

System Dynamics Tools III

Mapping the Stock-and-Flow Structure of Systems

Dynamics of Stocks-and-Flows

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Stocks-and-Flows

- Provide the source of information for decisions.
- Give systems inertia and memory:
 - Critical source of dynamics.
- Generate disequilibrium dynamics:
 - Accumulate difference between inflows and outflows.

Stocks-and-Flows

Stock and Flow Diagram:



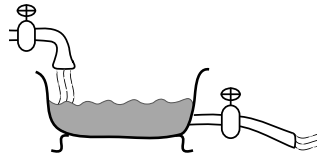
Integral Equation:

$$\text{Stock} (t) = \int_{t_0}^t [\text{Inflow} (s) - \text{Outflow} (s)] ds + \text{Stock} (t_0)$$

Differential Equation:

$$d(\text{Stock})/d t = \text{Net C hange in Stock} = \text{Inflow} (t) - \text{O utflow}(t)$$

Hydraulic Metaphor:



Source: John Sterman, 2000, MIT

Stocks and Flows

Balance Sheet

Wealth

CO₂ in atmosphere

Prevalence

Integrals

Water in Bathtub

Cash Flow Statement

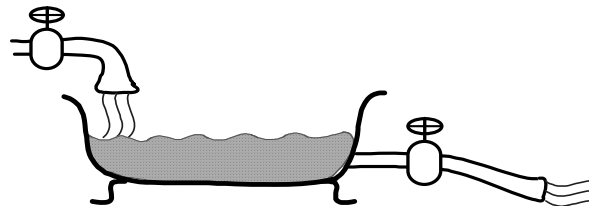
Income

CO₂ emissions

Incidence, Mortality

Derivatives

Flow from faucet



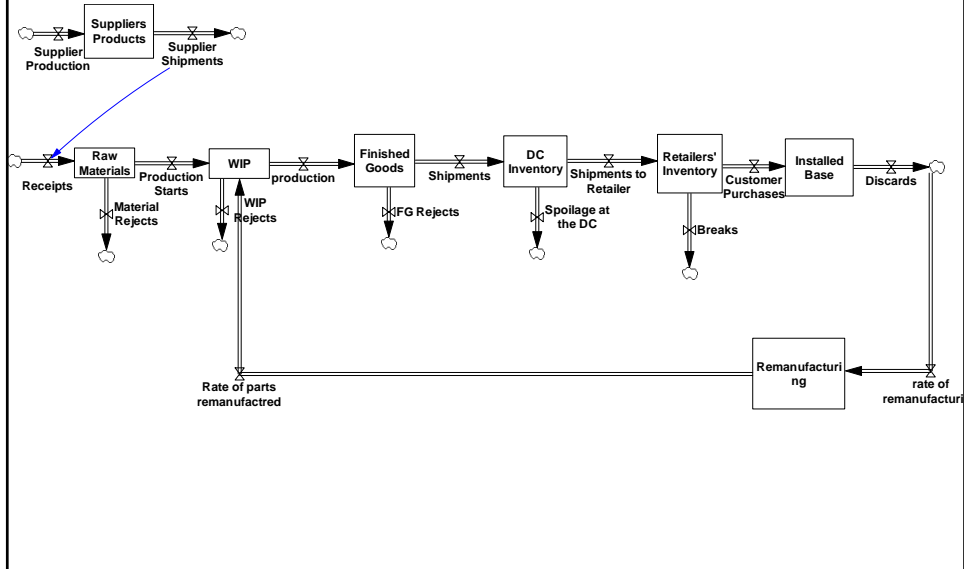
Source: John Sterman, 2000, MIT

Mapping the stock-and-flow structure of systems

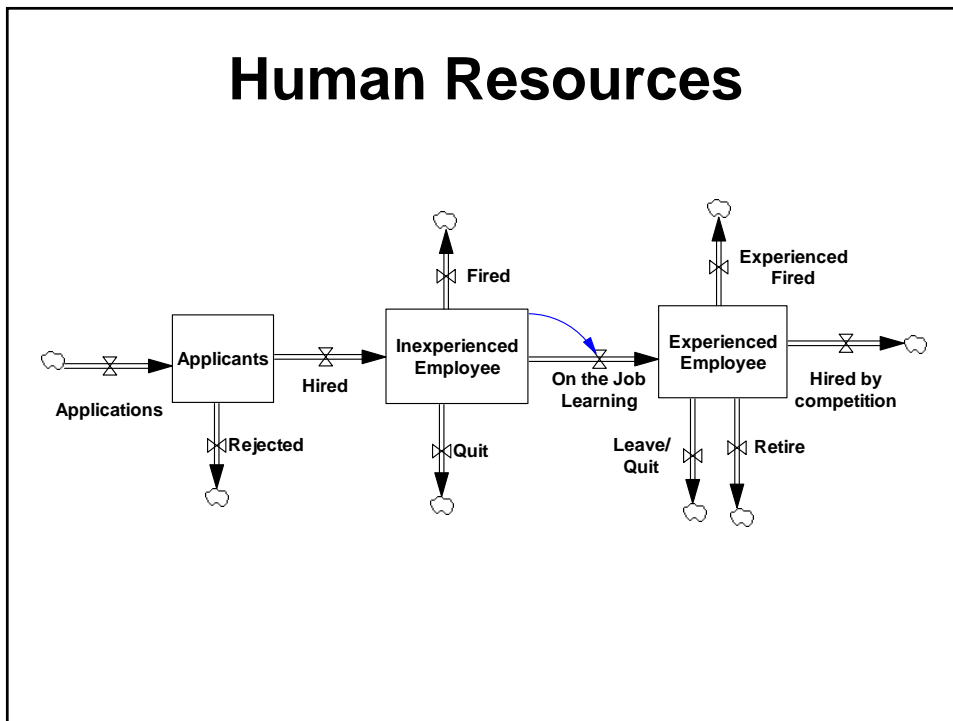
Stock-and-Flow Structure

- Electronics Supply Chain
- Human Resources at a Firm
- Master GC-LOG/ZLOG Admissions

