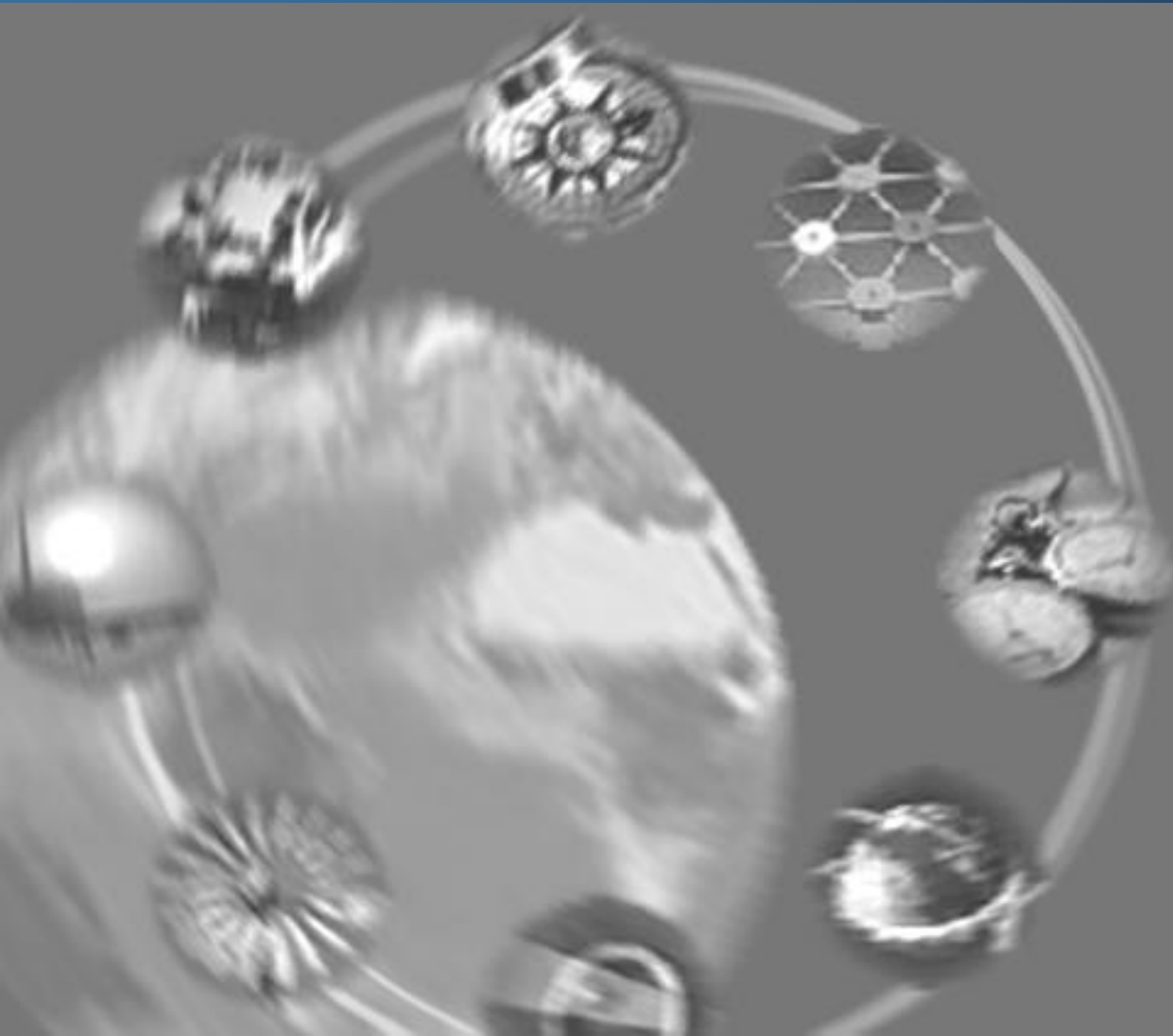


Where Did the Gasoline Go?

Identifying Stock & Flow Structure



Moonseo Park

Professor, PhD

39동 433

Phone 880-5848, Fax 871-5518

E-mail: mspark@snu.ac.kr

Department of Architecture
College of Engineering
Seoul National University



서울대학교
건설기술연구실

Dynamic vs. Static

	Dynamic system	Static system
OUTPUT changed by	current INPUT/ System Status (past IN/OUTPUT)	current/past INPUT
System characteristics	having MEMORY Variables changed by TIME Including energy storage	instantaneous system (no MEMORY)

Deterministic vs. Stochastic

- Deterministic models: output fully determined by the parameter values and the initial conditions.
- Stochastic models: possess inherent randomness. The same set of parameter values and initial conditions will lead to an ensemble of different outputs.

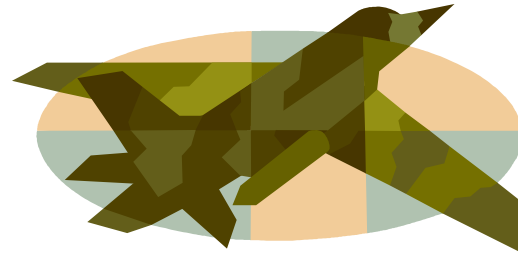
Lecture Outline

- Contribution of Stocks to Dynamics
- Identifying Stock and Flow Structures
- Mapping Stock and Flow Structures
- Where did the gasoline go?

Characterize the state of the system

Provide decision-makers with the basis for actions

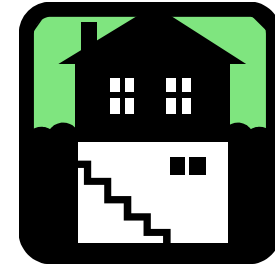
- Pilot: aircraft's position, heading, altitude, fuel level
- Firm: order backlog, inventory stocks, labor force
- Balance sheet: cash, inventory, payables, debt



Provide systems with inertia and memory

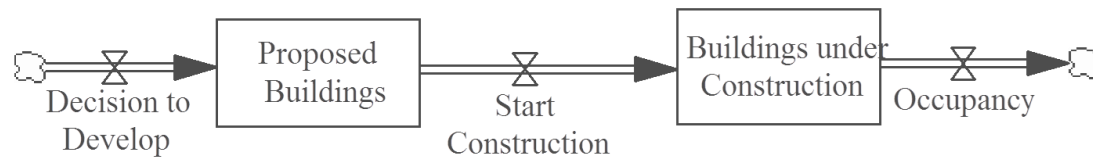
Stocks accumulate past events.

