# A Road Map for the Validation, Verification and Testing of Discrete Event Simulation

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## INTRODUCTION

The aim of this chapter is to give an elaborate reasoning for the motivation for Validation, Verification, and Testing (VV&T) in Simulation. Thereby, defining Simulation in its broadest aspect as embodying a certain model to represent the behavior of a system, whether that may be an economic or an engineering one, with which conducting experiments is attainable. Such a technique enables the management, when studying models currently used, to take appropriate measures and make fitting decisions that would further complement today's growth sustainability efforts, apart from cost decrease, as well as service delivery assurance. As such, the Computer Simulation technique contributed in cost decline; depicting the "cause and effect," pinpointing task-oriented needs or service delivery assurance, exploring possible alternatives, identifying problems, as well as proposing streamlined, measurable, deliverable, solutions, providing the platform for change strategy introduction, introducing potential prudent investment opportunities, and finally, providing a safety net when conducting training courses. Yet, the simulation development process is hindered due to many reasons.

Like a rose, Computer Simulation technique, does not exist without thorns, of which the length, as well as the communication during the development life cycle. Simulation reflects real-life problems; hence, it addresses numerous scenarios with handful of variables. Not only is it costly, as well as liable for human judgment, but also, the results are complicated and can be misinterpreted.

## BACKGROUND

There are four characteristics, which distinguish simulation from any other software intensive work, that also makes

*Table 1. Published research of V & V in WSC adapted from (Abu-Taieh & ElSheikh, 2006)*

| Year | V & V Papers | Total Published Papers | Percentage |
|---|---|---|---|
| 1997 | 15 | 280 | **5%** |
| 1998 | 22 | 236 | **9%** |
| 1999 | 26 | 244 | **11%** |
| 2000 | 19 | 280 | **7%** |
| 2001 | 15 | 224 | **7%** |
| 2002 | 1 | 119 | **1%** |
| 2003 | 12 | 263 | **5%** |
| 2004 | 6 | 280 | **2%** |
| 2005 | 11 | 412 | **3%** |
| 2006 | 10 | 412 | **2%** |
| **Total** | **137** | **2750** | **5%** |
| **Average** | **13.7** | **275** | **5%** |

distinction VV&T for simulation from VV& T for other software. The four characteristics were discussed by Page and Nance (1997): *time*, *correctness*, *computational intensive*, and *the uses of simulation*. In simulation there is an indexing variable, called *TIME,* that "establishes an ordering of behavioral events" (p. 91). The objective of *correctness* is very special to simulation software for this simple reason: how useful is simulation program "if questions remain concerning its validity" (p.91). Simulation is *computational intensiveness;* therefore, the execution efficiency is essential due to the repetitive sample generation for statistical analysis and testing alternatives. *Uses of simulation*: the uses of simulation are not typical; in fact there is "No typical use for simulation can be described" (p.91).

Accordingly, validation and verification methods and techniques that relate to simulation have been thoroughly discussed by 137 research papers in the Winter Simulation Conference (WSC) over the years 1997 through 2006, as seen in Table 1 and Figure 1, highlighting the fact that such numbers clearly indicate the importance, inimitable, and unique case of validation, verification, and testing of simulation software.

In this context, it is worth noting that validation, verification, testing, as well as experimentations, execution, and design are so important that Shannon (1998) suggested giving 40% of the project time for these steps.

## Why Do Simulation Projects Fail?

The arising issue of simulation projects falling short of being labeled as successful can be attributed to many reasons. An answer by Robinson (1999) has been put forth, as he listed three main reasons: the first being "poor salesmanship when introducing the idea to an organization," (p. 1702) which includes too much hope in too little time, while identifying the second reason as "lack of knowledge and skills particularly in statistics, experimental design, the system being modeled and the ability to think logically" (p. 1702), and pinpointing the third reason as "lack of time to perform a study properly" (p. 1702). Nevertheless, simulation inaccuracy has become a recurrent condition that instigated a thorough query into its sources.

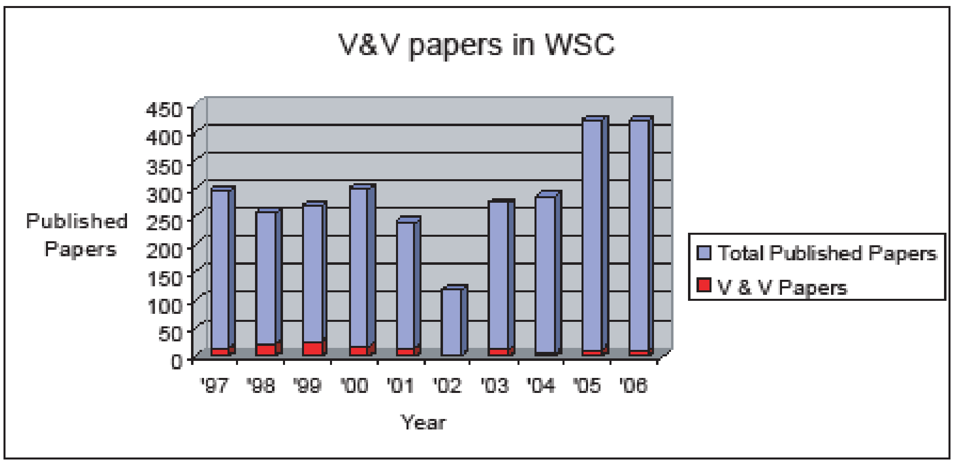
## Sources of Simulation Inaccuracy

There are three sources of inaccuracy the simulation project might be developing during the three major steps that are in the simulation life cycle, namely; modeling, data extraction, and experimentation (see Figure 2).

In this regard, the modeling process includes a subordinate set of steps, namely, the modeler understanding the problem, then developing a mental/conceptual model, and finally the coding. Note that, from these steps, some problems might mitigate themselves, such as (i) the model could misunderstand the problem, (ii) the mental/conceptual model could be erroneous, and (iii) the conversion from mental/conceptual model to coding could be off beam.

Furthermore, during the modeling process, the data collection/analysis is a key process element, particularly since the data collected is really the input of the simulation program. If the data is collected inaccurately, then the principle of *Garbage In Garbage Out* is clearly implemented; likewise, the data analysis, while using the wrong input model/distribution (see Leemis, 2003) is also a problem.

*Figure 1. V & V research papers in WSC adapted from (Abu-Taieh & ElSheikh, 2007)*



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