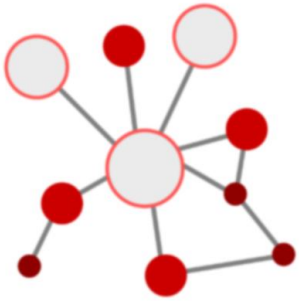
"Systems Engineering"— a reflection paper



graphics from Canva

I remember when I presented my work accomplishments when I applied for my ETEEAP assessment, I had done some initial research first about Industrial Engineering, the degree that I am going to apply to, looked up its standard bachelor's curriculum and I found out about systems engineering, which I only heard primarily in the field of IT.

While I am trying to find the line that connects systems engineering to every accomplishment that I owned, five keywords came up based on my initial research: "Complex (interdependency)", "Integration", "Lifecycle", "Benefits" and "Validation", in which I was able to deliver a connection with my previous work in facilities systems like the UPS system and other management projects.

However, I can't seem to wonder, "what does systems engineering covers" The confusion with my other line of work, "project management" because of a similar approach of managing a system, led me to asks, what discipline of systems engineering did I utilized?

Fast forward to my Systems Engineering class, this journal paper about the Hitchins-Kasser-Massie (HKM) Framework for Systems Engineering provides a comprehensive insight into the Systems Engineering profession itself. The author, *"Joseph E. Kasser"* coming from a challenge to develop a theory of systems engineering has stated, *"this paper applies systems thinking to systems engineering to propose a framework that can serve as a vital element in formalizing the discipline of systems engineering and potentially as a platform for developing such a theory."* This suggests an existing confusion on understanding systems engineering work including its formal definition, despite an existing profession on it.

The first word that catch my attention is "Systems Thinking", despite not establishing its definition in the paper, it clearly conveys an already mature concept from the keyword "Systems" which also shows how he dives into every possible aspect of the current state of systems engineering. *"This paper focuses on what systems engineers do and builds on past research and success. Documenting research using an object-oriented approach in a creative and innovative manner it discusses the evolution of a proposed framework for systems engineering that meets or shows promise of meeting the following four requirements"*

My first observation is that systems engineers seem to work in various fields and industries, particularly during 2007, as the year of the journal paper, which explains the lack of clarity in the discipline of systems engineering as mentioned in background section of the paper.

"- Systems engineering is struggling to be recognised as an engineering discipline in an environment in which it is perceived to overlap the activities of project management."
"- While universities offer degrees in systems engineering and pursue research, systems engineering still lacks a framework for research and education."
"- Systems engineers can't agree on what systems engineering is (activity)."
"- Systems engineers can't agree on what systems engineers do (role)."
"- Systems engineers can't agree on a definition of systems engineering."

This makes sense to me as I describe in the first part of this reflection paper. The overlap in other profession like project management, which also exists in various fields and industries and can both involve managing complex problems, is kind of a mess to set an identity for systems engineering.

The paper tries to enlighten us by setting a requirement first for the proposed framework, *"1. The framework shall provide an understanding of why systems engineers can 't agree on their roles and activities. 2. The framework shall provide an understanding of the reasons for the overlap between systems engineering and management. 3. The framework shall provide a way to cope with complexity. 4. The framework shall enable the development of a way of working that lowers the cost of doing work by at least an order of magnitude"*

The requirement for the proposed framework also includes the rationale behind those sentences but the keyword that I observed here is "understanding"

- *"Without such an understanding, systems engineers will continue to discuss rather than develop and apply systems engineering, and not move onwards to the creation of a discipline"*

To "understand", we need another enlightenment on the role of systems engineering. The paper discusses several historical opinions based on past research. The author concludes this by defining a common definition which is "problem solving"

I have a similar observation that it lacks the context and understanding in an holistic way that it covers the complexity of Systems engineering, even with the existence of systems engineering standard ISO 15288.

