Experiencing Strategic Decision Making

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ABSTRACT

The paper is about the use of Modeling & Simulation together with Artificial Intelligence, Intelligent Agents and Data Analytics tools and techniques for supporting Strategic Decisions. It focuses on innovative architectures, models and solutions while creating a working experience on these innovative frameworks for a wide spectrum of applications: from Business to Industry, from Defense to Homeland Security, from Oil & Gas to Public Services.

Our contribution includes methodologies, techniques, frameworks, software solutions and procedural approaches as well as projects, proof of concepts, validation & verification and capability demonstrations.

Keywords: Strategic Engineering, Decision Making, Artificial Intelligence, Data Analytics

1 INTRODUCTION

Nowadays, many researchers and professionals from the Modeling and Simulation (M&S) community are facing big challenges in of Strategic Decision Making due to many reasons. The complexity of current problems is pretty high and, from other point of view, the decision capability is limited by many factors, but there is evidence of a lack between the potential provided by big data available thanks to Company Digitalization, IoT (Internet of Things), Sensor and Social Networks respect their effective use. The key point is due to the fact that "big data" correspond usually to "big mess" with many inconsistencies, errors and dishomogeneous characteristics. The key point to succeed is to improve capability to elaborate data, to use extract information to evaluate alternative decisions and to have a closed loop to refine the models and evaluations based on reaction of the real system that evolve, usually including also not cooperative behaviors (e.g. competitors). From this point of view it is usually critical also the possibility to present the results and the alternative in an intuitive and clear way that could lead to obtain mutual trustiness between experts and decision makers; in facts M&S is also a very valuable solution both to predict influence among complex components and potential alternative decisions, operating jointly with Intelligent Agents (IA) directing the different behaviors of active components, as well as to present interactively and immersively the scenario to different stakeholders. Due to these reasons it is evident the potential of adopting Strategic Engineering Decision Making in strong connection with use of MS2G (Modeling, interoperable Simulation and Serious Games), a new paradigm combining interoperability and high fidelity simulation with the intuitive and engaging methods adopted for serious Games (Bruzzone 2018a). MS2G in decision making has a big potential and requires to develop skills and capabilities in young scientists as well as to create the proper mind set in experienced decision makers to get benefits from these solutions on their activity (Bruzzone 2018b; Mazal 2018). From this point of view, this paper provides an overview on the effective techniques that result immediately applicable for variety of industrial domains to improve the decision making process through the use of valuable information derived from the application of Modeling, Simulation, Artificial Intelligence, Intelligent Agents and Data Analytics techniques.

2 DECISION MAKING BY USING STRATEGIC ENGINEERING

The use of M&S methods to support decisions by simple "what if" analysis or more sophisticated techniques is well known since several decades (McLeod 1986; Clymer 1993; Kuhl et al.2000). Therefore currently it turn possible to combine simulation models in dynamic interaction with Artificial Intelligence, Intelligent Agents and Data Analytics; also these connections were active since decades (McLeod & Mcleod 1995, Li et al. 2010; Bruzzone et al. 2002), but currently many more data, much more frequently acquired and with higher resolutions are available from multiple source, while, at the same time, it is possible to send back to operational elements (e.g. people, machines, devices) information to control the system. These changes represent a major impact that it makes possible for these emerging technologies to face new challenges about the value of information and how to fully exploit it to gain a competitive advantage. This result useful not only for strategic planning but also for strategic management (Powell 1992; Mintzberg 1994; Hitt et al. 2012; Massei et al. 2014). These technologies motivate strategic engineers, scientists, researchers and professionals to act more consciously in designing and protecting systems as well as to be more directly connected with decision makers (Mazal 2018).

In this sense the innovative concepts of Strategic Engineering is the idea that Simulation, Modeling, AI and Data Analytics are dynamically integrated within a closed loop with the real system to support Decision Makers (Di Bella 2015).

To achieve this result it is very important not only to develop new methods, but even to create the cultural background in decision making community and among new scientists to adopt this approach. From this point of view it is fundamental to engage researchers and professionals from the Modeling and Simulation (M&S) community in facing the greatest challenges of Strategic Decision Making integrating them with Artificial Intelligence, Intelligent Agents and Data Analytics.

Indeed, researchers and professionals working in the Modeling and Simulation domain, whose research/work depends upon effective use of the new emerging techniques coming from Artificial Intelligence, Intelligent Agents and Data Analytics are the most suitable developers and educators in this field, while the concepts should be also presented and interactively demonstrated, by using immersive solutions, to Decision Makers and Industrial and Scientific Executives interested in applying these new solutions. Obviously the Young Engineers and PhD Students are expected to be proactive in providing new points of views as well as to understand the criticalities, needs and expectations in the field of decision making respect the use of these approaches.

