Systems Thinking for Design

Session 7

https://sites.google.com/a/iiitdm.ac.in/sudhirvs/courses/systems-thinking-for-design

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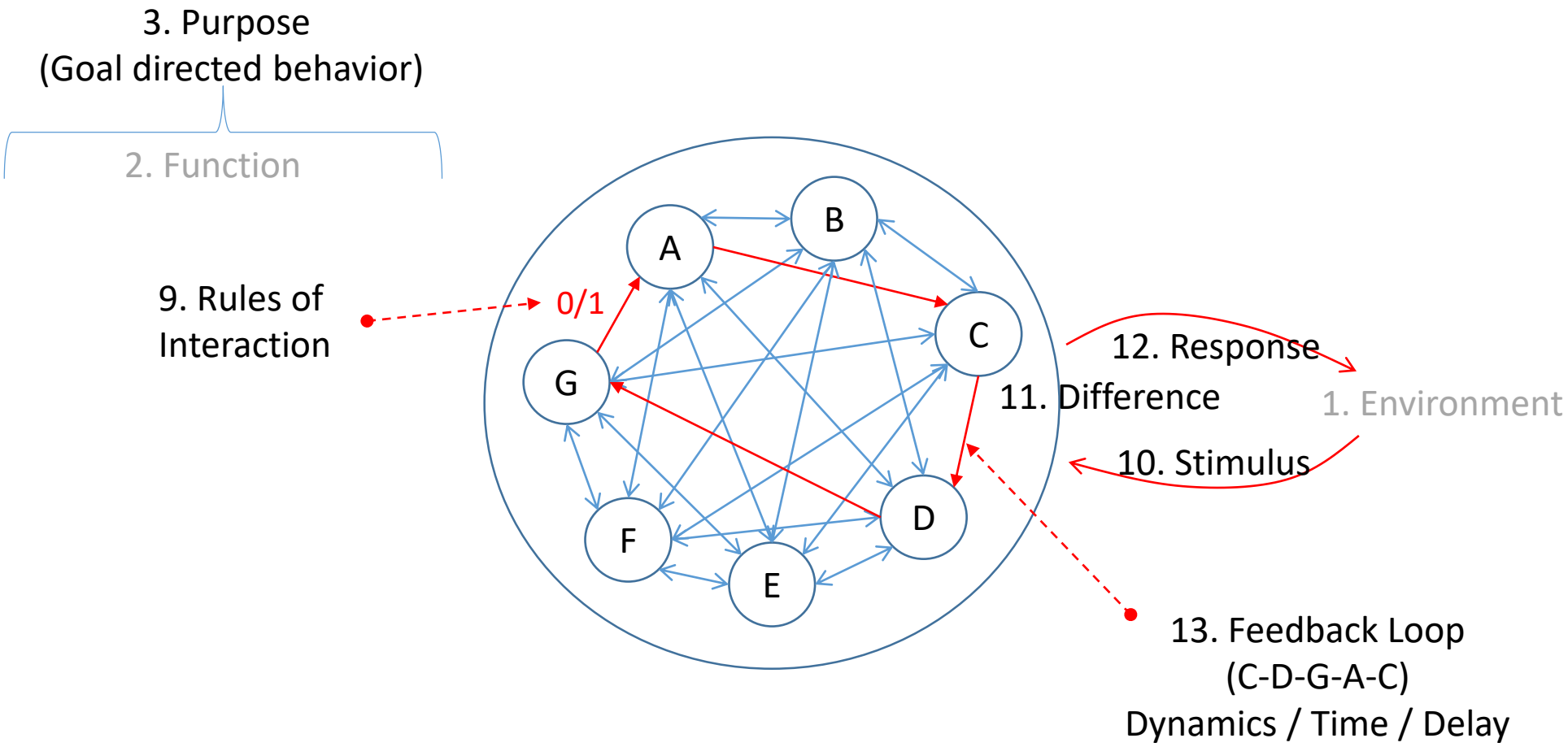
Session outline