Electronics Supply Chain

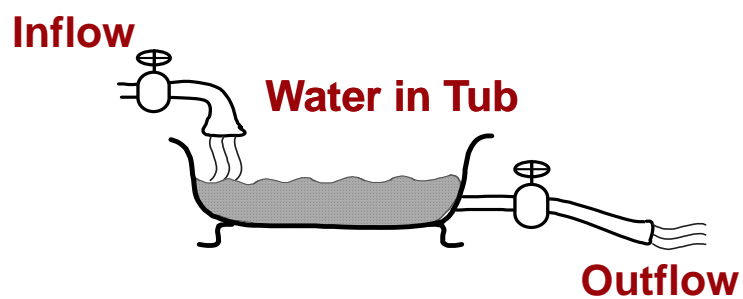


Human Resources



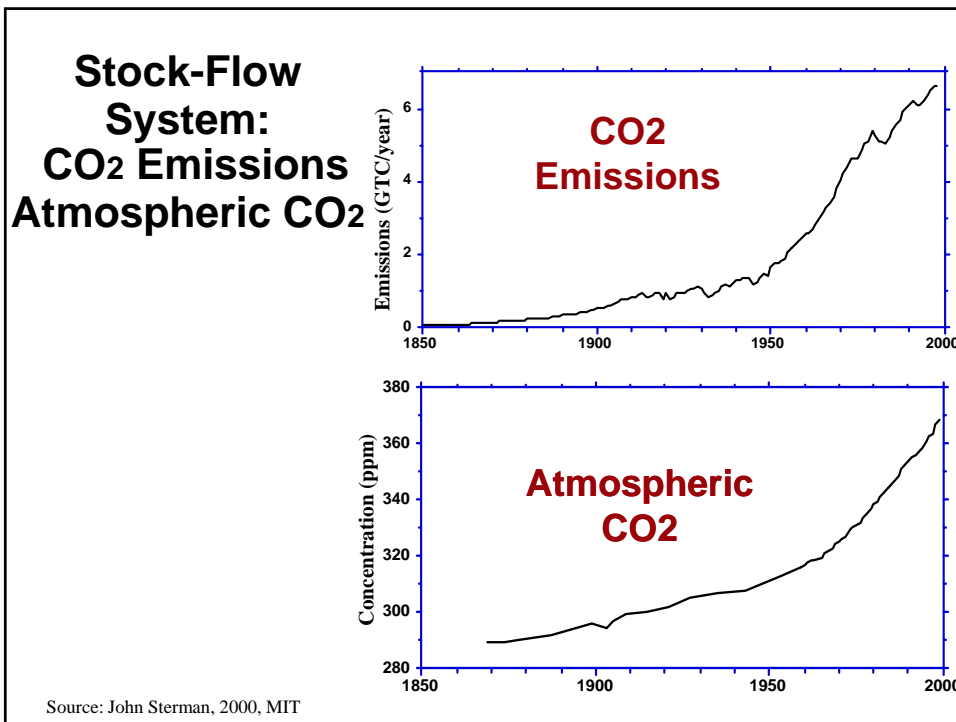
Dynamics of Stocks-and-Flows

Stocks and Flows

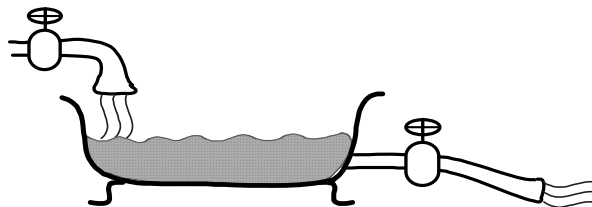


- **Inflow > Outflow:** Quantity in tub is rising
