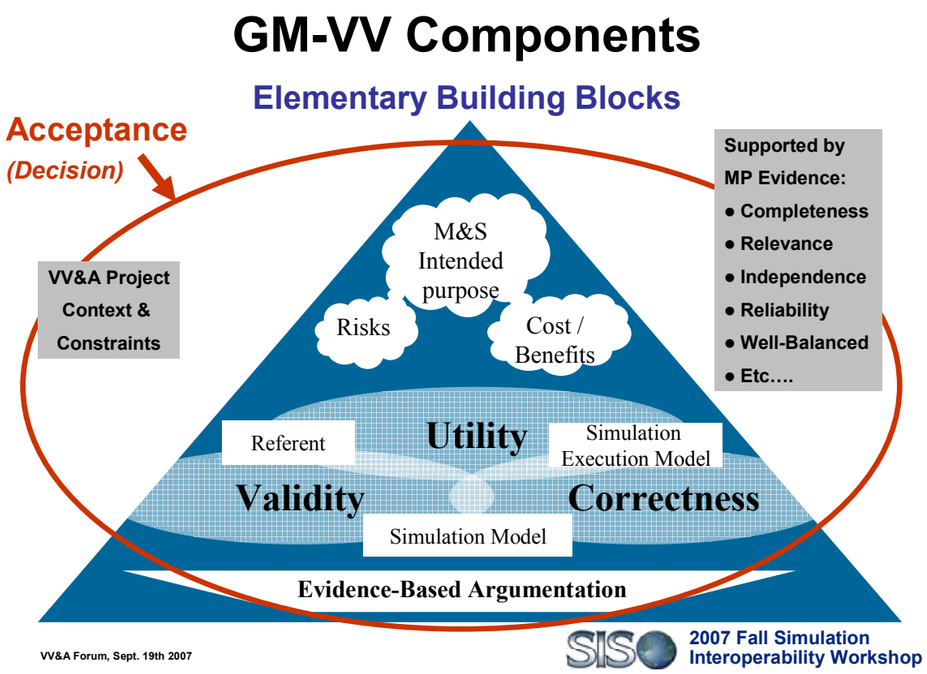
REVVA2 och GM-VV

VV&A årsrapport 2008

STEN-ÅKE NILSSON



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Sammanfattning

VV&A är en process som syftar till att belysa trovärdigheten (korrekthet och tillförlitlighet) för en simuleringsmodell samt dess lämplighet för ett givet syfte: V*erifiering* är en process som avgör om en modell utvecklas korrekt enligt specifikationer; *validering* är en process som avgör om en modell är lämplig för ett givet syfte; a*ckreditering* är ett officiellt bemyndigande att en modell får användas i ett visst syfte.

VV&A-processen bidrar även till att fel och ofullständigheter kan upptäckas tidigt under utvecklingsfaserna, vilket är av betydande ekonomiskt intresse. Detta kräver en genomtänkt plan för generella VV&A-aktiviteter, vilka bör skräddarsys för den aktuella tillämpningen.

FOI-projektet VV&A av simuleringsmodeller har tre huvuduppgifter: Forskning kring metoder och tekniker för VV&A, stöd till FM för att implementera en för det svenska försvaret lämplig VV&A-process samt kunskapsspridning rörande VV&A.

Under de tre senaste åren har projektet medverkat i ett europeiskt samarbetsprojekt med namnet Europa 111-104 ”Common validation, verification and accreditation framework for simulation, REVVA2”. Syftet med arbetet är att ta fram en teknisk plattform för en gemensam generell VV&A-metodik.

Resultatet från samarbetsprojektet skall utgöra dokumentationen av det förslag till en generell VV&A-standard som skall lämnas in till SISO, Simulation Interoperability Standards Organization.

Nyckelord: VV&A, M&S, validering, verifiering, ackreditering, VV&A-process, VV&A-metodik

Summary

Verification, validation and accreditation (VV&A) is a process which aims to increase the credibility of simulation models and provide their users with information regarding their suitability for a given purpose. *Verification* is the process of determining whether a model implementation and its associated data accurately represent the developer's conceptual description and specifications. *Validation* is the process of determining whether a model and its associated data provide an accurate representation of the real world from the perspective of the intended uses of the model. A*ccreditation* is an official certification that a model, simulation, or federation of models and simulations and their associated data are acceptable for a specific purpose.

The VV&A process also contributes to become aware of errors and deficiencies in the early phases of the development of simulation models, which is of great economic value. This requires a well analyzed method for VV&A activities, which also should be tailored for the specific application.

Our activities have three different focuses: research concerning methods and techniques for VV&A; support to the Swedish Armed Forces to implement a suitable VV&A-process; and dissemination of knowledge concerning VV&A.

During the years 2006 to 2008 the project has participated and focussed on the international project Europa 111-104 "Common validation, verification and accreditation framework for simulation, REVVA2". The aim with this work was to define and develop a platform for a common generic VV&A methodology.

During project time a study group within the VV&A Community has proposed that the result from this effort should be leveraged as a standard generic VV&A methodology. The first steps have been taken and a group, mainly REVVA2-members, is now formed to work for this standardisation together with SISO, Simulation Interoperability Standards Organization.

Keywords: VV&A, M&S, validation, verification, accreditation, VV&A process, VV&A methodology

Innehållsförteckning

1 Inledning

Detta är en rapport från projektet ”VV&A-kompetens för FM och REVVA2”

Rapporten redovisar läget om pågående metodikutvecklingsarbete inom området VV&A (Verifiering, Validering och Ackreditering) inom M&S (Modellering och Simulering).

Det första kapitlet ger en kort bakgrund om arbetet och en kort målbeskrivning. Kapitel 2 ger information om genomförandet av arbetet under året och kapitel 3 ger en översiktlig bild av metodiken som har utvecklats och är ämnad att kunna gälla som en framtida generell standard för VV&A inom M&S.

Arbetet är finansierat med medel inom FoT M&S.

1.1 Projektet

Arbetet innebär metodutveckling för VV&A inom M&S. Arbetet utförs till övervägande del inom det internationella samarbetsprojektet REVVA2 som är ett Europa-projekt, EUROPA 111-104, inom EDA. REVVA2 är ett fortsättningsprojekt till REVVA (THALES JP 11.20) som genomfördes under 2003 och 2004. REVVA2 upphör formellt 2008. Arbete med metodiken kommer dock att fortsätta även 2009 främst i form av fallstudier och standardiseringsansträngningar.

1.2 Bakgrund

Bakgrund till REVVA2-arbetet är behovet av en generell V&V-metodik inom M&S. VV&A är en mycket viktig aktivitet inom M&S, enär användning av M&S ökar och ingår i många av försvarsmaktens verksamheter. Behovet av att veta att de simuleringsmodeller som används och de data som erhålls från simuleringar är giltiga och trovärdiga växer med ökande användning och är också ytterst en fråga om risk och säkerhet.

Detta har också uppmärksammats och internationellt görs stora insatser för att ta fram och utforma användbara metoder för verifiering och validering och för att kunna ackreditera användning. Några av de mer välkända arbetena är:

- ITOP, International Test Operations Procedure,
- SISO VV&A Overlay to the FEDEP,
- VV&A of Federations, NMSG 019 (TG 016),
- M&S VV&A Guidebook, Canadian Departement of National Defence Synthetic Environment Coordination Office (DND SECO),

Andra arbeten som gjorts eller är på gång är:

- Interim Defence Standard 03-44, UK, 2007,
- V&V of Advanced Systems at NASA, Northrop Grumman Corp, 2002,
- M&S VV&A Implementation Handbook, Navy M&S Management Office, 2004,
- M&S VV&A Documentation Templates, DoD Standard Practice, draft Mil-STD-xxx002, 2007.

Även DMSO har mycket omfattande men ganska spretigt och svårtillämpat material om M&S VV&A.

1.3 Mål

Som synes av namnen på ovanstående arbeten är de oftast framtagna för ett specifikt ändamål, en specifik användare eller verksamhet. Ett mål med REVVA2-gruppens arbete är att ta fram och beskriva en generell metodik för VV&A inom M&S. Detta har också tagit sig uttryck i att en sådan beskrivning ska kunna gälla som en standard. Det andra målet med arbetet är också att få igenom denna metodik som en gällande standard.

1.4 Deltagande länder

Sex nationer har deltagit i olika utsträckning i REVVA2-arbetet. Varje land har haft representanter både i en teknisk (TG) och i en management grupp (MG) inom REVVA2. Ingående nationer är Frankrike (ordförande), Danmark, Nederländerna, Canada, Sverige och Storbritannien (England).

I samband med standardiseringsarbete har projektet också haft många kontakter och möten med amerikanska experter inom området. Bland dessa kan nämnas Simone Youngblood, MSCO (tidigare DMSO) och Scott Harmon, Zetetix.

2 Genomförande

2.1 Definition av arbetet, arbetspaket, dokument och dokumentstyrning

Vid arbetets start 2006 definierades arbetet genom att Requirements Specification (REQSPEC) togs fram. I detta definierades arbetspaket och tidplan samt arbetsmängd och område för respektive deltagande nation enligt överenskommelse. Denna plan utgick från arbete och resultat från tidigare REVVA-arbete varför strukturen var i stort sett densamma som då.

