"A vast halo surrounding the Milky Way galaxy" would be a simple analogical statement that represents the influence of "systems theory" in the scientific world as we know it. The halo is a system theory, and the galaxy is the collection of the different fields that make up the scientific world [1]".

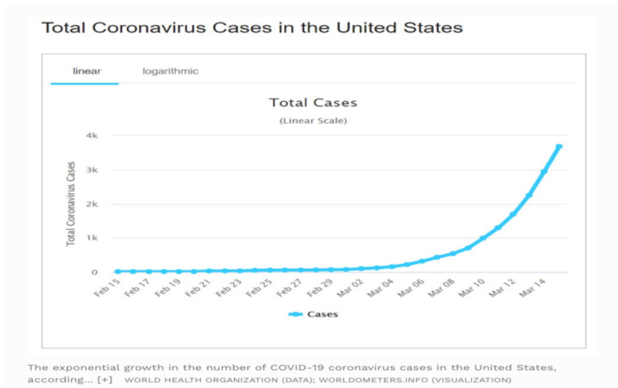
Introduction

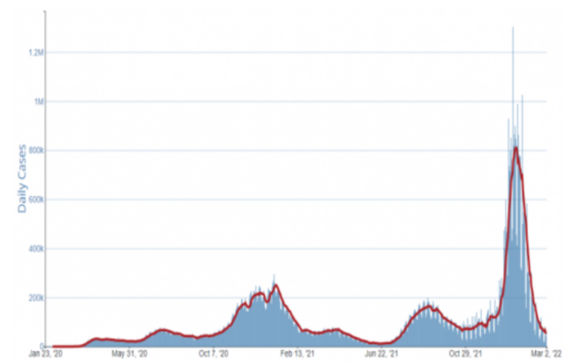
Surprisingly, every day we are confronted with a system comprised of elements that, at first glance, do not appear to be interconnected. General System Theory was outlined by the biologist Ludwig Von Bertalanffy in the 1950s, describing "how to break whole things into parts and then to learn how the parts work together in systems [2]." As Von Bertalanffy's theory emerged in the early 1930s, scholars from many disciplines discovered that the concepts of general system theory could be applied equally to their fields, such as chemistry, physics, and social sciences [2]. Over the years, with the ever-growing need for and importance of integration of knowledge, tons of available data, and information on an interdisciplinary level, systems theory has seen its stock rise on an exponential growth scale. Some system concepts were generated from elementary mathematical considerations, which later on were applied to a wide range of different disciplines. The small piece in the question is the Growth Concept, whose evaluation in light of system theory for possible and plausible impacts on engineering and technical management is the scope of this paper.

Analysis

The Growth Phenomenon

According to the growth equation, system laws may be found in numerous disciplines and a general system theory can be established by comparing them to each other. The single equation $\frac{dQ}{dt} = f(Q)$ can be extended into a Taylor series as $\frac{dQ}{dt} = a_1 Q + a_{11} Q^2 + \ldots \ \ldots$ (1). The first term of the series signifies that the growth of the system is directly proportional to the number of elements present. Depending on whether the constant a1 is positive or negative, the growth of the system is positive or negative, and the system increases or decreases [1]. With these statements, Bertalanffy is addressing "the growth phenomenon" as a major system concept in systems with these statements. Because the solution ($Q = Q_0 e^{a1t}$) of the growth function after considering the first term of the equation (1) is the exponential law (or "the law of natural growth") and is explainable in fields such as biology, sociology, chemistry, and finance, the growth concept is critical to the development of general system theory as a whole. Again, retaining the first two terms from equation (1) leads to the solution of $\mathrm{Q} = \frac{\mathrm{a_1Ce^{a1t}}}{1-\mathrm{a_{11}Ce^{a1t}}}$, is the logistic curve, which has an important effect in wide areas like chemistry, sociology, and biology. Thus, the growth model plays an important role in the advancement of general system theory as a whole. The growth concept is central to engineering/technical management because system/technical engineers assess systems, determine problems, address solutions to rising issues, design, upgrade, and maintain systems, and suggest the best possible improvements that can be made to a system in the future [3]. The following analysis will be more useful when talking about the growth concept in a systematic way.





- Pandemic is still ongoing and Covid-19 (SARS-CoV-2) is a contagious disease [4]. By looking at the first stage of Covid-19 data (year 2020) in the United States in between the mid of February and March on the graph [5] shows the number of coronavirus cases increasing in exponential growth with time. Situation was terrible and caused great fear among the people. Numerous numbers of people have died across the world, and it's still continuing. When the graph was rising exponentially, the system engineers used to think of Covid-19 as a system. Engineers used system thinking, which is a holistic approach to a better understanding of how the system elements interact with each other over time [6] and then examine the system problems by understanding the root cause, how it spreads from person to person, what age group is at the highest risk of dying, what necessary steps might help to stop the growing cases, testing their findings, and then implementing the ideas. Systems engineers from multiple disciplines like optical, electrical, mechanical, biomedical, computer, and chemical engineers all played a critical role in fighting against the exponential growth of Covid-19.

- According to the data provided by the CDC [12], the number of daily cases in the United States between January-February 2021 and January-March 2022 follows an exponential growth law, where the system's growth is negative, that is the system decreases. Proper system analysis is done by the system engineers were playing an analytical role is in the scale-up of therapeutics and vaccines. Scientists are discovering the vaccines — that's a scientific task, though there's also, engineering in it —but when you go from making 100 doses to a billion doses, that's a huge engineering challenge [7] and transporting them in a temperature-controlled vehicle on time wherever they are needed. The same is true for manufacturing therapeutics. So, in the negative growth rate, technical engineers are doing an excellent job.

- After the number of cases (Covid-19) increases exponentially, we obtain a sigmoid curve and attains a limiting value, which refers to a logistic curve (asymptotic growth) [8]. Components like mask utilization, 6 feet social distance, and hand sanitization played a huge role in limiting this exponential infinite growth. Technical engineers are working on maintaining the integrity of the supply chain by getting the right ingredients together to make masks and hand sanitizers, and those come from all over the world.

Conclusion

This growth concept study is based on a structured approach to identify the attributes that are of relevance in engineering management. Considering desired characteristics such as exponential law and logistic curve growth, this analysis, which is supported by strong evidence from existing literature, provides a clear picture of the impact that the principle can have on system thinking strategies and decision making. There is a common framework hypothesis that deals with the formal aspects of frameworks, and concrete facts showing up as their remarkable applications by simplifying factors and parameters that indicate the formal uniformity of nature.

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