- Lead in the paint of housing remains high (banned in 1978).
- Ozone-destroying chloride by CFC will remain for decades.
- Beliefs persist over time, generating inertia and continuity in attitude and behavior.



The source of delays

A delay is a process whose output lags behind its input. The difference between the input and output accumulated in a stock of material in process

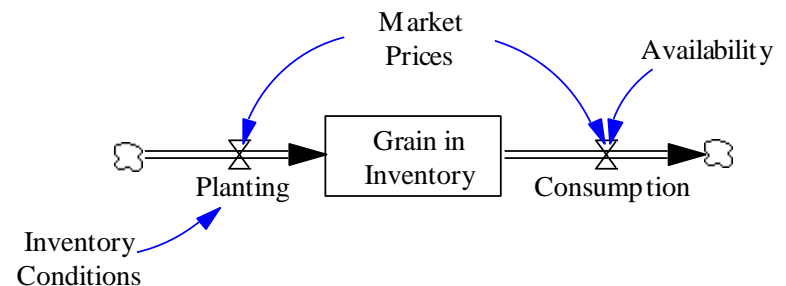


Create disequilibrium dynamics

Stocks absorb the differences between inflows and outflows, permitting them to differ. As a result, disequilibrium is the rule rather than the exception.

- What if there is no buffer or stock?
- Whenever controlled by different decision makers, subject to random shocks, a buffer or stock must exist.
- Whether/how equilibrium is achieved is an emergent property of a system.

Stockpiling grain during the 7 good years



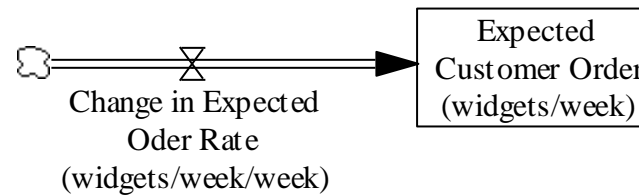
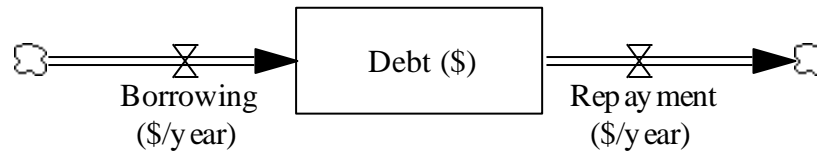
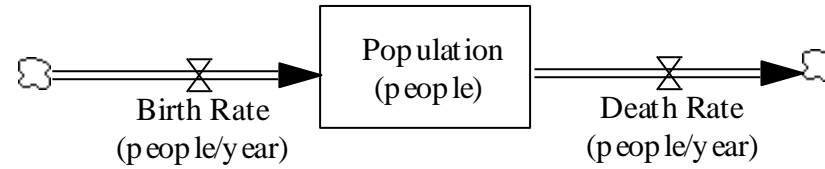
Lecture Outline

- ✓ Contribution of Stocks to Dynamics
 - Identifying Stock and Flow Structures
 - Mapping Stock and Flow Structures
 - Where did the gasoline go?

By units of measure

Items	Stocks	Flows	Units
Company sales			√
	\$/year		
Phone calls on hold	√ calls		
Workers	√ persons		
GDP		√	\$/year
Cash flow			√
	\$/year		
On-going projects	√ units		
Greenhouse gas emissions			√
	tons/year		
Price of product	√ \$/unit		
Employee morale	√ level		
Depreciation			
Construction work quality	√ level		%/year

