that has been properly calibrated, validated and verified will become increasingly important in order for M&S professionals and DoD clients to take advantage of other emerging technologies, e.g. war-gaming. If data is not properly verified, it can lead to disastrous results for projects within the M&S industry. Therefore, the field will have to foster the growth and development of specialists and experts in this specialized sub-field.

6 SUMMARY

In conclusion, data collection, verification, validation, and/or certification techniques are fundamental to the long-term success of any modeling and simulation project. Without proper data collection, where specific parameters are set, modeling and simulation projects are at risk for failures throughout the life cycle. Essentially, data integrity, through VV&C, is the basis upon which any successful project should begin. Without "good" data, the overall project may be compromised; thereby, causing a significant loss in revenue to clients or knowledge for the Department of Defense. There is ample justification for further research, as well as resource allocation into this field. DoD modelers may benefit from studying this field more in depth.

7 REFERENCES

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