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## Design as adaptation

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# Design as Adaptation

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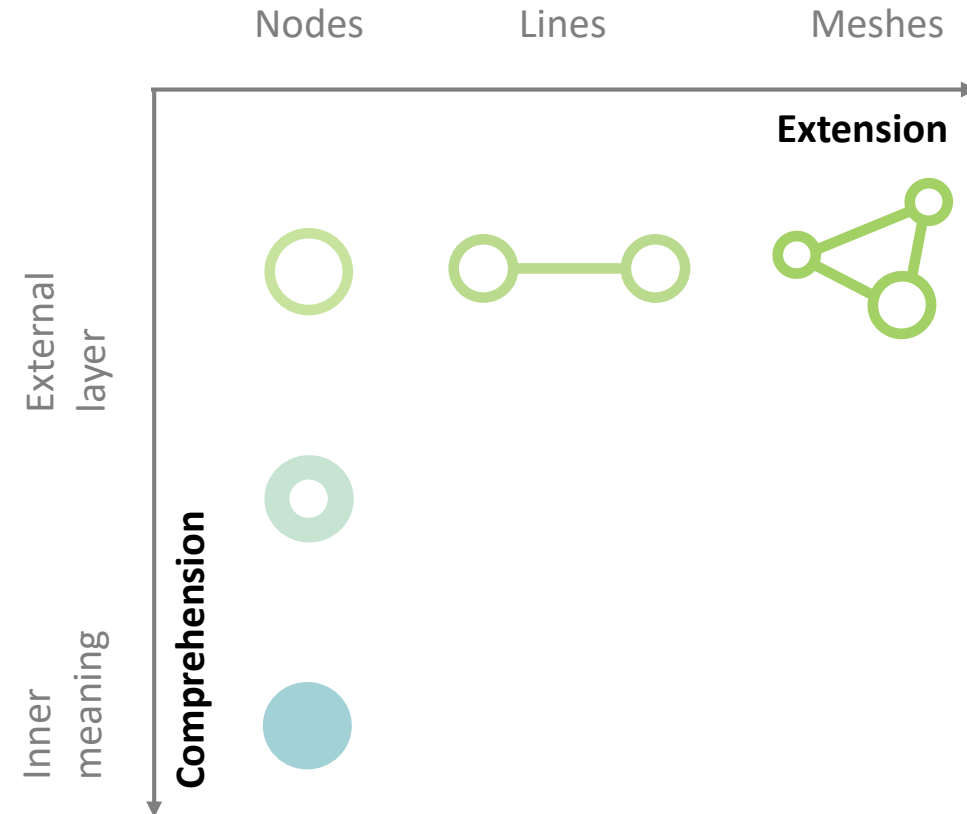
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**Laura Forlano, Ph.D.** Secondary advisor

# Expansion of design

Design draws upon a multiplicity of knowledge domains situated within entangled technical, economic and social systems.

Design as a term has grown in 'comprehension' and 'extension' (Latour, 2008) as a result of operating within the highly complex entangled systems.



# **Designing biology/ Designing with biology**

Biotechnology, deemed as the dominant technology of our century (Dyson, 2007) is shaping new and **unfamiliar design spaces** through new technological capabilities which enable designing with living systems.

**New design frameworks and tools to understand and act on the complexity that is formed around emerging technologies can facilitate navigating these design spaces.**

# Permeable boundaries

Biotechnology ecosystem is an example of an open innovation system that is comprised of heterogenous networks that weave small, science-based biotechnology companies, investors, and nonprofit research organizations into a coherent regional 'community' which operate based on the principles of aggregation, self-organization and soft-assembly (Powell & Owen-Smith, 2004).