- Diagnosing the system's ability to change (Cybernetics)
- Examples

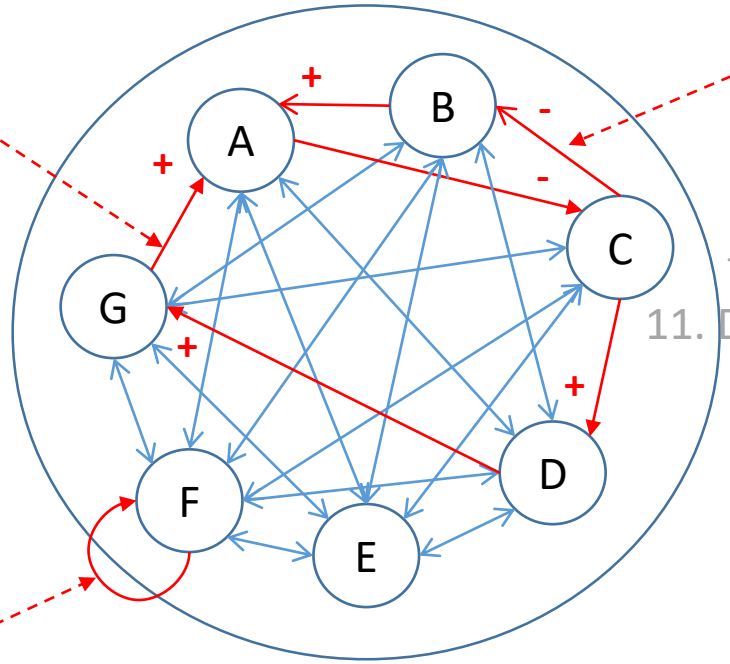
Principles of complex systems (3/8): Cybernetics



Principles of complex systems (4/8): Cybernetics

14. Self-regulation, Homeostasis, Negative Feedback (C-D-G-A-C)

15. Self-organization, deviance amplifying, Positive Feedback (C-B-A-C)



12. Response

11. Difference

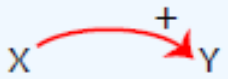
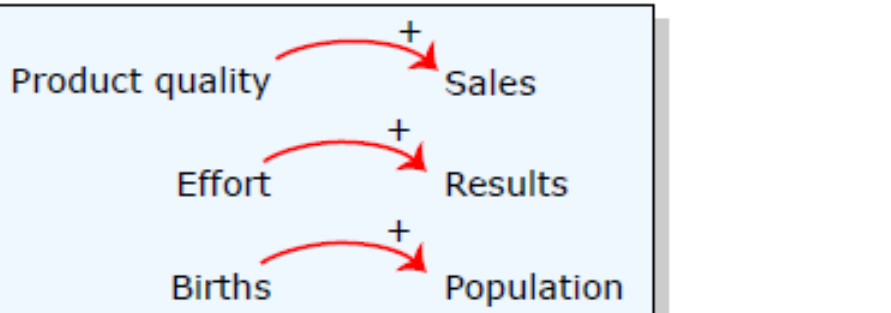
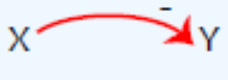
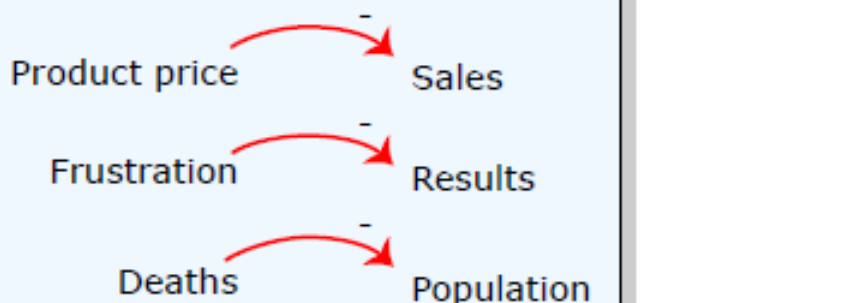
1. Environment

