

System Dynamics

Dr. Erik Pruyt

Assistant professor, Faculty of TPM, TU Delft

Overview

- What? Uses? Domains?
- How? The SD process
- Stock-Flow Diagram (SFD)
- Causal Loop Diagram (CLD)
- SD specificities
- Two examples

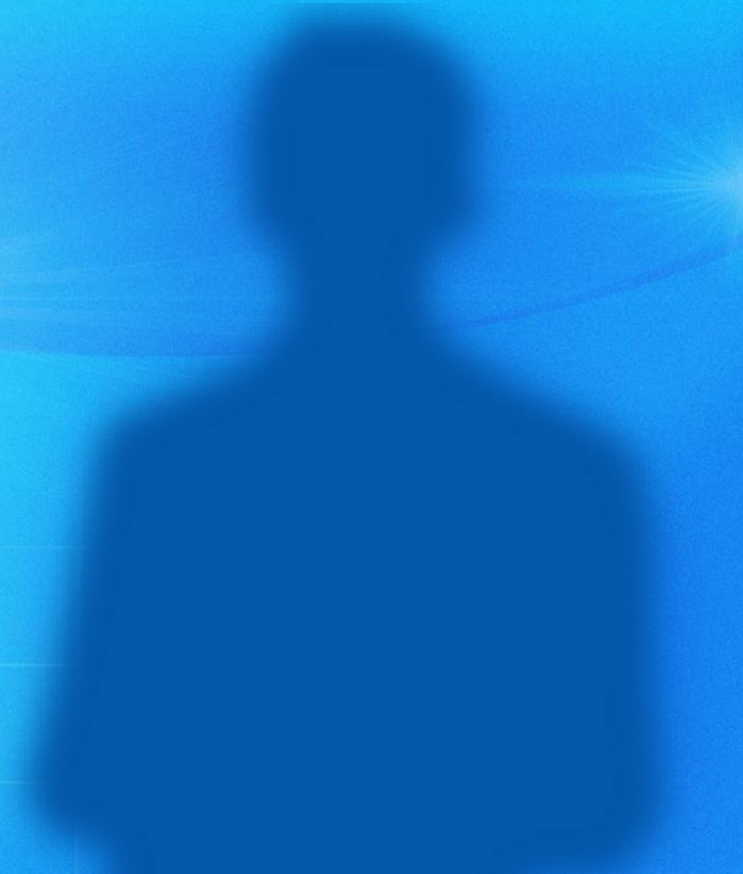
What is System Dynamics?

Method for modeling and simulating dynamically complex issues/systems characterized by feedback and accumulation effects.

What are its uses?

- Model & simulate systems
- Study structure \leftrightarrow behavior
- Experimentation (laboratory)
- Policy analysis/design/testing

What are its application domains?





