From rational to random re-composition: two design principles in synthetic biology

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Abstract

Synthetic biology is a growing post-genomic research field which aims to construct artificial biological components and systems. In this paper, I analyze different design principles which synthetic biology uses to re-compose and construct synthetic components and devices. I focus especially on two design principles called *rational design* and *evolutionary engineering*. Rational design uses computer simulations and fabrication to reduce complexity and create well-defined standardized synthetic components and devices. This principle is mostly championed by those researchers who argue that synthetic biology should use same kind of heuristics as engineering and treat biological systems with the same criteria as man-made systems (cf. Endy 2005). In turn, *evolutionary engineering* aims to create random mutation and variation on constructed devices and systems to optimize and find novel functional solutions (Dougherty & Arnold 2009). By some synthetic biologists, rational design is considered as an ideal design principle and evolutionary engineering's use of 'messy' processes is seen as 'ad hoc' solution for rational design principle's current limitations (cf. Brent 2004). I elaborate how these two design principles use different heuristics and abstraction. I analyze how these design principles take different stances towards complexity of biological phenomena, cellular context, robustness and modularity. Finally, I will argue that both design principles provide unique tools to understand biological systems and their dynamics, and successful research should continue using them complementarily.

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