10. Stimulus

16. Self-referential, Recursive, Self-producing, Self-similar/Fractal (F-F)

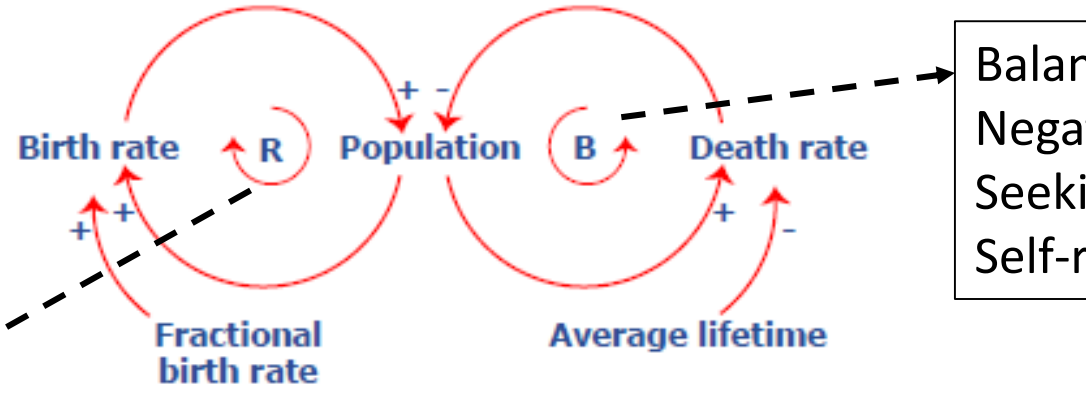
Explains some philosophical ideas

Guidelines for adding polarity to relations

Symbol	Interpretation	Mathematics	Examples
	All else equal, if X increases (decreases), then Y increases (decreases) above what it would have been. In the case of accumulations, X adds to Y.	$\partial Y/\partial X>0$ In the case of accumulations, $Y=\int_{t_0}^{t}(X+....)ds+Y_{t_0}$	
	All else equal, if X increases (decreases), then Y decreases (increases) below what it would have been. In the case of accumulations, X subtracts from Y.	$\partial Y/\partial X<0$ In the case of accumulations, $Y=\int_{t_0}^{t}(-X+....)ds+Y_{t_0}$	

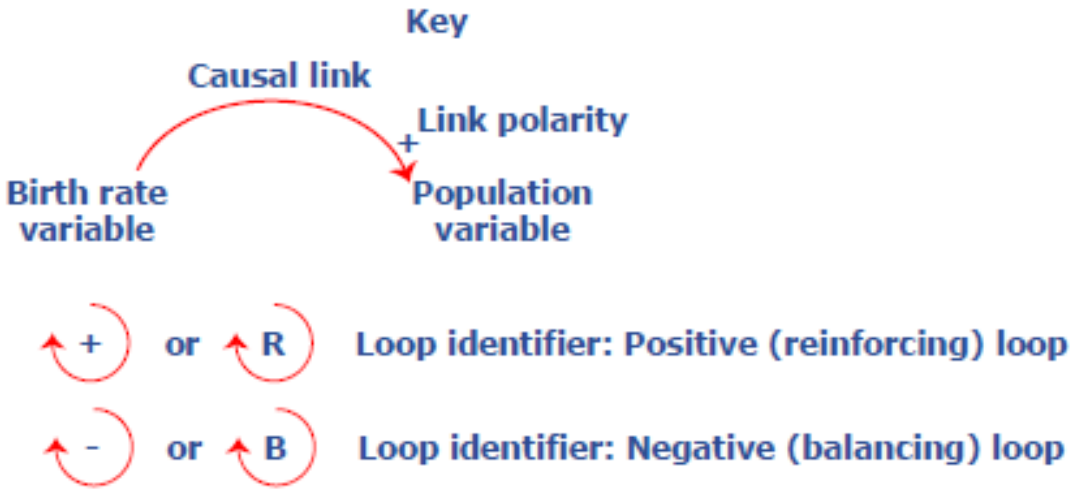
Source: Public (Internet)