Health policy

Energy policy





Resource dynamics
and management

Environmental policy



Urban dynamics and housing policy





Education & innovation

Strategic planning, business dynamics



Safety, security & risk



Public policy: e.g.
societal ageing



SD diagrams: Stock-Flow Diagrams



- Stock & flow variables

SD diagrams: Stock-Flow Diagrams



constant

- Stock & flow variables
- Parameters & constants

parameter

SD diagrams: Stock-Flow Diagrams



graph
function

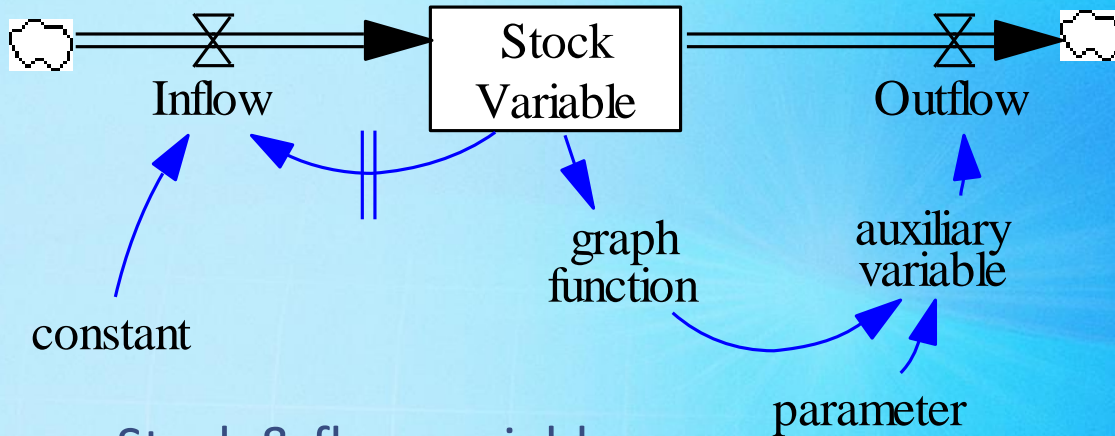
auxiliary
variable

constant

parameter

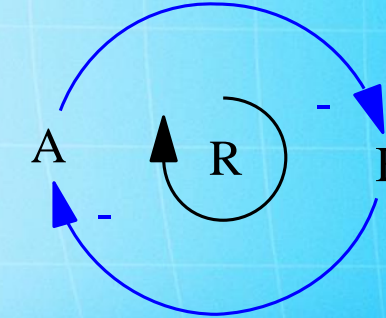
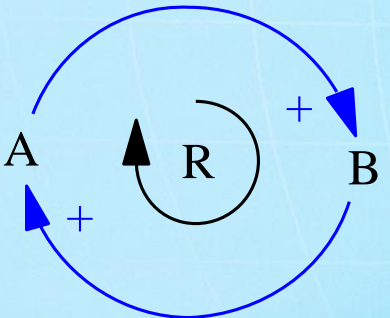
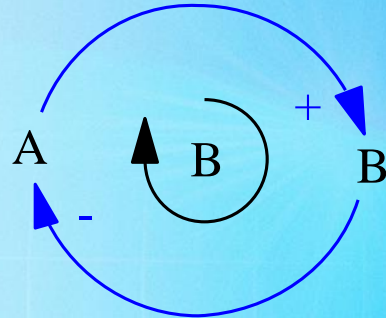
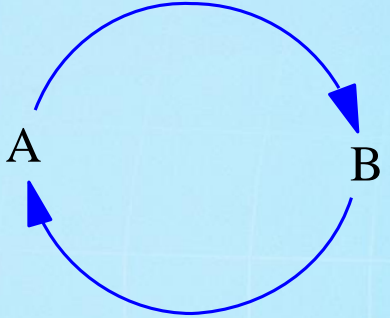
- Stock & flow variables
- Parameters & constants
- Auxiliaries (graph functions, delays, ...)

SD diagrams: Stock-Flow Diagrams

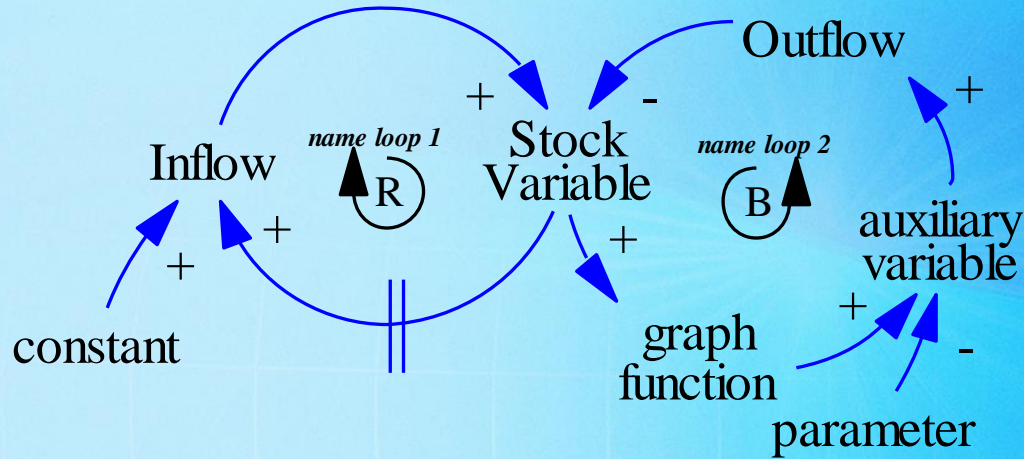


- Stock & flow variables
- Parameters & constants
- Auxiliaries (graph functions, delays, ...)
- Causal links
- Real-world counterpart?