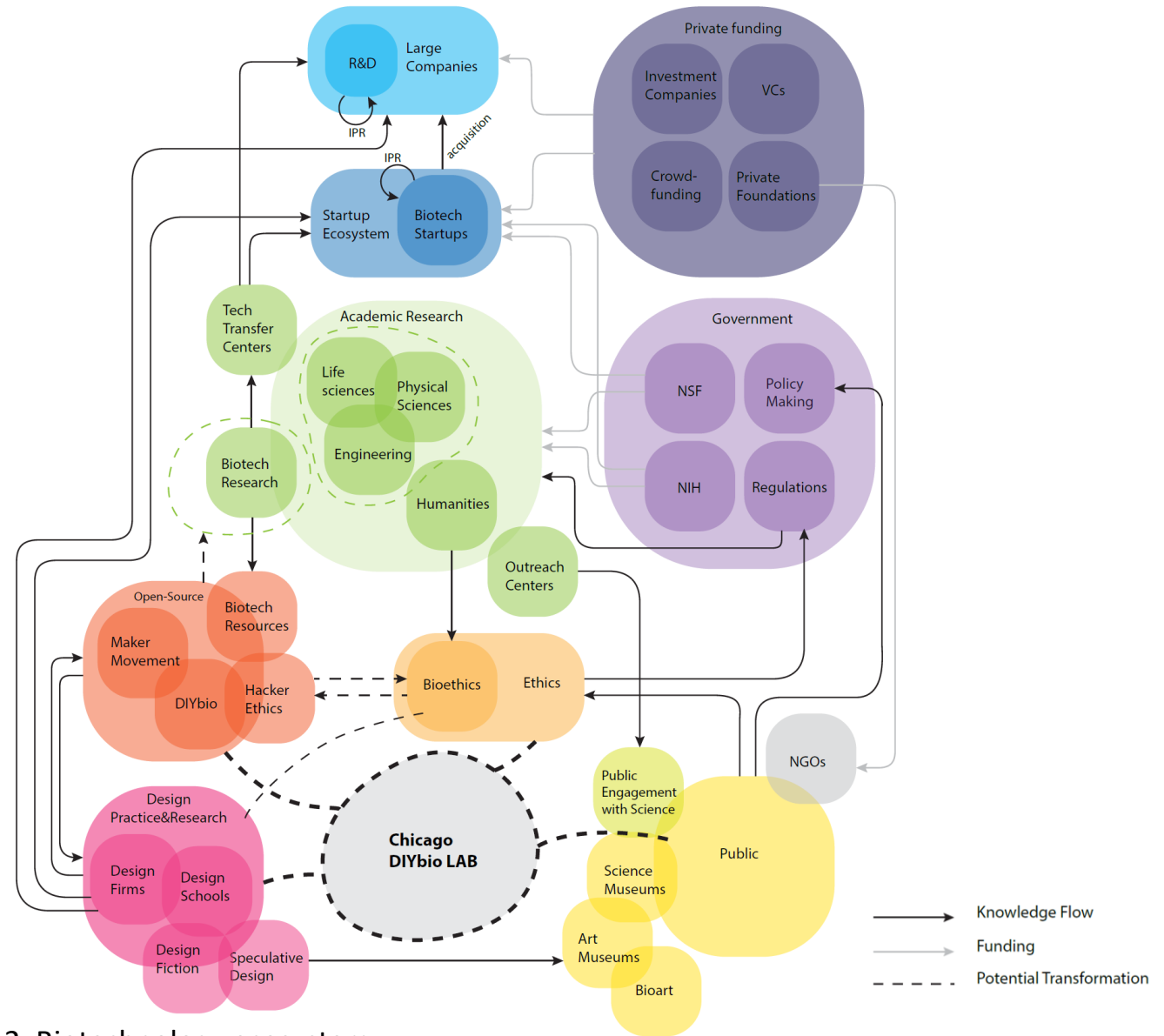


Fig. 2. Biotechnology ecosystem

# Convergence & Divergence

As the convergence of life, physical and engineering sciences, biotechnology builds on large spectrum of knowledge domains that span various disciplinary fields.

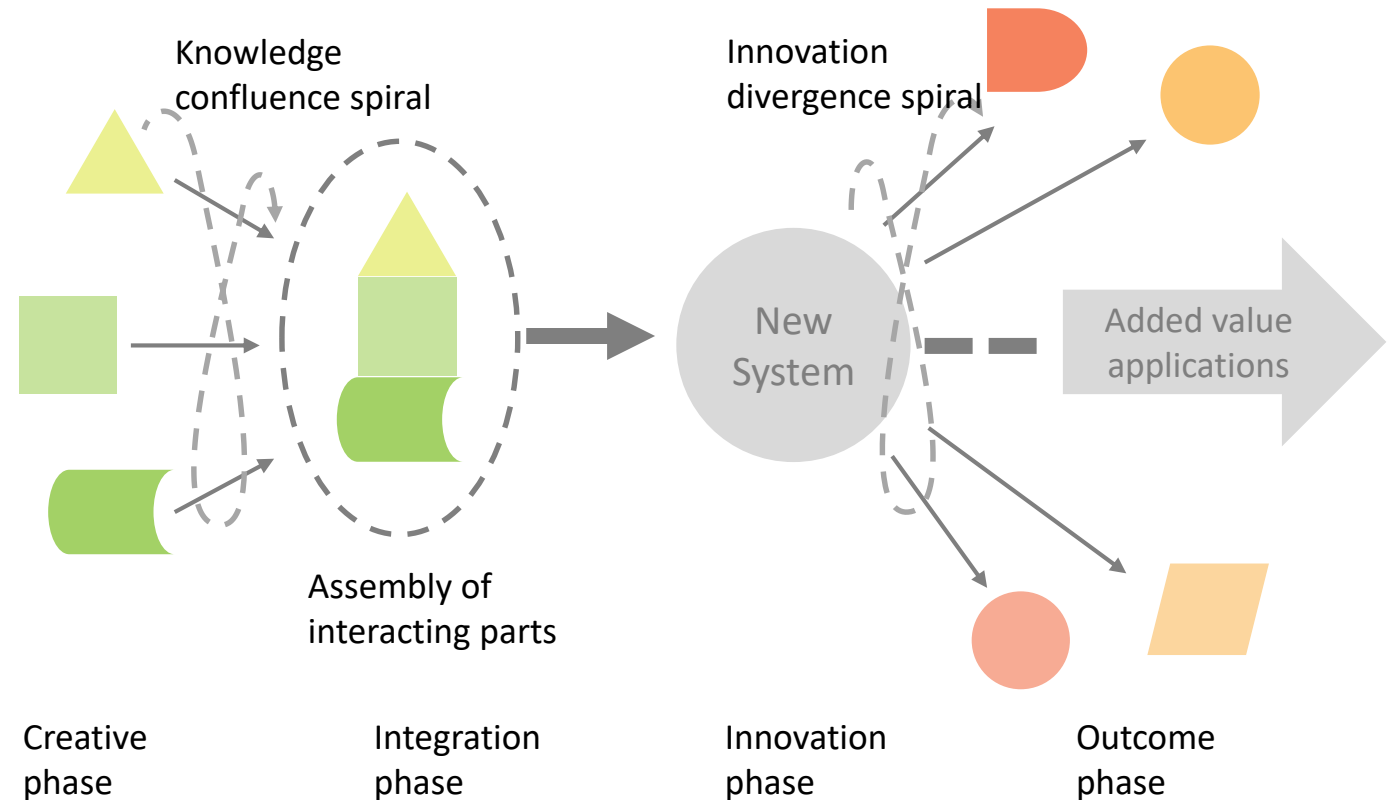


Fig. 6. Adapted from Roco et al. (2013). Convergence and divergence cycle

# Convergence & Divergence

The convergence of separate knowledge domains not only increases the number and diversity of application areas but also changes how research is being conducted.

