Insights from Forty Years in System Dynamics

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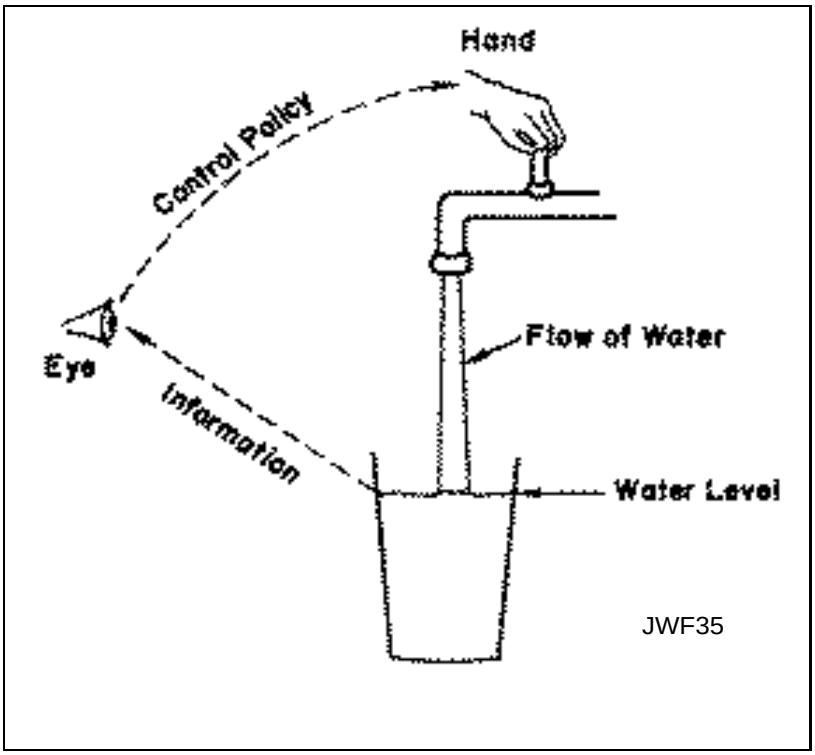
Systems as a basic foundation under all fields

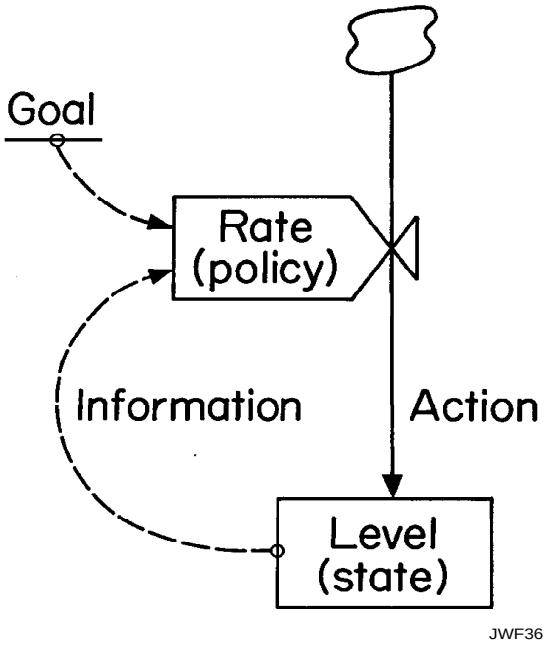
*******Graphic: Water Glass, JWF35



Crucial item, water, the level

Level, state of system, controls rates

*******Graphic: Simplest Loop, JWF36



Key concepts in systems

Stock and flow structure.