Identifying loops affecting system behavior



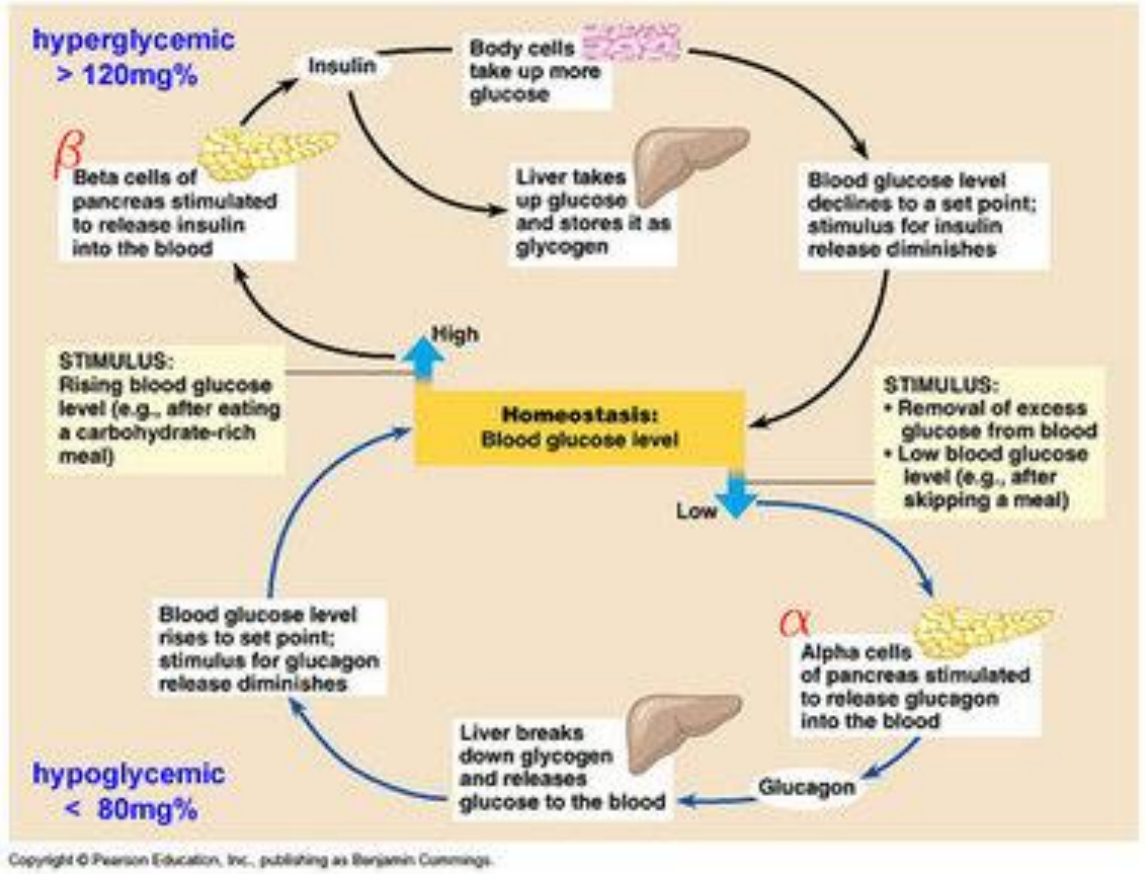
Balancing
Negative Feedback
Seeking stability
Self-regulating

Reinforcing
Positive Feedback
Deviation amplifying
Self-organizing



Source: Public (Internet)