Arbetspaket:

- WP0: Management (FR),
- WP1: Co-operation, dissemination and standardisation (FR),
- WP2: Specification and production of a VV&A methodology (FR),
- WP3: Development of fundamental concepts (SW),
- WP4: Techniques and tools (NL),
- WP5: Illustration by application (CA).

Inom parantes anges ansvarig nation (Frankrike, Sverige, Holland, Canada) och alla nationer var dessutom medansvariga mer eller mindre i andra paket förutom det egna. Dessutom åtog sig Danmark att stå för och underhålla en internetbaserad arbetsplats för att lagra dokument och för informationsutbyte. England deltog med kvalificerat stöd i form av medverkan av en representant från näringslivet.

2.2 Omdefinition av arbetet mot standardisering

Redan i mitten av 2006 togs beslut att REVVA2-arbetet skulle inriktas mot att utarbeta ett förslag till standard inom VV&A. Detta medförde, eftersom det redan då insågs att tiden och den bestämda insatsen inte skulle räcka till för båda inriktningarna, dvs. både WP enligt ovan och dokumentframtagning för beskrivning av standard, att det krävdes ett omdefinierat REQSPEC. En sådan gjordes första gången under sensommaren 2006 och ändrades en gång under januari 2007 samt justerades ytterligare en gång under våren 2007.

Denna nya ordning var anpassad till det som SISO ("Simulation Interoperability Standards Organization") kräver i fråga om dokument för standardisering och det beslutades att vi skulle ta fram fyra dokument som beskriver REVVA2-metodiken:

- Reference Manual (RM),
- User Manual (UM),
- Technical Notes (TN),
- Recommended Practice Guide (RPG).

På samma sätt som för de tidigare arbetspaketen tilldelades motsvarande insatser inom de nu definierade produkterna. Produkterna skulle produceras i flera steg; konceptversion,

draftversion och slutgiltig version. Verksamheten blev nu också inriktad mot att arbeta med och beskriva aktiviteter i stället för att utveckla specificerade arbetspaket.

2.3 Arbetssätt

Efter halva projekttiden formades ett ”Tiger team” i tekniska gruppen för att effektivisera dokumentskrivandet. Resten av tekniska gruppen fick därmed en mer granskande uppgift.

2.3.1 Möten och skrivarbete.

Ett stort antal möten har ägt rum under året, främst för dem som deltagit i ”Tiger team”.

Förutom dessa möten har många telefonkonferenser använts flitigt vid sidan om e-post-kommunikation för att diskutera och utväxla information.

2.3.2 Konferenser

Det är i huvudsak SIW-konferensen (Simulation Interoperability Workshop) som är i hög grad relevant för REVVA2-arbetet och vi har bevistat både vår och höstkonferensen samt Europakonferensen av SIW. Dessa konferenser har också innehållit möten i REVVA2-gruppen samt presentationer inom GM-VV (Generic Methodology for Verification and Validation and Acceptance of Models, Simulations, and Data) PDG, Product Development Group. För ytterligare förklaring om GM-VV se under begreppet ”Namn” i avsnitt 3.

Vid de senaste SIW-konferenserna har FOI medverkat med/varit medförfattare till tre olika presentationer inom VV&A-området:

- 07f-siw-015, A Method for VV&A Tailoring: The REVVA Generic Process Tailoring Case Study,
- 08s-siw-020, Towards A Generic Data Information Model for VV&A,
- 08s-siw-048, Verification, Validation &Accreditation of Legacy Simulations using Business Process Modelling Notation.

Se Referenser, avsnitt 6, för mer detaljerad information.

2.4 Utbildning och användning

Eftersom VV&A-processen för GM-VV arbetet ännu inte funnit fast form och mallar inte tagits fram har vi inte kunnat erbjuda någon kursverksamhet eller utbildning enligt konceptet.

3 Resultat

Slutskrivning pågår fortfarande av dokumenten men ansträngningarna görs nu främst på att de ska vara konsistenta.

Första omgången mot SISO reflector

Ett försök gjordes att presentera metodiken för ett år sedan då referensmanual (RM) och användarmanual (UM) gjordes tillgängliga på SISO reflectorn (hemsida hos SISO). De bemöttes dock av sådan stark kritik att det krävdes en ordentlig omarbetning av båda dokumenten. Detta har också medverkat till att arbetet med att färdigställa dokumenten ännu inte är färdigt.

Namn

Eftersom VV&A sedan länge har en skyddad betydelse, Verifiering, Validering och Ackreditering, och eftersom namnet på metoden skall ha eller vara en meningsfull akronym duger inte REVVA som metodnamn. Det är viktigare att lyfta fram i akronymen att vi avser en generell metodik varför vi har skapat GM-VV vilket står för Generic Methodology for Verification and Validation and Acceptance of Models, Simulations, and Data.

Skillnad från REVVA1

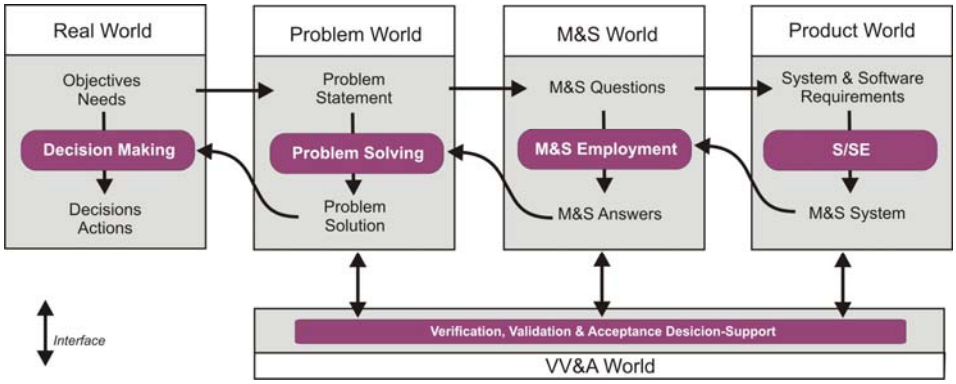
GM-VV bygger på REVVA1 men måste för standardiseringsändamål beskrivas mycket mer konsistent, på i det flesta fall vedertagna begrepp inom området och i det här fallet enligt SISO dokumentationsstandarder.

3.1 Metoden

Bilaga 1 består av den senaste presentationen från REVVA2 projektet och innehåller förutom metodiken också förutsättningar och korta beskrivningar av gjorda fallstudier. Istället för att översätta innehållet i bilaga 1 visas här i huvudtexten bara de viktigaste förutsättningarna och komponenterna av metodiken, för övrigt hänvisa till **bilaga 1** och den färdiga dokumentationen som kommer att vara tillgänglig under första halvåret av 2009.

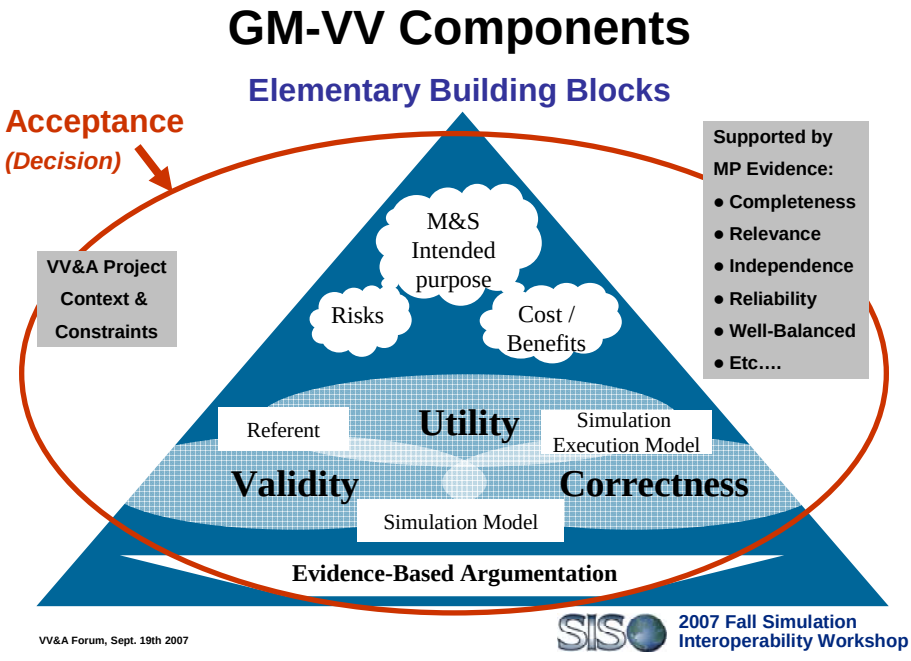
Förutsättningar

GM-VV definierar en fyra-världsvy, figur 1, för att positionera var VV&A av M&S är koncentrerad men också för att påvisa hur viktigt det är att se hur processer i systemutveckling och ”software engineering” samverkar och måste länkas ihop med liknande processer i M&S –världen. Faktum är att mycket av de vedertagna metodikerna och standards som finns i dessa båda världar kan återanvändas i M&S- och VV&A-världarna. Detta gör också GM-VV. Detta beskrivs på ett åskådligt sätt i GM-VV referensmanual.



