AIGA Pivot Conference Educator Workshops Phoenix

Tools For Understanding Context and Taming Complexity: A Whole Systems Approach to Design

Hugh Dubberly Dubberly Design Office

Systems are everywhere.









Columbia Broadcasting System (CBS)

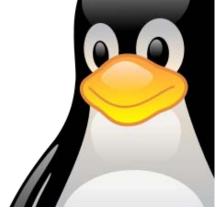
Federal Reserve System

Herman-Miller Action Office System

Honor system



Immune system



Linux operating system



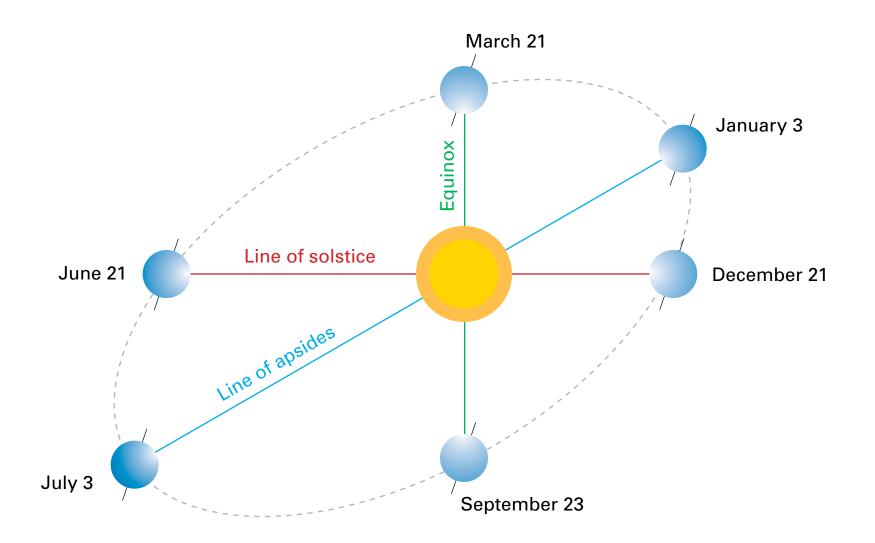
Mojave desert ecosystem



Schiphol airport signage system

Given the variation in form, function, and domain what do systems have in common? what makes them systems?

A system is a set of elements linked by processes.



Systems fall into three broad categories: - Formal systems: rules for combining elements - Production systems: resource flows - Control systems: information flows



Formal systems

Designers have an intuitive feel for formal systems, and employ them often.

Grid systems.

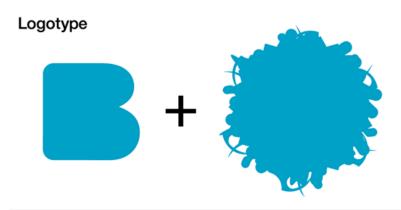
Signage systems.

Spor Track 2

Mod København H, Nørreport, Østerport, Helsingør, Fyn og Jylland Toward Copenhagen C, Nørreport, Østerport, Helsingør, Fyn and Jylland

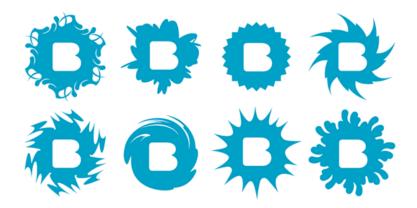
Tools Tor Understanding Context and Tarring Com

Identity systems.



Logotype Variations

Print Collateral



Secondary Mark **Brooklyn Museum**

Typography Brooklynesque

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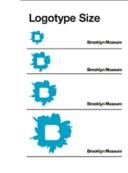
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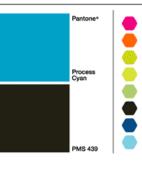


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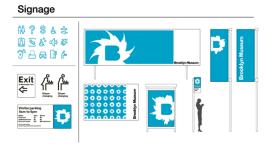
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Secondary Colors





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Uniforms

Brooklyn Museum identity system by 2×4

Tools for Understanding Context and Taming Complexity

Product families.



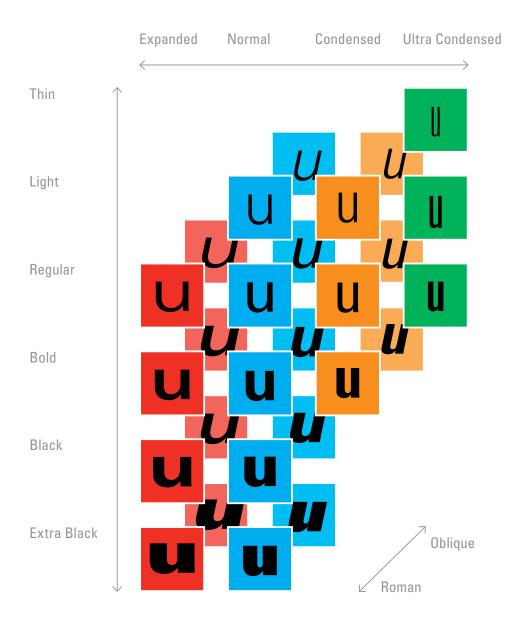
Typeface.

Jenson

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Typeface family.

Univers grid



Multiple language script typefaces.

