History and Basics of M&S[1]

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Everything has a history. What few realize is that Modelling and Simulation or M&S predates the computer. Many of you are familiar with the concepts of chess. What makes chess significant? For one it represents rules. It also contains a strategy with infinite possibilities. While today most regard it as a commonplace game, strategic prowess was taken very seriously in the ancient world where reputations, not to mention kingdoms were won and lost to military campaigns. Figurine warriors replicating the art of battle have been dated as far back as 2500 BC in Egypt. As best as can be determined, these figurines offer us the earliest known example of formation and manoeuvre. The Chinese were no exception. Sun Tzu, Chinese strategist and military philosopher wrote about the game Wei Hei or *encirclement* around 500 BC. India circa 700AD added pieces, moves and strengths to Shataranja, the closest predecessor to the chess we play today.

We fast forward to the 1600's to Germany where more military detail was added to a larger board and additional pieces. This larger board now sported rivers, forest and other terrain features. The enhanced version of war-gaming called Königspiel or *the King's Game* advanced a notion that war can be 'reduced' to distinct concepts and formal rules. In 1824, Prussian Baron von Reisswitz published a book called Kriegspiel or *wargame*. Instead of a flat board, another revolutionary addition was made in the form of three-dimensional terrain. Dice decides the outcomes of fires, introducing both abstraction and quantification. While Königspiel fostered the concept of *reductionism*, Kriegspiel gave us in due time topographical maps and the stirrings of battle calculus. If the field of M&S can claim its rightful origin chronologically, it is the 1800s where the basic concepts of M&S as we recognize them become evident.

Now we go to another continent – North America. In 1879**,** Army Major James Livermore, felt there was more to war than just battle. The new twists he added were logistics and the quantification of fatigue. A few years later, another Army Officer, Lt Totten, felt that Kriegspiel had an anomaly that prevented it from being played in a political context. His insight was that one should not jump into Kriegspiel immediately but instead proceed from the simple to the complex; adding layers to the game depicting the different facets or levels of war: tactical, operational, and strategic**.** This is the first time we see a 'hierarchy' in modelling. By 1887, wargaming becomes a permanent part of the curriculum at the U.S. Naval War College due to the efforts of William McCarty-Little.

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[1] Used by permission, Battle Command, Simulation & Experimentation Directorate, U.S. Army.

The beginning of the 20th Century witnessed a proliferation of techniques. In Berlin, wargaming developed the WW I mobilization plan. In Great Britain, Colonel Lanchester originated equations that translate the effects of battle on an area. Prior to WWII, Japan wargamed its incursions into Manchuria and China. By the 1930s, a Live-Virtual simulation carried Japanese pilots suspended from the ceiling over the mock topography that would later become the attack on Pearl Harbor, Hawaii. The effect of this technique also added to their misfortune at the Battle of Midway, signalling the beginning of the end.

While the first 50 years of the 20th Century overshadowed a preponderance of design constructs and analysis, the Cold War was still what we now consider manual…analogue…primitive. By 1950, it is still large boards, playing pieces and push pins. While still a novelty for many in the military community, the research industry continually improved their methods of quantitative analysis, bringing the two ever closer into a discipline.

Three significant occurrences changed the status quo: the transistor, integrated circuitry and commercially obtainable computers. Once this became available to the analysis community, M&S increased exponentially. Imagine if you will the notebook computer or personal computer that allows you to read this. Your operating system was only dreamed of in the 1950s. While the large wargaming rooms had mock terrain and push pieces, an equal amount of room was needed for our early models. The logic behind this impetus of modernization was simply one of global political-military competition. In 1958, the Cold War took on a new twist when Russia launched Sputnik. In response, President Eisenhower created a host of organizations in response. One of them is the Defense Advanced Research Projects Agency which played a role in our field as well as the precursor of the internet.

The Naval War College by this time has a computer-assisted wargame taking up three floors of an academic building. Built to accommodate a single wargame, it is torn down completely and reassembled from the very beginning for a subsequent effort. This capability was the natural progression of the wargames developed there by William McCarty-Little in the 1880's. In spite of its obvious drawbacks, this gets the attention of U.S. Navy fleet commanders, who send their staffs to train on it.

During the 1960's, IBM roles its mainframe computer called the '7070.' This is the first computer capable of supporting simulations; again a far cry from what you are using now. By 1964, the Naval War College replaces analogue technologies with digital and conducts its first remote wargaming. This is what we in the U.S. call the 'McNamara Era.'[2] During Vietnam, the overemphasis of quantification distorts decision-making at the highest levels and M&S suffered for some years afterwards.