It takes several negative feedback loops to keep human body stable

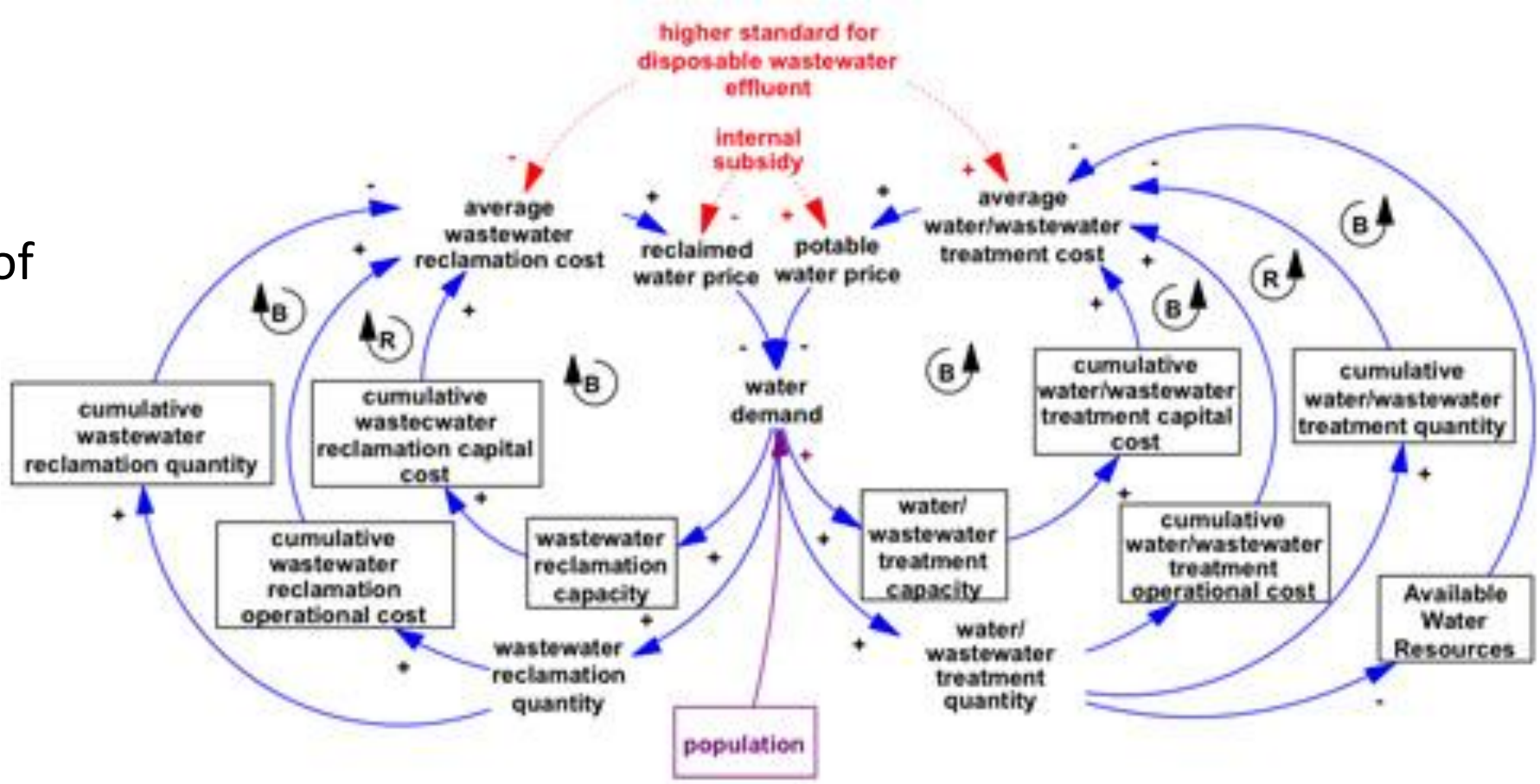


Source: Public (Internet)

Identifying and designing appropriate negative feedback loops to support bio-mechanics is a key principle in robotics … self-balancing bicycle etc.

Multiple loops shape system behavior

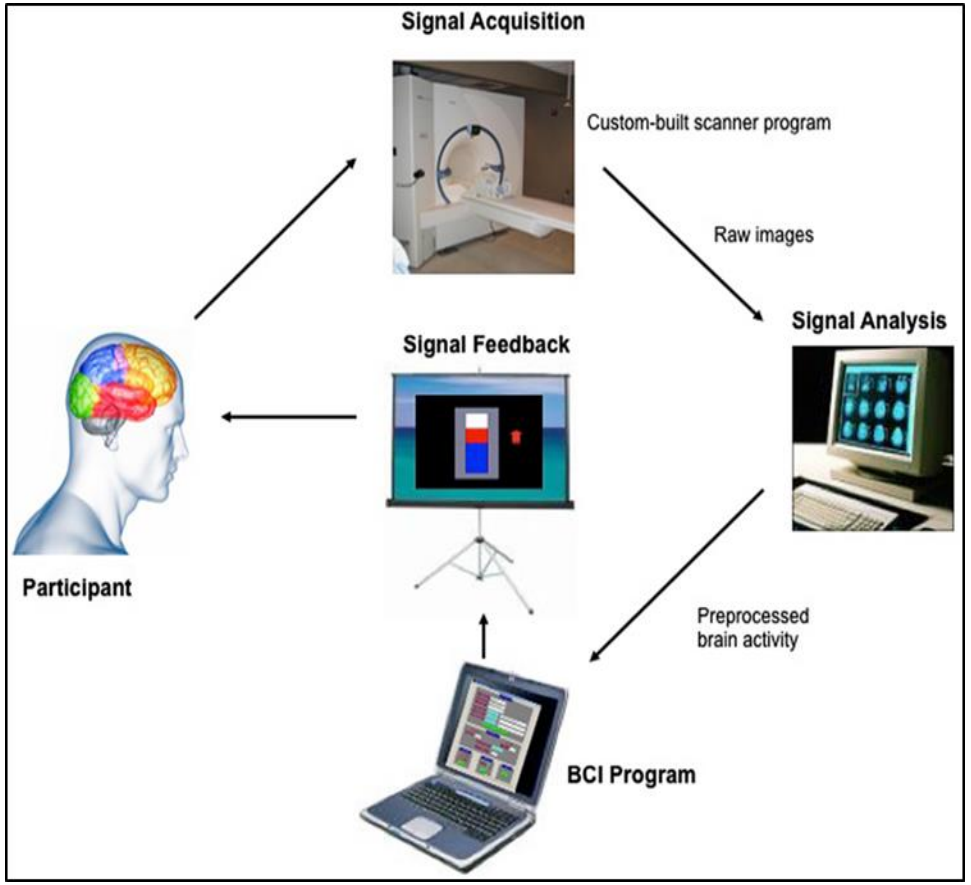
Water Resources Management: A complex system of balancing & reinforcing loops