Arial family

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АБВГДЕЖЅЗИІКЛМНОПСРСТОУ
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The elements that comprise these systems are related by shared form.

The shared form results from a set of rules defined by the craftsmen or designers who produce the system.

Often, the rules are not written down; they are simply embodied in the artifacts.

You can infer the rules from the artifacts.

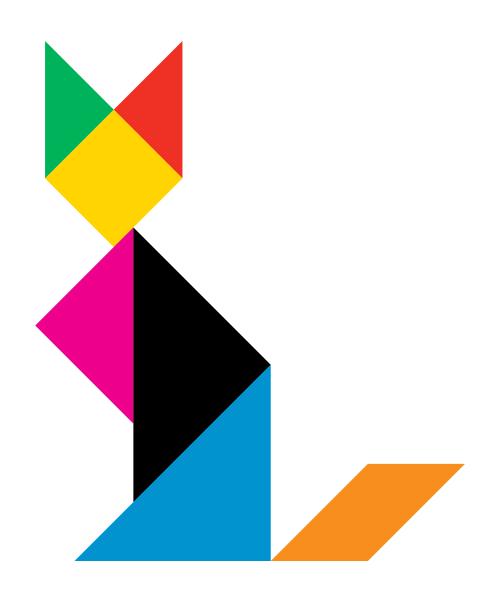
You can understand the spirit of Helvetica and add old-style figures. or create additional weights or create a Chinese version.

Helvetica 0123456789 Helvetica 0123456789

The idea of theme and variations a set of formal rules, in which others can create is quite old.

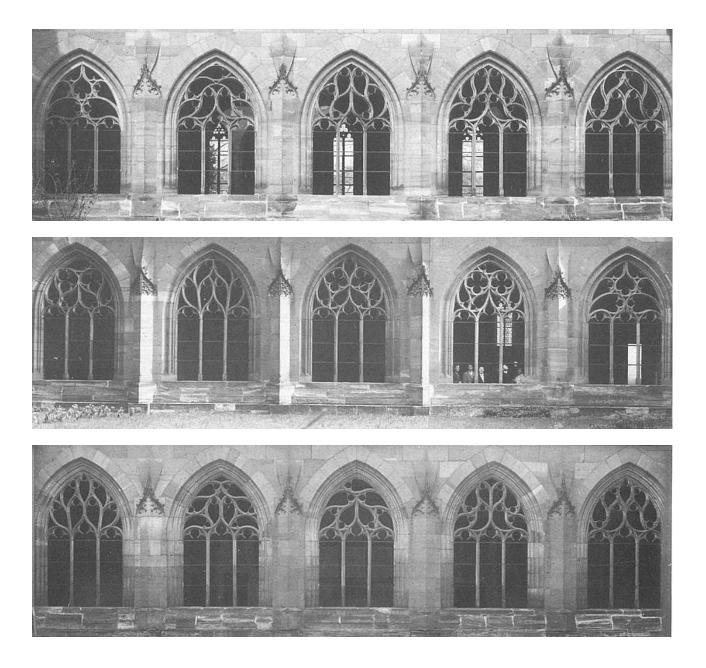
Tangram





Formal systems of theme and variations are common in architecture.

Basel's Munster Cathedral Cloisters.



The Alhambra.