Only two concepts

Annual report, balance sheet, profit and loss

Feedback loops

Control all action

Levels controlled only by rates

Rates controlled only by levels

Condition compared to a goal

System dynamics as a common language

As a basis for collaboration between disciplines

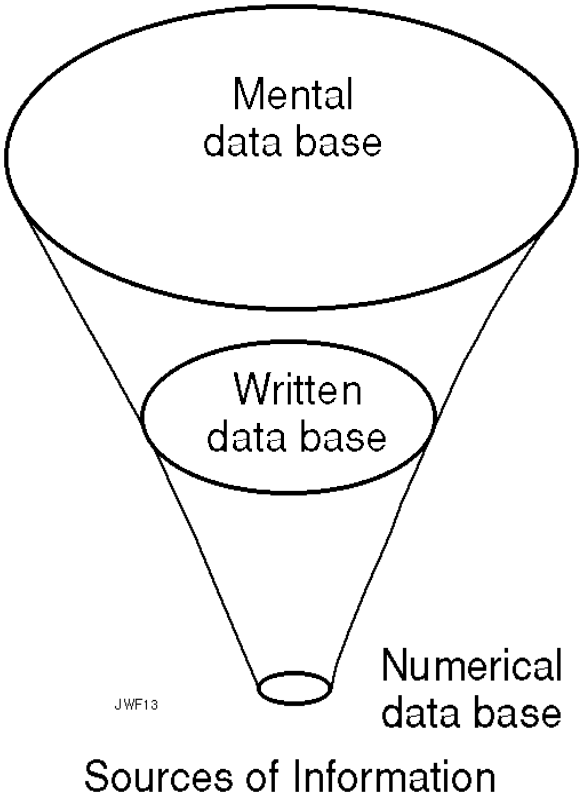
Mobility between fields

EE to diabetes

Info not in medical literature

But in doctor’s heads and notebooks
New syndrome

******Graphic: Mental/written/numerical JWF13



Who uses models for all decisions?

******Graphic: Models, JWF12

******Graphic: Computer simulation, JWF15

Focus on a question, or a problem, misbehavior, or shortcoming

Model should demonstrate how the behavior is created

Not merely from now forward

But also from the past to the present

Emphasis on keen observation of the real world

What is happening? Why? How it works.

Modeling is creating theories of how things work

- Observation
- Induction, not a stylized process
  - Invention, interpret the real world, creating a theory
- Analysis
- Deduction
- Synthesizing
- Revising the theory

Generic models

- ******Graphic: Generic structures, JWF7

Generic Structures

Transferable between:
Past and present
From one setting to another

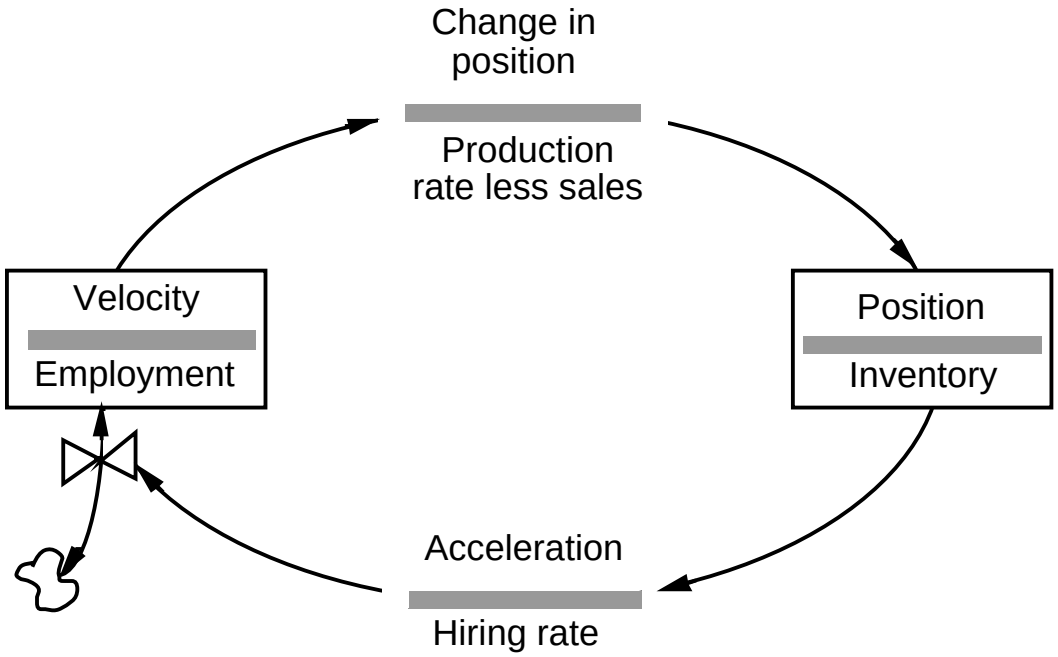
A small number cover a wide range of situations