Source: Public (Internet)

Delays and errors can make the system unstable

… and sometimes produce counter-intuitive behaviors



Importance of DSP & Machine Learning

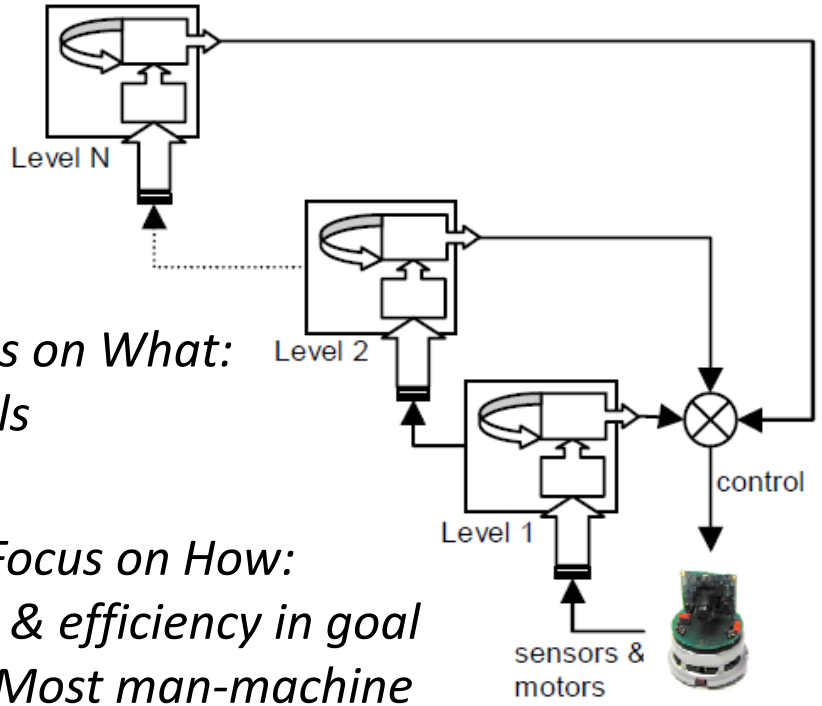
Multi-level feedback is critical for Learning and adaptation

