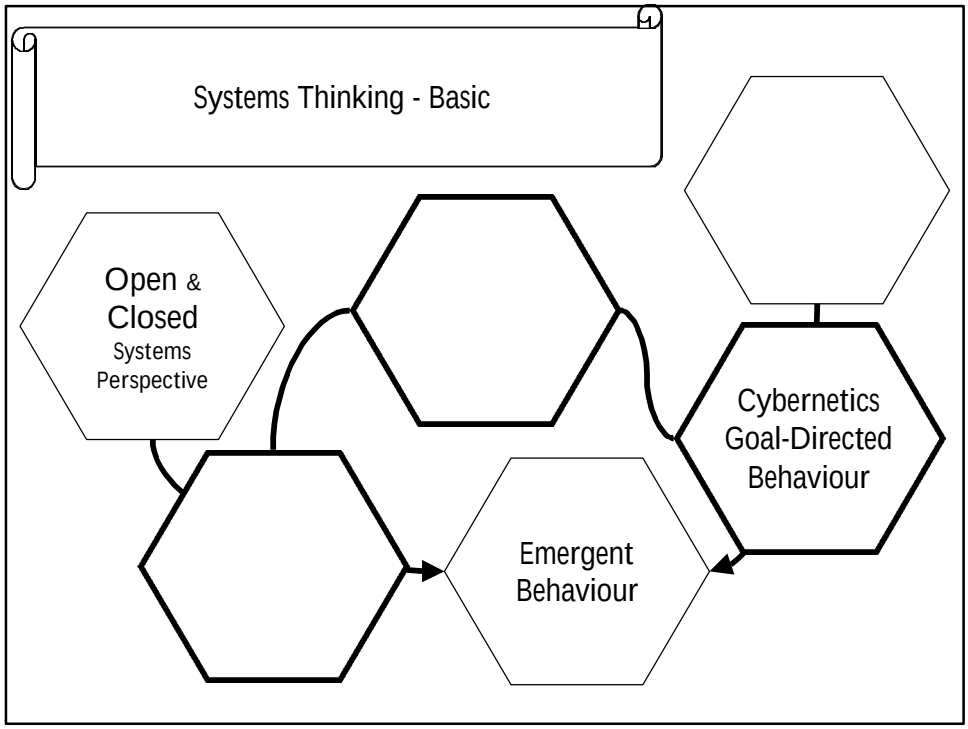

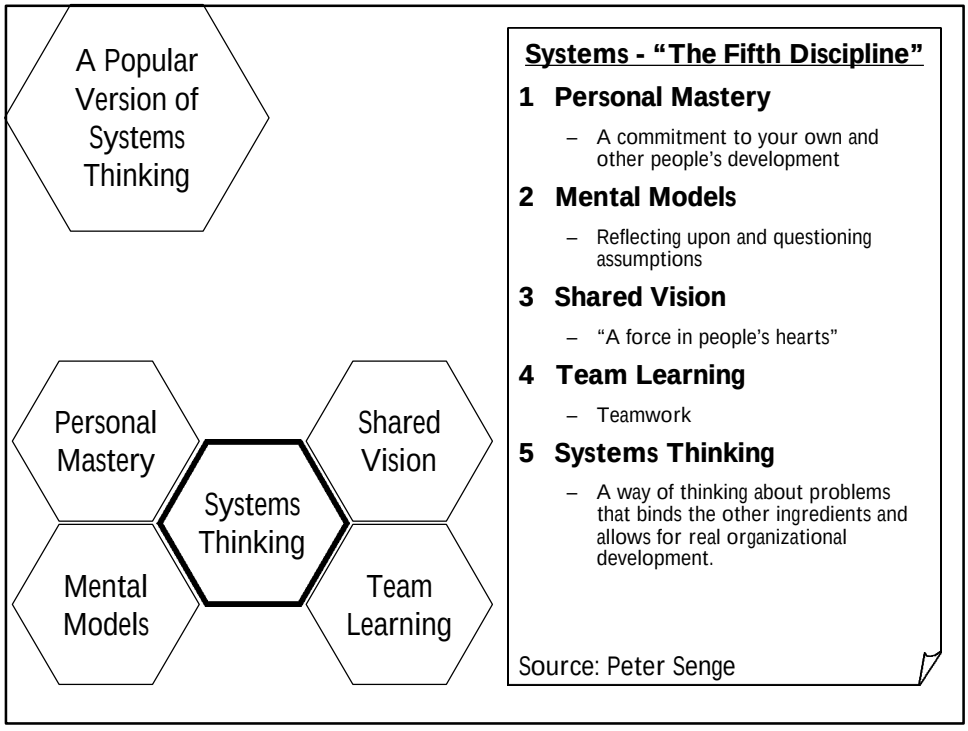

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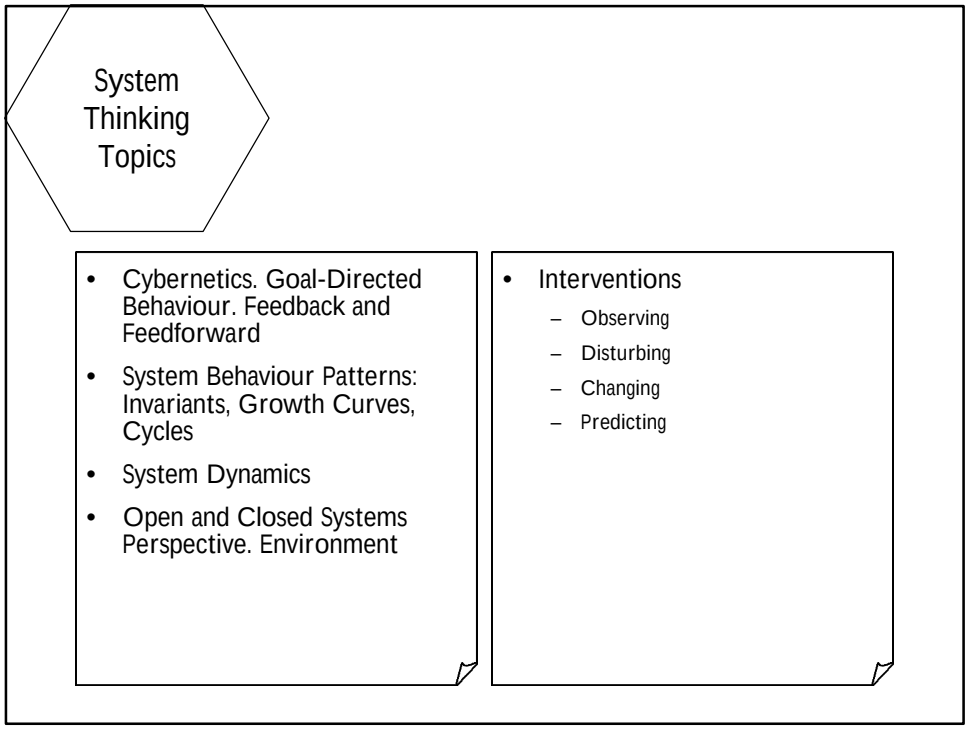

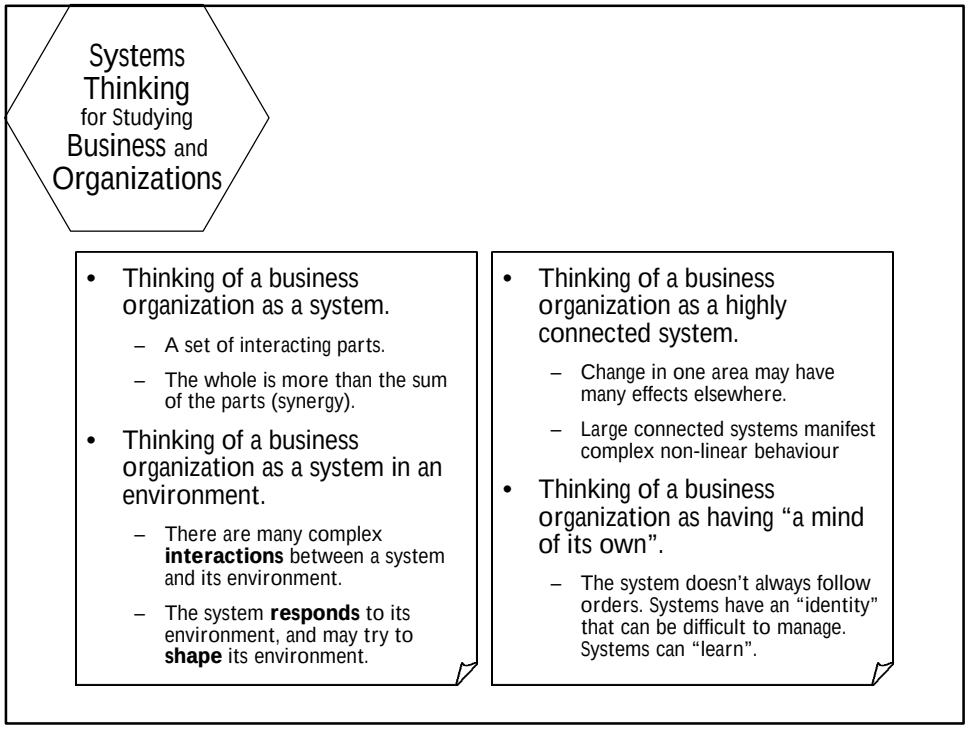

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Systems

- What is a system?
  - Systems are everywhere.
  - We often talk about systems as if they were familiar objects.
  - A system is anything we happen to draw a boundary around.
  - Difficulties of systems thinking: identity, scope, purpose and perspective.
- All complex systems have to be decomposed somehow, to make them manageable.
  - Wholes and parts are vitally connected.
- All systems are sociotechnical systems.

- People perceive systems differently.
  - Systems have many stakeholders.
  - A system may itself be a stakeholder.
  - Stakeholders have many intentions.
  - Stakeholders attach intentions to systems. Stakeholders make demands of systems.
  - People evaluate systems relative to a set of intentions. People identify and scope systems relative to a set of intentions.
- Systems change
  - In any systems intervention, scoping is a highly charged and significant process.

System & Environment

- **Social System**: Two or more social actors engaged in a more or less stable interaction within a bounded environment (Talcot Parsons)
  - Social systems are **homeostatic** - they tend towards equilibrium over time.
  - Social systems maintain their own **boundaries**
  - Social systems can be regarded **cybernetically**, as information systems or input-output systems.
  - Social systems involve **symbolic exchanges**, e.g. of language, money, influence or commitment.