3 WHAT WE ARE EXPECTED TO DO

In a world where we talk about Strategies more and more frequently, but we experience day by day very hard challenges, the current discussion involves experts from different sectors and addresses specifically "Epidemic models and the possible actions for crisis mitigation". In fact the Corona Virus is currently the main world crisis and it is putting back on the stage the CBRN Threats (Chemical, Biological, Radiological, Nuclear) that have been studied for a long time for issues related to Defense and Homeland Security, but which were underestimated and neglected for different reasons, while today they turn back to be fundamental elements in the war against the pandemic.

Being said that, applying Strategic Decision Making means being able to perform some critical tasks that reinforce well know concepts in M&S about crucial steps (Amico et al.2000):

- Identify criticalities in Strategic Decision Making;
- Have knowledge about validation and verification of Strategic Engineering Solutions
- Analyze needs and expectations of Decision Makers
- Evaluate the needs in Education to prepare young Scientists and Managers
- Evaluate the possible solutions to enhance capabilities of Senior Executive Managers

4 STRATEGIC DECISION MAKING: AN EXAMPLE ON PROBLEMS AND OPPORTUNITIES

It is interesting to outline some of the shortfalls and open issues that deal with Strategic Decision Making looking to a real example and covid-19 crisis represent a pretty good case where many plans where available, but decisions resulted not very effective. In facts, the plans to address a pandemic were available since very long terms considering potential scenarios dealing with Biological Warfare (BW), but it should be outlined that these guidelines and procedures have been updated continuously due to recent pandemics including H1N1 that it is estimated to have caused several hundred thousand casualties worldwide (Anderson et al., 1987; Croddy et al. 2002; Bossomaier et al. 2009; Bajardi et al. 2011). Therefore all around the globe, from Europe to North America, from Italy to UK, from Brazil to Chile, we observed many demonstration to be unable to address strategic issues in time even with good guidelines. In such case often very basic statistical approaches were used to deal with the problem, mostly time series analysis and forecasting techniques that don't have any capability to predict the impact of current decisions on the future because they just analyze past data. In case of covid-19, considering the inertia of the phenomena (e.g. incubation period, asymptotic patients, large impact on wide percentage of population respect capability to measure evidence of infection) this resulted in taking wrong decisions at wrong time. Before to continue, I would like to outline, that no plan, no smart leader, no effective health care or institutional infrastructures could deal with a pestilence: these phenomena affect so many humans that it is almost impossible to prepare and react very effectively. In facts when we have millions of people at risk, no any health care system could be ready considering economic sustainability along regular years, at the same time the unknown of these new events introduce so many assumptions that errors are normal. These considerations don't mean that plans are useless, proper health care preparation and management is irrelevant. In addition I am glad to remind a famous Latin sentence of my namesake: Errare humanum est, perseverare diabolicum; this means that errors are human, therefore to continue to repeat the errors is devilish and we observed in many advanced country very stupid perseverance in repeating errors already done by others or by themselves. It should be outlined that the problem don't arise from use of improper or too simplified models, but by many other factors that heavily influenced decision makers and promoted their evident and repeated errors. These elements included search for consensus, propaganda vs. trust, capability to understand the problem, ability to share the vision, etc. Therefore even these problems were partially due to a cultural background that resulted obsolete respect the capabilities of modern combined use of Data Analytics, Simulation and AI. Imagine yourself creating an effective system able to correlated the big data not only about infected people, but by social and digitalized companies, getting an up to date picture, using these data in simulation models able to predict impact of our current decisions on future and to apply AI to refine and correct dynamically the models, while XR (extended reality combining Virtual and Augmented) provides an intuitive dynamic and immersive representation of situation evolution and expected results due to alternative choice to be shared on the web or even to be used by people to provide their one proposals evaluated by smart strategic engineering solutions as crowd sourcing. These elements are a possibility nowadays and could create trustiness between people and decision makers as well as to improve reliability and reduce time to correct errors.

5 APPLICATION: EPIDEMICS

As anticipated, first of all, itt should be stated that there are no adequate solutions and resources to safely deal with a crisis of this size, starting from the availability of protective masks up to the impact on health, logistics and economic; therefore it is also clear that it is necessary to drive Strategies based on effective and rational methods and solutions, which today are entitled to take full advantage of innovative Strategic Engineering approach by accessing Big Data and using Intelligent Interconnected Models and Tools, even unthinkable until a few years ago.