Implications for human-machine interfaces

Level-3: Focus on Why: Redefining Purpose

Level-2: Focus on What: Revising Goals

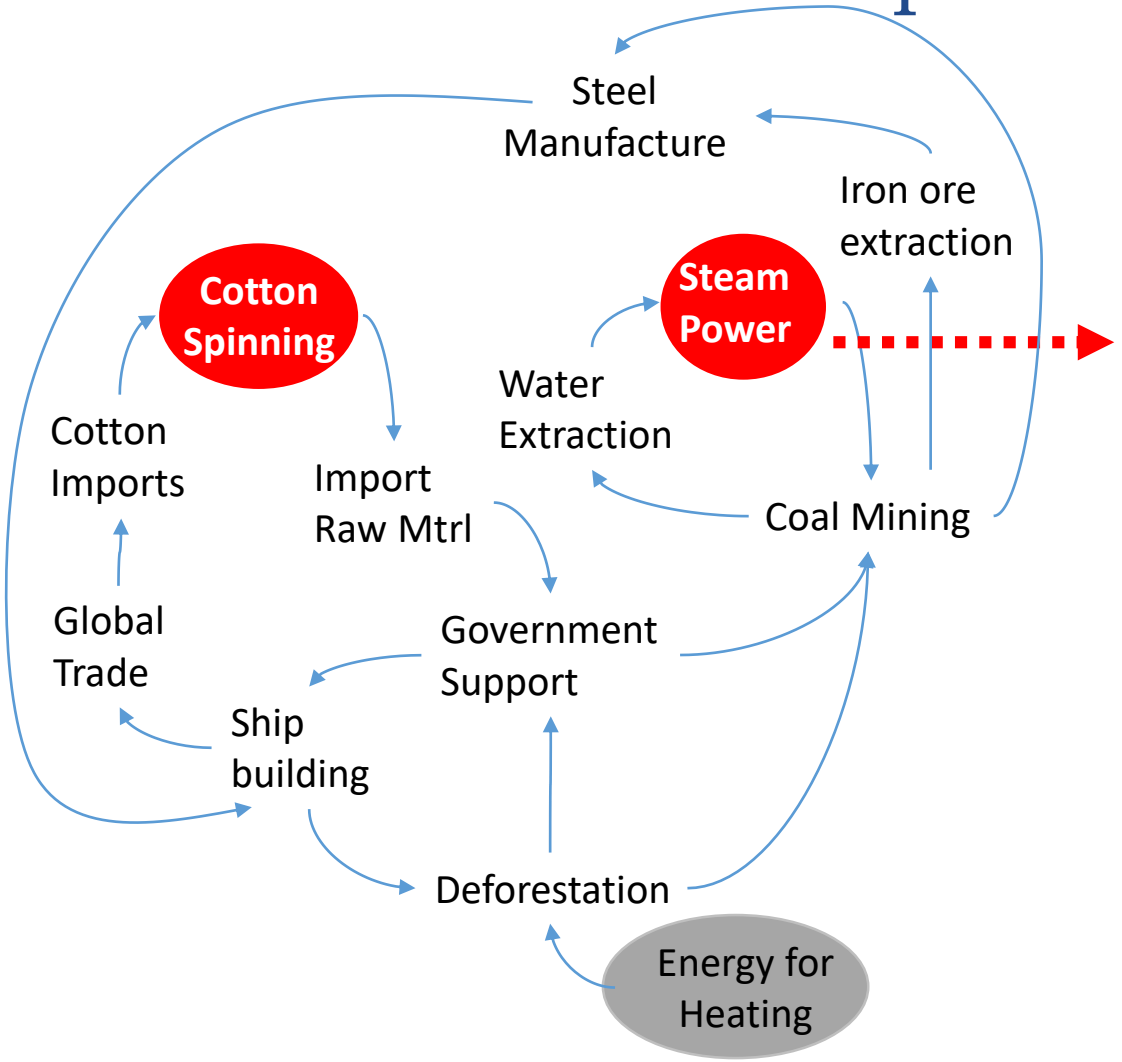
Level-1: Focus on How: Precision & efficiency in goal seeking. Most man-machine interaction & automation is at this level, example: robotics