Finally in the late 1980s, a prototypical simulation standard was developed linking technology with Division and Corps computer-assisted exercises. Additionally, the conceptual design of physical or virtual simulators is to link them or become *networked*. Terrain maps and overlays are now added to the screens and the Department of Defense (DoD) codified simulation policy through the 5000-series directives, thus establishing a formal policy in acquiring expensive M&S technology. For those that remember this era, the solitary computer was still prohibitively expensive – the prospect of computer commoditization still afar off.

Having given the history of M&S in rapid fashion, the question that deserves to be answered is 'so what?' If nothing else, the history of M&S provides a path-dependency to what it is now. It is through historical necessity that M&S allows us today an 'arms-length' analysis as an enabler of decision-making. M&S more often than not, affords a meeting of minds not only vertically within a given service but horizontally between all of them. This is far better than learning 'on-the-spot' within theatre, a prospect with disastrous implications. Thus defined, computer-based simulation attempts to place military decision-makers into

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[2] The McNamara Era is best understood by Secretary McNamara himself in the documentary film, 'The Fog of War.' (2003).

recognizable dilemmas bearing an uncanny resemblance to: processes, facilities, systems, organisational behaviour, environments and activities embodied by weapons systems, airframes and vehicles not to mention individual capabilities.

One of the spill-over effects of M&S was its contribution to 'Jointness.' The Aggregate-Level Simulation Protocol (ALSP) linked service wargames such as the Army's Corps Battle Simulation (CBS) and the Air Force's Air Wargame Simulation (AWSIM) long before the notion came into vogue. While the notion of Combined Arms Tactical Trainers (CATTS) seeks horizontal integration of branch-specific simulations such as artillery or air defence, a Marine Corps aviation unit can go to any Army Aviation Combined Arms Tactical Trainer (AVCATT) and fly a mission without raising any eyebrows.

This is not to say that the relationship is always smooth. Military-sponsored M&S it is fair to say is ahead in areas and well behind in others. The Army for example is pushing for the complete digitization of its communications and linking it to M&S. Also major commands purchase commercial software off-the-shelf or *COTS* because the government can only forecast and project expenditure for known requirements well in advance. Just when we thought the military community approached saturation, we found ourselves closer to square one after 9-11 than before. Due to the fungibility of the open market, niche programming in human agency is equally sought after.

Many then ask what if any the similarities and differences are between military and civilian simulations. We define simulations as a "model able to repeat the same events over time"[3] which appears to hold true for both. It is the military analyst not the simulationist with more in common with economists and political scientists. Again the simulationist serves a commander seeking training value available due to the evolution of gaming through history. The analyst on the other hand shares a common goal with the economist or political scientists through the isolation of a particular or singular phenomenon. One prime example is called Monte Carlo Simulations. Monte Carlo simulations approximates solutions to mathematical or physical problems by offering a range of values possessing a calculated probability of being the solution.[4]

More often than not, the military simulation is stochastic in nature. When you left the hotel room, a taxi could have struck you crossing the street, the entrance could have been blocked or an attractive lady could have asked you for directions. As opposed to Kriegspiel, events are not bad if you roll a one versus a six or as mundane if you have a 90-plus percent chance in Monte Carlo of being here on time. Figuratively speaking, a stochastic simulation is not one knob that can transform training events from easy to hard but several.

In this particular context, when a military-oriented simulation can act out a variety of behaviours conducive to combined-arms operations on a computer screen, we might say that we are witnessing a constructive simulation. There is also a situational dependency to combat power in constructive simulations, setting it apart from the others. When we dismount infantry crews from tracked vehicles in the simulation to attack terrain only navigable by foot, we have 'disaggregated' from the total combat value of the crew system. When we place them back in the vehicle, they are an aggregate once again. While these response cells (units) fight the war via computer, the reporting, maps, overlays, orders processes for the staff or primary training audience remains overall equally stressful as under real conditions.

If the simulation is weapon or crew-centric requiring navigation, acquisition or engagement inside a setting that is an imitation of the real thing, it is most likely a virtual simulation. Some competencies are impractical

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[3] Paraphrasing the DOD M&S Glossary.

[4] Monte Carlo has multiple variables with a range of probability spread along on a 'bell-shaped' curve.

or impossible to replicate through technology. The best way to integrate manoeuvre using live ammunition, negotiating with warlords or coordinating with another service is best done live. While it is impractical or too expensive to do everything live, the sum of its parts called *Live, Virtual and Constructive* simulations or L-V-C for short provides a matrix of values in obtaining the best training possible.

Considering the exposure to crews, line units, staffs and commanders, it is no exaggeration that the M&S professional maintains a finger on the pulse of readiness.