The VESTIGE solution addresses the management of epidemics. VESTIGE is based on strategic innovation Strategic engineering by integrating Simulation, Artificial Intelligence and Data Analytics to support Strategy strategies, keeping aligned with the scenario and human elements.

Indeed the models composing VESTIGE have been derived from several researches and projects carried out by the Authors for multiple applications, from simulation of Haiti Earthquake in Port of Prince to Humanitarian, Country Reconstruction Missions and Domestic Smart City initiatives (Bruzzone et al.2011, 2014, 201, 2017; Bruzzone 2013).

In facts, the VESTIGE models are simulating the population, people and resources by dynamically connecting them to georeferenced information and social networks that result continuously active data sources for initialization, updates and checks on the prediction reliability of the simulators. The differences between future estimates and real evolution of the scenario is useful not only to keep the systems aligned, but even for feeding an AI engine that fine tune the model internal parameters.

This solution reproduce the behaviors and the reaction of individuals, the population and interest groups, through digital twins led by Intelligent Agents who reproduce individuals and social networks against age, sex, health status, social level, education, ethnicity, religion and other users, including psychological modifiers such as fear, stress, fatigue and aggression. These models are integrated with data on population, cities, regions, social media and support: strategic planning, crisis management, risk assessment in the various hypotheses. VESTIGE evaluates the various courses of action and decisions in relation to the effectiveness measured on the media and in the field
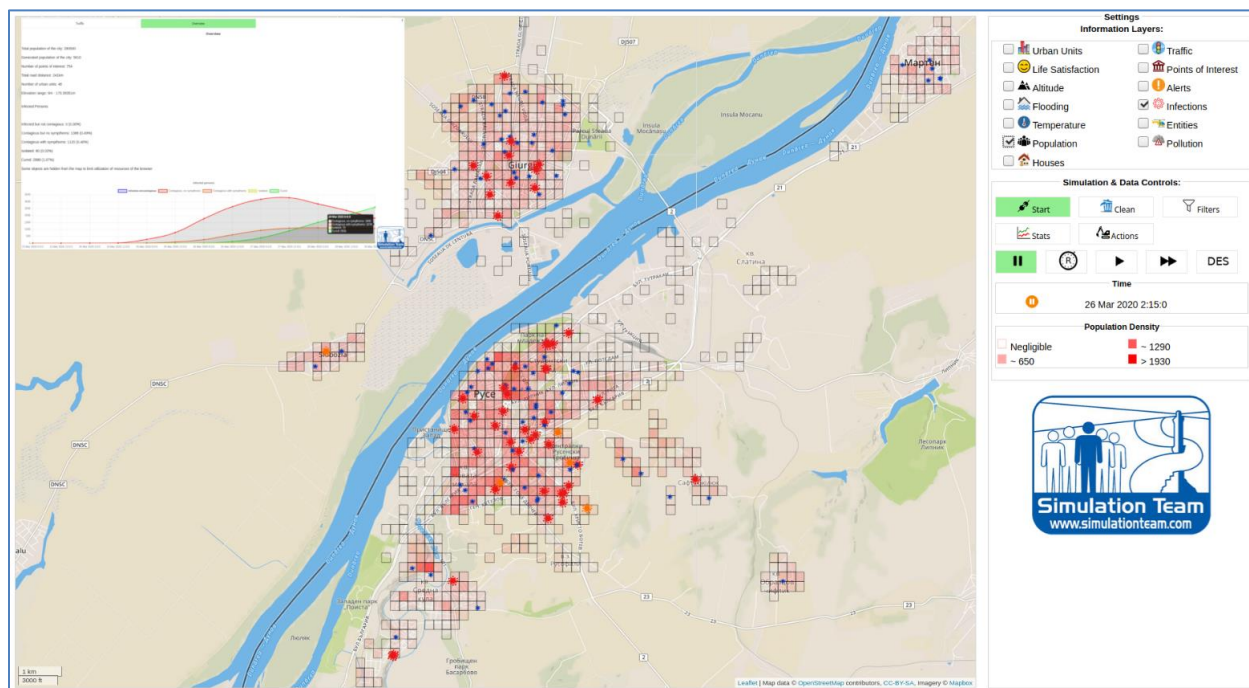

Figure 1 VESTIGE: Virus Epidemics Simulation in Towns & Regions for Infection Governance during Emergencies

VESTIGE uses a client server logic, leaving the heart of the simulator developed in concert with a university spinoff. On the server and allowing access with a browser within which information is provided on the simulation and positioning of assets, people and layers both infrastructural (e.g. roads, railways) and dynamic (e.g. contaminated areas, risk areas).