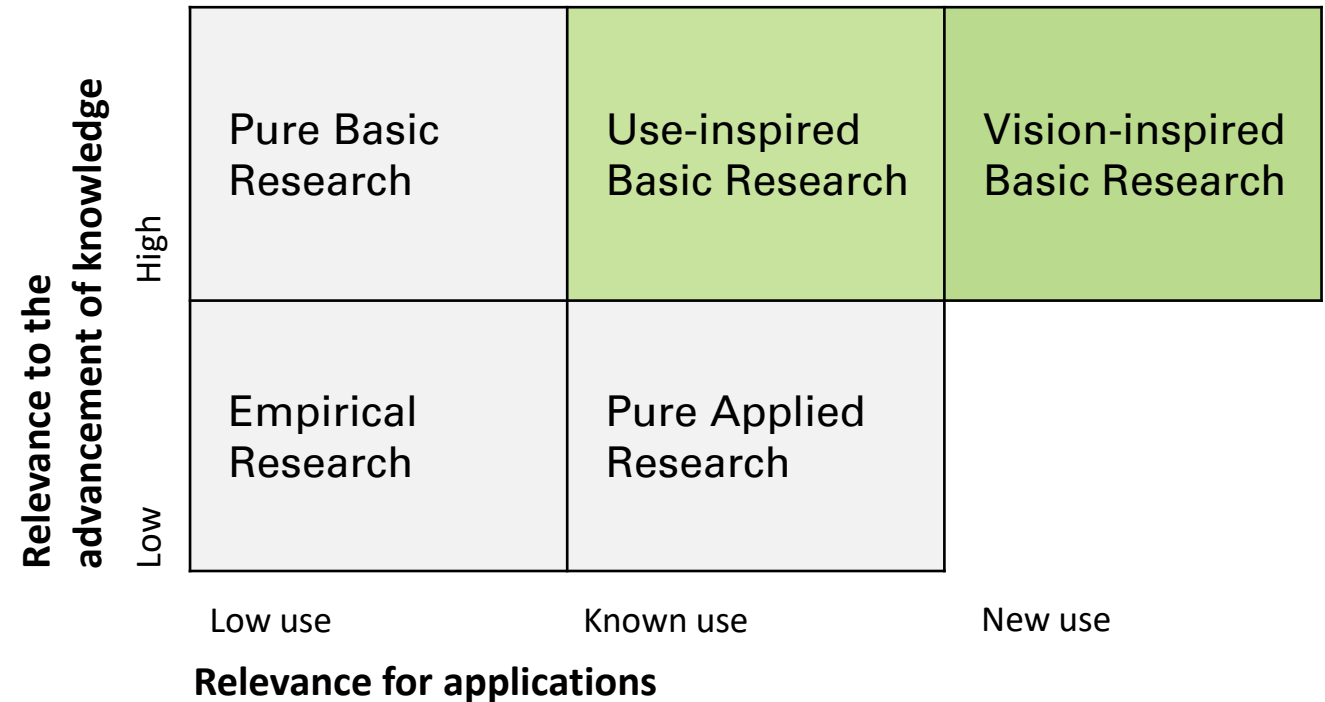


Fig. 7. Adapted from 'Modified Stokes model' with the addition of Vision-inspired basic research proposed by Roco et al. (2013).

# Value creation through design

According to Heskett, design acts as an interface between the *context of production* and the *context of use* (2017).

Value is created within and embedded in artificial structures that constitute context of production and context of use.

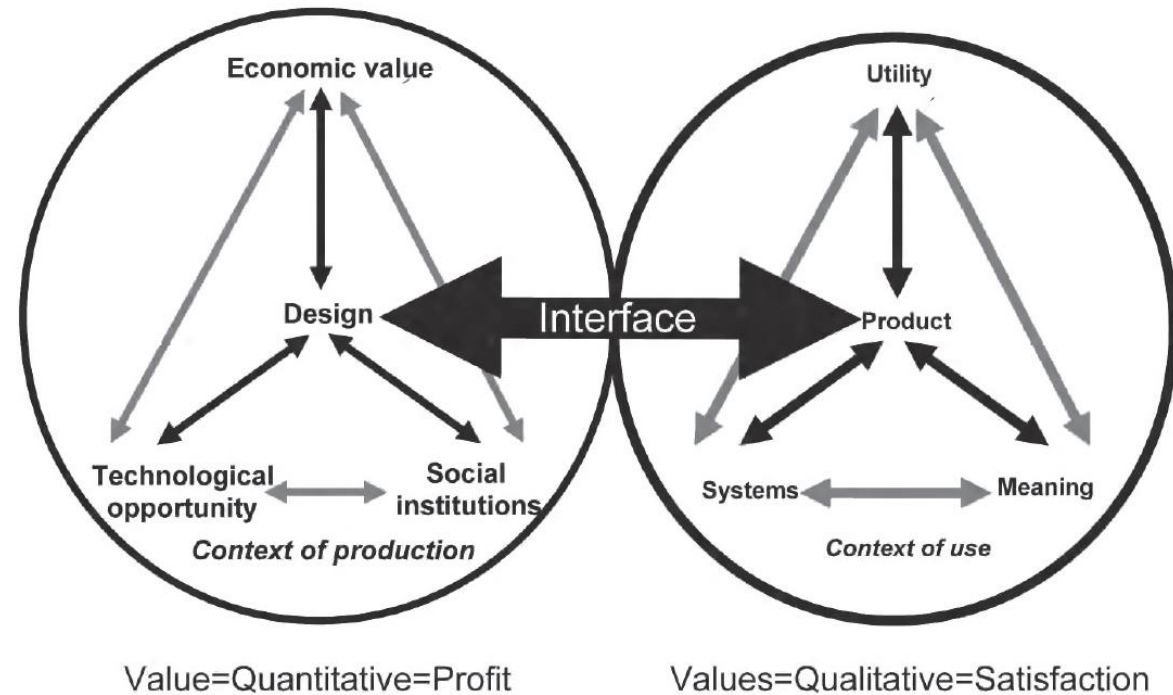


Fig. 8. Context of design practice, John Heskett, 2017.



