Collective Systems:
Physical and Information Exergies

Rush D. Robinett, III
Energy & Infrastructure Future Group

David G. Wilson
Energy Systems Analysis Department

Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-1108

Abstract

Collective systems are typically defined as a group of agents (physical and/or cyber) that work together to produce a collective behavior with a value greater than the sum of the individual parts. This amplification or synergy can be harnessed by solving an inverse problem via an information-flow/communications grid: given a desired macroscopic/collective behavior find the required microscopic/individual behavior of each agent and the required communications grid. The goal of this report is to describe the fundamental nature of the Hamiltonian function in the design of collective systems (solve the inverse problem) and the connections between and values of physical and information exergies intrinsic to collective systems. In particular, physical and information exergies are shown to be equivalent based on thermodynamics and Hamiltonian mechanics.