Causal Loop Diagrams



SD diagrams: Causal Loop Diagrams

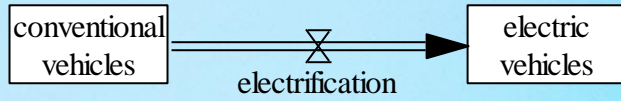


- Link polarities: + & - causal links
- Outflow: - link from outflow to stock
- Loops: balancing (B) & reinforcing (R)

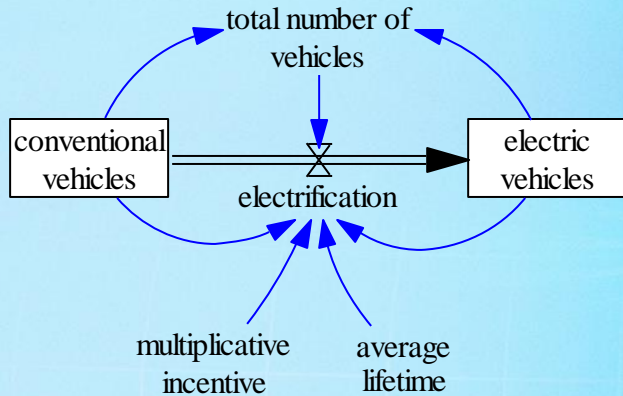
System Dynamics specificities

- Largely endogenous theories
- Aggregated: big picture, LT
- Numerical integration → dynamics
- Interpretation:
 - Modes of behavior
 - Policy insights
 - Not prediction
 - Tools for thought

Example 1: diffusion of EV's



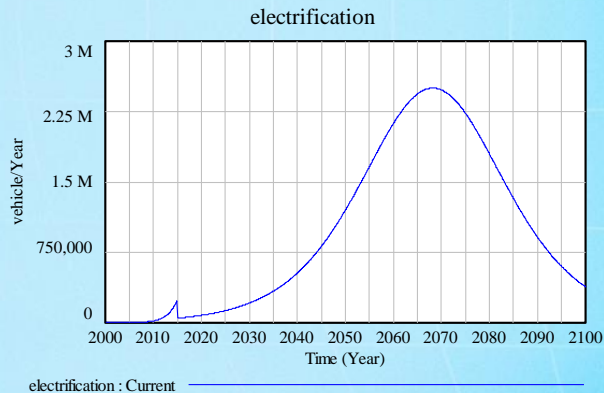
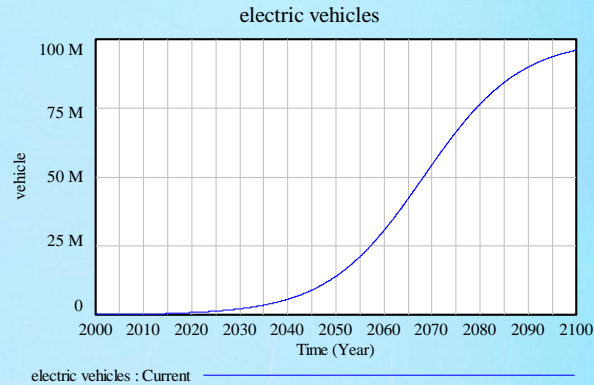
Example 1: diffusion of EV's

