

" Systems Thinking for K-12 Teachers "

**A New Course at the Graduate School
of Education and Allied Professions
Fairfield University in Fairfield, Connecticut**

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Abstract

This Graduate Level Course for K-12 Teachers will introduce them to the General Systems Theory Method of Thinking. This thought process is different from the analytical Mechanistic Method of Thinking from the Renaissance Period which produced the Industrial Revolution. The use of General System Theory, System Thinking and System Dynamics is aimed at bringing cohesion, meaning and interdependence to the K-12 curriculum. This process can introduce thinking, curiosity, creativity, and real world meaningful learning experiences into the classroom. The K-12 education establishment in the U. S. which is criticized for not preparing the students properly for college and the workplace could make a giant step forward by using Systems Thinking across the curriculum in the classroom.

This is an introductory course in System Thinking and the Philosophy of the Systems View of Reality. The history of the thought process of Systems Thinking and its application in the past, the present and the future is explored. Comparison with the Mechanistic View of Reality is presented. In depth studies of open, closed and feedback systems are developed and applied to social science, ecology, economics, biology, health care, physics, chemistry, mathematics, literature, government, business and etc.. Some of the graphical and software tool which have been developed for the study of systems will be used. About 50% of the course will involve working on the applications of system thinking and the computer simulation of systems.

A new text was written for this course. The following twelve overheads summarizes the materials and structure of this course. The text will be in draft form by the middle of 1996.

Systems Thinking - System Dynamics for K-12 Teachers

Presented at The 14th International System Dynamics Conference in Cambridge, Massachusetts
July 22-25, 1996

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1

What is Wrong With K-12 Education in The USA

- The curriculum is divided into specialties .
- The curriculum does not stress the real world.
- There is poor linkage between subjects .
- The graduates are not prepared for the ever-changing workplace .

2

How can a Systems Thinking - System Dynamics Course Improve the Education System

- Develop a study process applicable to all subjects .
- Develop a real world view of subject matter.
- Teach the students how to think .
- Prepare the students for the ever-changing workplace .

3

Systems Thinking-System Dynamics Course Text Material

- History and philosophy of Mechanistic Thinking
- History and philosophy of Systems Thinking
- Development of Loop Diagrams, Modelling, and Dynamic Simulation
- Computer applications of Systems Thinking-System Dynamics

4

"Renaissance - One" From the Dark Ages to the 1920's

- Pre-"Renaissance - One" Time Period
- The Giants of "Renaissance - One" Thinking
 - Galileo Galilei
 - Rene Descartes
 - Sir Isaac Newton

5

The Thought Processes of "Renaissance - One" Are

- Analysis by Division
- Determinism
- Cause and Effect Thinking
- Mechanistic Thinking

6

The Past, Present and Future of "Renaissance - Two"

- The Uncertainty Principle and Quantum Theory
- Cybernetics
- The Digital Computer and Information Storage
- General System Theory and System Dynamics
- The Internet and World Wide Web
- The Future Developments ??????????

7

General System Theory and System Dynamics

- Ludwig Von Bertalanffy's General System Theory
- Jay Forrester's Industrial Dynamics and Dynamo Software
- Arnold Tustin's "The Mechanism of Economic Theory"
- The work of Boulding, Ashby, Lotka, G.P. Richardson, Verhulst, and etc.

8

Discussion and Application of Software

- Dynamo Software
- IThink - Stella Software
- Powersim Software

9

Discussion of Classical Examples

- Coffee cup cooling
- Heating system of a house
- Prey- Predator dynamics
- Epidemic dynamics
- Hamlet
- Fish- fishing boat dynamic

10

Course Projects- Students Develop New System Studies Such As

- A combined Prey-Predator and Epidemic System
- A Combined Prey-Predator and Drought System
- A Shakespeare Play's System similar to the Hamlet Study
- Industrial Systems similar to the classical Industrial Dynamics System
- Etc.

11

The Future of Systems Thinking and System Dynamics at Fairfield University

- A second course for K-12 teachers
- Courses for the BEI School of Engineering
- Courses for the Graduate School of Business Management
- Courses for the Masters Degree in the Management of Technology
- Establishment of a Systems Thinking Institute to integrate Systems Thinking and System Dynamics into all degree program

12

Books and Background Material for Preparing System Course For K-12 Teachers
Abbreviated listing
Books

- Principles of Systems ----- Jay W. Forrester
Industrial Dynamics ----- Jay W. Forrester
The Fifth Discipline ----- Peter Senge
The Fifth Discipline Fieldbook --- Peter Senge
Trends in General Systems Theory ----- George J. Klir
Systems Theory and Scientific Philosophy ----- John Bryant
The Systems View of The World ----- Ervin Laszlo
Uncommon Sence (Life and Thought of Ludwig von Bertalanffy) ----- Mark Davidson
General System Theory ----- Ludwig von Bertalanffy
The History and Status of General Systems theory ----- Ludwig von Bertalanffy
Robots, Men and Minds ----- Ludwig von Betalanffy
The World as a Total System ----- Kenneth E. Boulding
Objective Knowledge ----- Karl R. Popper
Karl R. Popper Selections ----- David Miller
An Introduction to General Systems Thinking ----- Gerald M. Weinberg
Cybernetics ----- Norbert Weiner
Time Series ---- Norbert Weiner
God and Golem ---- Norbert Weiner
The Social Impact of Cybernetics ---- Charles R. Dechert (editor)
Redesigning The Future ----- Russel L. Ackoff
The Mechanism of Economic Theory ----- Arnold Tustin
Dynamics Of Growth In A Finite World ----- Dennis L. Meadows
Dynamo User's Manual ----- A.L. Pugh III
Elements Of The System Method ----- Jorgen Randers
Introduction To Urban Dynamics ----- Louis Alfred and Alan Graham
Managerial Applications Of System Dynamics --- Edward B. Roberts (ed)
Study Notes In System Dynamics ----- Michael R. Goodman
World Dynamics (2nd ed.)----- Jay W. Forrester
Urban Dynamics ----- Jay W. Forrester
Simulation And Analysis ----- Law and Kelton
Modeling For Learning Organizations --- John D. W. Morecroft and John D. Sterman(eds.)
Introduction To Computer Simulation -- Roberts , Andersen, Deal , Garet , and Shaffer
Introduction To System Dynamics Modeling with Dynamo -- G. Richardson and A. Pugh III
Number Series Method Of Solving Linear and Non-Linear Differential Equations -Albert Madwed
Nonlinear Dynamics and Chaos -----J. M. T. Thompson and H. B. Stewart
Order Out Of Chaos -----ILya Prigogine and Isabelle Stengers
Chaos , Making A New Science ----- James Gleick
Chaos and Integrability in Nonlinear Dynamics ----- Michael Tabor
Introduction to Non-Linear Mechanics ----- N. Minorsky
Digital Control Systems Theory, Hardware , Software ----- C.H. Houppis and G.B. Lamont

Publications

- Journals of The System Dynamics Society
Six years of the Pegasus Communication publication -- System Thinker which reports on practical applications .
Five years of the Pegasus Communication Conference --- System Thinking and System Modeling and System Dynamics Applications.
Proceedings of the International System Dynamics Conferences