The system integrates various geographic databases (eg Google with worldwide coverage) that widely cover the scenarios of interest to which maps (eg Copernicus CORINA Land Cover) can be added to consider the orographic factors (e.g. spread of airborne contaminants in case of Hardous Material Release and related thermal inversion on cities) and other open data on cities and regions that allow to generate with a smart data fusion a population consistent with the data present in the different databases (e.g. income groups by area, political, religious, ethnic, age groups) and place them on the territory both in terms of residence and jobs.

VESTIGE has client-server architecture which allows to enable Modeling and Simulation as a Service (MSaaS). In facts, the users connect to the server and create a new instance of the simulated world for each one, with environments generated on the basis of input files and stochastic factors. During the simulation the data exchange is carried out via WebSocket connections and messages in JSON format.

VESTIGE has a graphical web interface, which allows you to view data regardless of the operating system or platform. In particular, it is possible to see the movement of individuals, traffic, points of interest and other objects, geo referenced and shown on one of the available maps (e.g. OpenStreetMap, Google Maps).

Intelligent Agents (IA), that are driving VESTIGE, simulation have the position calculated by the simulation engine itself, therefore it is always correctly defined. However, it is possible to introduce a stochastic error in this calculation.

VESTIGE simulates realistic population behavior thanks to the model of individuals, represented by intelligent agents. This level of granularity allows you to test the efficiency of different tracking solutions, for example by changing the percentage of the population equipped with smartphones or by introducing a part of the agents who do not collaborate with the police and do not follow the restrictions introduced.

The original simulation environment was designed to be interoperable with the most advanced standards in use in the defense sector for simulation, namely High Level Architecture IEEE1516; this solution allows you to connect the system to other models and also to real C2 systems (command and control) to provide both operational support, and assistance with operational planning and training.

6 CONCLUSION

It has to be highlighted that in critical conditions such as the current ones, where there is no cure or vaccine, few intervention methods are present and some of them have strong implications on all fronts including ethical ones, but they must be evaluated against the dynamics of the scenario also considering uncertainty on info and available data.

Also, it is fundamental to manage communications univocally in a similar way to that foreseen in these crises within the military sector, by a figure who plays the role of Media Officer, leaving the floor, just for very crucial question, to the top Commander in assessing critical communications. In fact, the report provided from Far East confirmed that the initial situation of panic in the first 48 hours on Singapore was stopped by a firm and clear speech by the local prime minister and by the application of systematic control measures.

These are simple decisions that deal with a Strategic View that could be supported by a smart solutions combining Simulation, IA and Data Analytics as well as much more relevant elements about economic guidelines, safety procedures, important of training programs, strategic communications and media campaigns.

Indeed the author organized a series of webinars on Strategic Engineering for Pandemics with experts from worldwide during the lockdown for professionals and students under the International Master of Science Program STRATEGOS (Engineering Technology for Strategy and Security) organized by University of Genoa representing the 1st Strategic Engineering Master Program in Italy and among first ones internationally.
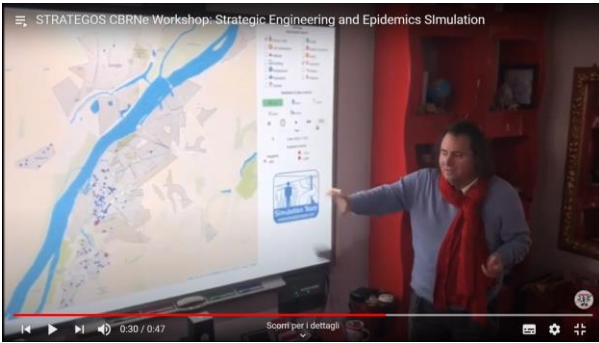
Figure 1 Webinar on Strategic Engineering for Pandemics, Prof Agostino Bruzzone from Italy
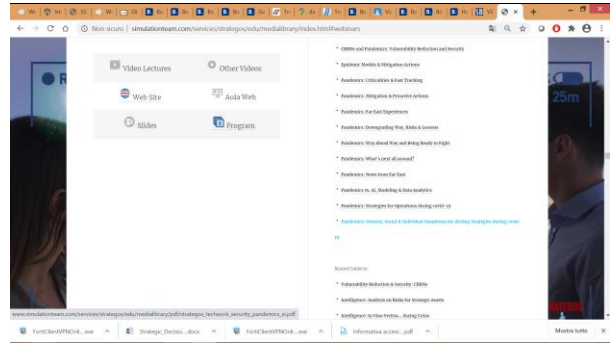

Figure 2 Strategic Engineering for Pandemics: list of events

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