omplexity

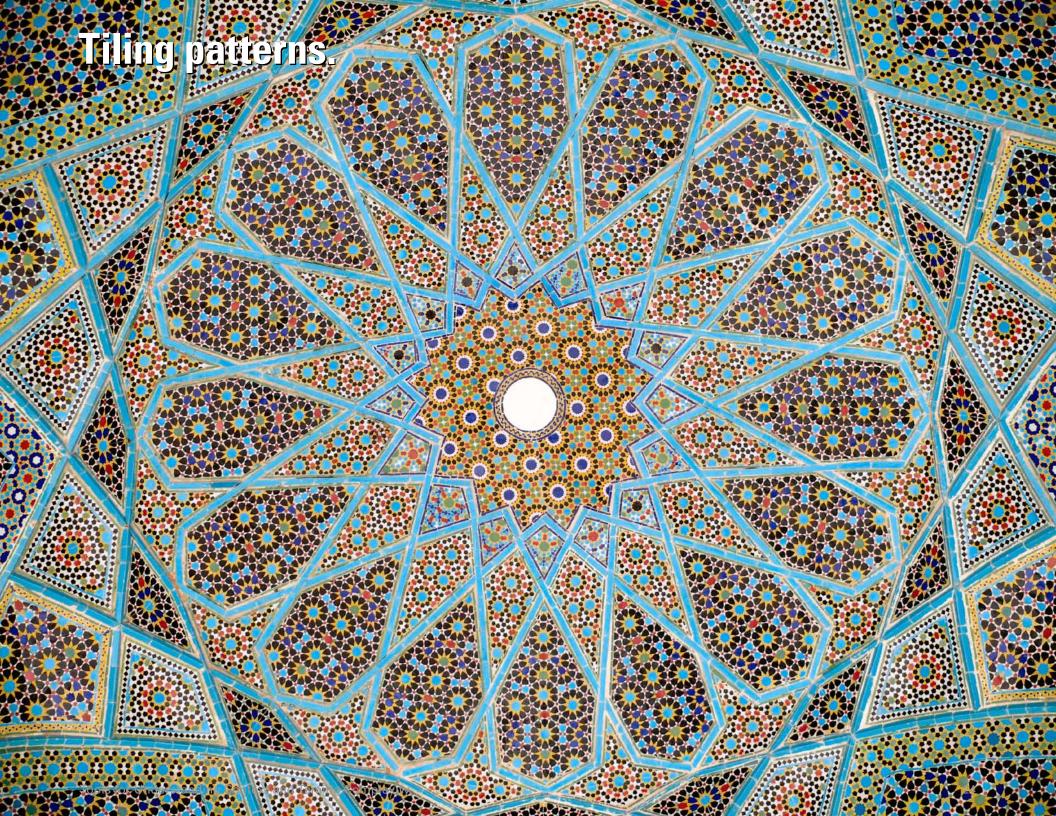


A REAL PROPERTY.

Tatami mats in Japanese architecture.

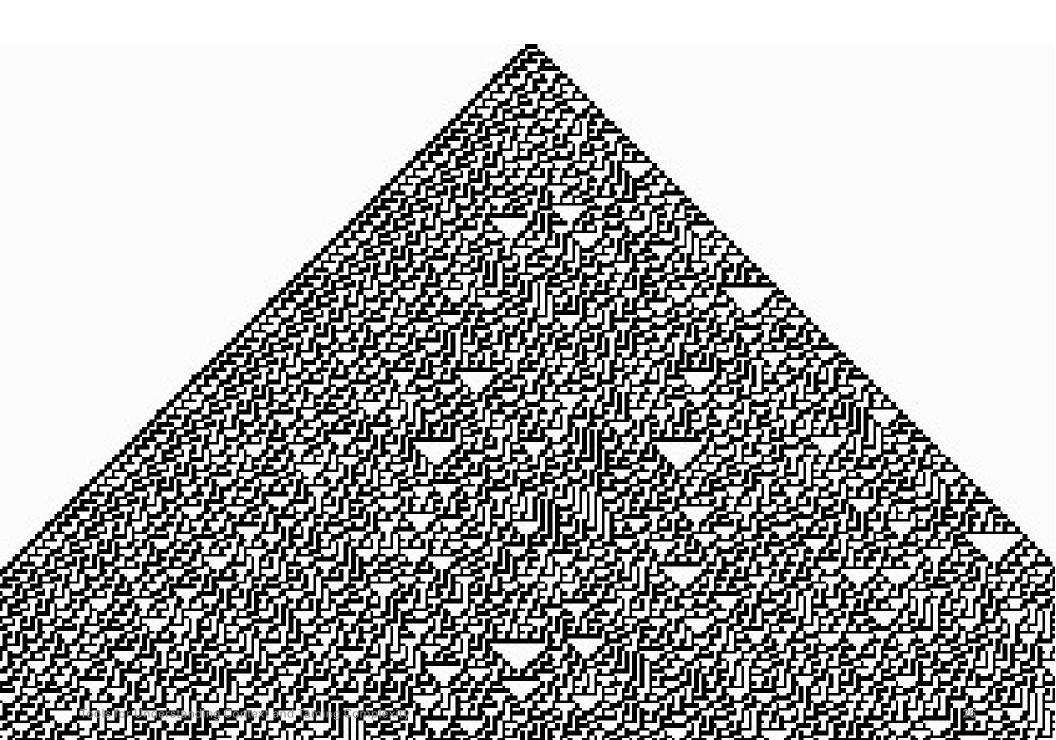


Systems of rules for theme and variations are branches of mathematics.

