Microbes implement myriad functions and regulatory strategies that enable growth and survival in diverse ecological environments. Cellular fitness is a complex function of multiple biological properties ranging from mechanisms to extract energy from the environment to collective population-scale behaviors. Resource constraints can generate trade-offs among these properties since the optimal solution for one objective will likely be sub-optimal for a different property. I will describe examples of evolutionary strategies to balance trade-offs across a range of scales from genetic circuits to synthetic microbial consortia. Yeast populations balance cellular fitness in temporally changing environments by harnessing advanced preparation and transient population diversification. The performance of engineered circuits embedded in host-cells can be modified through targeted manipulation of intracellular resource pools. Programmable mRNA decay can be used to divert energy from host-cell processes towards a synthetic device. In microbial consortia, competition over limited environmental resources can drive inter-species interactions. I will discuss an integrated experimental and computational modeling approach to decipher inter-species interactions in synthetic human-gut microbiome ecologies. Together, these methods will be used to extract generalizable design principles for ecosystem engineering including stability, resilience to perturbations and resistance to invasion.