THE HISTORY AND EVOLUTION OF SECURITY CONSIDERATIONS IN THE NUCLEAR INDUSTRY

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ABSTRACT

A modelling tool is to be used to study and improve the interaction processes of the security system at a nuclear facility. The evolution of security considerations in the nuclear industry is one of the newest but most effective applications which also serves as a model for other organisations in other sectors to apply. The basic essence of security provisions is to ensure the protection of an organisation's asset from adversaries and non-state actors. The rise of nuclear applications was unfortunately clouded by its weaponry capabilities. However, scientists and other stakeholders over the years, have invested and invented beneficial peaceful applications which have extended from medical, engineering, agriculture and of course research developments. Safety of persons working in these sectors of applications was initially held paramount but not necessarily the security of the atomic element which formed the core of production of the respective technologies. Modern technological developments have become immensely diverse in the global village such that a more complex but simplified model is required to unify the components of the security systems at various nuclear facilities. This is done in harmony with already laid out and also anticipated safety scenario events. To achieve this, surmounting challenges in the development, implementation of the regulatory framework and requirements for nuclear facilities is held paramount. After the incident on the world trade centres in the United States on September 11, 2001, world leaders and other Stakeholders decided to pay an equal attention to security, as is given to safety considerations at various nuclear facilities. Modelling of various facilities to detect, delay and respond to incidents is seen as one of the most effective tools applicable. Our security systems are fortified or made resilient by continuous, consistent-conscious efforts of interventions by state actors to counter actions or activities of adversaries of the flourishing nuclear industry which is in line with "Atoms for Peace" [1]. These Preventative and remedial actions which also inform the development of our security models are timely, adequate and offer a balanced and sufficient protection [1].

INTRODUCTION

This paper presents the historical and evolutional nature of the nuclear security industry, having gone through challenges of lack of confidence from

society in terms of sustainability due to resistance against adversaries and implementation of cost intensive facilities. The IAEA explains nuclear security as the prevention and detection of and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities. Modern Technological developments have become immensely diverse in the global village such that a more complex but simplified model is required to unify the components of the security systems at various nuclear facilities.

The fear of attacks on nuclear facilities comes from the inherently dual-use nature of current fuel cycle technologies which are enrichment and reprocessing. Other concerns are from stored highly enriched uranium and plutonium in research reactors, fuel cycle plants, or in military nuclear programs over the years. This situation is related to difficulties in the development, implementation of the regulatory framework and requirements for nuclear facilities. After the incident at the world trade centers in the United States on September 11, 2001, world leaders and other major stakeholders decided to pay an equal attention to security as is given to safety at various nuclear facilities [2].

Chernobyl, Ukraine (of former Soviet Union), April 26, 1986, is estimated to be the world's worst nuclear disaster till date. There was a sudden surge in power during a reactor system test and it resulted in an explosion and fire that destroyed Unit 4 of the facility. With the exception of nuclear accidents that occurred in the past, external attacks such as cyber-attacks and a crash of an aircraft into a reactor complex calls for nuclear security [3].

On August 6, 1945, Hiroshima city became the first city in the world to taste the devastating effects of an atomic bomb. On August 9, 1945 the United States attacked the city of Nagasaki by dropping plutonium atomic bomb into the city.

Currently, most nuclear plants are bounded by tall fences which are electronically monitored and also patrolled by a sizeable force of armed guards. Spent fuel is typically confined inside the plant's protected zone or a spent nuclear fuel shipping cask. Getting unauthorized access to these fuels for illicit use is extremely difficult. Exposure to the powerful radiation would certainly quickly harm or even kill anyone who attempts to do so [3]. Physical protection systems accounting and control of nuclear materials continuously gets modified to provide the needed security. However, it has always been advised to consider the human factor when it comes to using the technical measures. Hence the need to also assess nuclear security culture when making security considerations.

Elements of Detection, Delay and Response are the basic principles of controlling unauthorised access from unauthorised personnel who could cause a major damage to the nuclear industry. There are preventative and remedial actions that are timely, adequate and offer a balanced and sufficient protection to enforce the three elements of Detection, Delay and Response as stated above.

MATERIALS & METHODS

Numerous computing software analytical tools, built out of mathematical algorithms are used these days to model and simulate various facilities and isolate the anomalies and eventually make corrections to the security system. Examples of such computing software analytical tools are Python, Sketch-up and AVERT.