"—Despite the difficulties of finding a universally accepted definition of systems engineering, it is fair to say that the systems engineer is the man who is generally responsible for the overall planning, design, testing, and production of today's automatic and semi-automatic systems‖ (Chapanis, 1960 page 357). 2. The principal functions of systems engineering are —to develop statements of system problems comprehensively, without disastrous oversimplification, precisely without confusing ambiguities,

without confusing ends and means, without eliminating the ideal in favour of the merely practical, without confounding the abstract and the concrete, without reference to any particular solutions or methods, to resolve top-level system problems into simpler problems that are solvable by technology: hardware, software, and bioware, to integrate the solutions INCOSE 2007 Page 5 to the simpler problems into systems to solve the top-level problem‖ (Wymore, 1993) page 2). 3. —Systems engineering is a wide-range activity, and it should not be handled in the same form for all kinds of systems‖ (Shenhar and Bonen, 1997)."

The paper's next step was analyzing an existing problem-solving methodology which are mostly based on the complexity and types of system. The author's discussed how he focused on the *approach* of Maslow's hierarchy which is a more simple and shorter broad-based classification. From my perspective, this is just about finding efficiency as a systems engineer who handles complex systems.

The next section of the paper discusses the proposed framework itself, "The Hitchins-Kasser-Massie Framework" Its structure develops a three dimensional structure, which as mentioned based on systems thinking approach and as I can say these concepts immediately helps bring clarity to my confusion about systems engineering.

The first framework: The vertical side. It is about the different layers or scale of the systems that we are working on.

"Layer 5 - Socioeconomic, the stuff of regulation and government control.

Layer 4 - Industrial Systems Engineering, or engineering of complete supply chains/circles. Many industries make a socio-economic system. A global wealth creation philosophy. Japan seems to operate most effectively at this level.

Layer 3 - Business Systems Engineering - many businesses make an industry. At this level, systems engineering seeks to optimize performance somewhat independent of other businesses

Layer 2- Project or System Level. Many projects make a Business. Western engineermanagers operate at this level, principally making complex artifacts.

Layer 1- Product Level. Many products make a system. The tangible artifact level. Many [systems] eng"

This makes sense to me that a product builds on a project or system and to the whole business and can have a connection to as big as an Industry or Socioeconomic scale.

I think, the example I can give from my own understanding and experience is how a UPS hardware connects with a battery system, electrical system and network system, then it builds up to a higher level upon supporting critical business infrastructure and also designing

its business process, software monitoring system or even policies that affects the whole company

The second framework discussed in the paper, involves the Horizontal Axis. This is where the system lifecycle where from my experience, also need to be involve early in the process of system engineering as it analyzes, the eight important phases of our system.

"A. Identifying the need. B. Requirements analysis. C. Design of the system. D. Construction of the system. E. Testing of the system components. F. Integration and testing of the system. G. Operations, maintenance and upgrading the system. H. Disposal of the system."

As for the third framework , depth Axis, it concerns with the level of technological risk of what we are dealing with. One thing I can relate to is how my example UPS system project dealt with deciding for a type b, medium technology project vs type c, high technology project. Although, I didn't have this understanding before, I agree on the conclusion of the paper on the different level of risk involve for those two decision and consideration for how we perform with a different level of plan, timeline, maintenance and budget.

"Thus, that systems engineer could be working in Area _2Ba' if it is a low technical risk system or Area _2Bd' if it is a Super-High-Technology Project. Shenhar and Bonen stated that [the role of] systems engineering was a wide-ranging activity, and should not be performed in the same manner for all kinds of systems"

The next section of the paper discussed an important part that explicitly mentioned five domains to understand how to meet the first framework requirements . Traditional SE," " Military Platforms," and "Information Systems" are just different-shaped blobs of activity within the framework

Overall, the Hitchins-Kasser- Massie (HKM) Framework for Systems Engineering paper has a good insight that provides enlightenment of understanding systems engineering. It may not cover the comprehensive insights about how technology and business rapidly changes, as well as the overlap in similar professions like project management and the cost reduction framework, but I think the foundation of the framework makes us more aware and visible to identifying and diagnosing the different sides of the thing called "System".