The Snapshot Test

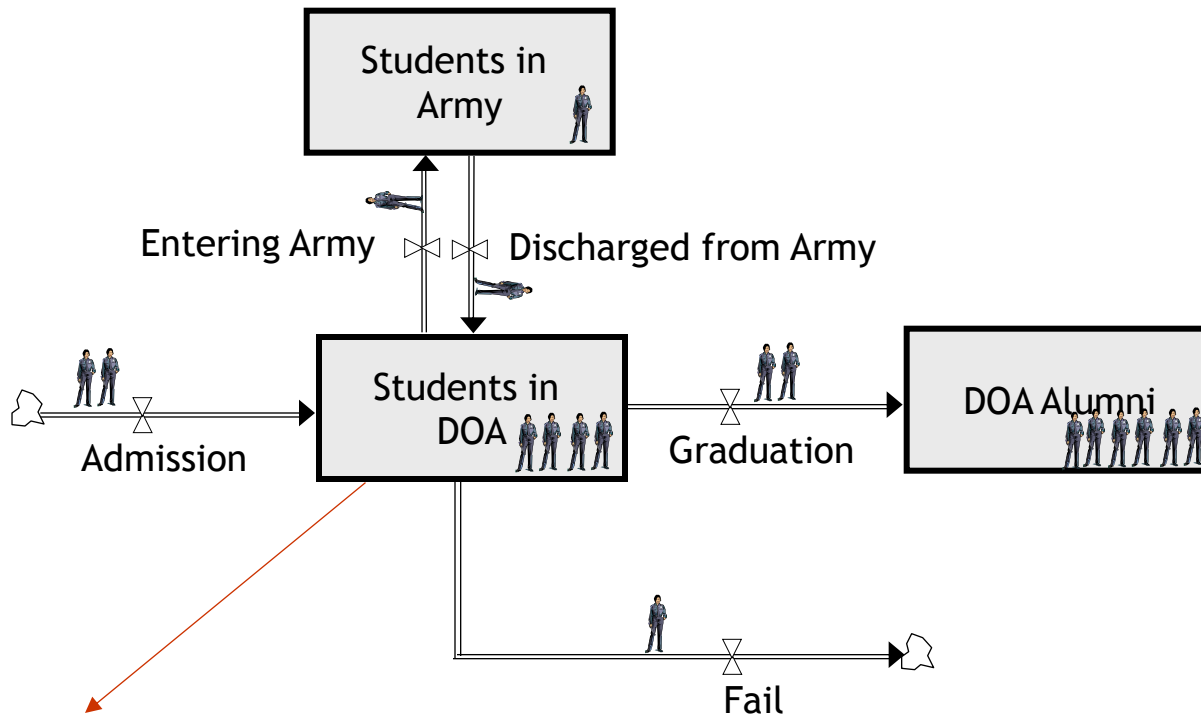


***Actual Customer Order:
a stock or flow?**

Lecture Outline

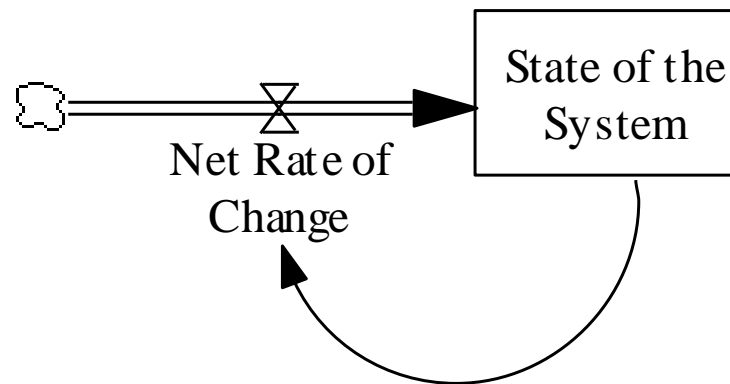
- ✓ Contribution of Stocks to Dynamics
- ✓ Identifying Stock and Flow Structures
 - Mapping Stock and Flow Structures
 - Where did the gasoline go?

Conservation of Material in S&F



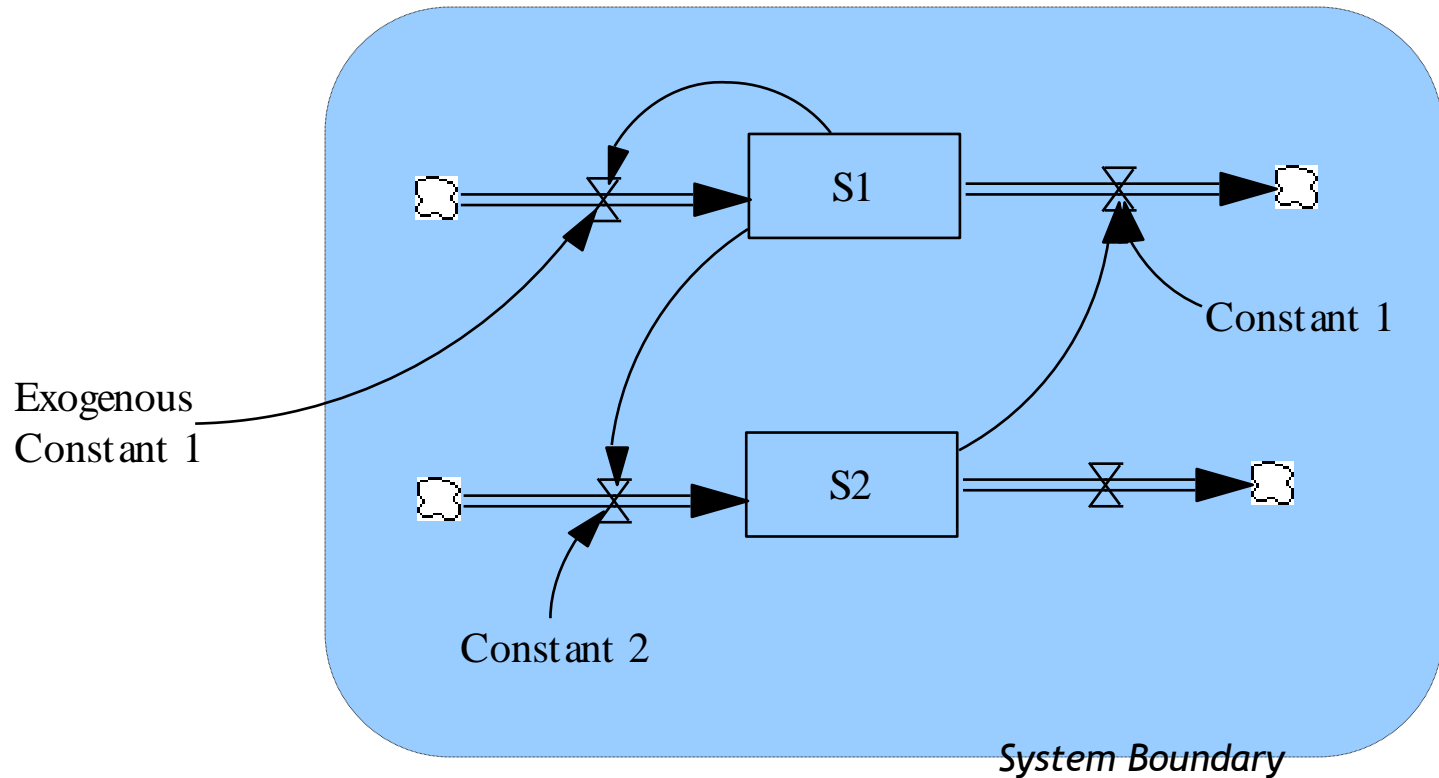
State-Determined Systems

Systems evolve by feedbacks of information from the state of the system to the flows, which in turn alter the states.

