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UPGRADING ALONG THE VALUE CHAIN: CONFORMITY BETWEEN HELICES

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1. VALUE CHAIN AND ITS DYNAMICS

Is our point of departure why the product cycle bends east while rising? Why does it not continue its rise?

The economist would define this rise as a fall in costs, a rise in net revenue, and a decline with diminishing returns, i.e., always a cost-based assessment. However, costs are not necessarily the only or most critical performance indicator in a competitive economy.

This is true mainly because of technological progress. Costs are accounting items and can be reduced independently of productivity. Pricing is essential and must be tackled, with the recognition that we are all predictably irrational. Homo economicus applies in theory but not in reality.

An increase in value-added may carry a cost element, but the value it adds via quality and better response to consumer demand contributes to a company's performance.

2. DOES ECONOMICS PROVIDE AN ANSWER?

Costs do not account for or consider the evolution of technology or consumer behavior/tastes. This effect is magnified when we consider intra- and/or inter-firm transactions. Furthermore, cost is a pricing concept and relates to buyers' budgets as much as what is offered.

The economic analysis considers production as the "production function," a relationship between output and the amount of capital and labor involved in its production. Elasticities of substitution between capital and labor add up to one and remain constant. This is what economic analysis commands.

Production in engineering involves material inputs and services, the technology of processing them according to an initial design and offering the output to a final user. Interdependencies between these "actors" continue, and the value chain evolves.

3. PROCUREMENT OR INTEGRATED PRODUCTION, THE PROBLEM REMAINS

The final user may be the consumer or another producer who combines this output with others to produce a final output. The entire process of "production," *i.e.*, the value chain, may be organized integrally, as was the

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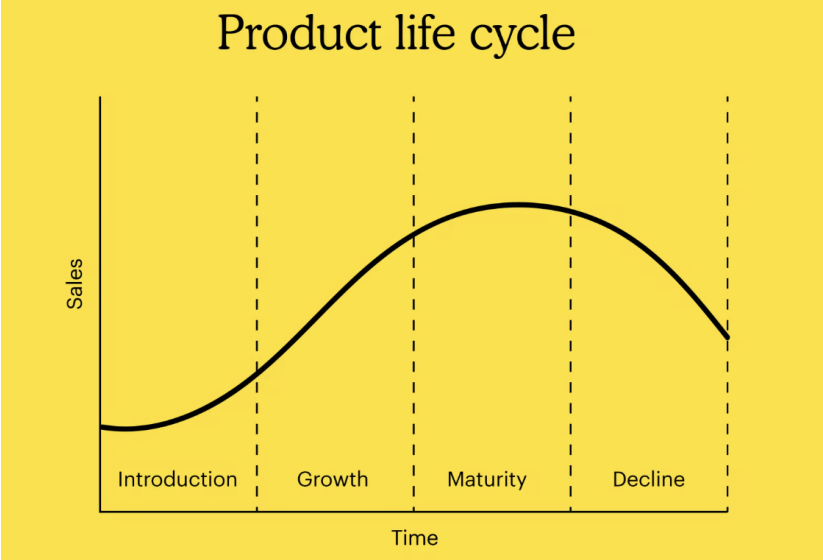
case in Henry Ford's Model T or some Korean manufacturers today, or it may depend on a symbiosis of suppliers and final manufacturers, OEMs.

Globalization has moved to a stage where we talk of vertical trading networks. OEMs are in three centers: the USA, Japan (China, Korea), and Europe (Germany, France, UK), with suppliers in countries in the network. These suppliers need to meet the requirements of their customers, who may be OEMs or other component suppliers. It should be kept in mind that those requirements change according to the technical mutation of the OEM or the other component supplier.

Our question is how we might synchronize this symbiosis, which is important for supply chain organization.

4. **GENETICS OF MANUFACTURING**

Here, we encounter the helix concept. C. Fine uses a helix to explain the fruit fly's life cycle, drosophila. The same concept applies to Professor Bejan's constructal law. The evolution of a growth survives in symbiosis with other materials that may help or hinder its growth.