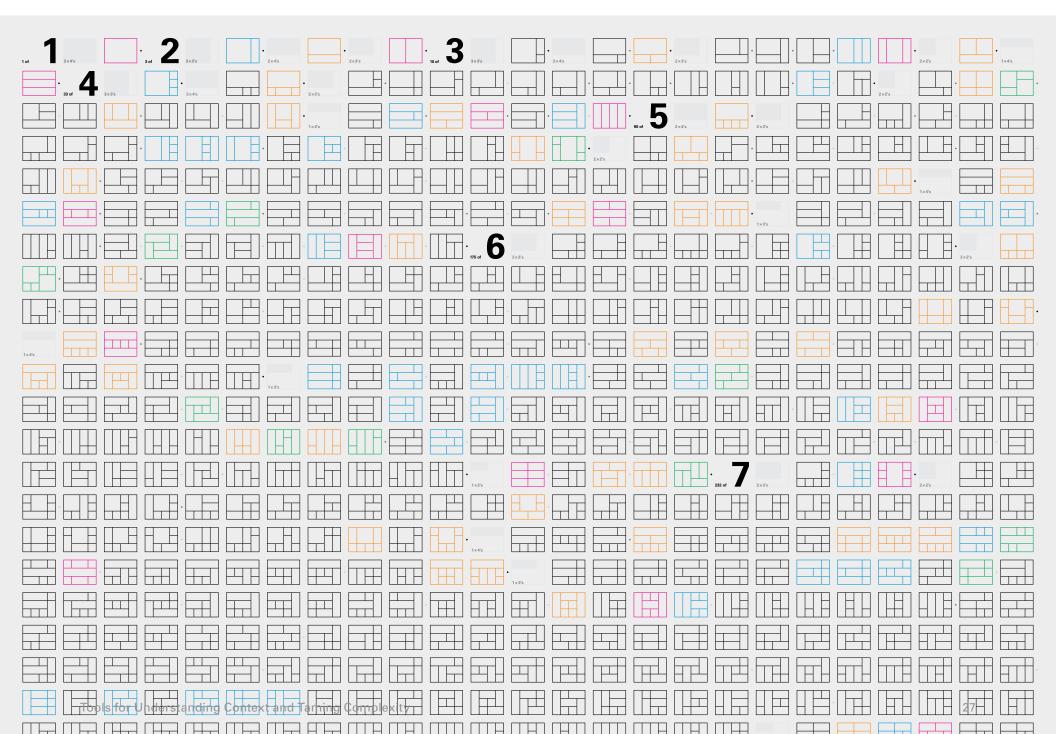


Fractals.

Cellular Automata.



Permutations.



Not all formal systems are visual.

- Musical forms, e.g., fugue
- Poetic forms, e.g., sonnet, haiku, limerick
- Rhetorical forms, e.g., syllogism, essay

Underlying these formal systems are deeper structures:

- Regional cuisines
- Musical scales
- Natural languages
- Computer languages

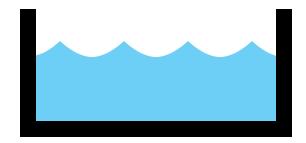
Designing systems of rules, which others use to design, is a growing area of practice.

- Standards, e.g., A-system of paper sizes
- Fastfood frameworks, e.g., Starbucks lattes, Chipotle's burritos
- Construction set, e.g., Legos
- Software tools and games

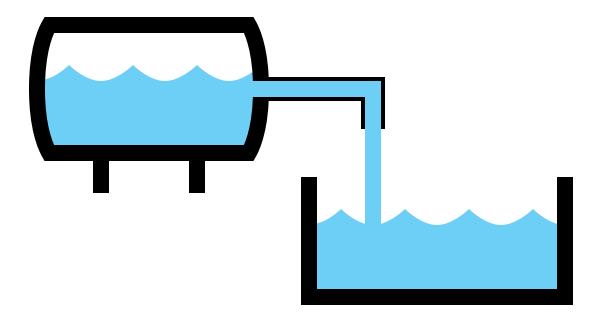
PART TWO

Production Systems

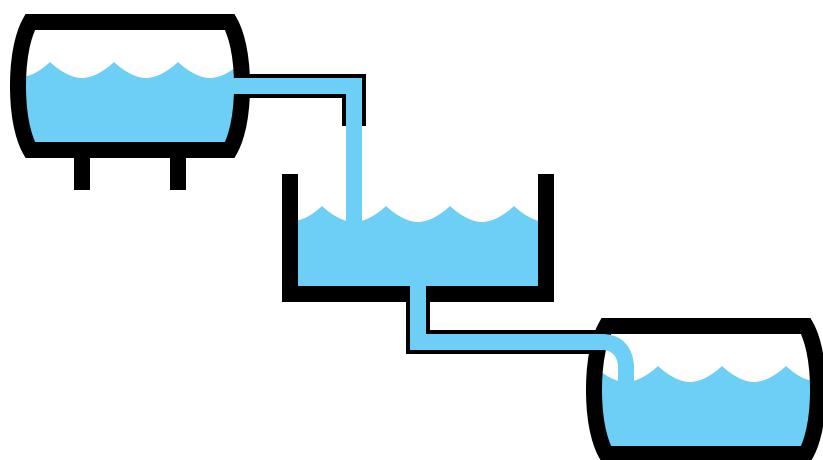
Productions systems focus on resources on stocks and flows. Consider a reservoir or tub of water a stock—it has a finite capacity.



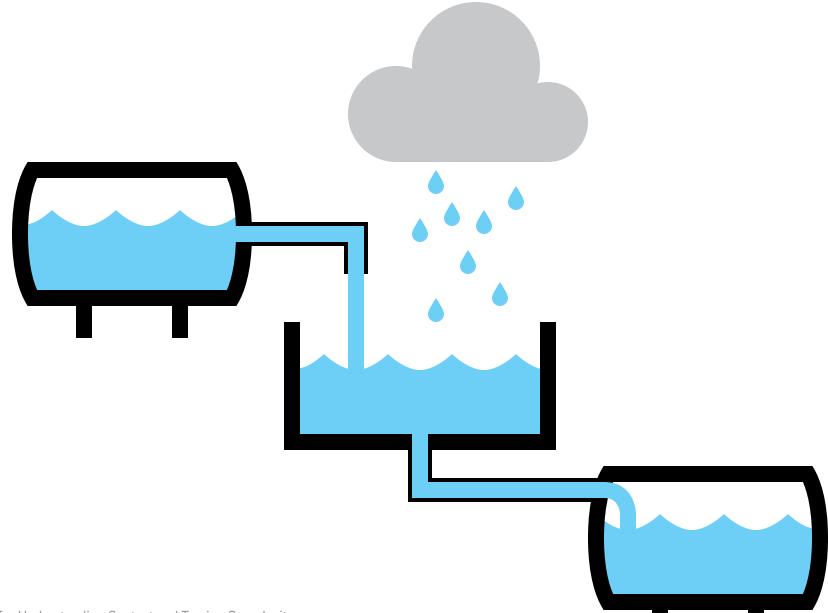
Water flows in from a source.