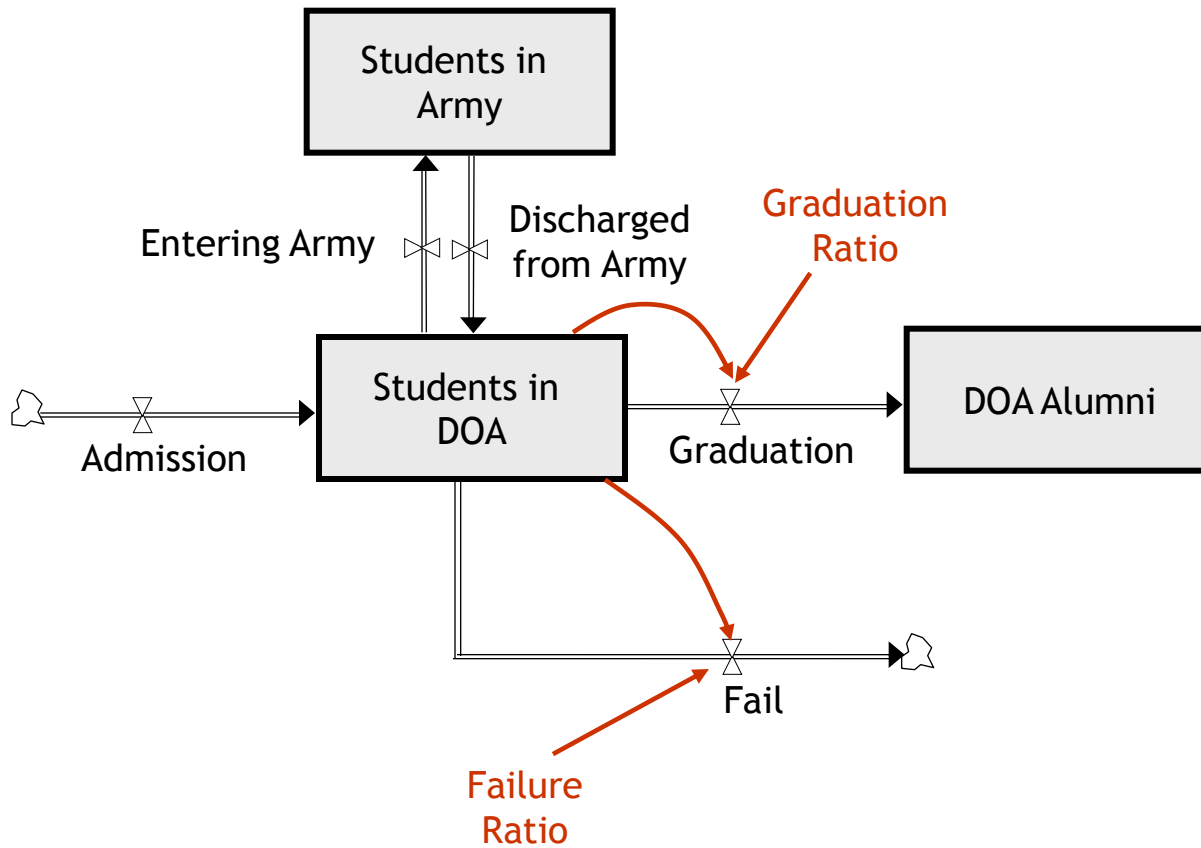


State Variables

State variables including constants (endogenous, exogenous) determine rates.

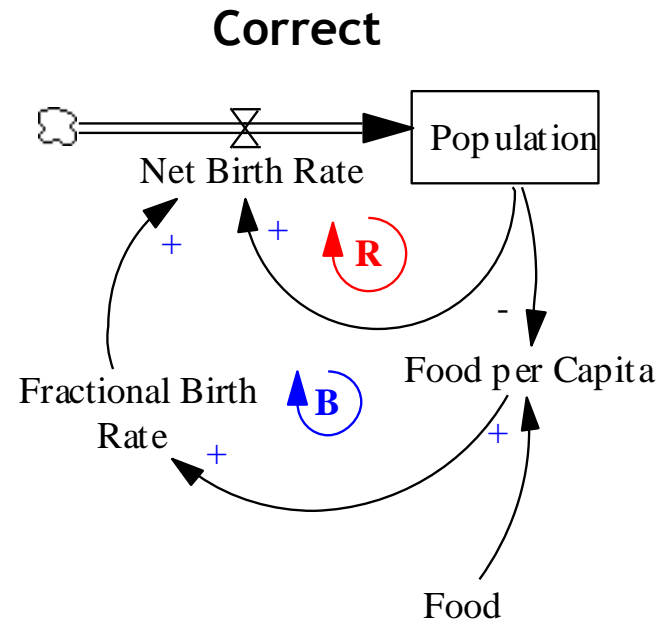
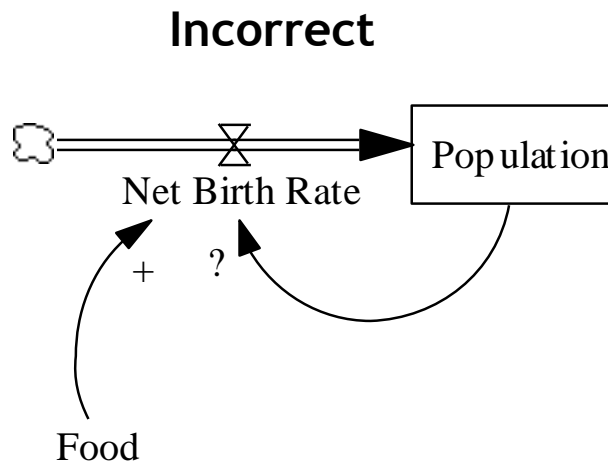


Examples



Auxiliary Variables

For easy communication and clarity, it is often helpful to define intermediate or auxiliary variables, which consist of functions of stocks (and state variables).



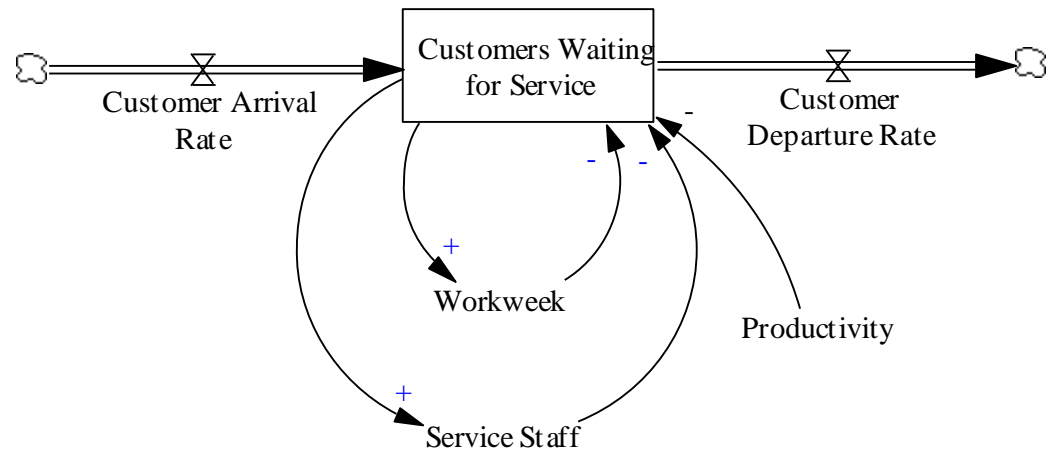
R: more people, more births, more people

B: more people, less food per person, lower fractional net birth rate, fewer births)