Figur 1. Fyra världarnas vy

Figur 2 visar de viktigaste faktorerna för att kunna acceptera eller ackreditera en simuleringsmodell, en simulering eller resultat erhållna från en simulering. Grundläggande komponenter är nytta, giltighet och korrekthet vilka alla tre måste vara sanna för acceptans. Här finns dock stora variationer. Välkänt är också det stora spannet mellan att använda en enkel modell vilken ändå kan vara fullt användbar för att uppnå ett specifikt syfte och att använda en avancerad modell, validerad för många användningar, men ändå inte lämplig. (Useful but unvalid or valid but not useful.) Man kan också uttrycka sig så att om en simuleringsmodell är användbar för ett specifikt syfte så är den också giltig (valid) för just detta syfte.



Figur 2. Acceptanstriangeln

3.2 Metodbeskrivning

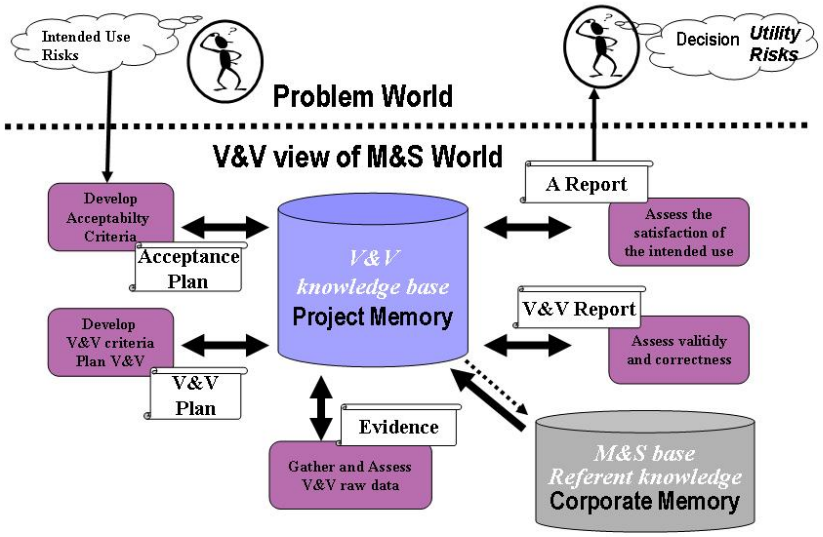
Följande är en mycket kort beskrivning av metodiken.

3.2.1 Grundläggande tre element

3.2.1.1 Process, Activity model

GM-VV definierar en process som beskriver flödet i hela V&V-arbetet, uppdelat i aktiviteter eller delprocesser. Flödet är mindre konsekutivt än i REVVA1 som var mer en V-process med delprocesser som avlöste varandra. Men redan i REVVA1 fanns loopar tillbaka i processen. GM-VV innebär i större grad att man skall arbeta mot ett datalager, ”repository”, och delprocesserna kan delvis genomföras samtidigt.

Figur 3 visar ett förslag till layout på process och produkter. Omarbetning pågår och detta är troligen inte slutversionen. Efterföljande text förklarar kortfattat produkter och innehåll.



Figur 3. Process och produkter, ”arbets” layout

3.2.1.2 Produkt

Varje delprocess i GM-VV processen ska dokumentera sitt resultat i en produkt.

”The Acceptance Plan”,

är det överordnade dokumentet som innehåller:

- beskrivning av avsedd användning för modell, simulering eller data,
- definition av acceptanskriterier, Target of Acceptance (ToA), på en högre, funktionell nivå,
- riskidentifiering,

- risk/nytta värdering av VV&A-insats och anpassning av insatser efter behovet, ”tailoring”,
- rllokering och tilldelning av roller i arbetet,
- riskussion omkring betydelsen av kvarvarande osäkerheter .

”The Acceptance Report”

Innehåller en sammanställning av VV&A arbetet, hur väl acceptanskriterierna är uppfyllda, värdering av icke tillgodosedda funktioner och vilken betydelse kvarvarande osäkerheter har.

Denna rapport skall ligga till grund för Acceptansbeslutet av M&S användningen.

”The V&V Report”

Input till detta dokument är dels resultat som fås från ”V&V and Acceptance Evidence” (bara ”Evidence” i figur 4) dels hur dessa matchas av beskrivningen i ”V&V Plan”-en. Innehållet i detta dokument ger dels ”Acceptance Leader” underlag för att ställa samman ”the Acceptance Report” dels ger dokumentet stöd till ”Problem Owner” och ”M&S Sponsor” för att kunna fatta beslut om slutgiltig acceptans tillsammans med innehållet i ”the Acceptance Report”.

”The V&V Plan”

Detta dokument innehåller ytterligare nedbrytning av funktioner och förmågor hos modellen tills man når en nivå som medger att man kan finna ett mått eller kvitto på specifik funktion i form av en parameter. (ToVV, Target of Verification & Validation.)

Dessa parametrar skall vara sådana att det går att sätta ett värde på dem.

V&V-planen innehåller också en detaljerad plan för hur arbetet skall genomföras för att finna värden på de funktioner/parametrar som valts.

“The V&V and acceptance Evidence” (ToE, Target of Evidence)

Innehåller sammanställning av svar på om och hur väl de eftersökta funktionerna uppfylls.

3.2.1.3 Organisation

GM-VV definierar parter, roller som bär ansvar samt aktörer som spelar rollerna.

Definierade parter är:

- kund/användare,
- leverantör,
- V&V-part.

Roller och ansvar:

- Acceptansledare,
- V&V-ledare,
- V&V-implementerare,
- ”V&V Information Manager”,

- ”V&V Project Manager” .

Aktörer:

- Aktörer är personer som träder in i de olika rollerna och som har tillräcklig kunskap och erfarenhet för att kunna utföra arbetet.

3.2.2 ”Tailoring”

”Tailoring” innebär anpassning av insatser: arbete, organisation och dokumentation efter behovet och där det ger mest nytta. Det som avgör vad som ger den bästa utdelningen kan vara av ekonomisk och/eller säkerhetsmässig art.

3.2.3 Datalagring, ”Repository”

GM-VV processen är i hög grad uppbyggd på att det finns möjlighet till datalagring av information, dokumentation och resultat. Effektivt utnyttjande av sådana lager kräver lämpliga verktyg vilket också studeras inom projektet och i samarbete med projekt som arbetar med sådana frågor.

3.3 Tillämpningar

Inom REVVA2 gruppen har både nationella och över gränserna gemensamma tillämpningar av REVVA metodiken genomförts. De tre större gemensamma är samarbete med CBRN (Jacquart et al., 2008), valideringsarbete för jämförelse av spridningsmodeller, MALO-projektet (Espenant et al., 2007) och OC1 (Espenant et al., 2008).

CBRN-arbetet gick ut på att jämföra och på ett metodiskt sätt beskriva olika europeiska länders modeller för spridning och påverkan av toxiska ämnen i olika miljöer. CBRN-projektet fick på detta sätt viss hjälp med VV&A-aspekter medan REVVA2-arbetet har fått en chans att testa GM-VV metodiken.

I Sverige genomfördes dessutom 2006 inom LKS-arbetet de första stegen i REVVA1-metodiken, vilket var till stor nytta främst för återföring av erfarenheter till arbetet med REVVA2 och GM-VV. (Nilsson & Svan, 2006)

I bilagorna 2-5 följer sammanfattningar/abstract från dessa arbeten.

Dessa fallstudier har dock i huvudsak tillämpats med den metodik som togs fram under REVVA1. GM-VV är ännu inte färdigdokumenterad och det finns inget färdigt tillämpningsarbete med GM-VV metodiken.

4 Fortsatt arbete

Under resten av den tid som REVVA2 är i arbete (2008) kommer dokumentationen; Referensmanual, Handbok (användarmanual) och RPG att slutskrivas.

Det finns ett initiativ att 2009 fortsätta och ta hand om det arbete som utförts under REVVA2 då en ny M&S-grupp, NMSG 73, startar, .

Denna grupp får i uppgift att:

- driva igenom standardiseringsarbetet av GM-VV inom SISO,
- och därvid hantera kommentarrunda och ”balloting” arbete (röstning) som hör till processen,
- samla och samordna ansträngningar i fallstudiearbetena,
- återföra erfarenheter av detta till GM-VV metodiken och införa i dokumentationen,
- ta fram utbildnings- och kursmateriel av GM-VV.

För Sveriges del kommer vi i första hand koncentrera oss på att göra insatser i fallstudier, att följa arbetet i NMSG 073 och att kunna erbjuda utbildning av VV&A (GM-VV) till FM, FMV och FOI.

5 Förkortningar

CBRN	Chemical, Biological, Radiological, and Nuclear
FEDEP	Federation Development and Execution Process
GM-VV	Generic Methodology for Verification and Validation and Acceptance of Models, Simulations, and Data.
M&S	Modellering och Simulering
MG	Management group
REVVA	Metodik för Verifiering, Validering och Acceptans
REVVA1	Arbetsgrupp *och* metodik
REVVA2	Arbetsgrupp
RM	Reference Manual
RPG	Recommended Practises Guide
SISO	Simulation Interoperability Standards Organization
SIW	Simulation Interoperability Workshop
TG	Technical group
TN	Technical Notes
ToA	Target of Acceptance
ToE	Target of Evidence
ToVV	Target of Verification and Validation
UM	User Manual
V&V	Verifiering och Validering
VV&A	Verifiering, validering och Ackreditering

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M. Roza, J. Voogd, C. Giannoulis. Paper presentation 08s-siw-020, Towards A Generic Data Information Model for VV&A, 2008.