Water may also flow out to a sink.



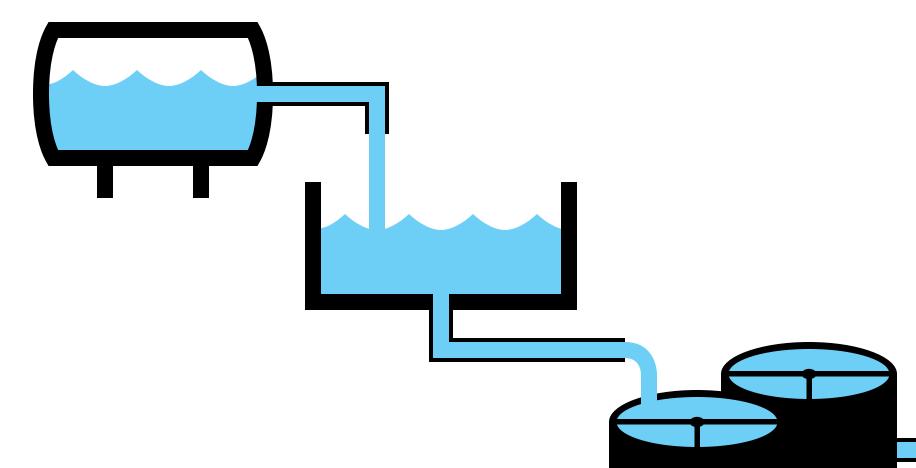
Many sources may flow into one stock, e.g., if the tub is outside, rain may also fall into it.



And one stock may flow out to many sinks, e.g., water in the tub will also evaporate into the air.



The main source may be a tank, which itself has a prior source, perhaps a water filtering plant. There is no ultimate source; each source has a prior source. The main sink may be a sewer system, which itself has a subsequent sink, perhaps a sewer water filtering plant. There is no ultimate sink; each sink has a subsequent sink.



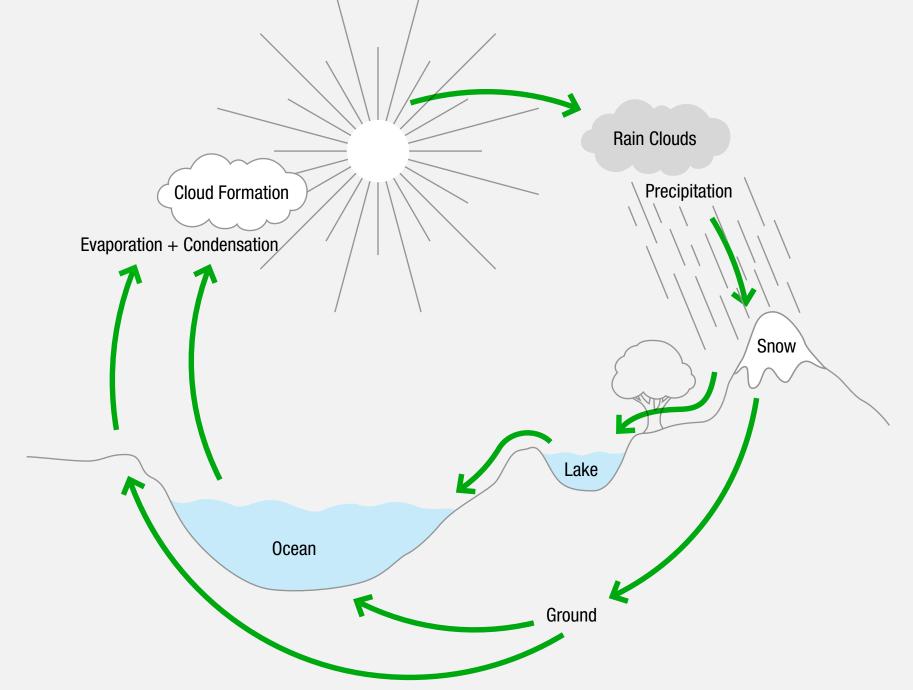


One person's source may be another person's sink.

