

Comparing Technological and Biological Evolution

Similarities in biological and technological evolution

Consider the following parallels in biological and technological evolution:

Biological evolution	Technological evolution
Occasional appearance of mutations	Occasional appearance of new ideas
Same mutations repeated in different organisms, in different time and places	Same ideas repeat themselves in different systems, in different times and places
Increasing probability of mutations along with deterioration of the environment or other conditions	Increasing probability of generating new ideas and concepts along with increasing number of problems in existing systems (deterioration of conditions or the appearance of threats)
Natural selection of the most appropriate organisms based on environmental conditions	Selection of the best technical solutions by the market
“Fight for survival” as a driving force of evolution	The fight for market share as a driving force of evolution
Selection of successful organisms rather than successful mutations	Selection of successful systems rather than partial concepts
Selection according to the following basic factors: <ul style="list-style-type: none"> • Functional efficiency of an organism • Reproductive efficiency 	Selection according to the following basic factors: <ul style="list-style-type: none"> • Functional efficiency of a technical system • Reproductive efficiency
Expansion of biological species into all possible ecological niches	Expansion of technical systems into all possible ecological niches
Evolution of evolutionary mechanisms	Evolution of evolutionary mechanisms



Differences in biological and technological evolution

Consider the following parallels in biological and technological evolution:

Biological evolution	Technological evolution
A biological system (organism) reproduces itself	A technological system does not reproduce itself
Species preservation at the expense of preserving information stored in the genes of every organism	Technical system preservation at the expense of storing information outside of the system (drawings, descriptions, etc.)
Generation of mutation caused by occasional mistakes in the “reading” of genes	Generation of changes caused by: <ul style="list-style-type: none"> • Occasional mistakes • Purposeful activities of engineers
Selection via elimination or removal of the reproduction function from the worst samples	Selection via: <ul style="list-style-type: none"> • Elimination or removal of the reproduction function from the worst samples • Choosing the best samples for reproduction
Narrow acceptable range of environmental parameters (pressure, temperature, radiation, components, etc.)	Wide and continuously increasing range of acceptable environmental parameters
Strong restrictions on acceptable materials	No restriction on utilized materials
Near impossibility of transferring “solutions” between remote species	Ability to transfer solutions between remote technological systems

Description of an evolutionary process applicable to both biological and technological evolution¹

Introduction

A comparison of the evolution of live (natural) and man-made (artificial) systems shows that both evolutions can be described in terms of their providing two main functions:

- Survival
- Reproduction

For live organisms these functions are trivial. It is well-known that an evolution unit represents a population of different (though capable of cross-breeding) organisms of the same species from which, at any given time, the most adapted participate in reproduction.

¹ Developed by Dr. Gafur Zainiev

For technical systems, the survival function is equal to the primary function. If a system does not serve its main purpose, it will be replaced with another one. The peculiarity of technical systems is that they are not self-reproducible but are reproduced by humans. Obviously, some systems are more successful in being reproduced than the others are.

All further considerations are based on the following complementary and non-separable pairs of definitions:

- Evolution and Reproduction (evolution and reproduction of technological systems)
- Hybridization and Integration (hybridization of technological systems and integration of technological processes)

In particular, the complete integration of a technological process corresponds to the replacement of several separate technological systems responsible for different steps of the process, with the whole process being provided by the single hybrid system.

Main definitions utilized for describing the evolution of technological systems

Generalized primary function of a technological system (TS)

The generalized primary function of a technological system (TS) includes two equally important components:

Survival function of TS:

- A function for which, if not performed, the system is replaced with a new one (i.e., the old system is sold, discharged, utilized for a different purpose, disassembled, etc.)
- Usually the function for which the TS was designed
- Also called the primary function

Reproductive function of TS:

- Not defined in technology
- In biology, each live system reproduces itself via copying (on its own or paired with another live system)
- Technological systems are reproduced without their participation. Various realizations of the reproductive function will be described separately.

“Superiority” of a given TS for a human being

1. The “superiority” of a given TS for a human being can be measured by the way an individual can benefit from the given TS, and usually relates to the following individuals:
 - Inventor
 - Investor
 - Producer

- Distributor
 - Consumer
2. For every TS there exists a minimally necessary and maximally acceptable magnitude of “marketing novelty.” A too-new TS cannot find customers; without new features customers will be unable to discern the TS from others – therefore, it should encompass an degree of marketing novelty. The superiority for a human being depends on novelty.
 3. A TS requires a human being in order to reproduce, therefore the TS with the higher superiority has a greater chance of being reproduced.
 4. We will also consider the “superiority” of a given TS for a certain group of people.

Model of a TS simplified in terms viable for a certain group of people

A simplified model of TS can be built in terms of what is important for a certain group of people, based on their values. This model will help in understanding which requirements cannot be ignored for this category of people.

TS reproduction via hybridization

- The majority of technological systems exist in more than one sample and thus are reproducible.
- Any technological system might be introduced as a complex TS that consists of more than one simple TS.
- The evolution of any TS can be described as a process of combining simple TS in various complex TS, which are then further reproduced.
- Both simple and complex TS are reproduced by human beings. Similarly to what was shown earlier, the people involved can be divided into the following categories: inventors, investors, producers, distributors and consumers.
- A new, complex TS can be created via hybridization of various TS.
- To build the most complete population of hybrids based on a given complex TS, it is necessary to reveal the pedigree (history) of this TS, reveal all its relatives and colleagues, and hybridize them in various combinations.
- From the population of hybrids obtained in the manner mentioned above, TS (one or more) should be selected that satisfies the requirements of those who make the selection.

Integration of a technological process via hybridization of TS involved

The following possibilities are available:

- Build the next generation of a technological process as an integrated version, which will be the most beneficial for any group of people (identified beforehand) involved. (See above.)
- Suggest a scenario of action that will lead to a preferable reproduction of this selected hybrid.

Other definitions utilized

- A pedigree of a given TS
- “Relatives” of a given TS
- “Colleagues” of a given TS
- “Relatives’ hybrids” and “colleagues’ hybrids”
- “Puzzle evolutionary portrait” of TS
- Evolutionary portrait and conceptual design