- According to Parsons, social systems are goal-directed, problem-solving entities with four sub-systems
  - Adaptation (A)
  - Goal-Attainment (G)
  - Integration (I)
  - Pattern Maintenance or Latency (L)
- Many critics argue that Parson's version of systems theory has several weaknesses:
  - Cannot deal adequately with conflict and change
  - Makes conservative assumptions about equilibrium and social stability.
- However, alternative versions of social systems theory have been proposed, which don't share Parson's ideological premises. These draw on such thinkers as Marx and Habermas.

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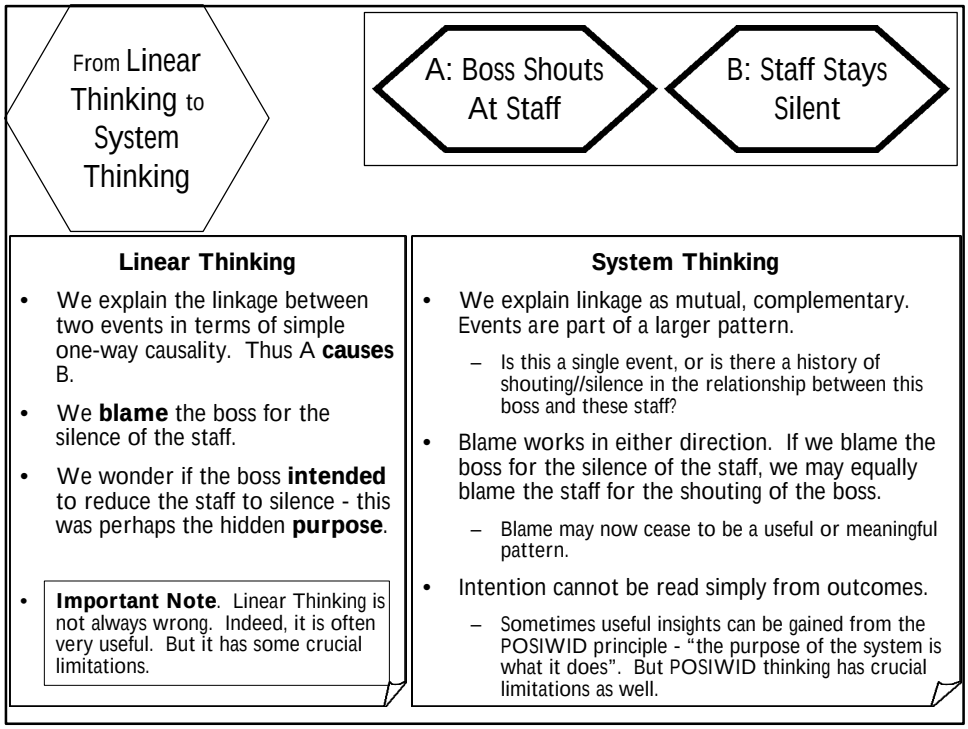

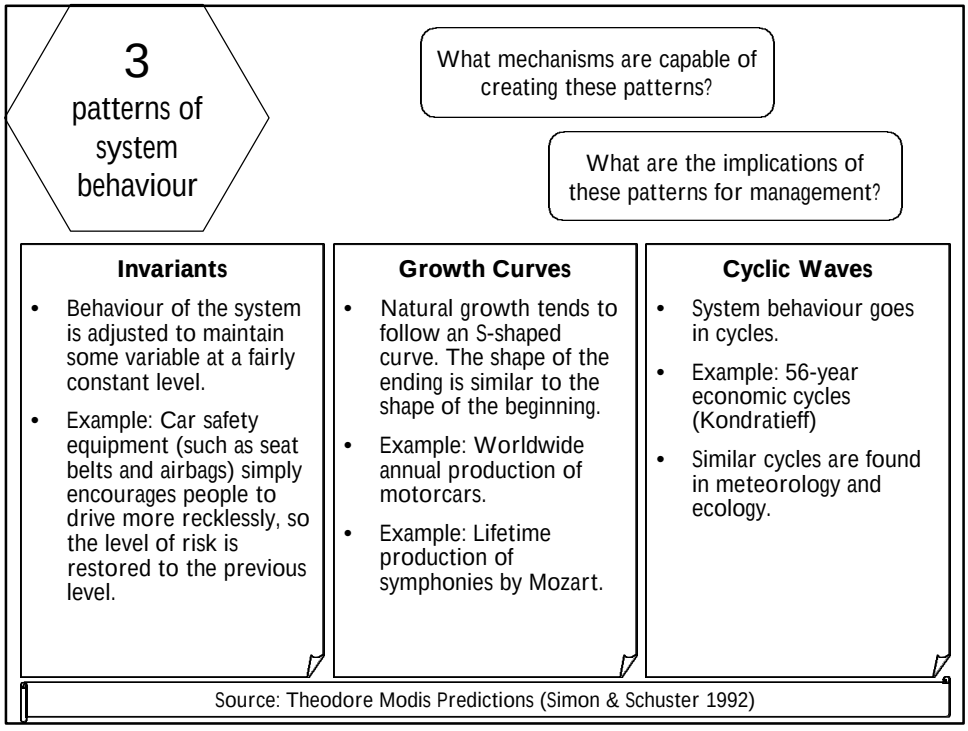

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Cybernetics

Feedback

- "Feedback is a method of controlling a system by reinserting into it the results of its past performance." [Norbert Wiener]

  but why - what kind of control is this?

