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THE FUTURE OF SYSTEMS ENGINEERING

In the world of technology:

It is clear that the prevalence of the main trends that had created the need for systems engineering methodologies (the increase in system complexity, time and budget constraints, and the extent of the clients' involvement) will only increase, and so will the need to systems engineering, mostly in technological organizations.

Today, systems engineering is mostly implemented in defense, aviation, and space enterprises. The estimate is that organizations in other fields – such as communications, medicine, digital printing and photography, or smart transportation systems – will adopt the same systems engineering processes that the defense and aviation industries have found to be so effective. Evidence of this is the rising number of students from other industry fields to join the systems engineering studying programs.

The emergence of systems engineering in these organizations is backed by the ongoing process of the field's institutionalization. Academic institutions are opening training programs for systems engineers. One such institution is the Technion, the only university in Israel to offer such a program: so far, its master's degree program has trained approximately 900 systems engineers. Israeli colleges are also offering academic programs in systems engineering.

Having come to understand the importance of systems engineering, more and more technological organizations are willing to integrate its work methods into their systems and even train systems engineers themselves. The managers of these organizations are also coming to the realization that systems engineering is the all-important

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link that connects them to the technological specialists, who develop the products of their organizations.

For example, at the INCOSE_IL (The Israeli Association for Systems Engineering) leadership panel, executives saw systems engineering as a discipline that includes tools and methodologies that help them make decisions throughout the lifetime of a project. They also saw it as a discipline that facilitates the creation of a synergy between engineers from various fields and thus helps put the project on the right track toward success.

Outside the world of technology:

It is currently impossible to estimate whether the evolution and growth of systems engineering will continue mostly within the boundaries of the technological world or penetrate other fields as well. This is not merely a practical issue; it is also a question of image and branding. On the one hand, systems engineering has emerged from out of the technological world, with the purpose of answering its needs; and the very fact that it is called "engineering" is suggestive of its native path of development: to remain, for the most part, within the technological world, as *engineering with management aspects*.

On the other hand, it may be that, in time, as other areas of practice gradually discover its benefits, nonengineers will also seek to adopt its methods, in their nontechnological content worlds. Thereupon, within these circles, systems engineering will become *management with engineering aspects*. It is also possible that these content worlds will expand beyond the spaces of management and engineering, supported by the tight connection between systems engineering and systemic-holistic thinking. Then, it can be implemented even in such areas as education, human resource development, politics, and more.

This approach may gain momentum due to the increasing importance of planning, a central pillar of systems engineering: Kobi Reiner says that, in situations of budget and other constraints, advance planning is of crucial importance, as it allows one to reduce the risk of failures. As Prof. Ovadia Harari stresses the decisive influence early-stage planning processes have on a project's chances of success. Norman Augustine completes the picture, by saying that methodologically, budget planning is no different from engineering planning.

If these approaches become prevalent, systems engineering will find a home outside the technological world too and will be adopted by an ever-widening range of areas of activity.

Additional trends:

The rise in the importance of the human factor in systems engineering is unmistakable. The leaders of the field, the vast majority of whom are, as we remember, engineers, place more and more weight on the importance of the systems engineer's interpersonal skills, in his position as the leader of multidisciplinary teams of engineers. At the same time, there is a rise in the importance of such qualities as simplification abilities, helpful when designing complex systems, which are naturally more prone to human error.

The importance of the human factor is also expressed in the realization that the user of a system is a central component within it. This is why today, there is an increasing

trend of designing systems that reduce the chance of the user making mistakes in their operation, due to their structure and complexity. Another way to present it is this: in the past, user failure was considered human error (ergo, the user's fault); today, the realization that these errors can be caused by the structure of the system (ergo, the system's fault) is becoming more common, and so they are called "usage failures."

Future developments in the computing fields will also affect the computerization of systems engineering processes. Advanced computing systems have been in the service of traditional systems engineering for years; yet, only in recent years have they begun to serve systems engineering as well. These newly developed computing systems are based on the clever use of models and simulations, successfully implemented in traditional engineering fields.

In systems engineering, this new combination should instigate changes in the traditional development process (the V model). Use of models and simulations in the development phase (the downward slope of the V model) allows the validation of system behavior models, using simulations early in the development process, thus eliminating the need for the construction of complex and costly physical testing systems.

Yossi Ackerman mentions the Internet's impact on systems engineering. According to him, the exposure of the public to large volumes of information has brought on a devaluation of the all-knowing experts and an increase in the importance of interdisciplinary teams. In a complex world, only experts from different fields thinking together can produce added value, and interdisciplinary team management is one of the fundamental abilities of systems engineers.