I think the next century will be the century of complexity.
Stephen Hawking
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WHAT IS COMPLEXITY?

When Einstein was asked what was most helpful to him in developing the theory of relativity, he replied, "Figuring out how to think about the problem." The challenges we face today and those we'll confront in the future require new ways of thinking about and understanding the complex, interconnected and rapidly changing world in which we live and work, and insights arising from the study of complex systems are helping us expand our thinking in new directions. Simply stated, complexity arises in situations where "an increasing number of independent variables begin interacting in interdependent and unpredictable ways." Traffic, the weather, the stock market and the United Nations are examples of complex systems.

From the moment of the Big Bang to the present, the universe has grown increasingly more complex; from a primordial soup of particles, we now have stars, solar systems, ecosystems and human societies. In the last twenty-five years, rapid advances in high-speed computing and computer graphics have created a revolution in the scientific understanding of complex systems.

The same technologies that have given us instant access to news and information from around the world—allowing us to think and act as one vast interconnected system—have made it possible for scientists to study the nonlinear dynamics of systems that once either were hopelessly inaccessible or took years to understand. In much the same way that the microscope assisted biologists and the telescope assisted astronomers, computer technology has given scientists powerful new tools of insight, opening the door for dramatic discoveries.

We hear the words "chaos" and "complexity" used daily to describe everything from the security and democracy-building efforts in Iraq to the relief efforts following Hurricanes Katrina and Rita, and the traffic congestion on highways and at airports during a major winter storm. Yet very few people, the news media and policy-makers included, have stopped to ask what the words really mean and what the new science of complex systems might contribute to our

understanding of and responses to unexpected events, emerging issues and dynamic situations.

Complexity science represents a growing body of interdisciplinary knowledge about the structure, behavior and dynamics of change in a specific category of complex systems known as *complex adaptive systems*—open evolutionary systems in which the components are strongly interrelated, self-organizing and dynamic. Rain forests, businesses, societies, our immune systems, the World Wide Web, and the rapidly globalizing world economy can be thought of as complex adaptive systems. Each of these systems evolves in relationship to the larger environment in which it operates. To survive, the system as a whole must adapt to change.

In recent years, scientists have identified many of the basic characteristics and principles by which complex physical, biological and social systems organize, operate and evolve, leading to important insights and research implications in almost every field. As a result, we are witnessing the integration of knowledge across disciplines and the emergence of new concepts, tools and a vocabulary of complex systems thinking. From health care to city planning and international politics, complexity science is creating a fundamental shift in how we view the world, and with it the need for a shift in how we must think about, organize, plan for and lead 21st century organizations.

Across the frontiers of science, this new more complete, whole systems approach is replacing the old reductionist paradigm, where scientists traditionally tried to understand and describe the dynamics of systems by studying and describing their component parts. Complexity science is moving us away from a linear, mechanistic view of the world, to one based on nonlinear dynamics, evolutionary development and systems thinking. It represents a dramatic new way of looking at things; not just looking at more things at once. Insights from complex systems research provide a new *theory-driven framework* for thinking about, understanding and influencing the dynamics of complex systems, issues and emerging situations.

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