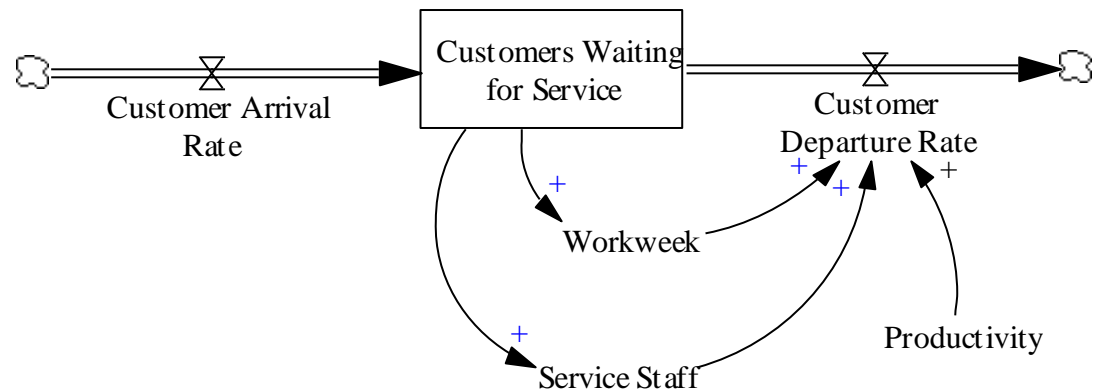
Stocks change only thru their rates

No causal links are allowed directly linked into a stock.

Incorrect



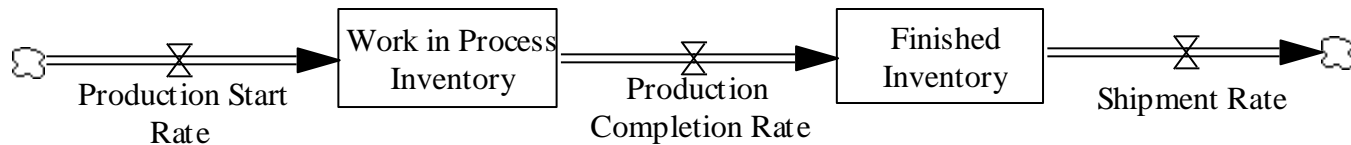
Correct



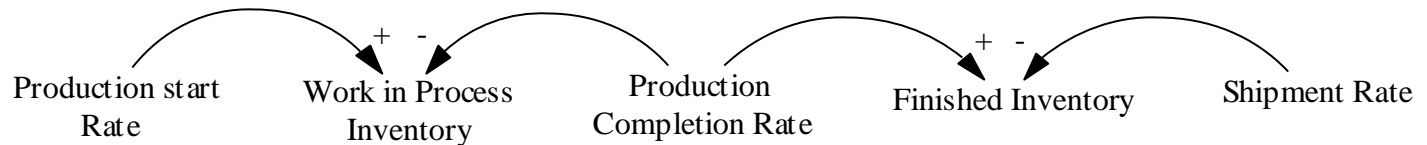
When to show S&F Structures?

When representing physical processes, delays, or stocks whose behaviors are important in the dynamics you seek to explain.