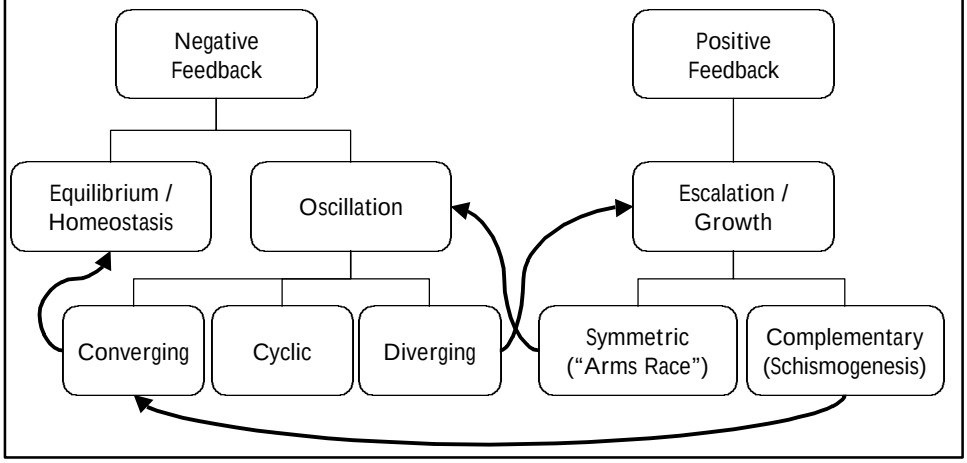
- "A system - organism, corporate firm, computer program - spends energy feeding the past back into the present because this is an economical way for the system to deal with the future. To see into the future one must see into the past. A constant pulse of the past along feedback loops informs and controls the future." [Kevin Kelly]

Feedforward

- Feedforward describes control based on information derived from the environment.
- For example, a marksman hits a moving target by receiving and interpreting dynamic information about the position of the target, and may use this information to anticipate its future position.
- Feedforward does not itself form a causal loop, although it may form part of a larger causal loop.

Feedback

- Complex systems are typically composed of multiple interacting feedback loops - some positive and some negative.
- Converging oscillation is usually a good enough approximation to equilibrium.
- Sometimes it can be hard to distinguish diverging oscillation from genuine growth



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Oscillation

- Sometimes the effect of negative feedback is to cause a system to oscillate between two states.
- Example: whenever the heating system is on, it gets too hot. Whenever the heating system is off, it gets too cold. The system is constantly switching itself on and off, off and on.
- The effects of oscillation can be reduced by **damping**, which reduces the **sensitivity** of the system to the signal. For example, if the temperature has to fall by more than x degrees before the heating is switched on, the system will not respond to fluctuations smaller than x. This reduced sensitivity is known as **attenuation**.

- In business, oscillation often occurs when an organization is trying to achieve two contrary goals, and the balance of power is constantly shifting between the two camps. This can typically be explained by the interaction between two separate feedback loops.
- Oscillation may also be the result of two or more opposing **mechanisms**.

System Dynamics

- The elements of a system have states such as:
  - Company order books are full or empty
  - Consumer spending is up or down on last month
- Material and information flows between the elements:
  - Government spending on unemployment benefit was £Xbn
  - Inflation is predicted to rise next year by Y%

- People put measures in place to try to understand the state of the system:
  - M3 money supply
  - Estimators on the size of the black economy
- Causal links can be complex and subtle:
  - Consumer spending responds to:
    - Weather
    - National football results
    - International news

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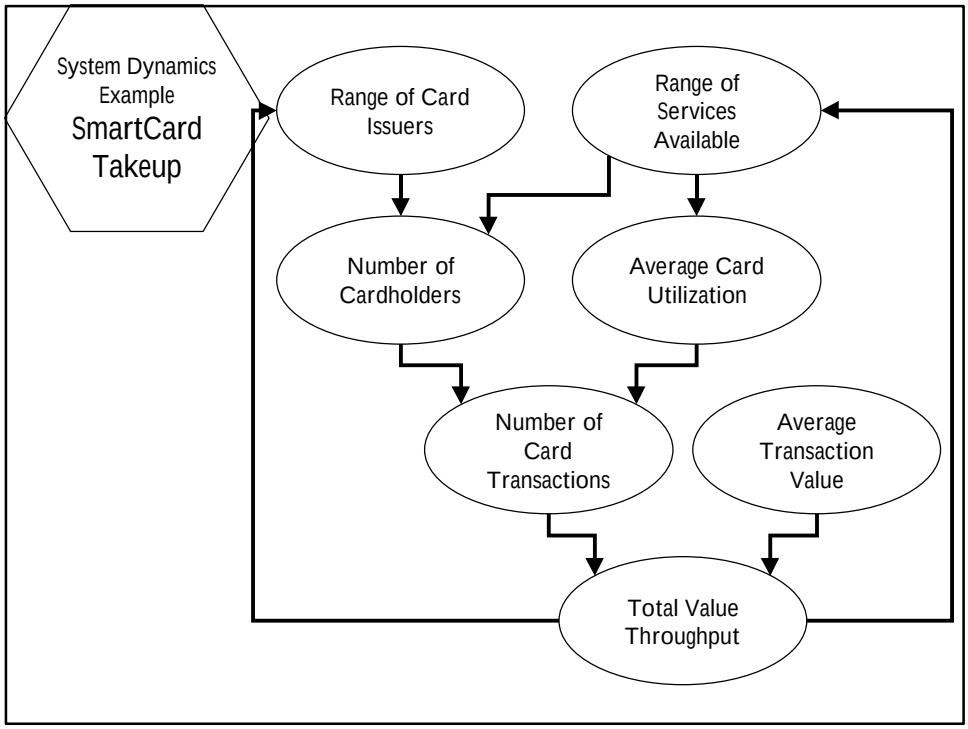