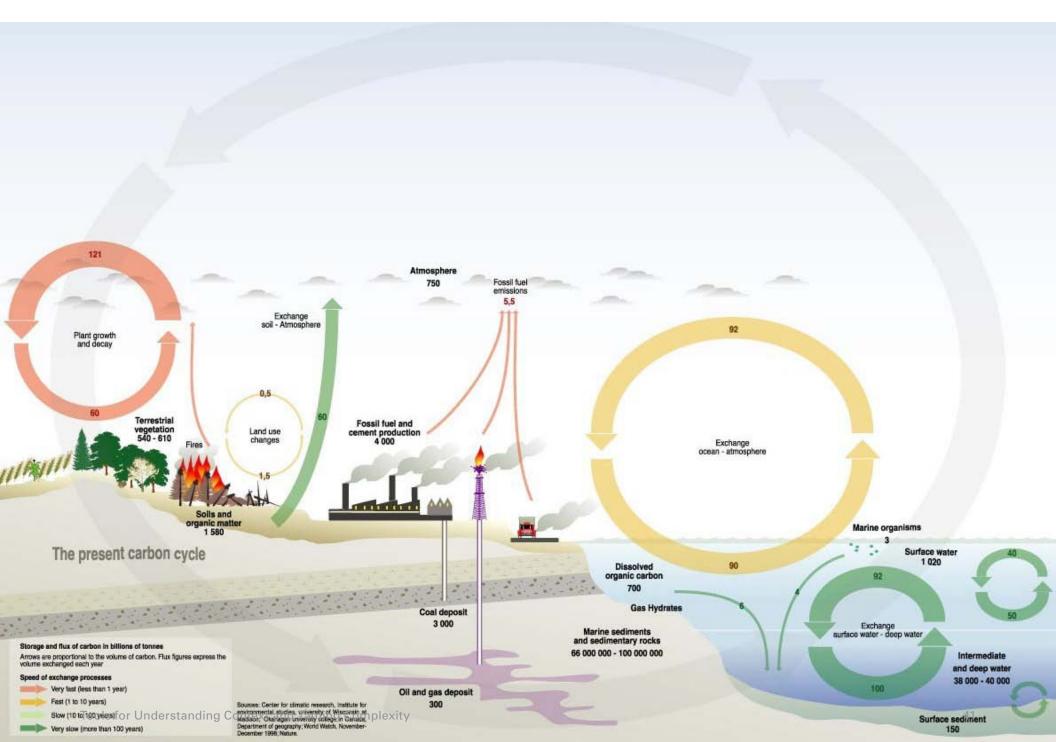
People in Amsterdam get much of their water from the Rhine; people upstream in Basel, discharge their treated sewer water into the Rhine.

Along the way, a drop of water may travel through the cycle several times.

Water travels continuously through a cycle.



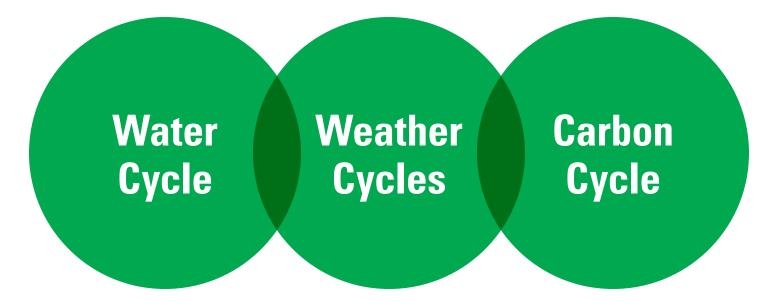
Carbon also travels through a cycle.



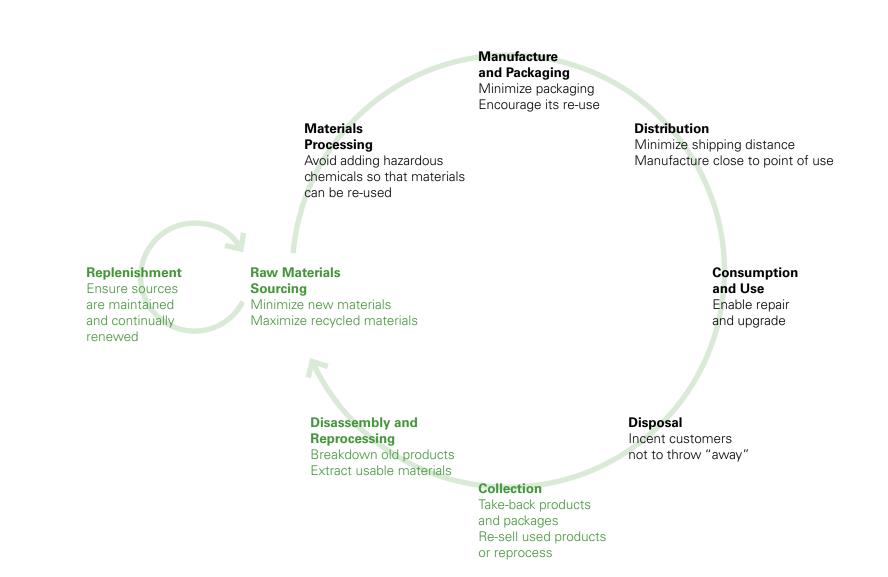
Sometimes large quantities can be tied up sequestered—

so that they are not traveling through the cycle. Changing stock levels—

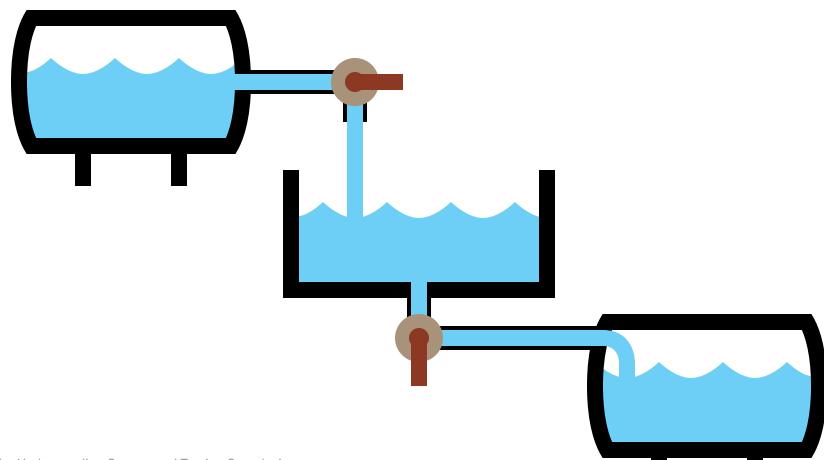
sequestering or releasing water or carbon affects the climate as ice or carbon dioxide interacts with the planet's weather system.