S&F

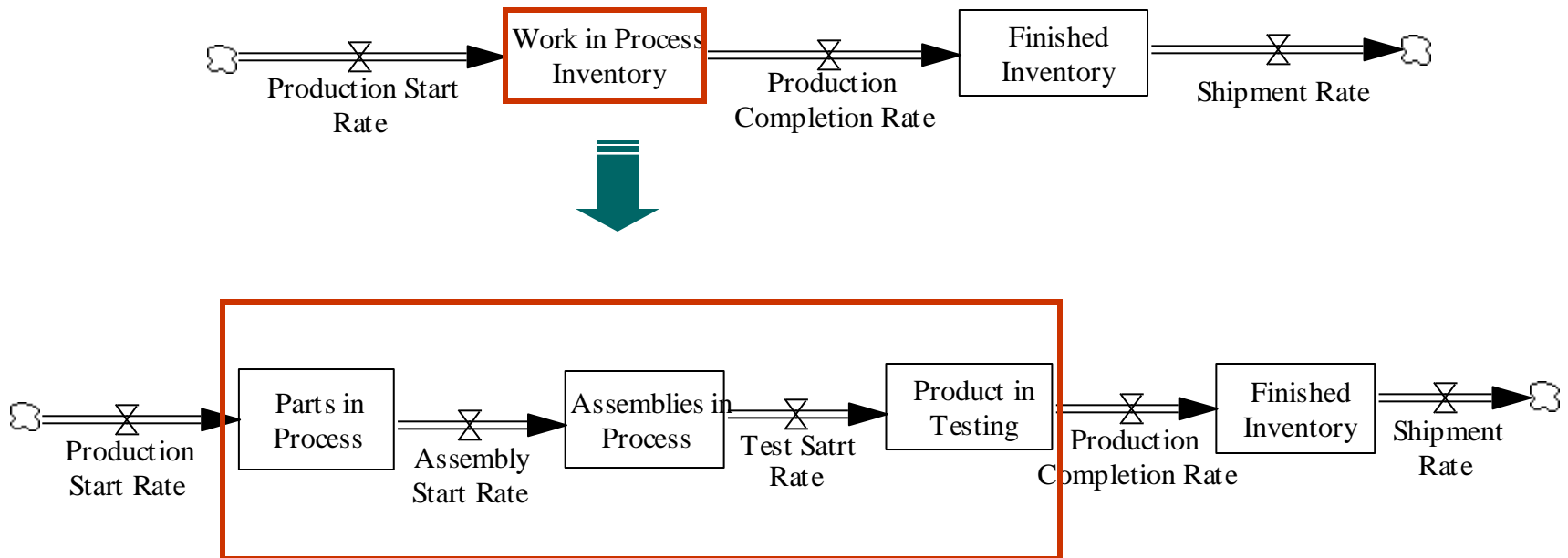


CLD



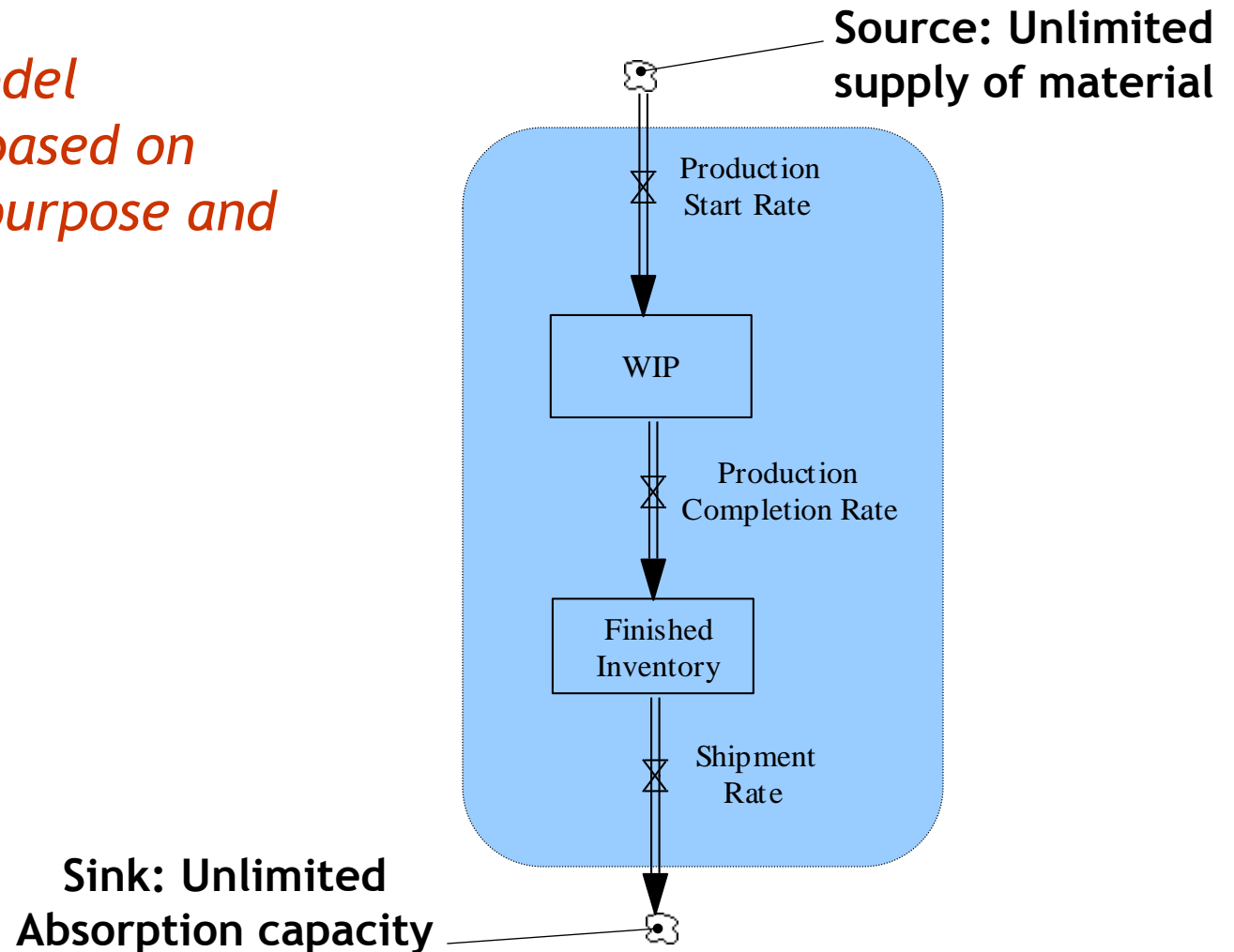
Aggregation & Disaggregation

Appropriate level of aggregation should be decided depending on modeling purposes.



Challenging the clouds

Set the model boundary based on modeling purpose and scope.



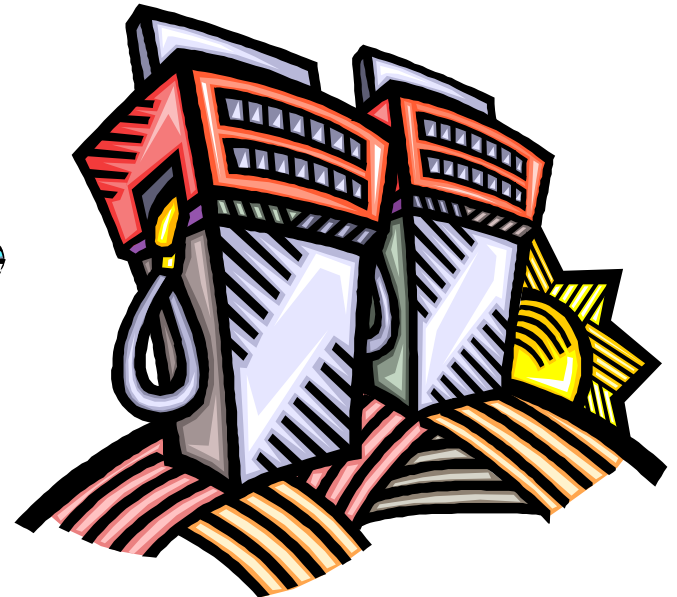
Lecture Outline

- ✓ Contribution of Stocks to Dynamics
- ✓ Identifying Stock and Flow Structures
- ✓ Mapping Stock and Flow Structures
 - Where did the gasoline go?

Where did the gasoline go?

