PARK CENTER FOR COMPLEX SYSTEMS

# Introduction of the MIT Park Center for Complex Systems

## History

The Park Center for Complex Systems at MIT was established in 2002 to conduct educational and research programs in the field of complexity and complex systems. The Park Center was created as the research of its predecessor organization, the Manufacturing Institute at MIT, had been increasingly diversified to deal with complexity issues in many fields of engineering and science, including the field of manufacturing.

The Park Center is named to honor an MIT alumnus, Dr. BJ Park and his wife Mrs. Chunghi Park, who have provided a generous gift to fund operating costs, including graduate and post-doctoral fellowships.

## Mission

The mission of the Park Center for Complex Systems is to research and understand complexity, to educate students and scholars on complexity, to design complex systems for the benefit of humankind, and to disseminate knowledge on complexity to the world at large. In particular,

1. To conduct basic research in complexity
2. To demonstrate the power of basic scientific framework for complexity by designing robust, stable and reliable engineered systems
3. To reduce complexity of existing systems through the application of complexity theory
4. To understand the complexity of natural systems through the application of the complexity theory to the workings of biological and environmental systems
5. To apply the complexity theory in improving socio-economic political systems for their efficient design and operation

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**Research Goals:**

## A. Design of Innovative Engineered Systems

Engineered systems are designed by engineers and technologists. However, the conventional product development processes are inefficient and unpredictable, often requiring iterative trial-and-error processes. It typically consists of "design/ fabricate/ test/ fix" cycles, which result in high cost and long development times with uncertain outcome. Engineering should strive to change the design paradigm to: "design it right the first time".

We have designed systems using the tools and ideas derived from Axiomatic Design Theory and Complexity Theory. The complexity theory has been developed based on a specific definition of complexity, partly based on the framework of Axiomatic Design.

The Park Center has designed engineered systems, some of which are highly innovative. Examples of our projects are as follows:

1. We have created a new disruptive electrical connector technology based on the "woven connector concept" for the $34 billion electrical connector industry. See www.tribotek-inc.com
2. We also worked on the design of the landing systems for NASA's Crew Exploratory System (CEV).
3. We created new automotive components: automotive suspension and engine designs.
4. We are designing high-speed precision stages for the semiconductor industry.
5. We are designing a new fuel cell system.
6. We are conducting research and development of various engineered systems based on a "surface engineering" concept.

There are many other innovative technologies that the Park Center has developed.

## B. Reduction of Complexity in Engineered Systems

Complexity of engineered systems should be reduced for robust operation, long-term stability, and reliability. In designing engineered systems, we must achieve a number of goals, which we call functional requirements (FRs), at the same time. When we reduce the complexity of a system, it becomes more reliable, robust, and stable. One of our research goals is to establish the theoretical basis for reducing the complexity of engineered systems.

Examples of our work are as follows:
We reduce the complexity by reducing the time-independent real complexity, by eliminating time-independent imaginary complexity, and by transforming a system with time-dependent combinatorial complexity into a system with periodic complexity. The transformation of a system with a combinatorial complexity into a system with a periodic complexity is done by identifying "functional periodicity".

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### C. Understanding the Complexity of Natural Systems,

We are working on the idea that we can reduce the complexity associated with understanding the behavior of natural systems such as biological systems by applying our theory. The goal of our biology project is to explain the physiological functions of biological systems in terms of molecular behavior of DNA, proteins, etc.

### D. Application to Non-Technical Systems

We have successfully applied our AD and complexity theories to explain the design and the behavior of socio-economic political systems. Examples include the development of Korean economy plan in 1980's and the reform of NSF (National Science Foundation).

For more information on the Park Center for Complex Systems, visit our web site at:

http://web.mit.edu/pccs