The product cycle hypothesis assumes that growth tapers off at a point as a consequence of diminishing returns. However, we are living through a period when this is not correct. Software has taken over during the last decade to exploit the ground provided by chip technology by creating new environments of "needs and solutions."

5. **A DIFFERENT HELIX BEHAVIOR**

For this reason, the product cycle does not bend east at an inflection point but continues its northward climb, in line with J.A. Schumpeter's "creative destruction" hypothesis. If this scenario fails, the company/industry in question will fall out of the marketplace because overall technology progresses, offering new avenues for growth.

The helix concept is also used to explain technological change. Under the triple helix, collaboration between universities, government, and industry is foreseen. The quadruple helix brings in the collaboration of media, art, and innovation. Finally, the quintuple helix introduces global warming and the environment as drivers for innovation.

We will stick to the helix explanation of endogenous growth, innovation, and technical progress in our effort to understand how the value chain with its contributing elements may upgrade and increase value-added and create new products. Electric cars, autonomous mobility, and other solutions in life sciences, daily life, space technology, and AI are examples of today.

6. **SYNCHRONIZATION OF DIFFERENT HELICES**

The question that brought me to this conference is whether and how we might identify, define, and measure the elements constituting the helix. The end purpose is to explore the synchronism of progress's evolution in each of these elements. When I mentioned this question to Adrian Bejan, this might be an exciting subject at the Bucharest Conference.

The analysis differs according to industry in question. In process industries, agriculture, and life sciences, helix in its original sense would apply, as constituting elements would have biological and chemical characteristics, hence definable like in the original explanation of the double helix, i.e., the relationship between sugar and phosphates in the evolution of the genome.

How can helices be defined in material sciences so that the evolution of, for example, an aluminum particle, graphite, or magnesium can be investigated and joint operation with a part made of steel or petrochemical products can be secured? In the end, similar to the growth of the genome into a human being, we want the product cycle to continue its climb so that technology progresses and the value chain upgrades via the development of innovations and new solutions.

7. **APPROACHES TO DEFINE THE HELICES**

Some research attempted to tackle the question using input-output methodology; however, that is based on fixed production coefficients, whereas we need to identify ever-changing routes and modes for A. Bejan's rivers and trees to proceed to advance and to grow or for pharmaceutical industries to develop solutions in the field of life sciences. The question applies to battery technologies today, which are the subject of research in the electric vehicle industry. If AI is to bring a solution, what and where will the data be used in the process? We return to the question, "How can respective resilience, sustainability, tolerance, and the like be measured, and concordance be secured?"

The Late Nobel laureate R. Solow questioned the impact of technical progress; lacking alternative measurement possibilities, the production function was the basis of analysis, where the "Solow residual" was interpreted as the output of technical progress, i.e., output rising beyond that made possible by the increase in labor and/or capital.

May QFD, quality function distribution, serve as an instrument to identify where technical specs of different "molecules" conform or conflict while the technology of the entire material world is changing and evolving and the helix is progressing? May we imagine a system where digital QFDs attached to constituting

parts of a helix talk to each other and offer solutions? Or am I being more far-fetched in my imagining exercise than Ray Kurzweil?

In other words, how can the dynamics of endogenous growth in production and the value chain be defined and measured?

Ecochain, a consultancy based in Amsterdam, develops tools for "life cycle assessments" across industries. While not stated on its website, Ecochain seems to deliver sustainability studies on demand, presumably to meet the demands of the EU rules.

What we seek includes sustainability in the economic sense but also involves the technological progress potential of every industry. Talking of progress potential, may AI help answer the question? Could I refer to ChatGPT instead of speaking to you?

If so, where would AI obtain the data? This question takes us back to the original question: how to define and measure the specs of numerous inputs in a value chain. We face this question at the design phase, all the way to the shop floor and marketing. I believe this question underlies the entire evolution process.

8. **EXPECTATION**

I end my presentation not with proof, as would be the case for a paper in engineering, but with a question. The question also concluded my book on the Evolution of the Value Chain, published recently in Turkish. The book also proposes a new look into economics, not constrained by diminishing returns. This offers a new paradigm for investors, company managers, and engineers by highlighting new opportunities. It also suggests governments adopt a new look into industrial policy.