# Value creation through design

Emerging technologies form new contexts of production. Hence, the structures that enable value production are not solidified in the earlier stages of technological development.

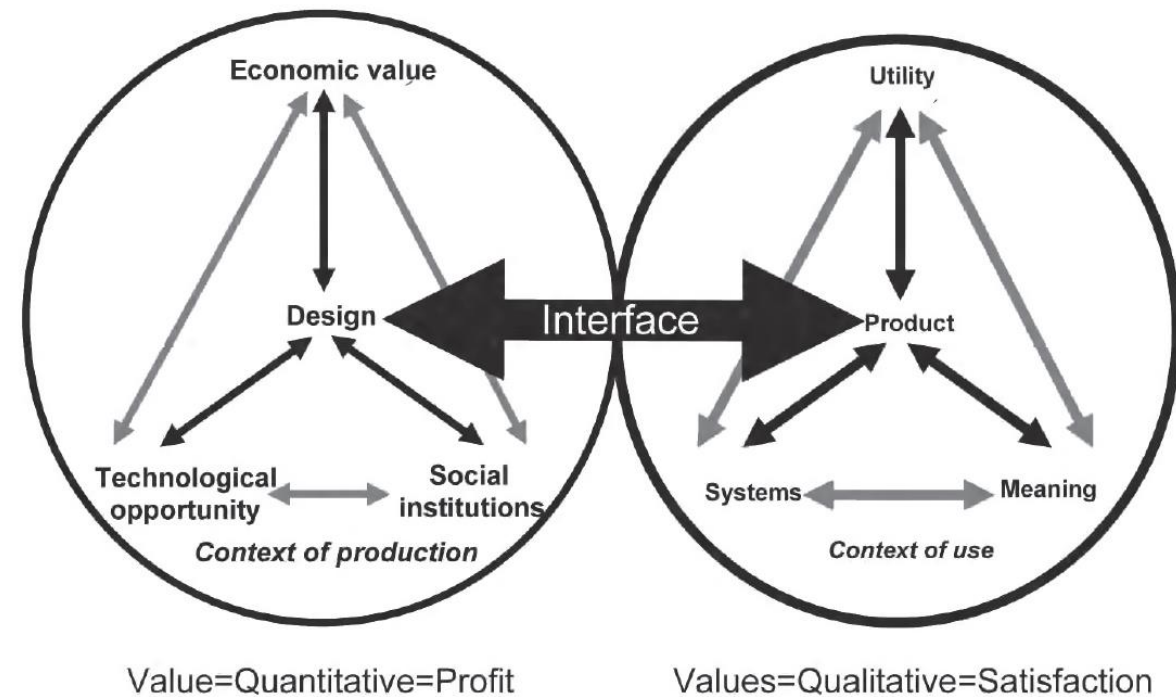


Fig. 8. Context of design practice, John Heskett, 2017.

# **How can design influence use-inspired and vision-inspired biotechnology research?**

# Fitness landscape

The fitness landscape model locates the attributes that contribute to fitness and visualize the distribution of fitness across the topography.

Thus, the model can also inform how the agents might move across the landscape to increase fitness, in other words to adapt.

