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Exercise 1: Model Development, Problem Exploration

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Stocks & Flows/Causal Loop Diagrams

Flow Diagram Basics

Read **Sterman, Sec. 6.1 - 6.2.7** (16 pgs.)

Look for the **storages** ("accumulations")

- they may be physical or conceptual
- "states" or conditions
- resources (consumable or catalytic[?])
- constraints
- shock absorbers or de-couplers
- are buffers
- have momentum
- "freeze test" (if you freeze time, does the item still have or "hold" its value?)
- contents are conserved
- The **flow rates** are the defining aspects
 - pipe or conduit
 - spigot or valve
 - stuff in motion (could be intangible stuff)
 - the same stuff must flow between stocks!
- **Caution:** It is easy to overlook the connections that are often present from storages to their rates.
- There are often many more converters (auxiliary variable) than storages
 - targets, discrepancies
 - non-conserved
- Importance of **dimensional consistency**
 - more on this in the "More on Operational Thinking Module" (next)

Examples of stocks and flows

This following list is from the Creative Learning Exchange newsletter:

- inventory of a store
- bank acct. balance
- babies born in the U.S. in a year
- the nat'l debt
- incoming orders at a business
- speed of a car on the hwy.
- amount of exhaust a car emits
- tons of garbage in a dump
- no. of cars on the road today
- blood pumped from the heart to the body
- air pressure in a tire
- withdrawals from a bank acct.
- your present weight
- gas you are pumping into your car

*** There is a **self-test** to see if you can tell which are stocks and which are flows (the self

test icon is in the frame above this).

Contrast FDs (Flow Diagrams) with CLDs (Causal Loop Diagrams)

CLD's are NOT specific enough to be "operational" (and accurately reflect behavior)

- It is easier to see feedback loops with CLD's, however
 - So, one might use CLD's very informally during problem exploration & then later to describe the feedback mechanisms at work, but NOT during model formulation
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Guidelines for Causal Loop Diagrams

Read Sterman, Sec. 5.1 - 5.2 (20 pgs.)

Notes:

- causation versus correlation
 - label link polarity
 - how to determine loop polarity
 - name your loops
 - indicate important delays in causal links
 - choose variable names carefully
 - importance of CLD layout
 - choose right level of aggregation
 - don't put all loops into one large diagram
 - make the goals of negative loops explicit
 - distinguish between actual and perceived conditions
-

Selecting Names for CLD's (brief notes from an article in [The Systems Thinker](#))

- CLD guidelines:
 - use nouns to name
 - make them measurable
 - express them in the positive sense
 - make goals of loops explicit
 - indicate perceptions [of key aspects] as well as actual or objective values [of these aspects]
 - indicate and differentiate between short-term impacts (connections) and impacts (connections) that take a long time to manifest themselves
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There is a quiz associated with these notes ([link to C&E CLD quiz](#))



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Task: View this topic