AN ABCEDARIAN SYSTEM DYNAMICS HANDBOOK:
ACCESSIBLE, BRIEF, CLUSTERED

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PURPOSE: This workshop responds to a need for a system dynamics handbook for secondary school and undergraduate students that is:

- **Accessible** - easy to understand; easy to use; written and illustrated with wit and verve (see Coyle and Alexander's "rich picture for the Dystopia drug trade," *System Dynamics Rev.,* 1997, 19(3), p.219).
- **Brief** - no more than 250 pages long
- **Clustered** - Based on G.A. Miller's rule that our capacity to process information is limited to seven, plus or minus two, we should "cluster" units of information accordingly. (See for ex., Richmond's seven tracks of system thinking skills, *SDR,* 93(2):122 and Forrester's three foundations of system dynamics, p.185 of the same issue).

I. What the world needs now are effective methods to conceptualize and solve complex problems such as:
   - controlling ozone depletion and air and water pollution;
   - maintaining sustainable fishing and forestry;
   - controlling epidemics, such as AIDS

   A. Robert Reich (1991), former U.S. Secretary of Labor, asserts that the demand for skilled symbolic analysts will surge in the 21st century; "symbolic analysts [presently secondary and undergraduate students] …learn how to conceptualize problems and solutions… refining four basic skills:"
      1. abstraction
      2. system thinking
      3. experimentation
      4. collaboration

   B. BENCHMARKS FOR SCIENCE LITERACY (1993), which identified the ideas needed for students to make sense of the ideas in SCIENCE FOR ALL AMERICANS (1989)
      1. some benchmarks state what students should know by end of grade 12:
         a. understanding how things work and designing solutions to problems of almost any kind can be facilitated by systems analysis. In defining a system, it is important to specify its boundaries and subsystems, indicate its relation to other systems, and identify what its input and its output are expected to be.
         b. the stability of a system can be greater when it includes appropriate feedback mechanisms.
         c. even in some very simple systems, it may not always be possible to predict accurately the result of changing some part or connection (266).
         d. as the number of parts of a system increases, the number of possible interactions between pairs of parts increases much more rapidly (279).

e. a physical or mathematical model can be used to estimate the probability of real-world events (230).
f. almost all control systems have inputs, outputs, and feedback. The essence of control is comparing information about what is happening to what people want to happen and then making appropriate adjustments (51).
g. mathematical modeling aids in technological design by simulating how a proposed system would theoretically behave (33).

2. Significant similarities exist between these benchmarks and the aims and practices of system dynamicists.

II. System Dynamics provides a method for understanding the dynamics of complex physical, biological, and social systems which builds on the benchmarks identified by the American Association for Advancement of Science.

A. While system dynamics has been defined slightly by various experts in the field, the key common elements are:
1. it is a rigorous method for studying our world
2. it deals with how complex systems change over time
3. it focuses on feedback loops within the system's structure
4. it helps us qualitatively describe, explore, and analyze the processes, organization, and boundaries of complex systems
5. qualitative analysis facilitates computer simulation modeling

N.B. Many definitions of the method include computer simulations as an integral part of the systems dynamics method.

B. An abcedarian (basic) guide to system dynamics for secondary and undergraduate students could focus on:
1. characteristics of complex systems
2. stock and flows - including references to Richmond (1994) 140-141
3. feedback loops
4. simple positive and negative feedback structures
5. oscillation
6. sigmoidal growth - and urban growth, jobs and migration
7. overshoot and collapse

III. This workshop is designed to generate ideas for

A. the contents of the handbook
1. the proportion of theory, philosophy, and applications
2. the relative emphasis on qualitative and quantitative SD
3. the use of influence and stock flow diagrams
4. the role/reference to "Road Maps" (ch. 1-9)
5. the role/reference to "Creative Learning Exchange" material
6. the role of games (Beer Distribution?); microworlds (People Express)

B. the design of the handbook-
1. spiral bound? loose-leaf packet? other?
2. the proportion of white space per page; diagrams; cartoons; etc.

C. strategy for the production/funding/underwriting of the handbook

The creation of an abcedarian handbook for system dynamics would be an important step to disseminate systems thinking for the next millennium.

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