When understood in one setting, they are understood in all settings

Basis for effective education

JWF7

Graphic: pendulum/inventory,, JWF39



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JWF39 d.5

Palo Alto medical experiment

Jan Mons, discipline system

- Could apply in many places
- Student standardized testing?
- Employee relations?
- Family dynamics?
- Teacher/administration interactions?

Look for transferability of structures

- What is common to apparently different settings?

Avoid causal loops

They do not identify the levels (stocks or integrations)

- They do not contain the measures of condition of system

Start modeling from the stocks, not from the feedback loops.

In a more complicated system
Do not foresee the many loops
World Dynamics book, 5 levels, 80 loops through population

Systems thinking vs. system dynamics
Systems thinking, no more than a door opener
Thinking about systems is not understanding systems
3-day seminar on systems thinking—know it all?
GSP—450 hours as only an introduction

Road Maps
How many know about the Road Maps series?
How many have read 9 chapters?
How many have done all the exercises?
How many have done the exercises and studied the book references?

Disciplines have more in common than differences
Similar dynamics structures imply similar behavior
Generic structures that transcend disciplines

What insights should students acquire?

******Graphic: Characteristics of complex systems, JWF10a

10a

Characteristics of Complex Systems

Transfer of problems between sectors.

Tradeoffs between present and future.

Resistance to most policy changes.

Very few high-leverage policies.

Transfer burden to the intervener.

Cause and effect not close in time or space.

JWF10a

Challenge: Expand this list

Planning a full 12-year systems curriculum

- What concepts at what stage?
- Don't underestimate what the students can do.
  - Teachers, "I had no idea these students could do so much!"
- Tim Lucas: Introduce kindergartners to stocks and flows
  - More logical than causal loops
  - More evident in real life
  - Computer models in 5th grade
- By 9th grade, can probably learn all SD now taught in universities
- Need 12 more years of material
  - 4 in high school, 4 undergraduate, 4 graduate
  - Such can and should exist, for full professional education

Question: How much of this should be taught in teacher's colleges?

Is it time to talk about a unified 12-year K-12 systems curriculum?

Also, effect of system viewpoint on nature of a classroom
Q: How much change have you seen in social structure of classrooms?

*******Graphic: Change in nature of classroom, JWF157

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CHANGE IN NATURE OF CLASSROOMS

LEARNER-CENTERED LEARNING

PROBLEMS COME BEFORE SOLUTIONS

RELEASING STUDENT INITIATIVE

TEACHER BECOMES COACH AND ADVISOR

INTERDISCIPLINARY

STUDENT ENTHUSIASM AND CAPACITY

JWF157

Modeling to improve communication, clarity of thought

- Mutual improvement of a model and a written text.
- Model is clearer than the text.
- Back translation to improve clarity of text.

Let teams of consecutive grades work together

- Learning by teaching

Have students critique each other

Leave open alternative paths, not a single curriculum

Organize SD clubs

Restore imagination as a key feature in schools

Encourage students to ask questions, not just receive knowledge

Introduce intellectual freedom

Freedom to be wrong

- Inventions, theories, designs seldom right on first attempt.
- Experiment and improve

Release students to run ahead of teachers

Introduce the atmosphere of a university research laboratory in K-12

The next frontier—the century of understanding social systems

Graphic: Frontiers, JWF153