Bilaga 1 – GM-VV presentation på NMSG 60 Symposium

Verification, Validation and Accreditation (VV&A): The GM-VV contribution and roadmap

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VERIFICATION, VALIDATION AND ACCREDITATION (VV&A): THE GM-VV CONTRIBUTION AND ROADMAP

Increasingly, Modelling and Simulation (M&S) is being exploited as an enabling technology to support tactical, operational and strategic objectives and shape decision-making within the military domain. Verification and Validation (V&V) of models and simulations are intended to ensure that only correct and suitable results are used thereby facilitating risk management with regards to M&S use as well as supporting and contributing to the organizational Knowledge Management (KM) strategy focusing on M&S interoperability and reuse.

Recognizing the risk of use and misuse of M&S in a domain that looks to improved interoperability and reuse, decision-makers must be cognizant that the simulation may "…appear more realistic than the underlying data and algorithms would suggest….resulting in 'Garbage in, Hollywood out!'"[1]. With this in mind, the value and importance of embracing a VV&A policy and methodology is reinforced.

This paper presents the work of REVVA 2 consortium that, under the auspices of WEU and the Simulation Interoperability Standards Organization (SISO), have focused on developing a generic and comprehensive VV&A methodology to be submitted as an internationally recognized standard and recommended practice for the application of VV&A. The REVVA methodology has been applied in a number of military M&S projects and has incorporated the contributions of NMSG 19/TG 16 VV&A of Federations. A discussion of how the work on VV&A will impact defence M&S out to 2015 and beyond will be addressed as well as recommendations to fill the gaps that have been identified by the international VV&A work.

1.0 INTRODUCTION

Preparing to deal effectively with the changing risks, complex and emerging threats and threat perceptions of the future security environment is a major challenge for decision makers within the defence domain. The NATO Alliance will be required to face the threats associated with terrorism, instability due to failed or failing states, regional crises and conflicts, and their causes and effects, the growing availability of sophisticated conventional weaponry; the misuse of emerging technologies; and the disruption of the flow of vital resources [2].

To address these challenges, M&S is being used as an enabling technology across many domains to support tactical, operational and strategic objectives and has become a powerful and resource-efficient capability for:

- Training and education;
- Mission analysis and rehearsal;
- Decision support (such as exploration of doctrinal alternatives);
- Capability management;
- Investigation of leading-edge technologies;
- Effective support to the acquisition process; and
- Concept development and experimentation.

Coupled with the Future Security Environment (FSE), the challenges afforded by emerging concepts such as Network Enabled Capability (NEC) and Network Centric Operations (NCO) look to advances in M&S to address the underlying complexity associated with these domain applications. With Defence initiatives such as Future Combat System (FCS), the requirement for the application of M&S is a precursor for the effective realization of new capabilities and systems.

The effective use of M&S in these applications necessitates insights into the utility, validity and correctness of the models and simulations within the context of their intended purpose. As articulated by Sargeant (2001) "The developers and users of these models, the decision makers using information derived from the results of these models, and people affected by decisions based on such models are all rightly concerned with whether a model and its results are correct. This concern is addressed through model verification and validation" [3]. Tullos-Banks (2005) describes Verification, Validation, and Accreditation (VV&A) as "three interrelated but distinct processes that gather and evaluate evidence to

determine the simulation's capabilities, limitations, and performance relative to the real-world object that it simulates, based on the simulation's intended use. The goal of VV&A is to assist the user in making an informed and independent judgment in regards to the credibility of Models and Simulations (M&S) being used in a specific program or project of interest to the user" [4].

As discussed in detail by Brade [5], "The main driver for the V&V of models or simulation results is the risk incident to their application…. Simulation results must only be used, if they are sufficiently credible with respect to the impact of their use, and the influence of the simulation results in comparison to other non-M&S influences ("conventional" information) ". With the introduction of serious gaming and improved animation and 3-D graphics, decision-makers must be cognizant that models and simulations may appear "…more realistic than the underlying data and algorithms suggest" thereby revising the adage from "'garbage in, garbage out' to 'Garbage in, Hollywood out'" [1].

Many decisions, which involve large amounts of money, impact organizational efficiency, geopolitical consequences and human lives, are already based on simulation results. The weakness or scarcity of data sources, the difficulties to define reproducible, predictable experimental frames are so important that M&S of complex systems (aggregated, including human in the loop, devoted to high level training) are very inclined to suffer from what is known as errors of type I (rejecting valid outcomes), type II (accepting invalid outcomes) or type III (solving the wrong problem). The aim of VV&A is to increase the trustworthiness of M&S products through a disciplined process of capturing and analyzing evidence of the simulation performance.

To address the shortcomings in the M&S community with regards to the application of VV&A, the Generic Methodology for Verification, Validation and Acceptance (GM-VV) was developed by the Simulation Interoperability Standards Organization (SISO) GM-VV Product Development Group (PDG). The intent of the GM-VV is to provide a generic methodology for making formal and well-balanced acceptance decisions on a specific usage of models, simulations and data. Leveraging the work of REVVA 1 and REVVA 2 (Reference Project for VV&A) consortium, comprised of an international membership including France, Denmark, Sweden, UK Industry, The Netherlands and Canada, the SISO PDG aim is to develop an internationally accepted generic VV&A standard.

2.0 RATIONALE FOR A GENERIC VV&A METHODOLOGY

Despite the fact that the existing standards, methods and practices have contributed to the M&S community, there are still aspects of VV&A that have not been adequately addressed or cannot be facilitated by a method.

To the best of our knowledge no VV&A method generic enough exists to facilitate all M&S applications. Existing standards, practices and methods are dependent on a specific technology (e.g. IEEE 1516.4 on HLA [6]) or on a specific development paradigm (e.g. waterfall, the FEDEP [7]). Therefore, there is a need for a method that will be able to address both universal aspects of VV&A within M&S, while at the same time be subject to tailoring in and meet the specific needs of any M&S product within any domain (e.g. M&S for training).

Another consideration is sharing of knowledge and its reuse. As described in ITOP [8] there are no common procedures when planning, implementing and documenting VV&A efforts and in most cases they are executed in various non-uniform and incompatible ways. Such heterogeneity stresses the need for a method that should be able to facilitate the

complexities of knowledge exchange and reuse in M&S. Thus, it should lead to formalized sets of products and processes adoptable to diverse organizational forms.

Moreover, an additional need comes from the fact that VV&A currently faces a shift from being project based to enterprise service oriented. Well established members of the M&S community (e.g. NASA's IV&V Program [9], Aegis' VV&A program execution [10] Pitch's strategy for long-term M&S investments based on interoperability and reuse [11]) are moving M&S on enterprise levels, thus constituting VV&A as a service essential beyond the boundaries of a single project, investing on interoperability, knowledge capitalization, sharing and reuse in the long run. Such a shift of focus is driven by the need for more effective and efficient VV&A efforts balancing confidence, objectivity and quality assessment, with risks and costs.

Confidence, objectivity and quality assessment depend both on maturity (e.g. a validation process maturity model [12]) as well as on different V&V levels (e.g. residual uncertainty, rigor, etc. [13]). At any case, final outcomes of VV&A efforts are accompanied with related uncertainty, which varies depending on many parameters (e.g. criticality of the M&S product use, availability of resources, etc.). By definition no absolute acceptance assessment on an M&S product is realistic, therefore effort needs to be put on quantifying the related uncertainty to support the assessment's confidence, objectivity and quality affecting both the risks and costs involved.

3.0 GM-VV DESIGN CONTEXT, RATIONAL AND ASSUMPTIONS

Models and simulations are not entities that exist on their own or for any unknown purpose. Instead models and simulations are developed and employed to fulfil the needs of its intended users and other stakeholders. It is within the objectives of a whole operational context in which the benefits, cost and risks of utilizing models or simulations have to be assessed in order to make well informed acceptance decisions on using their outcomes. Therefore, the GM-VV vision on VV&A is strongly centred around an evaluation process of the model and simulation utility and confidence with respect to the outcomes from the actual employment environment and operational objectives perspective. The principle VV&A endeavour objective in this global GM-VV vision is to provide the information and arguments necessary to support stakeholders in the acceptance decision-making process on the utilization of models, simulations, underlying data and outcomes to satisfy their goals.

The methodology design associated with the GM-VV is compliant, builds-upon and complements well-established systems engineering and other international standards and incorporates argumentation mechanisms with various levels of formality that allows for both rigorous and traceable decision making.

Due to the wide range of domains in which models and simulations are employed, the methodology has been designed to be independent of any particular M&S system development paradigm and technology. Moreover, the design is tailorable in such a way that methodology can meet or conform to any specific needs, procedures, standards or policies that are common practice in certain domains or organisations. In here the required VV&A information and products that have to be developed during a VV&A endeavour are the most stable factor. The GM-VV design is thereby strongly product oriented and its tailorability is primarily accomplished through adaptation of processes and organisational elements.

According to the GM-VV vision, the VV&A endeavour investments must be balanced in accordance with the model and simulation operational objectives, cost and risks, hence the methodology is goal-oriented and product driven. GM-VV provides the language, methods, practices and techniques that facilitate better communication and capture the interplay between and allocation of VV&A resources, stakeholders' needs, and M&S use risks throughout the VV&A endeavour.