Fig.1. Demonstration of Sketch Up model [4]

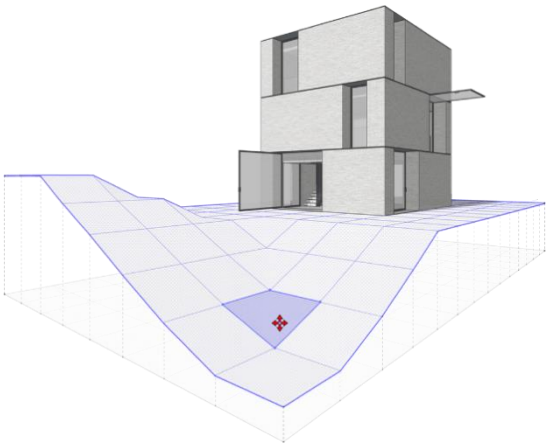

Fig.2. Graphical representation of Sketch Up [4]

Python is a powerful programming language which has been simplified to allow beginners to comfortably use to model several algorithmic processes. The data yielded is highly efficient and produces the object of discussion sufficiently. Python's designed input mode of operation and its interpreted nature, presents it as an ideal language for diverse scenario developments in the nuclear security study and in many areas on most platforms [5].

From Lessons learned and hypothetically assumed scenarios, these Software analytical tools are used to design, solve and interpret the futuristic expected results. The past occurrences have taught and brought much knowledge for the development and sustenance of the nuclear industry today.

RESULTS & DISCUSSION

Nuclear Security professionals trained in using such modern software such as Sketch- Up and Python are able to Simulate, extract possible security

breaches and derive tangible explanations to assist in effectively making the established nuclear security framework of an organisation to be very robust and efficient. An Algorithm can be developed to feed the modelling process using the python software as shown below in Figure 3.

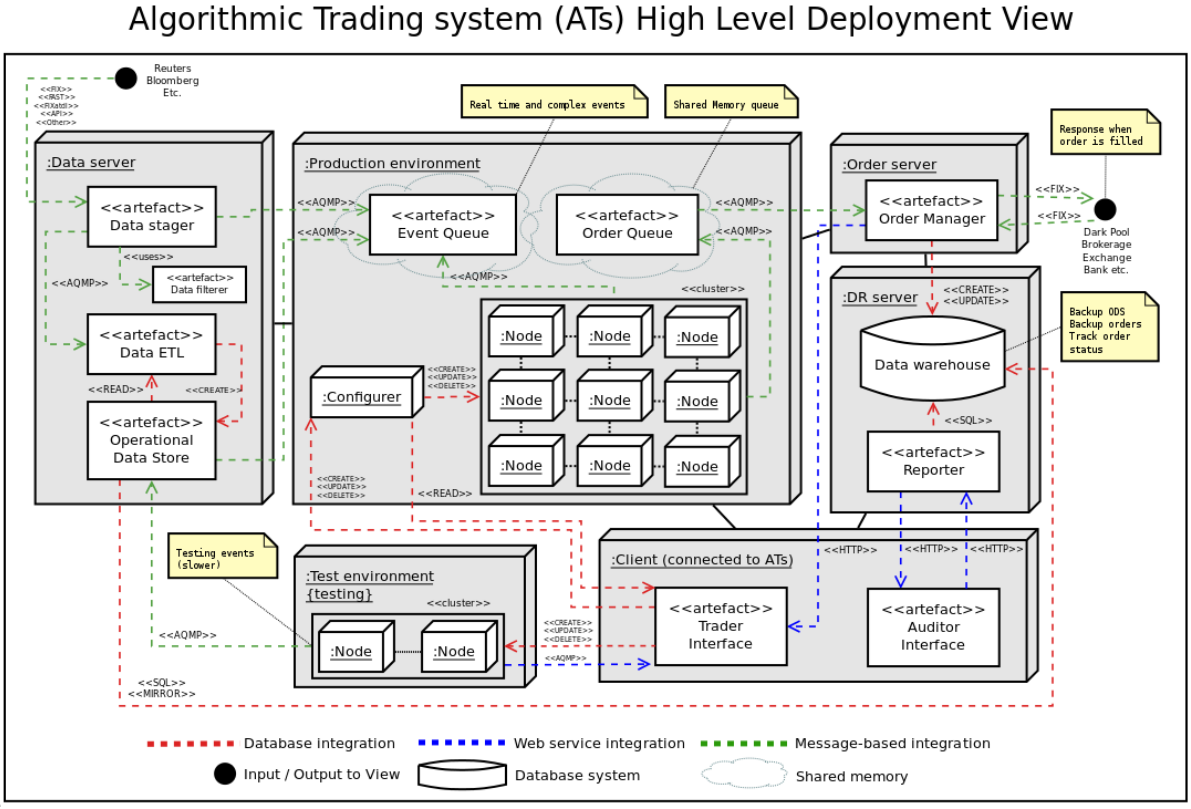

Fig. 3. A demonstration of how python models using the algorithmic approach [3]

After modelling, experts are able to navigate through a nuclear or radiological facility as shown below in Figure 4.