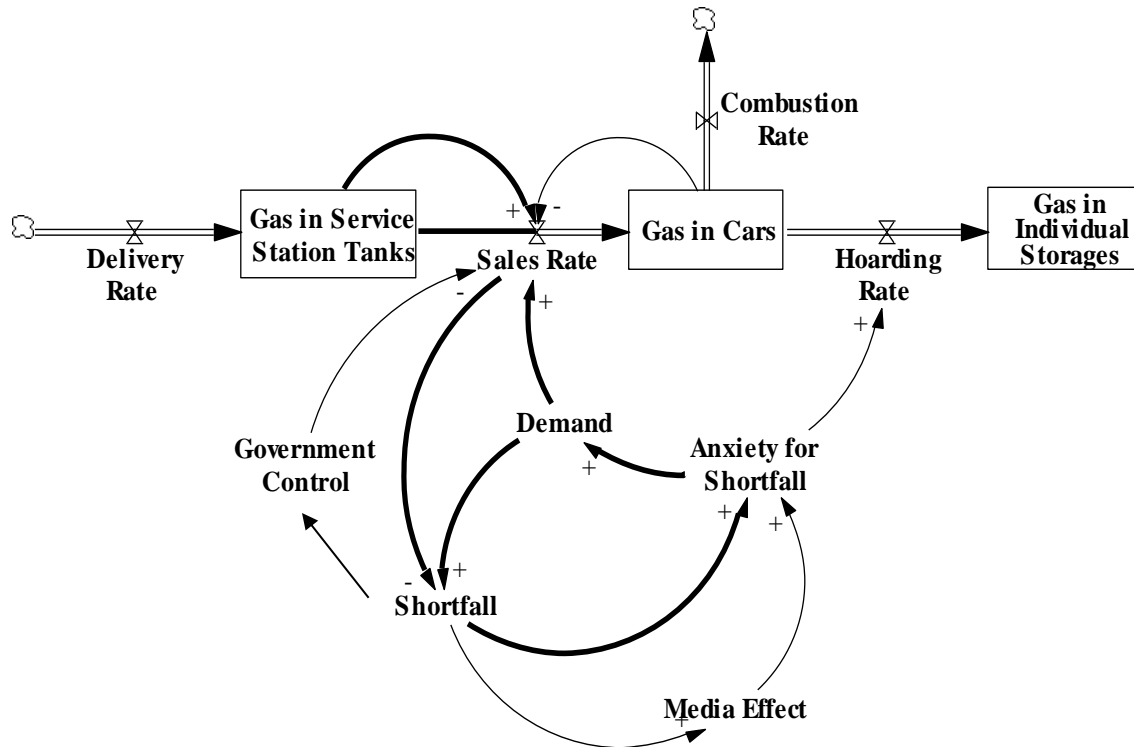


NO GAS



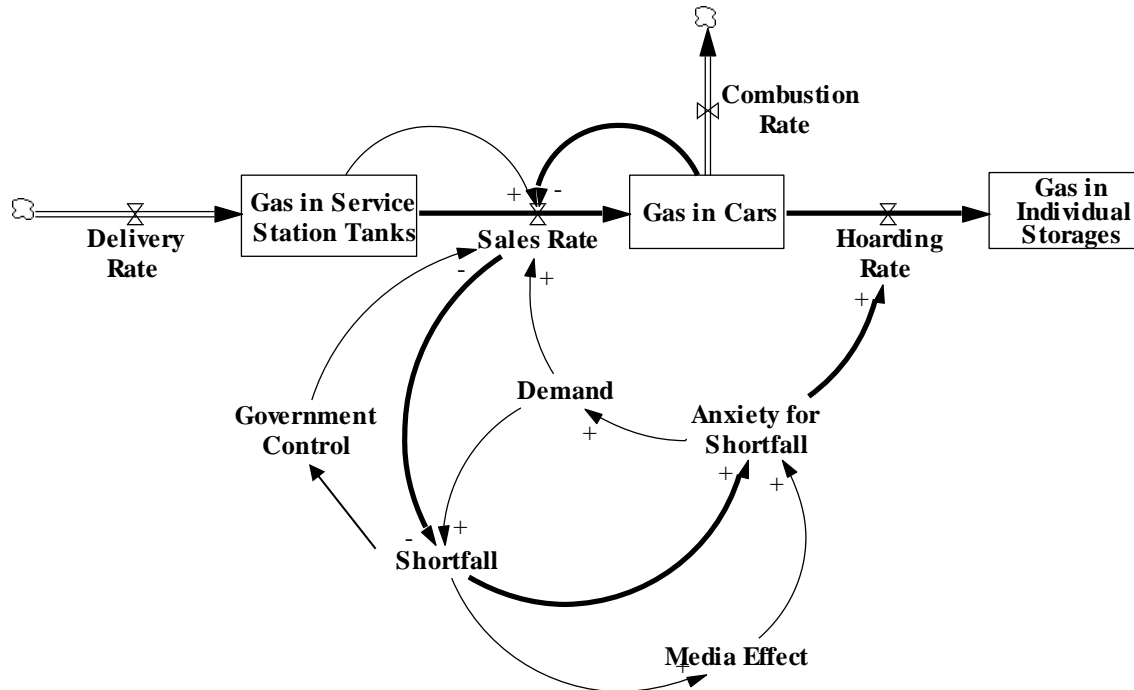
Drivers, remembering

the first oil embargo in 1973, and worry that they will not be able to get their tanks fill, begin to demand more. The abrupt increase in demand triggers the momentary shortfall, which again increases people's anxiety and makes people demand more.