4.0 GM-VV KEY CONCEPTS AND COMPONENTS

4.1 The Global GM-VV Approach to VV&A

The basic premise for GM-VV is that any model or simulation artefact is considered to be a system. This total (training, analytical, etc.) system is referred here as the M&S system and provides a solution to resolve the problem or needs of users and stakeholders. A four-world view has been adopted by GM-VV to structure the world in which the problem is addressed (**Figure 1**). In the first of these four worlds, the real world, a need may arise that requires certain decisions or actions. These translate into a problem statement which has to be solved in the problem world. Within the context of GM-VV, the M&S world is the way to solve this problem through a well-controlled employment of the M&S system. This M&S system is the result from a systems engineering process within the product world.

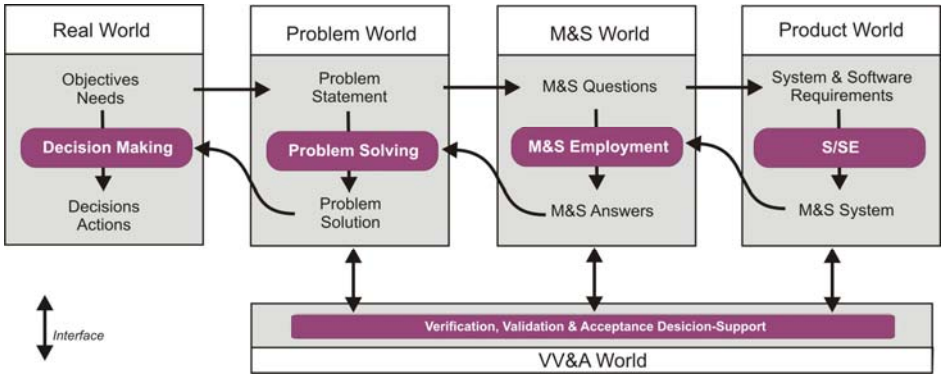

Figure 1: The VV&A World and the Four Worlds of Problem Solving

GM-VV considers VV&A as a separate problem domain with its own specific objectives and issues. This domain is referred to as the VV&A world. The objective of this VV&A world is to provide acceptance decision support throughout the whole M&S system life cycle. The world diagram also clearly demonstrates that the system of interest for VV&A extends beyond the M&S system itself in the product world. The VV&A system of interest also includes the evaluation of the operational context in terms of the M&S system employment and outcome utilization process and organisation.

The key activities in the GM-VV VV&A worldview comprise M&S system verification, validation and acceptance decision support. Within the GM-VV, verification yields evaluation of the M&S system correctness and validation yields evaluation of the M&S system validity. Acceptance decision-support yields the development of an acceptance recommendation based on the outcomes of the verification and validation activities complemented with an evaluation of the M&S system utility. Each of these three

interrelated property classes address and provide a set of metrics for evaluating a specific part of an M&S system:

- *Utility:* Assesses the effectiveness and efficiency of the M&S system in solving the real-world needs from an operational M&S employment context. Evaluation metrics for utility comprises three areas: value or benefits (MoE, MoM, etc.), costs (money, time, etc.) and use risks (impact, money, etc.)
- *Validity:* Assesses the level of agreement of the M&S system behavioural representation with that of the real system. Validity metrics are also used to assess the consequences any behavioural discrepancies have on the utility of the M&S system.
- *Correctness:* Assesses whether the M&S system implementation conforms to the model specification, is free of error and of sufficient precision. Correctness metrics are also used to assess the consequences of implementation discrepancies on both the validity and utility of the M&S system.

Besides these three properties, GM-VV evaluates for the M&S system an extra property class that are defined in relationship to one or more utility, validity or correctness properties. These so called, meta-properties contain metrics for evaluation of aspects such as reliability, completeness and independency.

Within this GM-VV framework of VV&A properties, M&S acceptance is given a precise definition in terms of acceptability criteria. A rigorous goal-oriented requirements engineering approach is provided by GM-VV to derive and justify the acceptability criteria for the utilization of the M&S system to accomplish the stakeholders goals. Demonstration whether such acceptability criteria are met by the M&S system, requires the presence of appropriated evidence to be able to justify such a claim. To this extent, GM-VV provides a strong evidence-based argumentation approach to properly acquire evidence and formal reasoning with this evidence in relationship to these acceptability criteria.

4.2 The GM-VV Product, Organization and Process Pillars: A Layered View

GM-VV has adopted a three-pillar view to structure and translate its underlying VV&A approach, concepts and methods into a single consistent methodology. These GM-VV pillars are the VV&A product, organisation and process pillars. The product pillar specifies all principle VV&A products that should be developed throughout a VV&A endeavour. This pillar contains the most precise and formally defined technical components of the methodology, which are the least negotiable and tailorable. The process pillar specifies all VV&A technical and related life-cycle processes that deliver the VV&A products in the aforementioned pillar. These processes are an instantiation and extension of the IEEE system life-cycle process standard [19] [23] [24] [25]. The third pillar provides the minimal organisational context for conducting VV&A. This context is specified in terms of assigned authority, responsibilities and obligation relationships with respect to the required VV&A products and their delivery processes. A layered view is adopted by the GM-VV to further structure this organisational context and to facilitate the actual deployment of the methodology. **Figure 2** shows a schematic diagram for how this fits into the overall methodology.

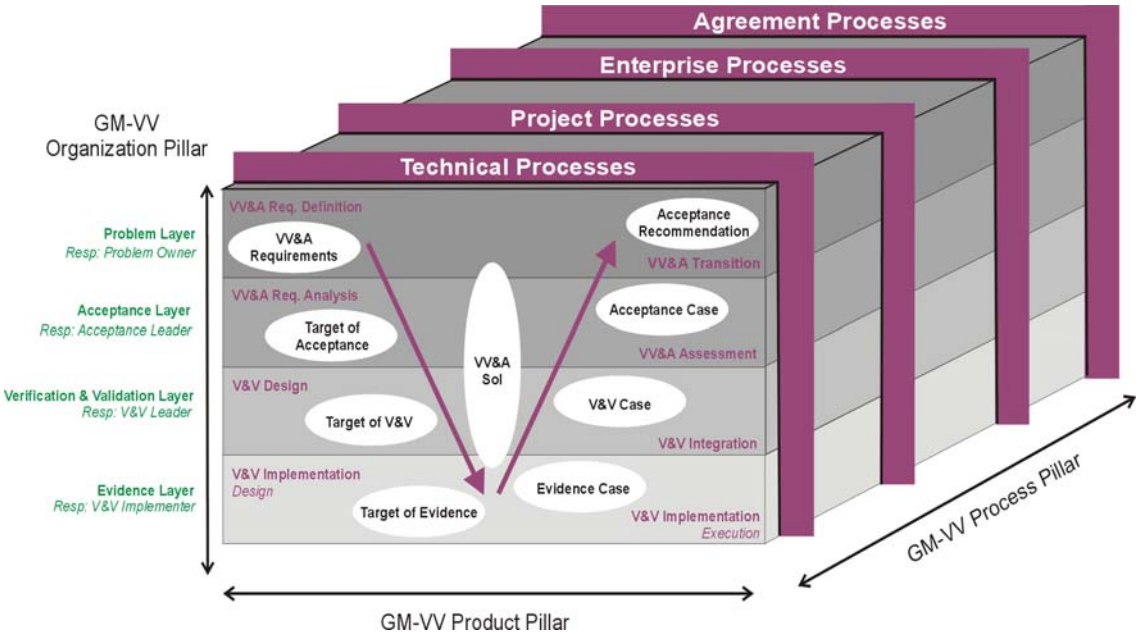

Figure 2: GM-VV Global Methodology Overview

In **Figure 2** the tabs along the process pillar axis resemble the four major sets of life-cycle processes part of the GM-VV. Each of these sets contain several related processes that can interact with any of the other processes inside the whole process pillar.

4.2.1 Problem Layer

The top-level layer of the GM-VV is the problem layer. The problem layer gives the operational context in which the VV&A endeavour is initiated, contracted, performed and the produced deliverables are deployed. From the technical processes perspective, this layer is governed by the M&S problem owner. It is the problem owner who is responsible for defining the requirements posed on the VV&A endeavour to ensure that the desired VV&A results are produced in order for him or her to make a well-informed acceptance decision.

Usually the actual VV&A requirements definition process is delegated to the acceptance leader, who develops the VV&A requirements for the problem owner. This acceptance leader is considered in GM-VV as the technical lead engineer for the whole VV&A endeavour. Through an agreement process he or she will negotiate with the problem owner stakeholder until a final agreement is achieved. Usually but not necessarily, he or she comes from the VV&A agency which is contracted by the VV&A acquiring party to conduct the VV&A endeavour. In some cases multiple agencies could be involved or subcontracted to execute some parts of the VV&A project or service. Such considerations are also made in the problem layer as part of the agreement process and reflected in the VV&A requirements. In case any issues arise along the duration of the VV&A endeavour on a technical level, he or she will report and interact with the problem owner to reach an agreement on the resolution.

It is the acceptance leader's responsibility to assure that VV&A endeavour produces the VV&A results in accordance with the agreed VV&A requirements. Once these VV&A results are available, the acceptance leader shall produce an acceptance recommendation, thereby translating these results into an understandable and useful VV&A product. This

acceptance recommendation is considered in GM-VV as the final deliverable of any VV&A endeavour, however it is the problem owner's responsibility to sign off the delivered acceptance recommendation based on the agreed VV&A requirements. The problem owner thereby also becomes responsible for whether or not utilizing this acceptance recommendation in the decision-making process and thus also takes any liability for the possible consequences. This decision-making process is thus not part of GM-VV.