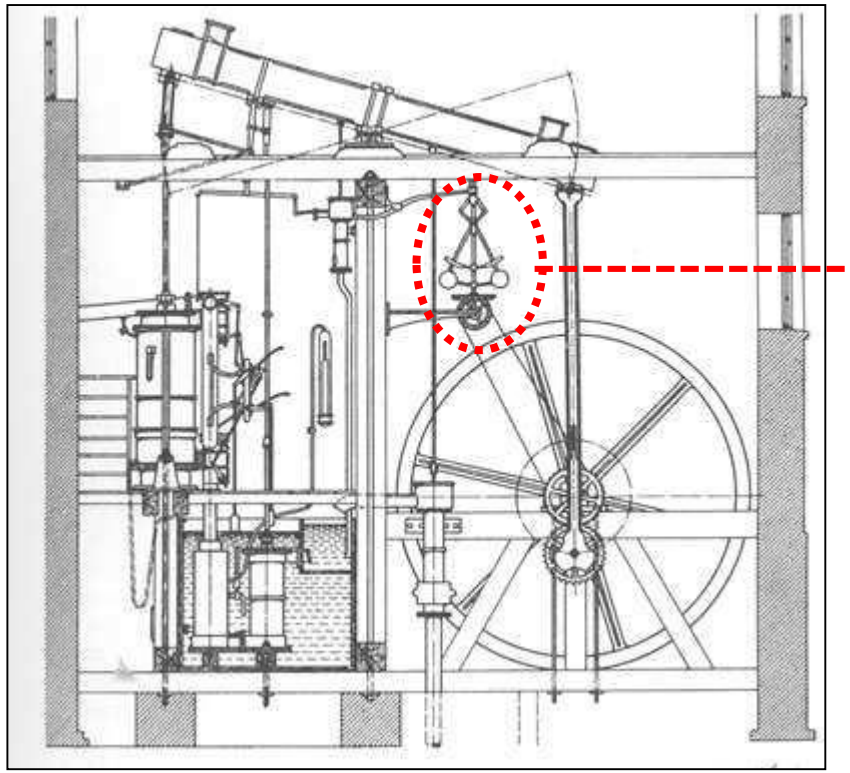


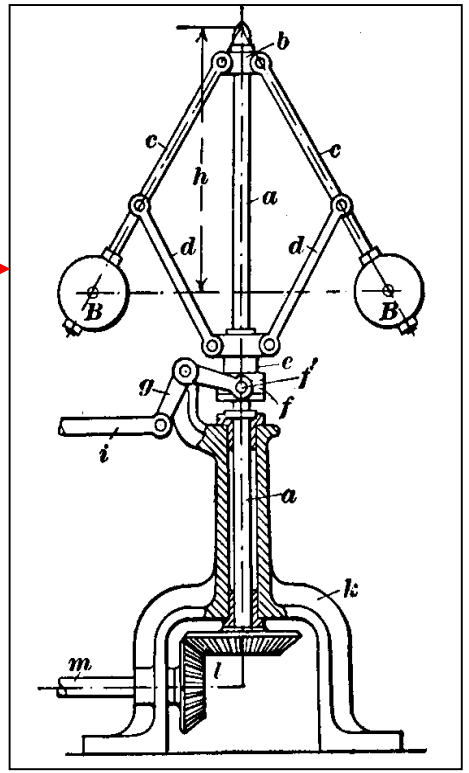
Source: Public (Internet)

A general developmental robotics architecture.

Constraints & loops that fueled Industrialization







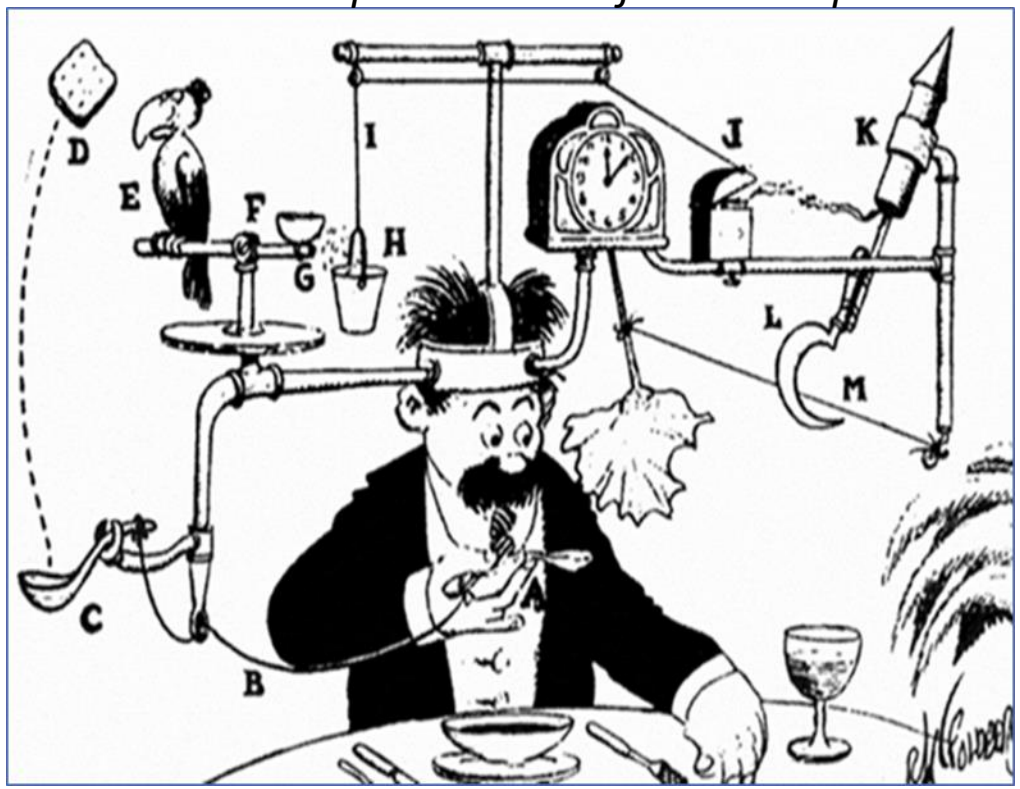
Watts speed governor

Innovative designs through use of feedback

Innovative solutions/designs can emerge by adding new linkages that connect unique elements in the context through negative or positive feedback loops

For example, soft rock chair powered by energy harvesting

… and some complicated ones for human productivity



Exercise 7

- Identify the feedback loops in the model
- List down those loops that keep the system stable
- List down those loops that have potential to de-stabilize or change the system
- Identify critical intervention points

Appreciate unique aspects of the problem

Reflect on today's session and post your comments.