Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Designability as a Selection Force? An Analysis of the Yeast Cell Cycle Dynamics. YIGAL NOCHOMOVITZ, SURYA GANGULI, HAO LI, UCSF — The concept of designability may play a role in the evolution of biological phenotypes. We define "designability" generally as the number of genotypes that encode a particular phenotype. For networks, the designability of a dynamical phenotype is the number of topologies that encode a particular ordering of dynamical states. By analyzing ensembles of simplified models of topologies and dynamics (Nochomovitz, Y.D. & Li, H. PNAS 103, 2006.) we have begun to explore the validity of the designability hypothesis at an abstract level. We have discovered from these exploratory studies that certain dynamical signals are highly designable, indicating that some dynamical signals can be realized by many different topological connections. To test the designability hypothesis on a real biological system, we analyze the dynamics of the budding yeast cell cycle. We compute the designability of the yeast cell cycle phenotype and the designabilities of ~ 1000 weakly perturbed variants of the yeast cell cycle phenotype. A comparison of the designability of the true yeast cell cycle phenotype with the designabilities of the pool of perturbed phenotypes reveals that the designability of the budding yeast cell cycle dynamics is near-optimal. This finding provides some evidence for the hypothesis that designability, as an "entropic" force, may couple with the traditional fitness landscape to influence the evolution of biological phenotypes.

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Date submitted: 20 Nov 2006 Electronic form version 1.4