4.2.2 Acceptance Layer

The acceptance layer has as the primary objective to develop, manage and execute an acceptance strategy for producing VV&A results that can be transformed into a GM-VV acceptance recommendation deliverable. This acceptance recommendation has to satisfy the problem owner needs as specified by the VV&A requirements. To this extent, VV&A requirements are subjected to a careful analysis process, which shall produce an appropriate and feasible acceptance strategy. This acceptance strategy is called in GM-VV; the target of acceptance (ToA). The ToA and all other technical VV&A products, which are developed in this layer, are under the responsibility of the acceptance leader. In case an appropriate ToA is not technically feasible within the imposed VV&A requirements, the acceptance leader should communicate and negotiate with the problem owner to reach an agreed resolution.

The ToA comprises a semi-formal goal-based argumentation network, which has the intended use of the M&S system at its root and the acceptability criteria that must be evaluated as its leafs. The ToA is developed from various information sources but at its basis stand the VV&A Requirements.

Based on the produced V&V cases, the acceptance leader should make an assessment on whether the M&S system meets the specified acceptability criteria. For this purpose, the acceptance leader is responsible for the GM-VV acceptance case (A-Case) that shall be produced. An A-Case comprises a semi-formal claim argumentation network, which has as its leaf nodes claims on the accomplishment of each acceptability criteria. The A-Case root node is a single acceptance claim on the M&S system employment in the problem owner's utilization context. An A-Case is developed by the evaluation of the evidence, available through the V&V case, against the acceptability criteria and justifying their integration into the acceptance claim. The A-Case thus provides all necessary evidence and rigorous argumentation to back-up an acceptance claim. Therefore, the A-Case is the basis on which the acceptance recommendation is established.

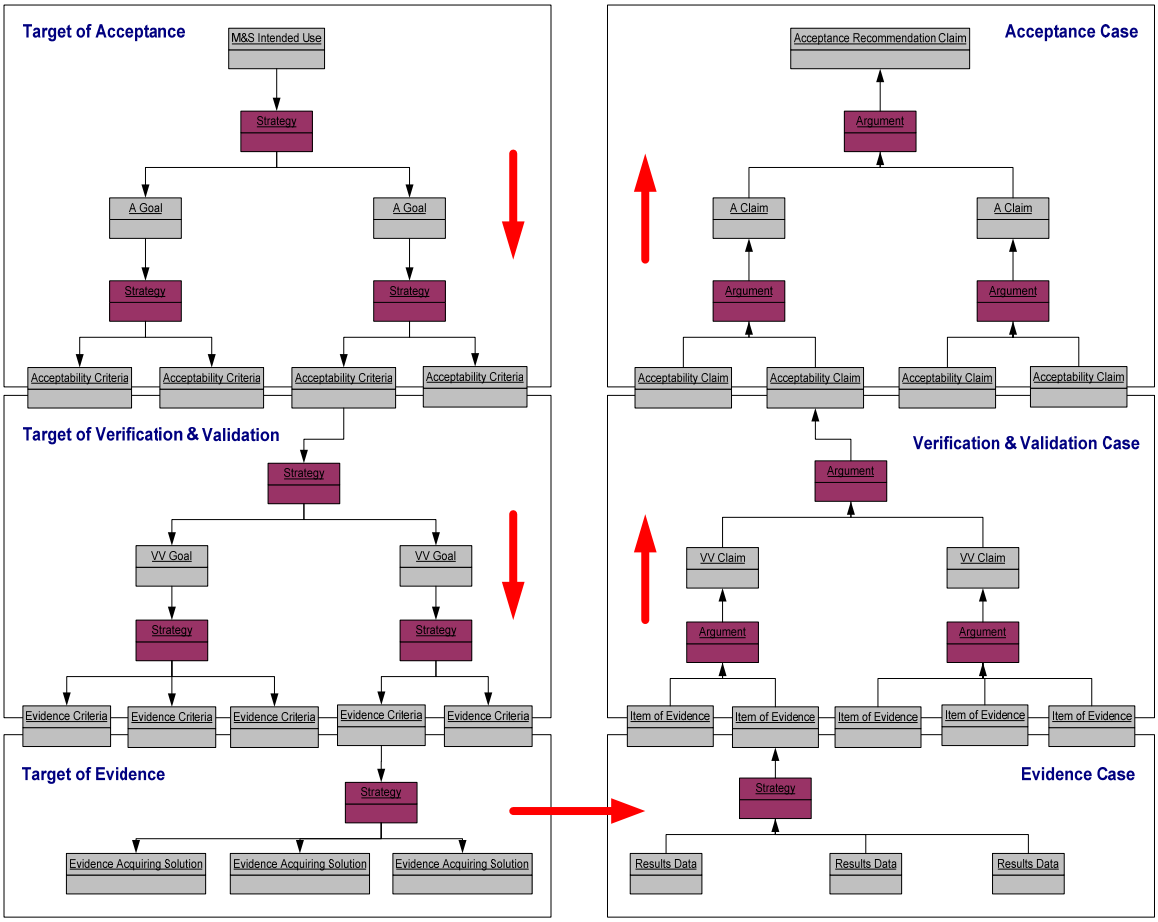

Figure 3: GM-VV Goal and Claim Argumentation Network for VV&A

4.2.3 Verification and Validation Layer

The primary objective of the verification and validation layer is to develop, manage and execute a verification and validation strategy for acquiring evidence that can be used to demonstrate the accomplishment of the acceptability criteria. To this extent, the ToA is used as the start-point to design an verification and validation experimental-frame or frames that specify the required evidence and criteria for their generation. These evidence criteria relate to one of the VV&A evaluation properties (utility, validity or correctness). In GM-VV, this strategy and frames shall be produced in the form of one or more targets of verification and validation (ToVV). The ToVV and all other technical VV&A products, which are developed in this layer are under the responsibility of one of more acceptance leaders. In case an appropriate ToVV is not technically feasible within the imposed VV&A requirements, the V&V leader should communicate and negotiate with the acceptance leader to reach an agreed resolution.

The ToVV comprises a semi-formal goal-based argumentation network, which has one or more acceptability criteria of the ToA as its root nodes and the criteria for the evidence that must be generated as its leafs. The ToVV is developed from various information sources but at its basis stand the ToVV. In this effort, it is essential that a deep understanding of the M&S system and its constituent subsystems is gained to properly develop evidence criteria. Such M&S system information refines and shall be capitalized in the VV&A SoI.

Based on the produced items of evidence the V&V leader should make an assessment on whether each item meets the specified evidence criteria. For this purpose the V&V leader is responsible for the GM-VV verification and validation case (V&V-Case) that shall be produced. A V&V-case comprises a semi-formal claim argumentation network, which has as its leaf nodes claims on the accomplishment of each evidence criteria. The A-case root node is a single acceptance claim on the M&S system employment in the problem owner's utilization context. A V&V-Case is developed by the evaluation of items of evidence, available through the E-Case, against the evidence criteria and justifying their integration into the acceptance claim. The V&V-case thus provides necessary integrated items of evidence and rigorous argumentation to back-up claims on the accomplishment of one or more acceptability criteria in the A-Case.

4.2.4 Evidence Layer

The primary objective of the evidence layer is to implement the VV&A experimental frames specified by one or more ToVV(s) to generate the required items of evidence. The implementation of these frames shall result in detailed implementation design strategies, referred as the target of evidence (ToE). The ToE comprises a semi-formal goal-based argumentation network, which has evidence criteria from the ToVV as its root nodes and specific VV&A techniques, tools, soft and hardware solutions as its leaf nodes.

Next step in the implementation is the execution of this ToE by means of deploying the specified experimental techniques, tools, soft and hardware to generate the items of evidence. The produced experimental data shall be assessed and integrated into a set of justified items of evidence. Again this is done by means of a semi-formal claim argumentation network. This resulting GM-VV product is called the evidence-case (E-Case).

4.3 The GM-VV Information Management Component

To facilitate a cost-efficient implementation of VV&A endeavours, GM-VV offers as an integral part of its methodology, the information management approach. This approach embodies the GM-VV concept of the pragmatic execution of and tool support for VV&A in both project and service-oriented operation modes. The GM-VV project and corporate memory product specifications are the technical realisation for this approach and facilitate the development of interoperable tools for VV&A.

The basis for these product specifications is the semi-formal GM-VV data information model, which captures all GM-VV technical and lifecycle process products information. The information model has also entries and capabilities to facilitate information management of advance VV&A aspects such as return of investment, risk and process maturity. Moreover, the GM-VV project and corporate memory specification also provides generic mechanisms and interfaces that allows for VV&A information import, export and views in different representational formats. Through this interface and the usage of schema in combination with template structures (plug-ins), various commonly used VV&A documentation sets can be generated or imported. This facilitates the adoption and tailored application of the GM-VV in organisations and communities that have their own VV&A standards and policies in place.