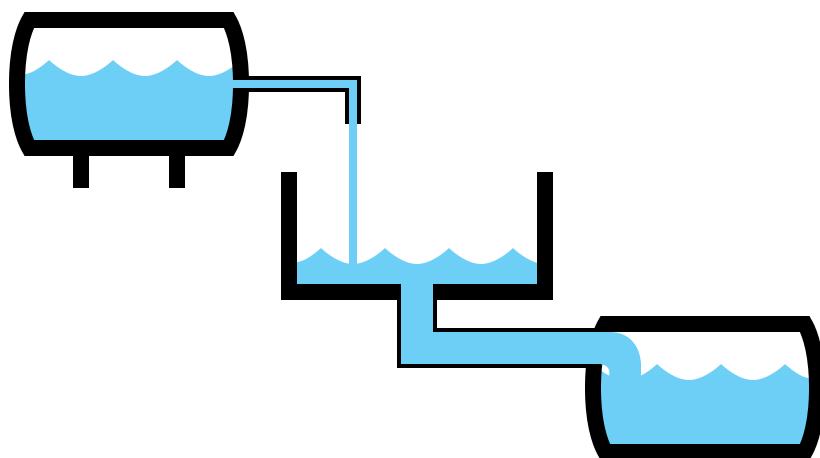
The phrase cradle-to-cradle suggests we build products so that they can be disassembled and recycled.



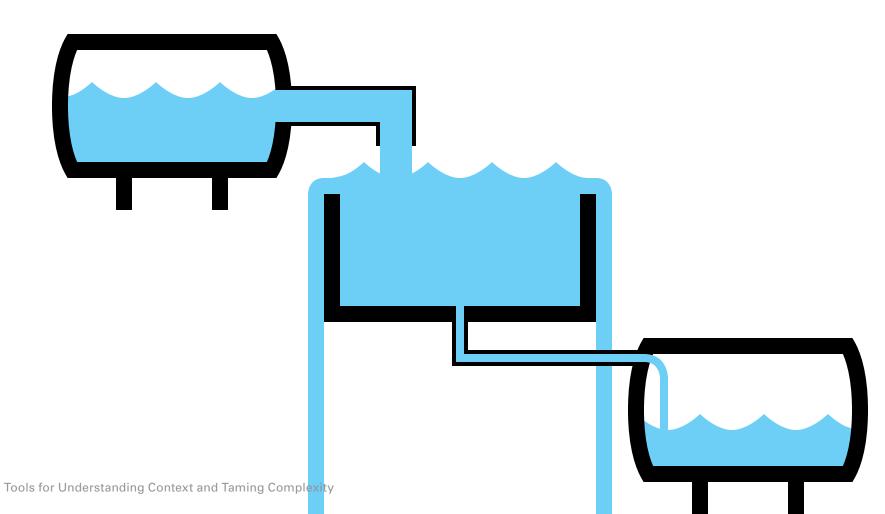
For a given stock, the rate of inflow and the rate of outflow may change; we can open or close a valve.



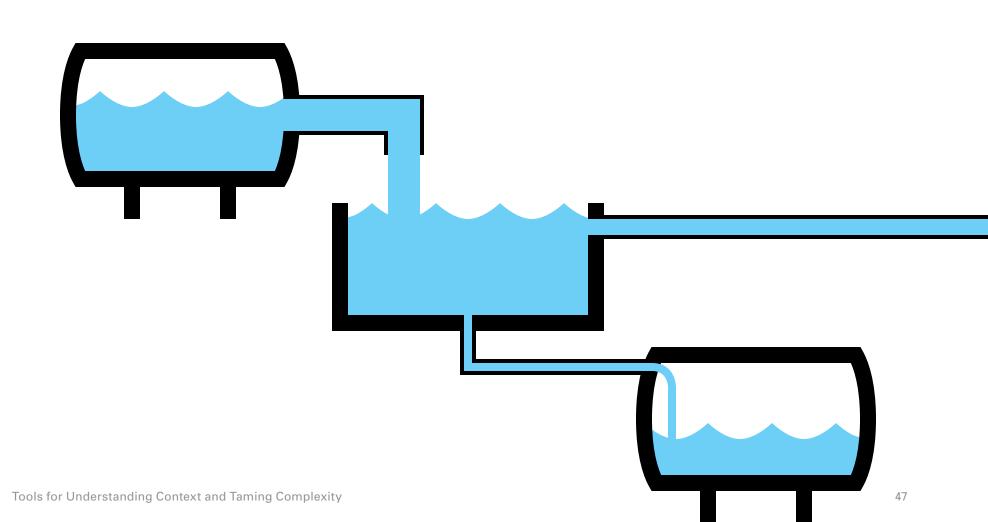
If 'the rate of inflow' < 'the rate of outflow', the tub will drain.