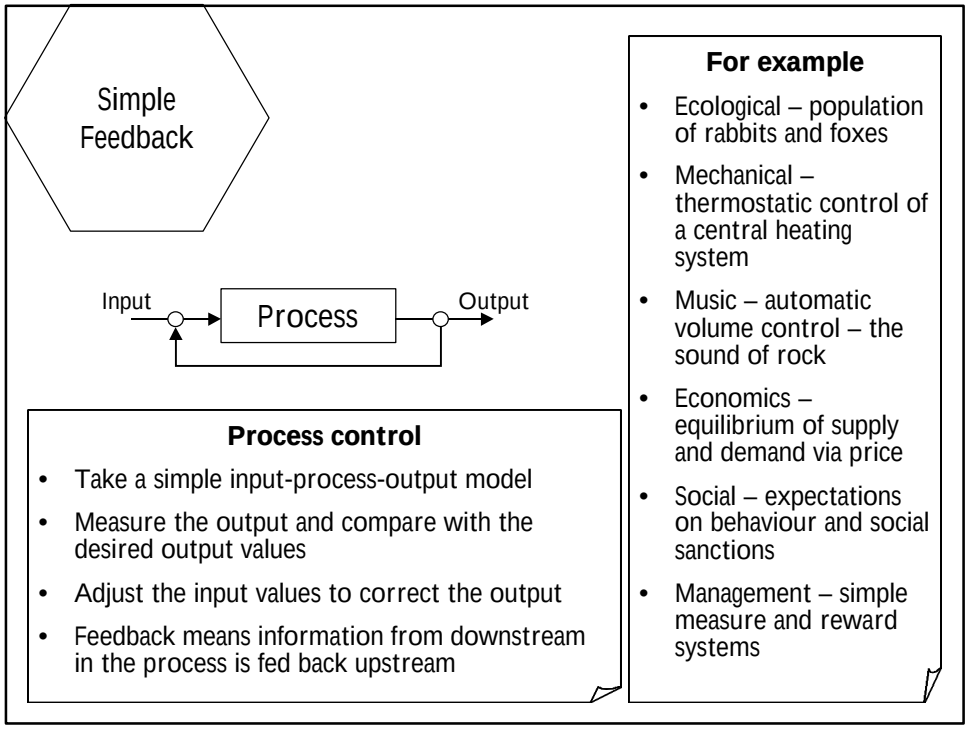

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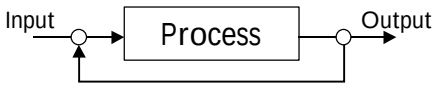
Gain and delay



Gain

- The gain of a negative feedback process is the scale of the version of the output fed back into the input.
- For real feedback processes the appropriate gain may not be obvious, as it may not be possible to interrupt the process to produce test conditions.

Delay

- The second parameter is the delay that is introduced between the output and where it is fed back into the input.
- Long delays produce instability in the system so that it cannot be controlled by this mechanism.
- Medium delays delays produce oscillation where the system "hunts" around the desired value for the output.
- Short delays give a smooth response converging on the desired output.
- For real feedback processes the effects of delay period can also be difficult to observe clearly.

Information flow

Control information

- Information about what has been achieved in the output is fed back to allow the process to be tuned
- Without this information no learning or improvement can take place over time
- The cost and energy involved in feedback affect the efficiency of the system
- In social processes the feedback has to be interpreted

Issues

- Only reasonably linear processes benefit from simple feedback
- The statistics of measurement on the output are crucial
- Distinguish single and double loop learning in the process
- Discontinuities in system behaviour may be more important than the continuous behaviour

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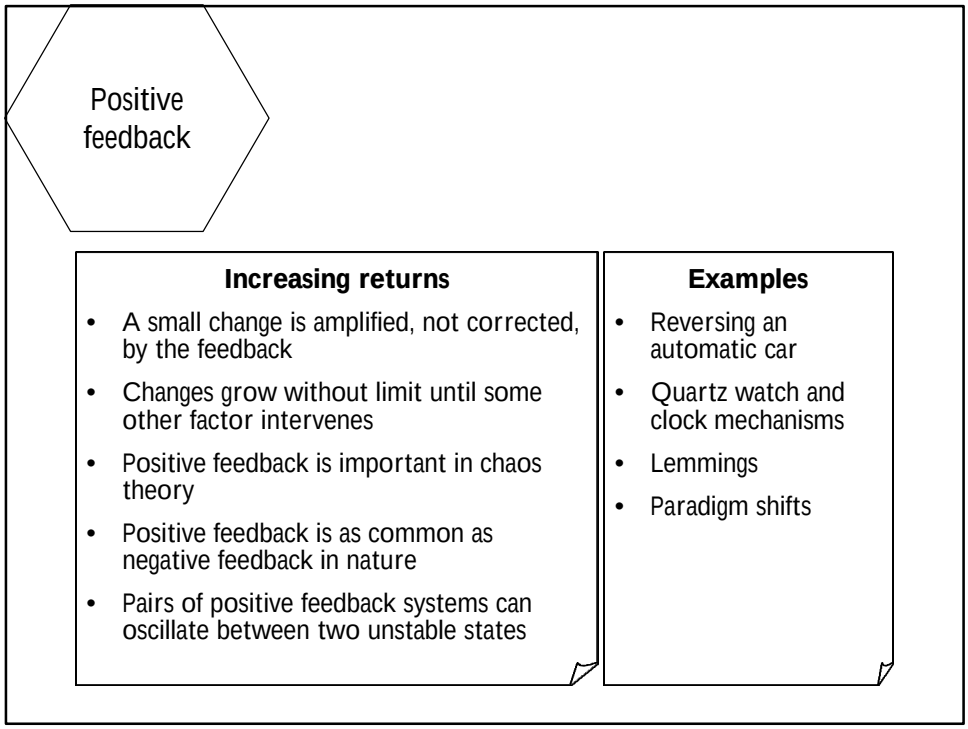