4.4 GM-VV Documentation Structure

The GM-VV is intended to be used by a broad range of stakeholders. Among many others, these stakeholders include decision-makers, acquires, suppliers, developers and user of M&S systems and VV&A products as well as developers of engineering support tools. The GM-VV is presented by means of three interrelated documents to facilitate the

information exposure and needs each of these stakeholders may have. The GM-VV handbook is the top-level document for the methodology. This document gives the methodology rationale and overview from an end-user's perspective. It provides guidance on deploying the methodology from both an enterprise and a project organisational viewpoint, in terms of what shall be done to deliver the required GM-VV products and related responsibility matrix. The GM-VV recommended practice guide presents a series of common best-practices, strategies, techniques and tools to effectively develop these GM-VV products. This is a how-to manual for the everyday VV&A practitioner. A full definition of what constitutes the methodology and its VV&A products is given by the reference manual by means of semi-formal specification. This document is intended for the real VV&A experts seeking deep understanding of the methodology or those who want to develop case-tools, knowledge-bases and repositories for VV&A endeavours.

5.0 CASE STUDIES

The Maritime Air Littoral Operations (MALO) project was conducted by Defence R&D Canada Ottawa as part of the Technology Demonstration Program. MALO comprises medium and high-fidelity models integrated into a distributed simulation federation supporting both constructive and virtual man-in-the-loop simulation and synthetic environment elements to facilitate tactics and doctrine development. In support of the REVVA 2 project, the MALO TDP was selected as an initial case study of the methodology [14]. The application of the VV&A Overlay (IEEE 1516.4) provided implementation guidance for the VV&A effort within the context of a distributed simulation. As the MALO TDP employed the Federation Development and Execution Process (FEDEP), the VV&A overlay proved to be most beneficial. Guiding the overall VV&A effort, the VV&A team employed the salient elements from the REVVA 1 methodology. Of particular note was the effectiveness of using the Goal Structure Notation (GSN) as the argumentation framework to develop the ToA and ToVV as depicted in figure 4 [26]. The Assurance and Safety Case Environment (ASCE) toolset was employed in the development of the ToA and ToVV and proved most helpful in developing the argumentation structure from which the V&V Test Plan emerged in addition to acting as a communication tool for the user and developer with regards to the VV&A issues.

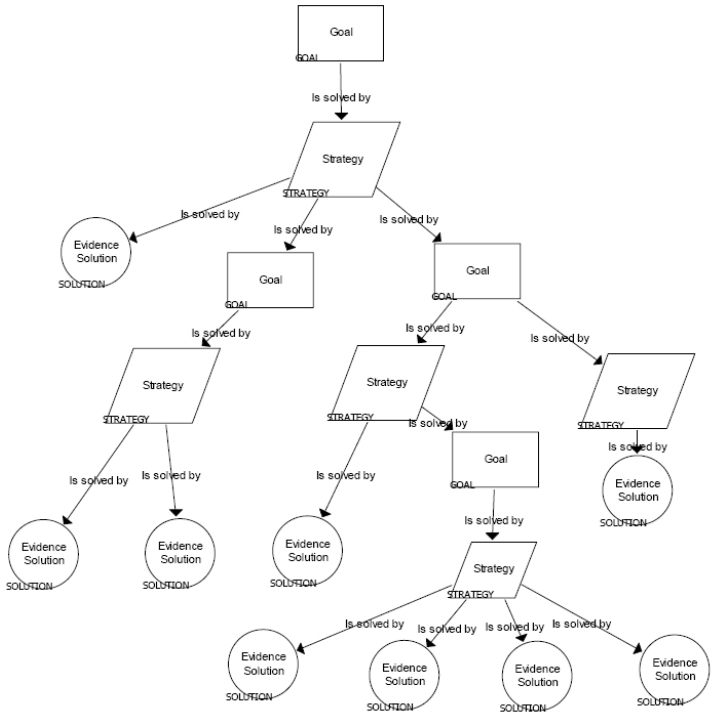

Figure 4: Goal Structure Notation based Argumentation Framework

To further develop and inform the REVVA 2 methodology, a second case study was conducted by DND SECO. The case study was conducted in support of War-in-the-Box: Exercise OLYMPIC CHALLENGE 1 (WIB/OC1). This simulation employed Air Force and Navy constructive and virtual simulations, linked together to create a joint synthetic environment to facilitate both operator and command and control training. The exercise represented the inaugural distributed simulation event of the Air Force Distributed Mission Operations Centre (DMOC).

Exercise WIB/OC1 was set in the west coast of Canada during the 2010 Olympics. The scenario was developed to support the training objectives of the participants and notionally commenced with airspace management including airspace incursions requiring visual identification of unknown aircraft.

The VV&A was conducted to evaluate the highest level claim with regards to the feasibility of the DMO for the conduct of air force training. As described in the technical notes of the GMVV, an argumentation framework was developed to facilitate the aggregation of evidence into claims in support of the high level ToA (figure 5). This goal-driven approach that characterises the REVVA 2/ GM-VV methodology was employed within the context of OC1 intended use, development, use-risk, cost benefits and project constraints. The results of the VV&A case study [15] revealed the strength of a well-articulated argumentation framework and disciplined approach to VV&A. This was particularly evident in the way the argumentation framework facilitated insights into the validity implications resulting from the fluid and dynamic changes that transpired during the development and execution phases.

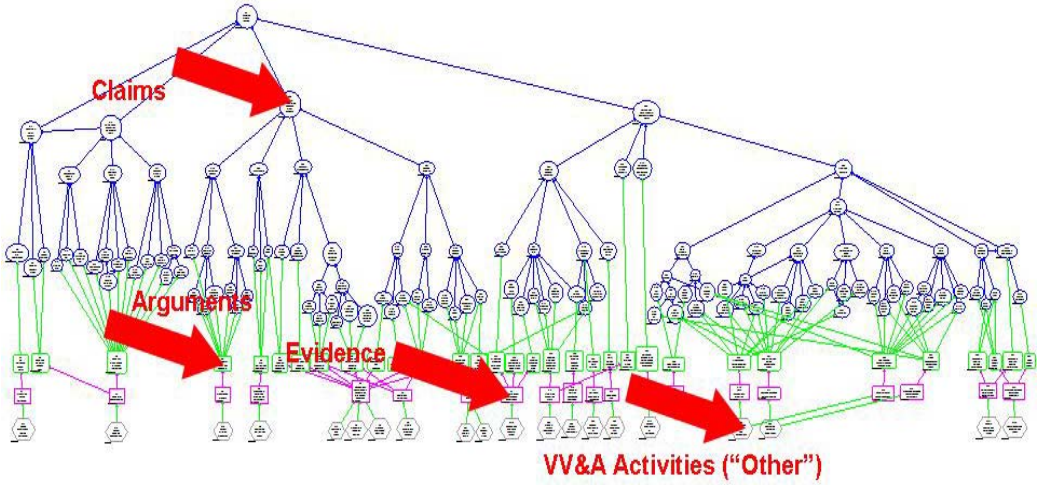

Figure 5: Argumentation Framework developed for OC1

A third case study was conducted which focused on the systematic comparison of chains of models for given generic (but somehow realistic) scenarios, in order to identify discrepancies between models, influential factors, and to improve or discard respective sub-models for the given purpose. The use of the REVVA/GM-VV methodology facilitated the comparison and the validation, which consisted of documentation of models (parameters, timing…), establishing verification steps during model setting, critical comparison between models, and possibly validation, after building the referents. The results of this effort demonstrated the versatility of the REVVA/GM-VV methodology in addressing M&S questions of validity outside of traditional simulation efforts.

6.0 FUTURE WORK

Unresolved issues persist within the M&S community as it pertains to credibility of results and VV&A. These issues include, risk, confidentiality and property rights, levels of uncertainty, objectivity, confidence, maturity model and tailoring. Some of these are currently being addressed in parallel VV&A initiatives. For example, NMSG 54 is currently examining Risk-Based Accreditation (RBA). The RBA employs the VPMM to evaluate the trade-offs between resource requirements and use risk. In this trade-off analysis, the risk associated with using the simulation depends upon the uncertainty associated with the V&V results and thereby stems from the techniques selected to perform the V&V tasks, which is related to the selected level of maturity.

The major objective of NMSG 73 is to create a follow-on process for finalizing the standardization work on generic VV&A for models and simulations. The TG will be responsible and engaged in specific activities with the following objectives:

- To finalize the work on the VV&A document set (this task started under the European REVVA consortium banner and is now under development by the SISO GM-VV PDG);
- To guide the proposed document set through the formal SISO standardization process;
- To participate in the review, commenting and balloting efforts needed for creation of a new SISO standard;

- To assemble confidence in and fine-tune the methodology on the basis of 'real' case studies; and
- To provide education and training based on a documentation set for dissemination.

7.0 CONCLUSIONS

Preparing to deal effectively with the changing risks, complex and emerging threats and threat perceptions of the future security environment is a major challenge for decision makers within the defence domain. Valid M&S applications can assist in providing insights into these challenges supporting tactical, operational and strategic objectives. The use-risk associated with the employment of M&S is revealed through the advent of VV&A initiatives.