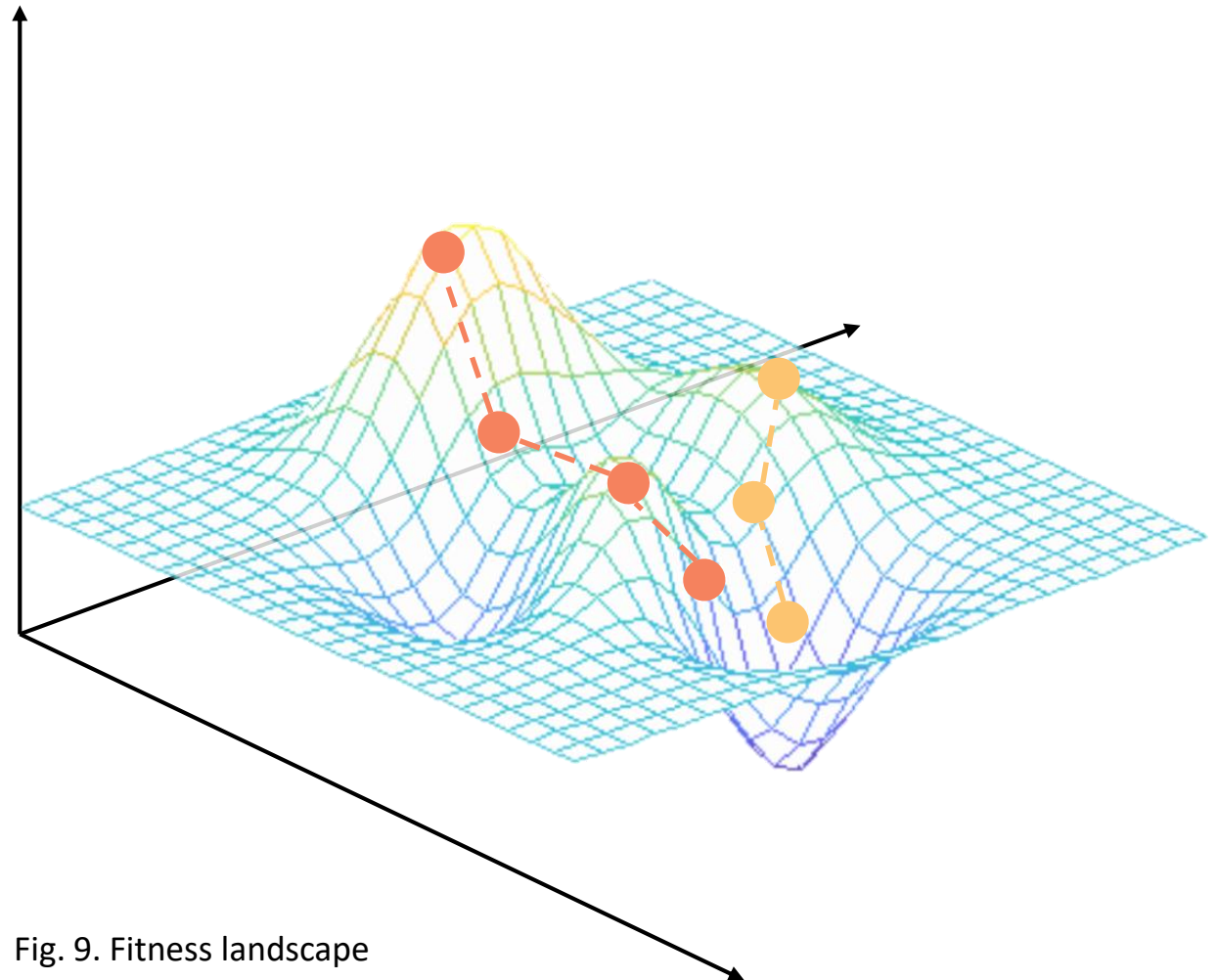


Fig. 9. Fitness landscape

# Fitness landscape

Evolution is a process of search over fitness landscapes in which the topography determines the likelihood of success (Kauffman, 1992).

Success is determined by the agent's ability to adapt to the landscape, and it is dependent on both the attributes of the agent and its interdependencies to other agents in the ecosystem.

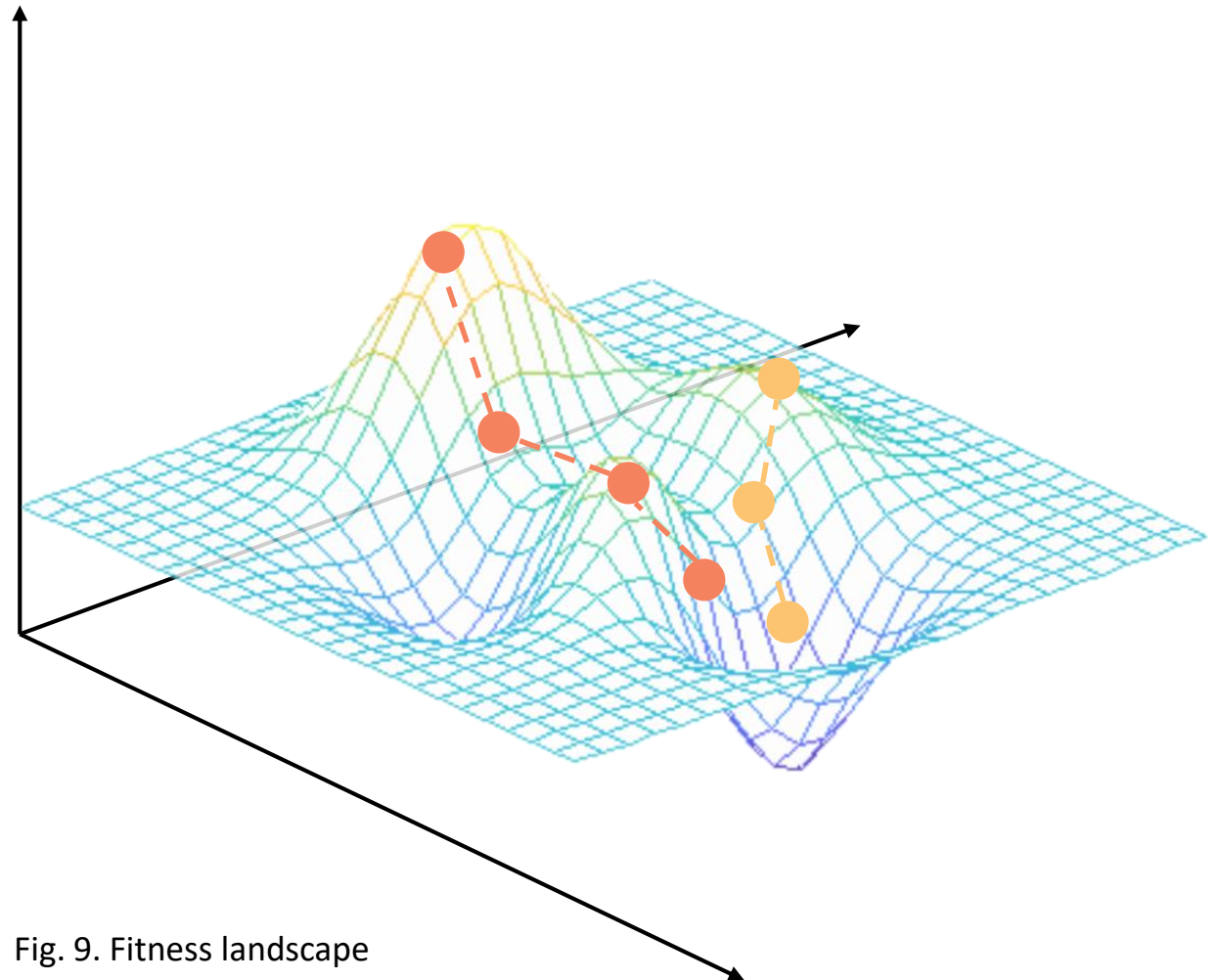


Fig. 9. Fitness landscape

# Fitness landscape

Hill climbing is an effective strategy in finding local peaks (Norman and Verganti, 2013) but in non-linear networks the search for the global optima can not be performed successfully by pure hill-climbing algorithms (Klein et al., 2006).