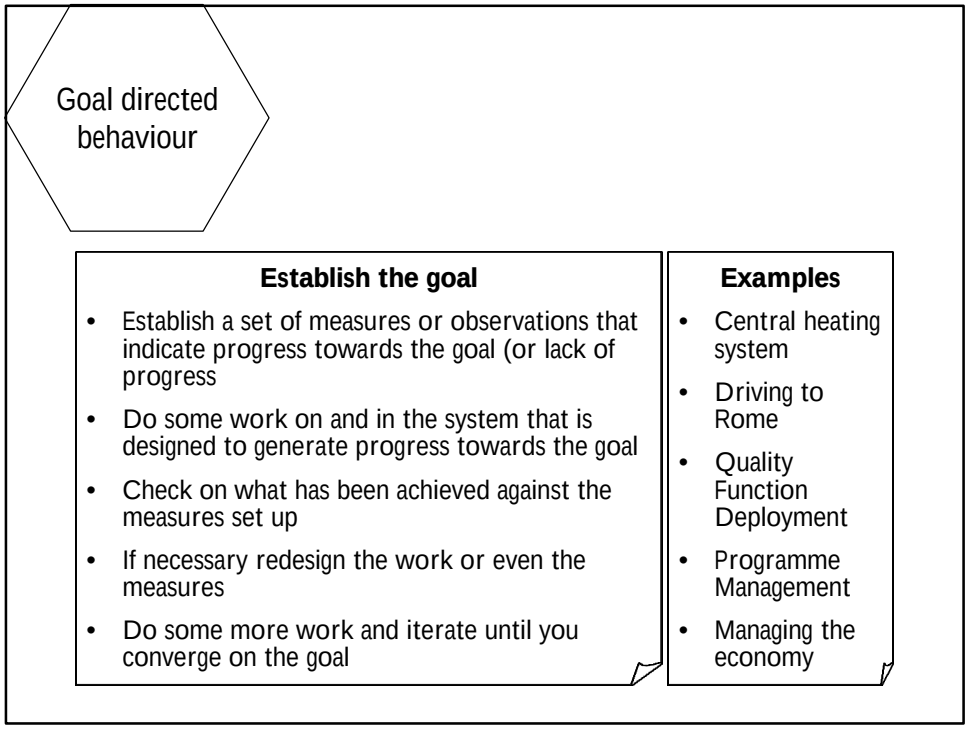

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Controlling Systems

Useless Controls

- Control actions that only seem to produce the required behaviour
- Control actions that are working against the logic of the system
- Control actions that are subverted by other actors in the system

Subtle Interventions

- Adjustments or additions to simple rules
- Adjustments to the set of relationships
- Making the connections between actions and system purpose more transparent

Emergent behaviour

"The basic rule of systems theory is that, if you want to understand some phenomenon or appearance, you must consider that phenomenon within context of all completed circuits which are relevant to it." (Bateson)

But is this possible?

- **The behaviour of the system cannot be predicted on the basis of the behaviour of the elements**
  - Can't use reductive logic
  - Can't assign causes to parts
- **Interventions in the system have inherently unpredictable outcomes**
  - Can't produce closed plans for change
  - Can't assign individual responsibility for actions

- **E.g. testing of medicines**
  - Each individual is genetically unique
  - There are unlimited environmental factors
  - There are unlimited behavioural factors
  - We don't know the connection between body and mind

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Ecologies

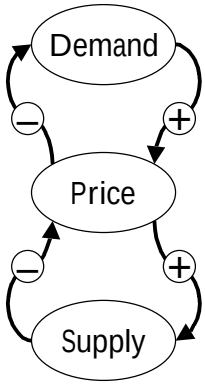
Behaviour of ecologies

- Populations of different species inhabiting same environment
- Each population specialises the environment for each other species
- Over time species adapt to their environment, as specialised by other species, thus changing the environment
- Reaction to this change by other species results in co-evolution of species in a mutual dance

Systems insights

- Each system has enclosing and interlocking systems
- Change changes itself
- Mechanisms of interaction can be infinitely subtle
- Systems are dynamically stable

Price Equilibrium through Market Forces



Using A Systems Model to Describe a Situation

- According to this model, the function of price in a market system is as follows:
  - It is an **effect** of a given relationship between supply and demand
  - At the same time, it is a **causal factor** influencing the levels of supply and demand.
- Thus sometimes market forces have the effect of **balancing** supply and demand, and **stabilizing** prices.

