

Biophysics is becoming Bioengineering (in the 21st century)

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Today, in the 21st century, the science approach to the living world, life, and living organisms, especially in terms of the evolution of biological species, begin to see as to technology - organized systems of the technologies - from the positions of **bio-cyber-engineering**. The Living World is a continuous bioengineering creativity. Conceptually, biology is becoming technology, and physically – *Vice Versa* – technology is becoming biology (W. Brian Arthur, “*The Nature of Technology*”, 2009). “**Biology is the technology**” announce Rober Carlson in the book (Harvard University Press, 2010). Because each biological species is a special bio-technological system to survive, i.e. successfully deal, effectively combat the **entropy** by bio-informatics technologies (genetics, hormones, and nerves) in certain ecological conditions. What, in the twentieth century, was called the **System Biophysics**, in the 21-st is recommended to call **bioengineering**, because **engineering** thinking is indispensable for both – in **Synthetic Biology** and in research for **Analysis-by-Synthesis** method.

Bioengineering is the creative application of biological sciences of technology, mathematical methods, and empirical evidence to the innovation, design, construction, operation and maintenance of structures, machines, materials, devices, systems, processes, and organizations. The discipline of engineering encompasses a broad range of more specialized fields of engineering, each with a more specific emphasis on particular areas of applied mathematics, applied science, and types of application. The term **engineering** is derived from the Latin *ingenium*, meaning „cleverness“ and *ingeniare*, meaning "to contrive, devise".

Two decades ago the USA National Science Foundation (NSF) announced the an innovative Nano-Bio-Info-Cogno (NBIC) Convergence of Technologies program, which basically lies in the belief that future - **Human enhancement technologies (HET)** - must be developed and implemented in the field of living nano-technologies and principles. This NBIC2 program variation now is extended to 2030.

(<http://www.wtec.org/NBIC2/Docs/FinalReport/Pdf-secured/NBIC2-FinalReport-WEB.pdf>)

Decade ago in Harvard University came the HUB program - Bioengineering, Engineering Biology for the 21st Century, a Plan for Bioengineering at Harvard. Harvard has a unique opportunity to create a program that will define bioengineering for the 21st century. The Harvard University Bioengineering initiative to become a HUB and a worldwide focal point of pedagogy and collaborative and translational research of life scientists and engineers working together.

([file:///C:/Users/Dobilas/Downloads/RG%20\(17\).pdf](file:///C:/Users/Dobilas/Downloads/RG%20(17).pdf))

In 2012 the STOA of the European Parliament discussed program „**Making Perfect Life, European Governance Challenges in 21st Century Bio-engineering**“, have seen the emergence of a new engineering approach to life which is driven by an increasing convergence of the physical and the biological sciences in terms of two bio-engineering megatrends – „**Biology is becoming Technology**, and - *Vice Versa* - **Technology is becoming Biology**“.

(http://www.europarl.europa.eu/RegData/etudes/etudes/join/2012/471574/IPOL-JOIN_ET%282012%29471574_EN.pdf)

There is a need to look at life with the eyes of engineering – as to “machines” – therefore the systems biophysics is transforming into bioengineering, because the study of complex biosystems requires Analysis-by-Synthesis (Bionics and Systems Biology or Biophysics) methods. The „machine metaphor“ was proposed by René Descartes in the *L'homme*, 1664. That's has noticed that like any animal, so Man is a "machine" too. Therefore, there is a need to look at life with the eyes of engineering – as to “machines” - the systems biophysics is transforming into bioengineering,

Descartes conceived of the universe as comprising three substances: *res extensa* (measurable things), *res cogitans* (thinking things), and God. Animals are automatons. The human bodies are like those of animals, but connected to a **thinking thing** (*soul*, after Descartes or *information* today) by way of the pineal gland. A healthy body is like a “*well-made clock*”. That has noticed that like any animal, so Man is a “*machine*” made up of functionally purposeful rather than random components. The live “machines” requires a cybernetics or bioengineering approach.

It is worth pointing out, that in 2018 commemoration of the 250th anniversary prof. Vilnius University **Jędrzej (Andrzej) Śniadecki**, that, before ~ 215 years ago his **Theory of Organic Beings** and published books at the University of Vilnius with this title are the beginning of the **Systems Biophysics** not only in Lithuania. In 1904, Sniadecki claimed, that living organism are controlled by **organic - organizing forces**. Today, the **organic forces**, we call Gibbs free energy, and the **organizing forces** – as the **information**, as maintaining the system's operational order that is it control or management. Such a bio-cyber-physics, yet bionic-technological approach to Systems Biophysics at Vilnius University has been developing since 1962. Systems Biophysics as bioengineering is promoted in VILNIUS as the bioengineering Closed-Loop Coding-Decoding (CL-CD) concept (https://link.springer.com/chapter/10.1007/978-3-319-22599-9_10). The cell as bioengineering CL-CD system (Synthetic Biology), as the first step to the biophys-engineering is also considered. (<http://www.lnfk42.vu.lt/thesismanager/thesis/494KIRVELIS.pdf>). Today his Theory is trasforming to **Bioengineering 21th century**.

In recent years, the bioengineering approach has become particularly relevant in the Yuval Noah Harari 2015-16 bestseller “Homo Deus **Homo Deus: A Brief History of Tomorrow**”, which globally looks at the evolution of the living world and humanity and future transformations, seeing inevitably the coming of the new era of the Earth - TRANSHUMANISM.

(<https://en.wikipedia.org/wiki/Transhumanism>)

(<http://dobilas.kirvelis.lt/index.php/mokslas/29-transhumanizmas-10>)

Accepting the view, that the Living World is biotechnological systems, the most appropriate method of the scientific interpretations is **bioengineering**. That’s why basic Life science – **BIOPHYSICS must be called „BIOENGINEERING“**