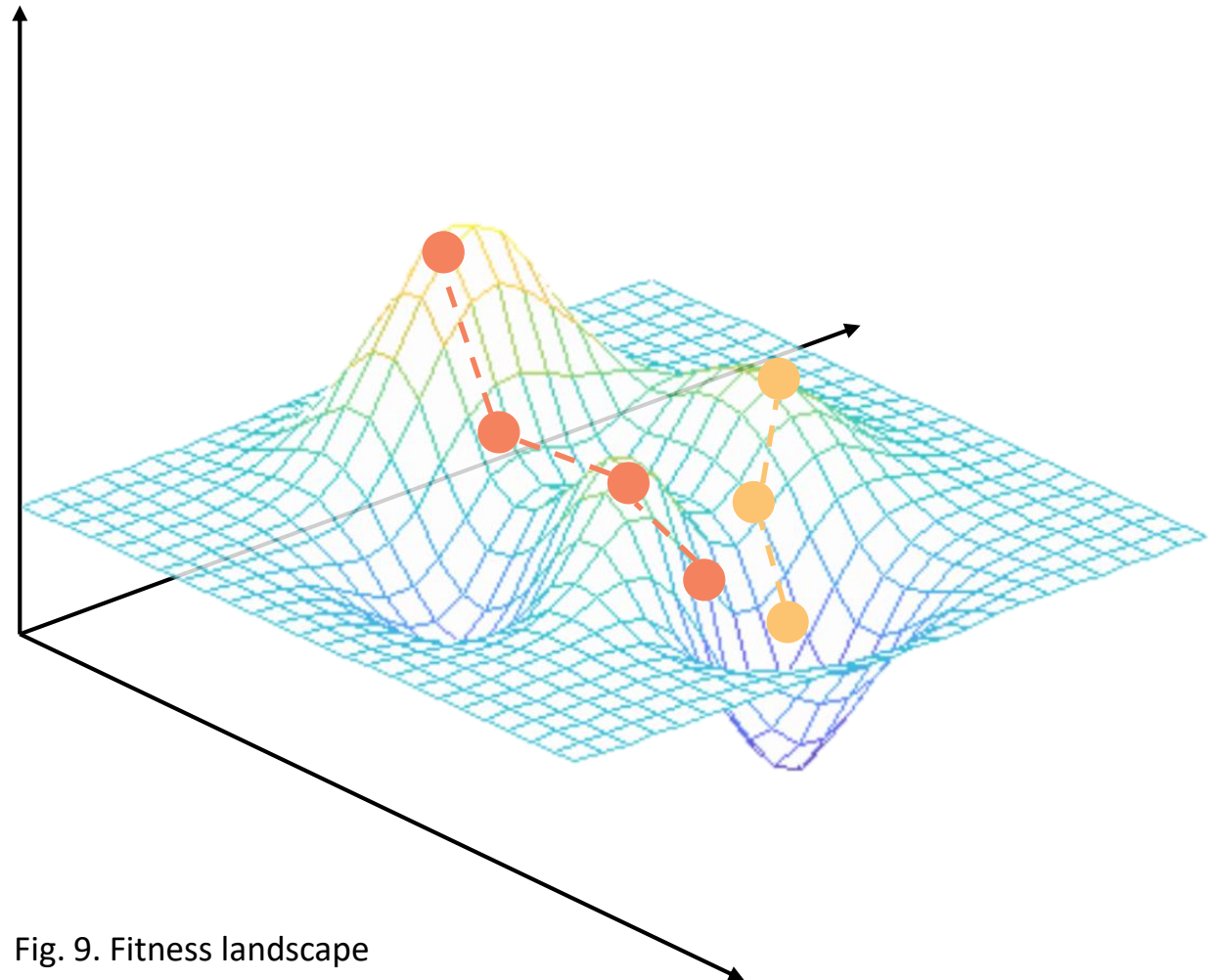


Fig. 9. Fitness landscape

# Designing Fitness

In unfamiliar design spaces that are being shaped by radical technological changes, navigating the fitness landscape requires an exploratory walk.

- **How might design help exploring the landscape?**
- **How can design increase fitness in a dynamic topography?**