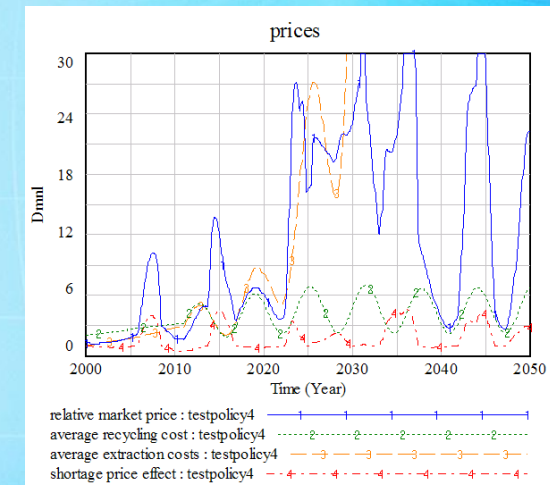
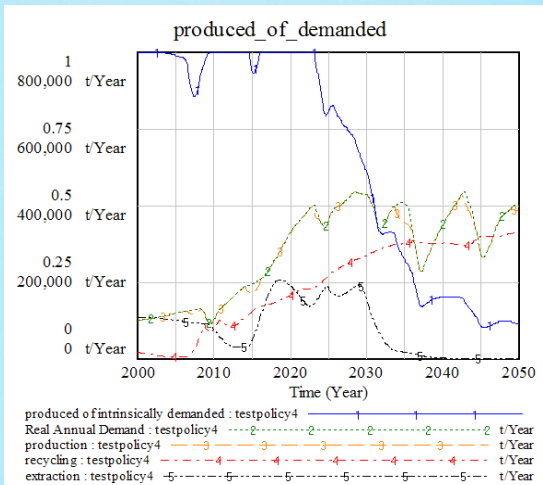
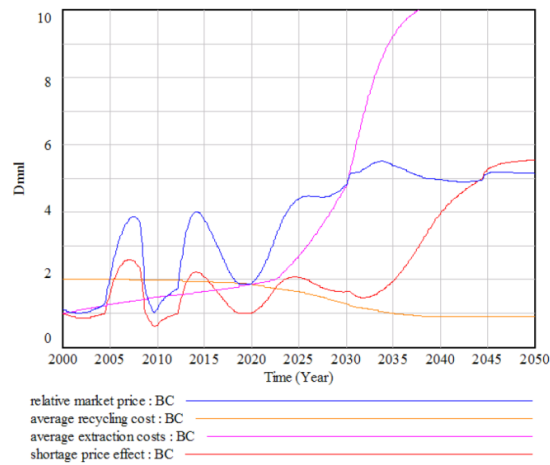
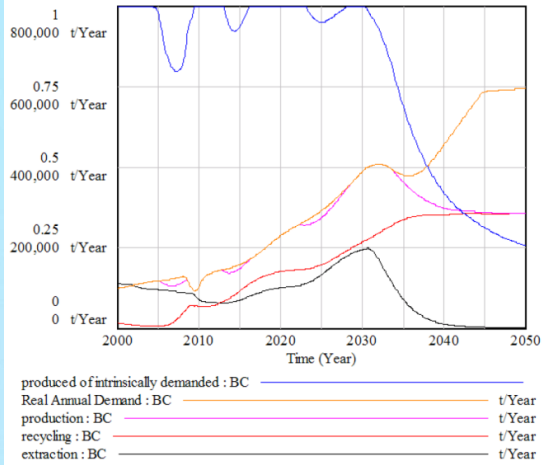


Electrification =

conventional vehicles / average lifetime *
electric vehicles / total number of vehicles *
multiplicative incentive

Example 1: diffusion of EV's





Conclusions

- Modeling complexity & simulation dynamics
- Dynamic complexity: too hard *wo* simulation
- System Dynamics allows to deal with it

- Here: basics (causal links, loops, stocks, ...)

- From here on:
 - Free e-book/OOC, online resources, ...
 - Introductory books (e.g. Sterman 2000)
 - Project with supervision/on job coaching
 - Advanced courses and workshops (e.g. @ ISDC)
 - Combination/comparison with other methods

Thank you for your attention!

Please post any questions you may have on our discussion forum.

References

- <http://www.flickr.com/photos/48639212@N02/6198962657/>
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