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Integrating Thermodynamics and Biology for Sustainable Product Lifecycle Design

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The linkage between raw resources consumption and economic growth through product manufacture and disposal is creating an untenable pressure on the planet's natural systems; therefore understanding and embracing the mechanics of the biology and physics of our context could lead to novel approaches in the design of human-built systems/products.

Designers are, by active association, responsible for that pressure and much of the impact can be traced back to the early stages of the design process. For designers and engineers the main constraint is accessibility to knowledge of multiple and complex factors in easily digestible form when starting a project. Added to this is the possibility to transcend the realm of products and explore creative solutions throughout the entire life cycle, giving designers the opportunity to propose entire new business models and systems.

This paper exposes the search for an intuitive soft modeling tool that considers some of these factors and inspires the innovation of business and systems innovation from a biophysical perspective. The aim of this tool is to enable the exploration of these factors in a playful intuitive way and relate these outcomes to the design of a business model operating within the principles of trophic levels.

The first key question to the development of this approach has been: how does it work in nature? Organisms search for their food in other organisms and at the same time are the food of others; biomass and energy are transferred from one level to another, losses occur, higher qualities of energy are created and all is maintained in continuous cycles. The linear human production of goods can be rethought by taking into account this basic principle of thermodynamics and although this is not a technological problem, the relevant constrains need to be integrated for this approach to be feasible. These are from an economics origin: how to achieve a healthy business from a non-linear process? It is proposed that an analogy between natural and human systems: autotrophs = manufacturing, heterotrophs = distributors and consumers, their concentration and size, their possible combinations and their eventual business interpretations, is referred to as Trophic Economics.

The envisioned tool will combine the exploration of the complex factors involved in the lifecycle of a product with the suggested Trophic Economics models. The outcome could be sketches of the possible boundaries and structures of new business and products, to be resolved later on the drawing board.

In order to measure and keep track of the most relevant decisions, a designer must embrace tools like emergy accounting, MIPS and MI (Wuppertal Institute, 2002) used in related combination, plus indexes of CO_2 emissions and relevant economic, social-demographic and ecosystems information about the countries involved in any give proposition of manufacture and use.