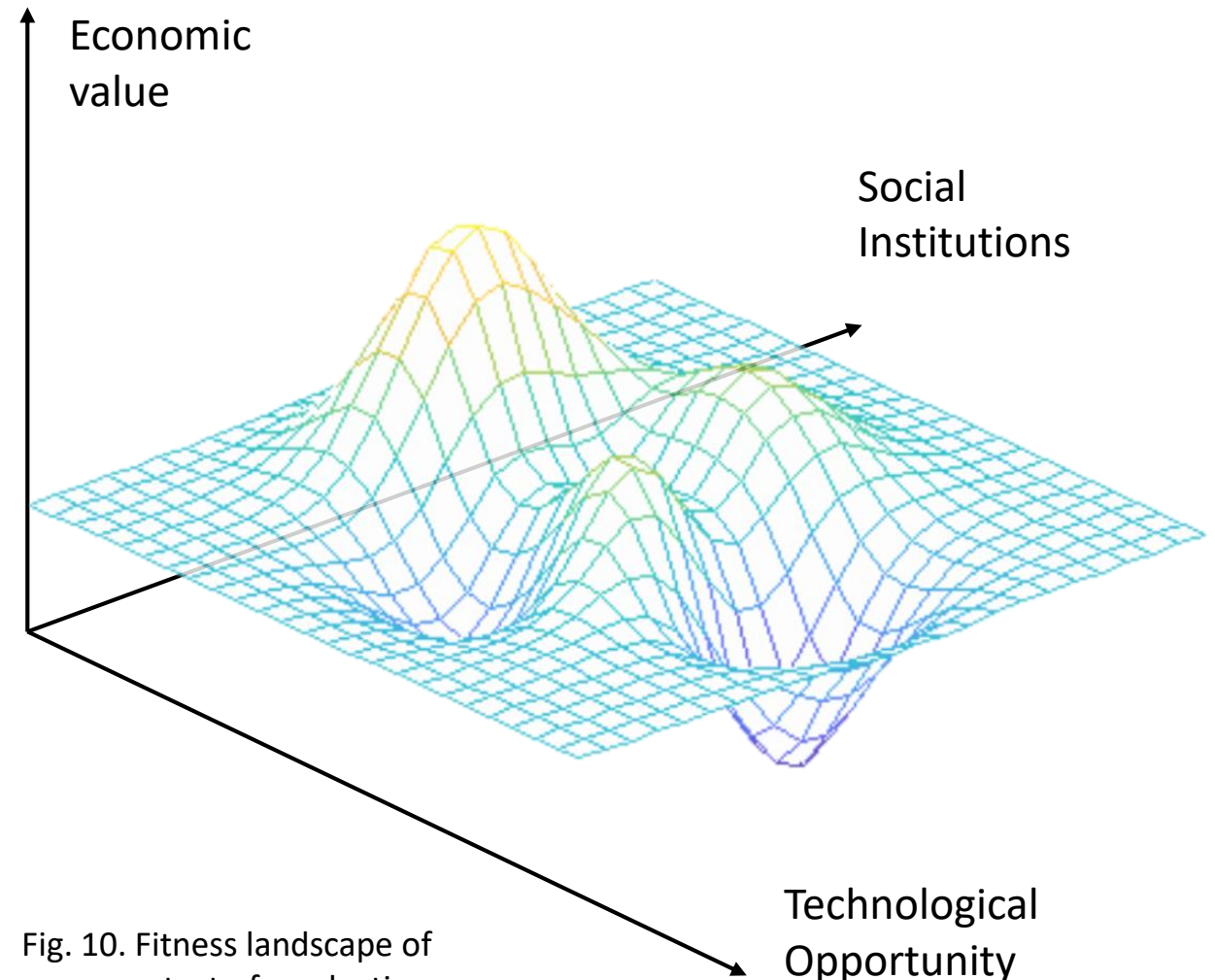


Fig. 10. Fitness landscape of context of production

# Design Trajectories

Design could be employed as a generative process to increase the diversity of efforts in innovative search, thus, generating more recombination possibilities of technologies for application and reconfiguring internal structures to adapt to environmental changes.