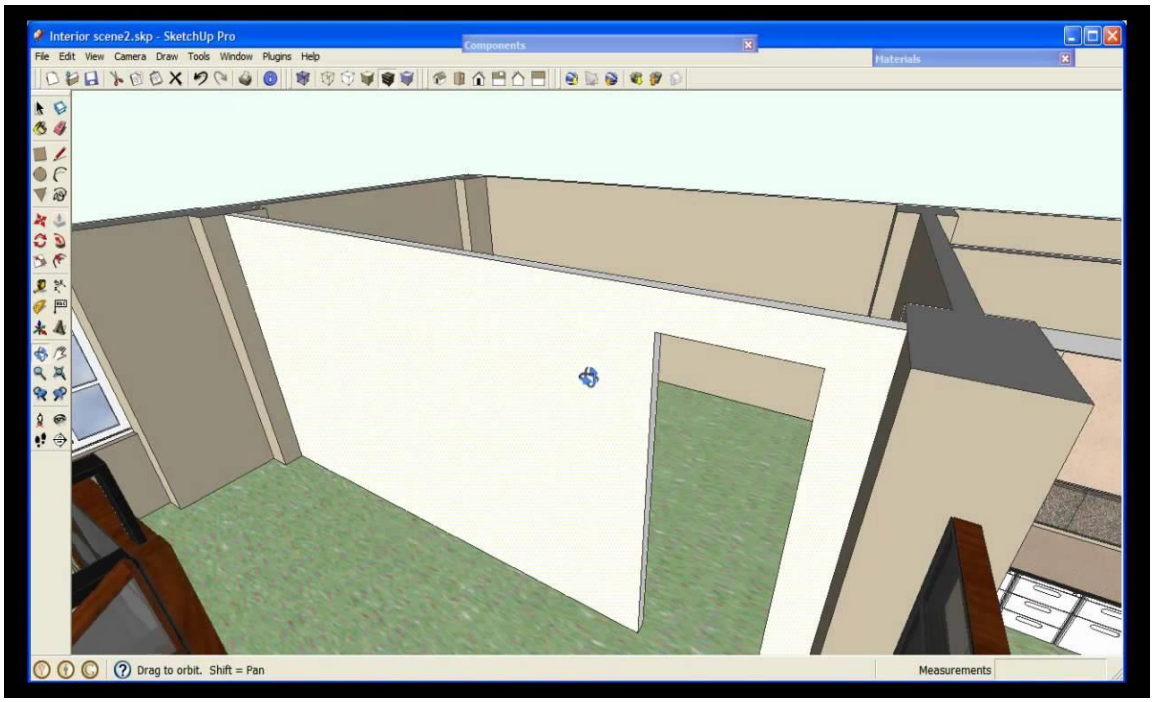

Fig. 4. Showing a navigation of the interior section of a facility [4]

The needed result, is to assist first responders and other known security personnel to familiarise best with the facility, as would be required in special cases of detecting an intrusion, delaying an adversary or responding to an indicated alarm [6].

CONCLUSION

Nuclear technology and its adoption began decades ago and has grown from just an ordinary technological inclusion in the diverse pool of scientific applications to a complex but extraordinarily useful unique to enhance development in science research, medical, industrial and agricultural applications. Applications of nuclear technology were initially adopted without grave concerns for safety of working staff or patients and end users. Today, Safety concerns have been uplifted and merged with security concerns to ensure that the technology being used is effectively protected from adversarial attacks or sabotage. Currently, very effective levels of security modelling tools are applied in a much more robust protection enhancement.

Our security systems are fortified or made resilient by continuous, consistent-conscious efforts of interventions by state actors to counter actions or activities of adversaries of the flourishing nuclear industry which is in line with Atoms for Peace. These preventative and remedial actions are timely and adequate and offer a balanced and sufficient protection.

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CONTRIBUTION OF DMITRI IVANOVICH MENDELEEV IN SCIENCE AND TOMSK POLYTECHNIC UNIVERSITY

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Annotation: Chemistry is important part of science and human daily life. The main reform came in the chemistry due to versatile Russian scientist