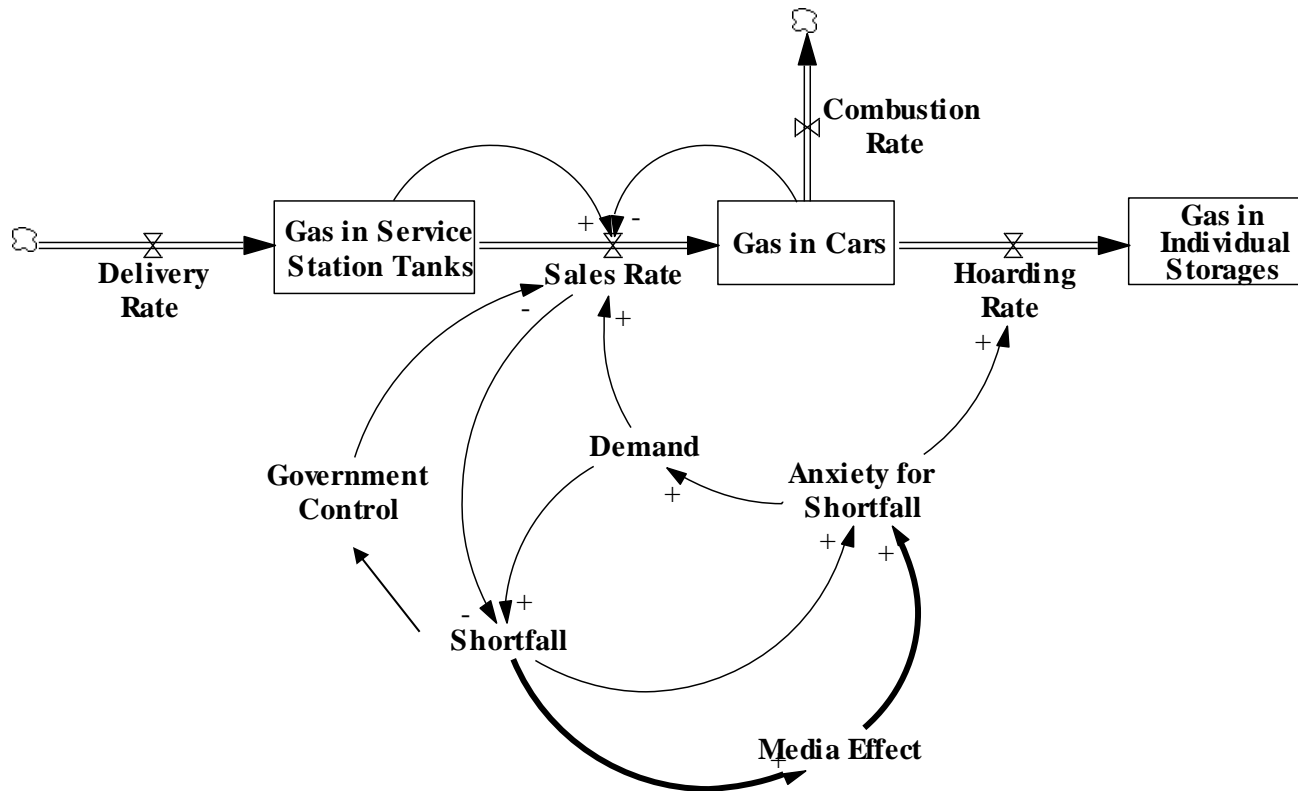
The more anxiety people

have the more gas people hoard in their storage, which makes the situation worse.



Furthermore,

the media makes the situation worse.



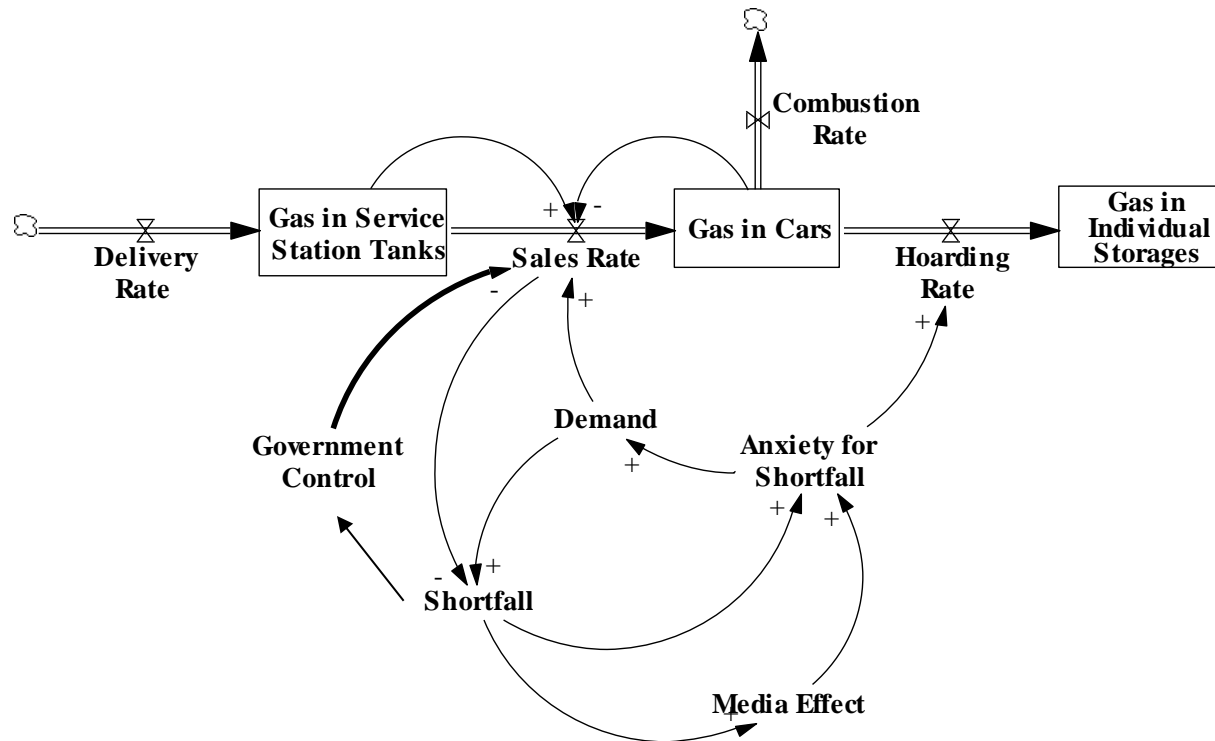
As a result,

the gas went to individual storage....



The government's policies

employed to cope with this situation failed to ease the shortage making it worse.



Then, how to ease people's anxiety?

References

- Avraham Shtub, Jonathan F. Bard, Shlomo Globerson, “Project management : engineering, technology, and implementation”, Englewood Cliffs, NJ, Prentice Hall, 1994
- Frederick E. Gould, Nancy Joyce, Chapter 8, “Construction project management”, Upper Saddle River, NJ, Prentice Hall, 1999
- James M. Lyneis *, Kenneth G. Cooper, Sharon A. Els, “Strategic management of complex projects: a case study using system dynamics”, System Dynamics Review, Vol. 17, No. 3, 2001
- Christopher M. Gordon, “Choosing appropriate construction contracting method”, J. of Construction Engineering & Management, Vol. 120, No. 1, 1994
- Feniosky Pena-Mora, Jim Lyneis, “Project control and management”, MIT 1.432J Lecture Material, 1998
- Barrie, D.S., and Paulson, B.C., “Professional Construction Management”, McGraw Hill, 1992
- Halpin, D.W., “Financial and Cost concepts for construction management”, John Wiley & Sons, 1995
- Yehiel Rosenfeld, “Project Management”, MIT 1.401J Course Material, 2000
- Sarah Slaughter, “Innovation in construction”, MIT 1.420 Course Material, 1999
- Gray and Hughes, “Building Design Management”,.
- Murdoch and Hughes, “Construction Contracts: Law and Management”, E&FN SPON, 1996
- Gray, Hughes and Bennett, “The Successful Management of Design”, Reading, 1994
- Sterman, J., “Business Dynamics”, Mcgraw-Hill, 2000