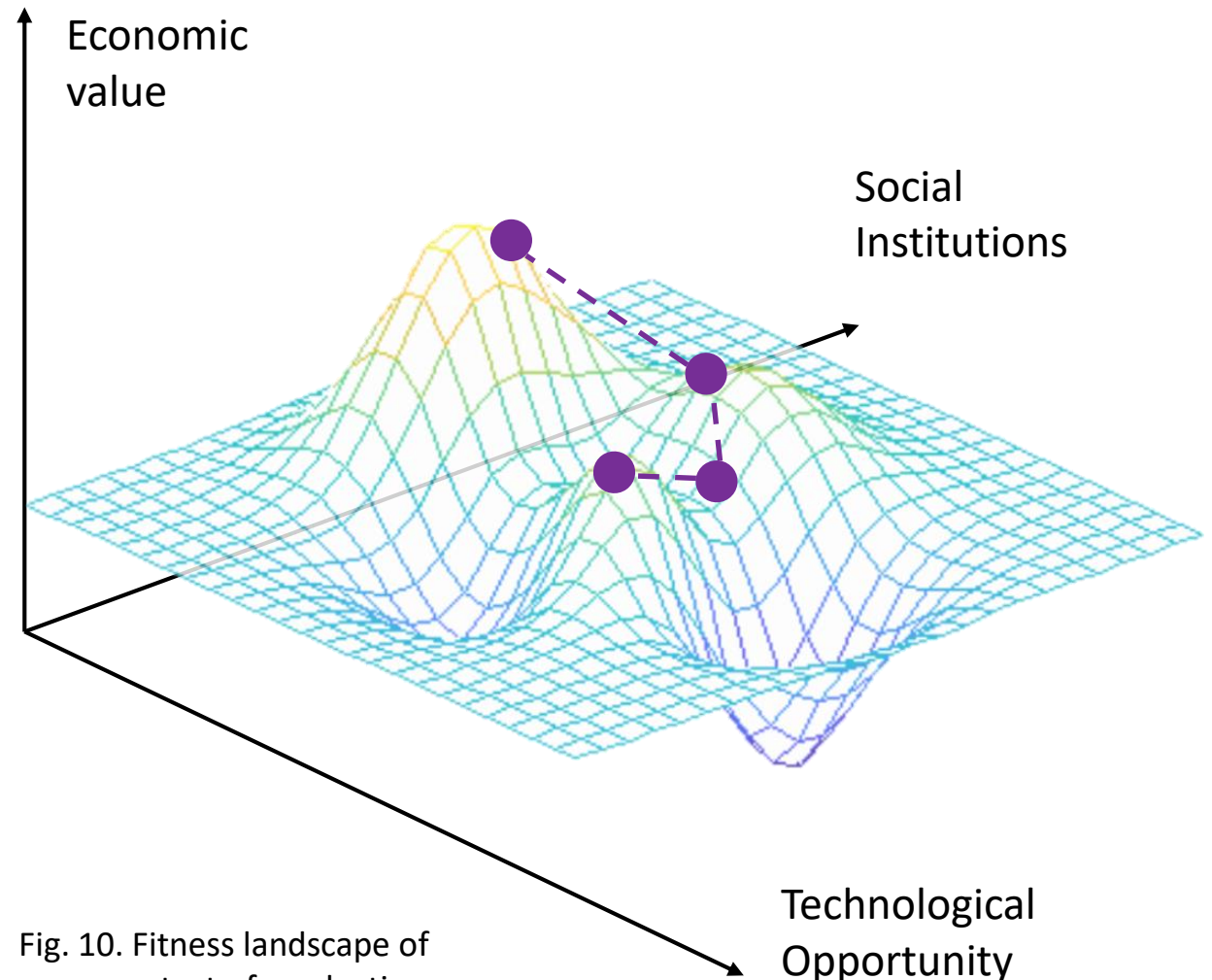


Fig. 10. Fitness landscape of context of production

# Designing the landscape

Since a major determinant of a fitness landscape is the density of interdependencies among interacting agents within a system, the primary landscape design activities would involve the manipulation of these interdependencies.

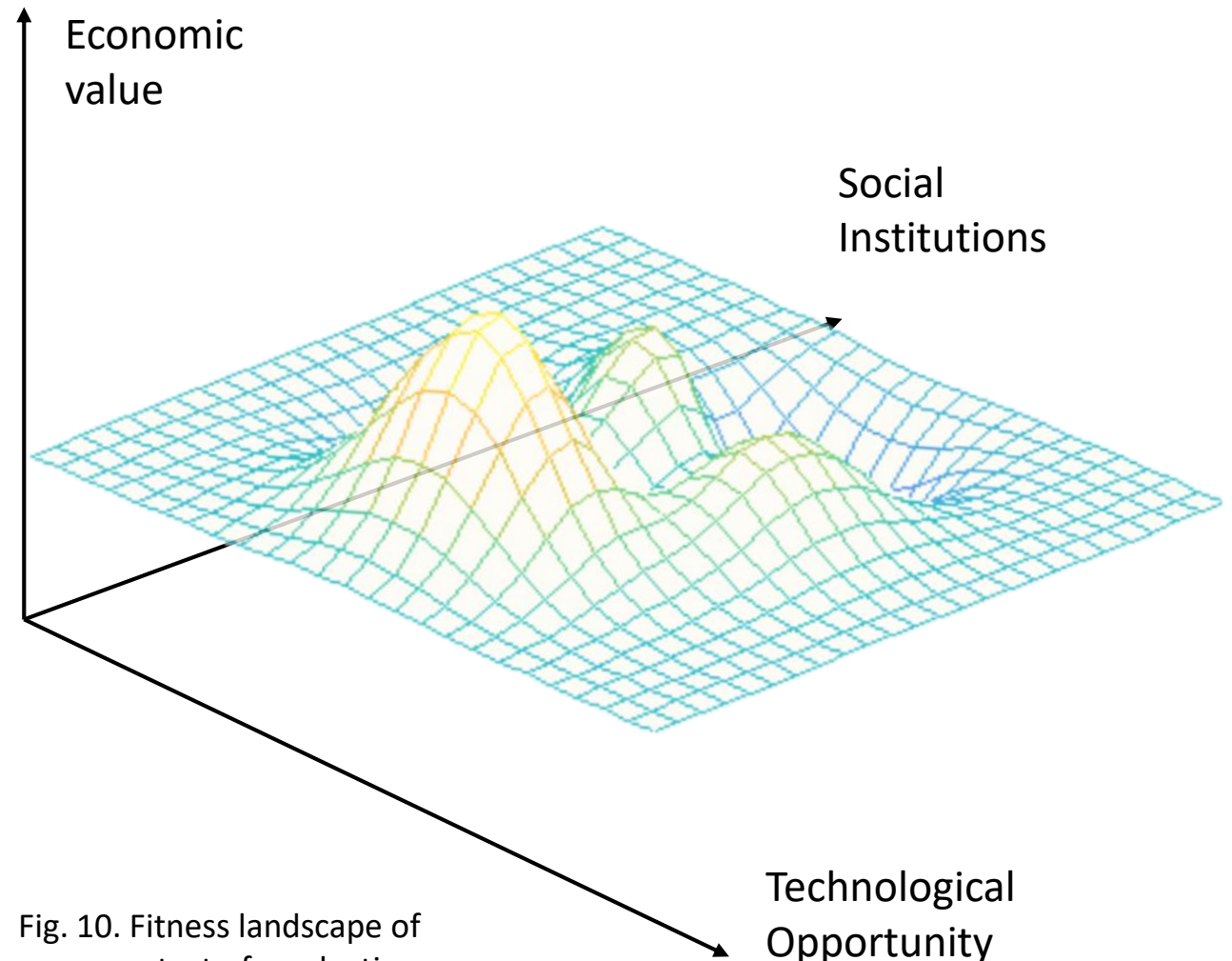


Fig. 10. Fitness landscape of context of production



# Thank you!

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