Understanding the Limitations of a Systems Model

- But sometimes differences in prices are not reflected in changes to supply or demand.
  - **Elastic** - responds strongly
  - **Inelastic** - responds weakly, slowly, or not at all.
- Sometimes changes in supply or demand are not reflected in the prices.
- And sometimes there is so much other stuff going on (market turbulence) that the effects of market forces are obscured.

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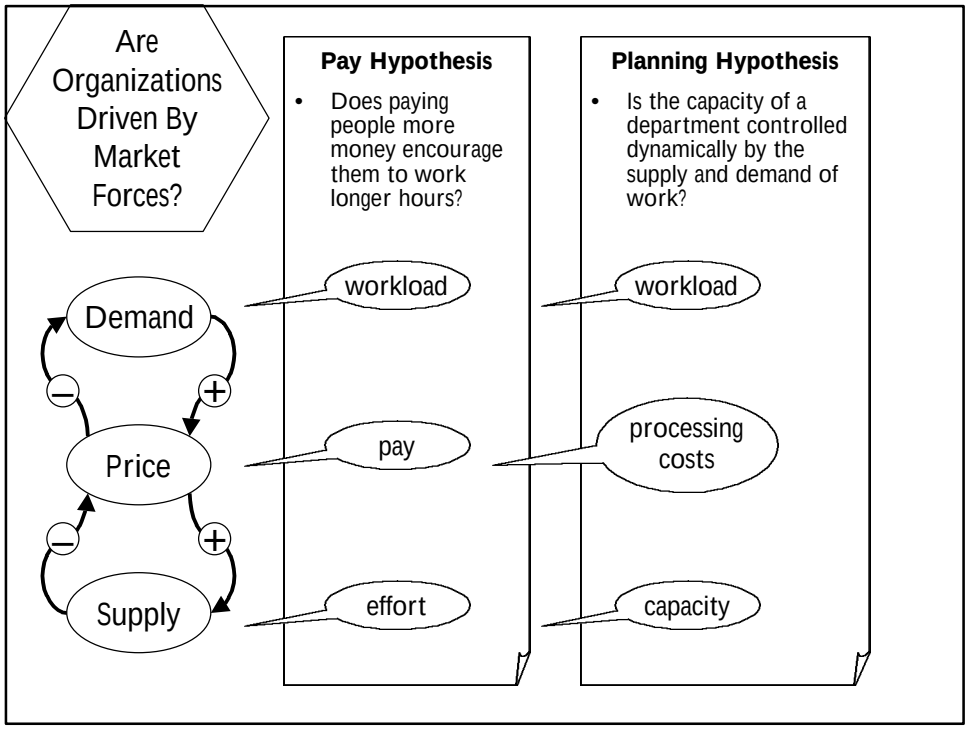