This paper presented the challenges that we face now and in the future with regards to the application of M&S. To address these challenges the GM-VV provides added clarity to the issues at hand pertaining to VV&A. The main advantages of the GM-VV are:

- The GM-VV is focused on M&S products, however, it stems from principles that cover a wide range of existing standards and practices, both from the same domain (IEEE 1516.4-2007 [6], IEEE 1516.3-2003 [7], NASA-STD-I-7009 [16], UK Std [17] & SECO [18]) and others like Systems Engineering (IEEE 15288-2008 [19]; e.g. the GM-VV life cycle processes), Requirements Engineering (DMSO recommendations [20]), Safety & Security Engineering (NDIA Systems Assurance Guidebook [21], IEEE 1012.2004 [22]), Argumentation & Evidence Theory, Enterprise & Project Management Theory.
- Considerations on enterprise level, rather than project, are taken into account. Thus, the GM-VV extends the established project oriented approach other methods follow to service oriented. VV&A needs can be facilitated in the long run.
- Knowledge capitalization is put in the centre of attention as the GM-VV mandates the existence of an information model to support the VV&A effort, starting from a project basis (Project Memory), extending it to the enterprise (Corporate Memory) and facilitate knowledge sharing, reuse as well as interoperability.
- The VV&A effort is based on argumentation via a goal network structure providing reasoning and adequately documented arguments in a fully traceable manner to support the confidence on final outcome.
- The GM-VV includes a semi formal specification of its components, which constitutes the foundation for uniformity and interoperability due to the fact that it guides the development of tools to support VV&A.
- The GM-VV is generic, as suggested by the name, and therefore, when tailored as provisioned, applicable to any VV&A effort at any context, by any enterprise, regardless of the development paradigm followed, technology adopted or organizational structure established.
- Being generic, the GM-VV suggests a lightweight approach that does not require a long list of requirement to exist a priori. It is part of the method to build up and formalize the requirements needed for the VV&A effort.
- The method suggests different layers separating the concerns, responsibilities, needs and expectations for the different groups involved in a VV&A effort.

Moreover, the VV&A effort under the GM-VV is goal and product oriented. The goal network developed and evolved through the whole effort is the basis for the final (final recommendation) and any intermediate product generated.

The REVVA 2 project will be completed December 2008. The complete document set will be delivered to SISO January 2009 for standardization. At this point a new NMSG task group, NMSG-73, will oversee the standardization process, and contribute to further developments of the GM-VV documentation, leveraging the contributions from NMSG-54 and case-studies.

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Bilaga 2 - CBRN case study

A case study in applying the GM-VV VV&A methodology

ABSTRACT:
The Generic Methodology for Verification, Validation and Acceptance (GM-VV) is intended to provide a common generic framework for making formal and well balanced acceptance decisions on a specific usage of models, simulations and data. GM-VV will offer the international M&S community with a Verification, Validation (VV) and Acceptance methodology that consistently embraces a wide variety of M&S technologies and application domains. The GM-VV builds upon a triad of three pillars; the products, the organization and process pillar which are used to evaluate the Acceptability Criteria generated from the M&S intended use. In this paper the GM-VV has been used mostly in the initial VV&A activities and phases of the NBC-MODEL EUROPA project.

The NBC-MODEL EUROPA project started from the observation that a lot of legacy NBC simulation programs exist and that it is important to compare, complement and harmonise their contributions. This was the objective of the NBC-MODEL project per se. The NBC-MODEL project identified these simulations and decided simultaneously to explore the identification and specification of scenarios considered as reliable representation of operational uses. This was done by the NBC-MODEL project. In parallel the use and actual application of principles coming from the GM-VV has been considered by the NBC-MODEL project as a valuable input to reach their objectives.

This paper presents the basic context of the GM-VV and of the NBC-MODEL project for making the paper self-contained and then focuses on the NBC case study of the GM-VV. The article emphasizes the support offered by the GM-VV framework to reach the goals of the NBC project, say the comparison and evaluation complementarities of the considered NBC models. Some experiments supported by existing tools and lessons learned from these experiments are reported as well. The case study shows that dedicated tools for the support and organization of VV&A information are mandatory.

Bilaga 3 - MALO case study

Applying the SISO FEDEP VV&A Overlay to the MALO Project using the REVVA VV&A Process

31 December 2007

Executive Summary

The Maritime Air Littoral Operations (MALO) project was conducted by Defence R&D Canada Ottawa as part of the Technology Demonstration Program. MALO included medium and high-fidelity models integrated into a distributed simulation federation for the analysis of maritime doctrine and tactics by the Maritime Warfare Centre (MWC). The federation was created using the Federation Development and Execution Process (FEDEP), and it was important to assess the veracity and validity of MALO, ie, did the system represent what the user would want represented, and was the representation accurate in comparison with the real world. Further acceptance criteria included the ability of the MALO system to conduct the necessary doctrine and tactics analysis using existing and potential maritime systems and scenarios within a utilization process that could be conducted by the MWC.

The Synthetic Environment Coordination Office (SECO) wished to evaluate new processes for VV&A: an overlay for the FEDEP developed by the Simulation Interoperability Standards Organization (SISO), and a generic VV&A process for Modelling and Simulation (M&S) by the REVVA consortium. As a result, the MALO VV&A was conducted using an amalgamation of these processes, including creation of a VV&A plan using a new software.

There were significant limitations on the ability of the VV&A agent to conduct the project, including limited access to users and demonstrations, limited documentation from both the FEDEP and system development perspectives, and a late start to VV&A and a lengthy hiatus in the critical phase of MALO. As such, the degree to which the VV&A plan could be executed was limited.

According to the credibility criteria determined for the MALO system, the VV&A determined that MALO was tentatively acceptable for the intended use, but with significant uncertainty caused by insufficient information and lack of time and resources to complete all V&V activities.

The use of the SISO and REVVA processes was very successful – they showed their worth in the integration of VV&A with the FEDEP and in providing structure to define the necessary VV&A activities. The processes were amalgamated ad-hoc by the VV&A agent; one of the recommendations of the project was that a more formal amalgamation of the processes be created.

Bilaga 4 - OC1 case study

Verification, Validation, and Acceptance

of the

Olympic Challenge 1

Distributed Mission Operations Exercise

25 July 2008

Executive Summary

The Canadian Forces Air Warfare Centre includes a Distributed Mission Operations Centre (DMOC) whose goal is to stand up a permanent capability in the Air Force for conducting DMO training using distributed simulation amongst many Air Force simulation centres. The DMOC held its inaugural distributed exercise in June 2008 entitled Olympic Challenge 1 (OC1). The primary goal of OC1 was to show that they could create and run a distributed simulation exercise; there were no training or analysis goals, however, it is intended to conduct follow-on exercises to increase the DMOC and Air Force capability (as provided by the Canadian Advanced Synthetic Environment (CASE) project), and to show that realistic training and evaluation is possible using DMO.

CAE Professional Service (CAE PS) previously conducted Verification, Validation, and Acceptance (VV&A) on the Maritime Littoral Operations (MALO) Technology Demonstration project, using it as a case study to evaluate a new VV&A process and a V&V overlay to the Federation Development and Execution Process (FEDEP). The client for this work, the Synthetic Environment Coordination Office (SECO) wished to use OC1 as a second case study, and the DMOC was interested in the results of the VV&A from the standpoint of assessing and improving their distributed simulation exercise capability.

The VV&A was conducted to evaluate at highest level the claim that “DMO is a feasible way to conduct Air Force training”, which included evaluating Air Force culture and readiness for DMO, the capability of the DMOC, and the actual success of the OC1 exercise. A V&V plan was prepared using the REVVA methodology of creating a Target of Acceptance (ToA), which represents the acceptability criteria for the client, and a Target of V&V (ToVV), which represents claims about exercise, simulation, and organizational suitability for evaluation. CAE PS observed OC1 and conducted V&V as per the plan; this report details the creation and content of the plan and results, and gives recommendations for future DMO simulation requirements and for conduct of VV&A.

The result of the VV&A is that OC1 was acceptable within its limited goals, but that several areas of exercise conduct, process creation, management, and documentation, exercise analysis, and simulation fidelity must be addressed before considering that the DMOC has achieved the goal of a providing a suitable permanent DMO capability. The VV&A also found, however, that the DMOC has established an impressive capability in a short time, and that the required capabilities are not outside their reach.

Bilaga 5 – V&V av LKS

VV&A Lessons learned within the C^2WS (LKS) project

Samtidigt med utvecklingen av ledningskrigföringssimulatorn (LKS) har metodarbete utförts inom området VV&A för denna simulator eller demonstrator som den hellre benämns i denna sin första version. Avsikten med VV&A-arbetet har varit att om möjligt finna tillräckligt underlag för att kunna validera simulatorn för sin användning. Två olika VV&A-metoder har använts och erfarenheterna från detta arbete beskrivs i denna ”lessons learned”-rapport.

Den visar att VV&A-arbete är resurskrävande, saknar bra standarder och vägledning samt att det inte finns någon gemensam kravbild och förståelse för arbetet hos kund och utförare. Detta är också grunder för att det i många arbetsgrupper runt om i världen pågår arbete med avsikt att avhjälpa dessa brister.

VV&A-arbetet som utförts för denna tillämpning har inte objektivt kunnat visa att simulatorn är giltig för sin användning. Spel som genomförts visar dock att simulatorn kan uppvisa de eftersökta egenskaperna och kan ge en ökad förståelse för området hos användare och systemutvecklare.

VV&A-arbetet har dock givit utvecklingsgrupp och beställare en ökad förståelse för vikten av VV&A. Kunskap och erfarenheter från arbetet återförs också till metodutvecklarna inom VV&A-området, särskilt till REVVA-gruppen, vars process i huvudsak använts för arbetet