- **Inflow < Outflow:** Quantity in tub is falling
- **Inflow = Outflow:** Quantity in tub is constant

Source: John Sterman, 2000, MIT

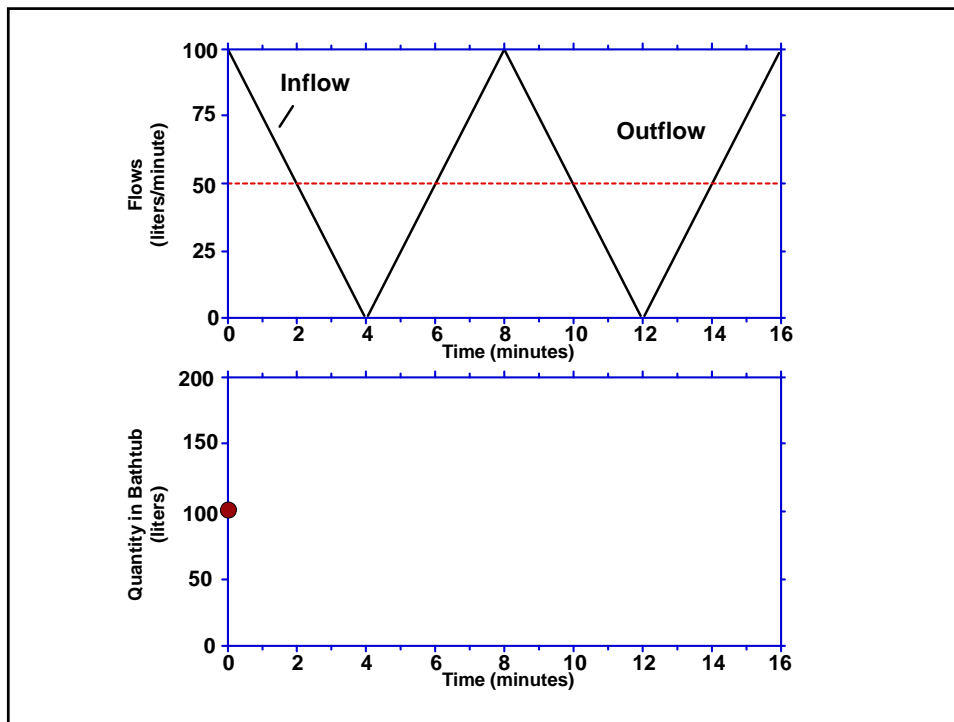


Consider the bathtub shown below. Water flows in at a certain rate, and exits through the drain at another rate:

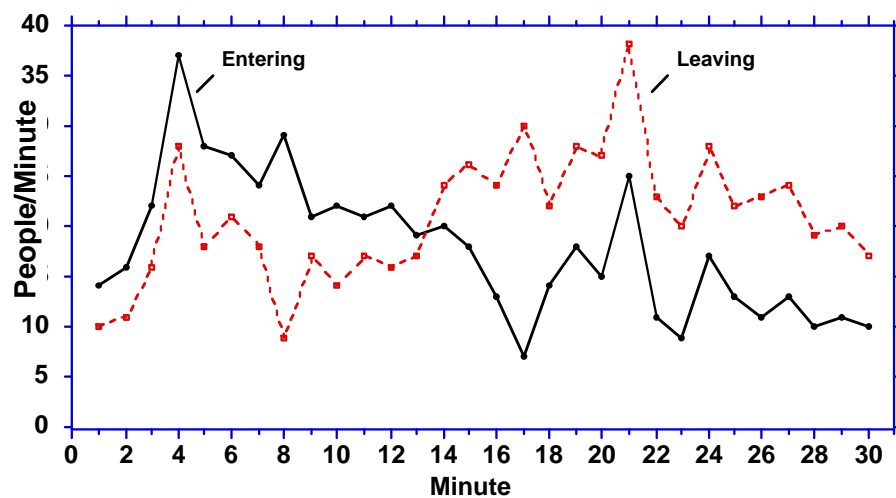


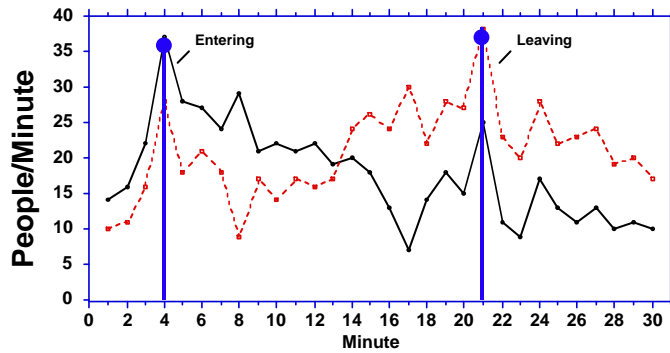
The graph below shows the hypothetical behavior of the inflow and outflow rates for the bathtub. From that information, draw the behavior of the quantity of water in the tub on the second graph below.

Assume the initial quantity in the tub (at time zero) is 100 liters.



The graph below shows the number of people **entering** and **leaving** a department store over a 30 minute period.





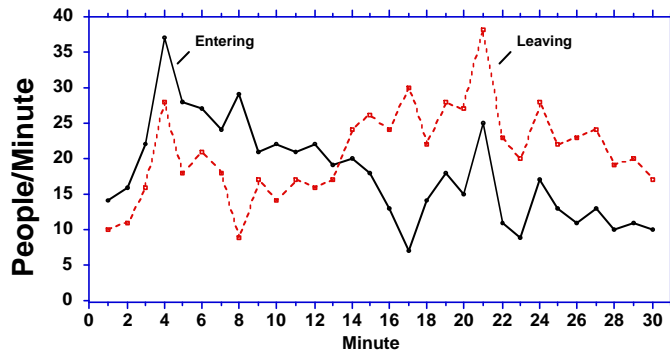
Please answer the following questions. Check the box if the answer cannot be determined from the information provided.

1. During which minute did the most people enter the store?

Minute _____ Can't be determined

2. During which minute did the most people leave the store?

Minute _____ Can't be determined



Please answer the following questions. Check the box if the answer cannot be determined from the information provided.

3. During which minute were the most people in the store?

Minute _____ Can't be determined

4. During which minute were the fewest people in the store?

Minute _____ Can't be determined