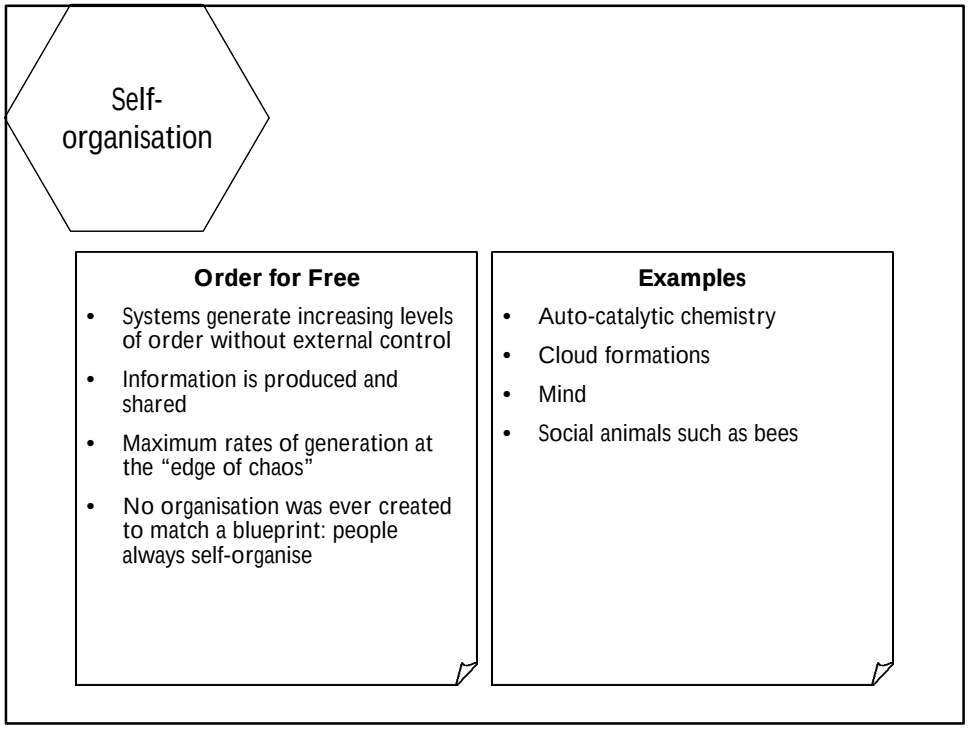

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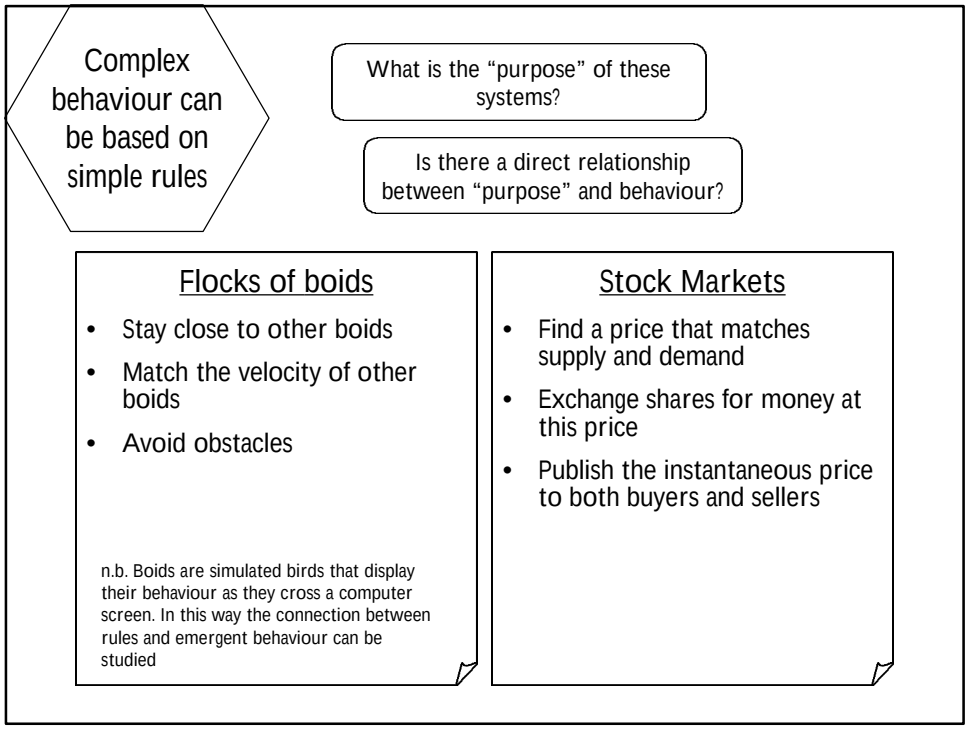

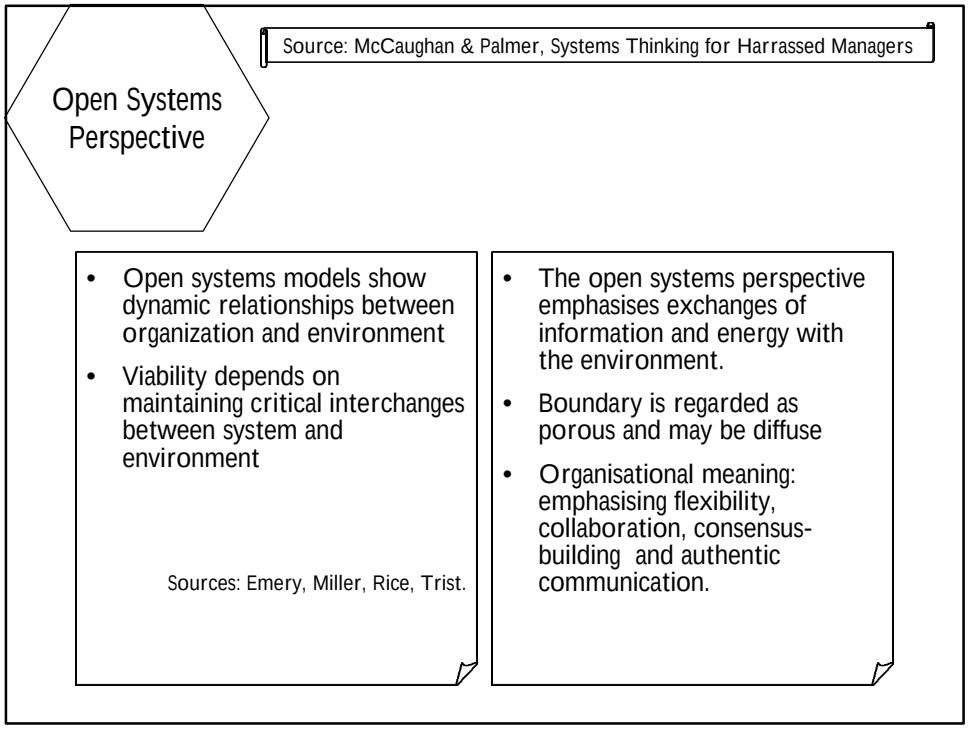

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Closed Systems Perspective

An organisation is neither open or closed. We can study it from an open systems perspective or a closed systems perspective and learn different lessons

- Closed systems models involve recursive patterns of feedback
- Viability depends on maintaining identity and stability
- Self-construction, "autopoiesis"

Sources: Bateson, Beer, Maturana, Varela

- In the "closed" systems perspective, a system is analysed in terms of its own information and perspective
- Boundary is regarded as closed
- Organisational meaning: emphasising stability, group loyalty, security, clear boundaries and tight controls

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Introductions

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- Barry Oshry, **Seeing Systems: Unlocking the Mysteries of Organizational Life** (Berrett Koehler)

Three easy introductions -- each packed with insight, but very different in style. McCaughan and Palmer present things clearly and simply; Oshry is flamboyant and American; and Gall makes it humorous.

General Systems Theory Books

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