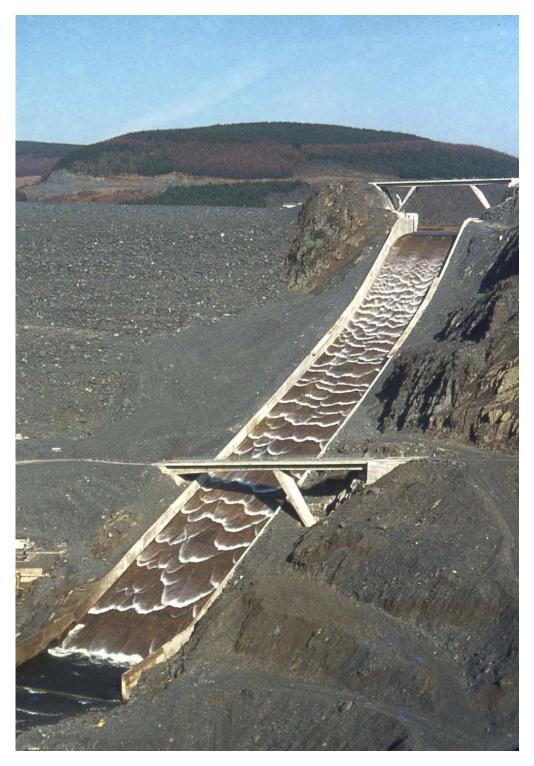
If 'the rate of inflow' > 'the rate of outflow', the tub will reach capacity and overflow.



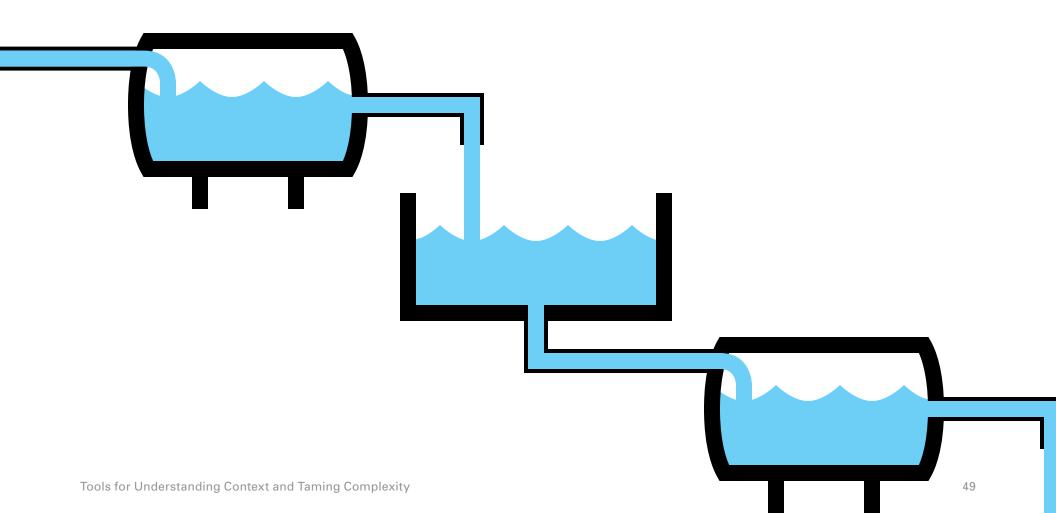
Most bathroom tubs include an overflow drain, which automatically prevents spills.



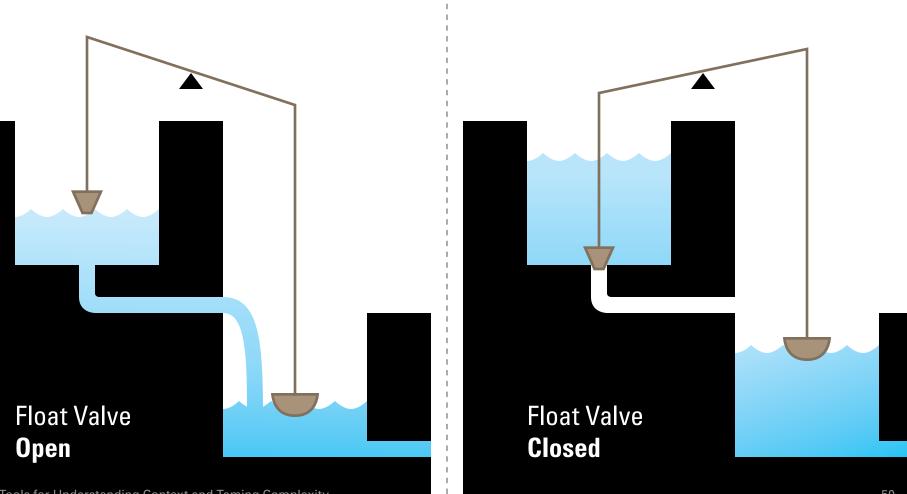
Man-made dams often include spillways to protect the dam from any overflow that might weaken it.



When 'the rate of inflow' = 'the rate of outflow', the system is in dynamic equilibrium; that is, the water level in the tub remains constant even though water is flowing in and out.



For almost 2,000 years, people have used float valves to automatically reduce or shut off in-flow.



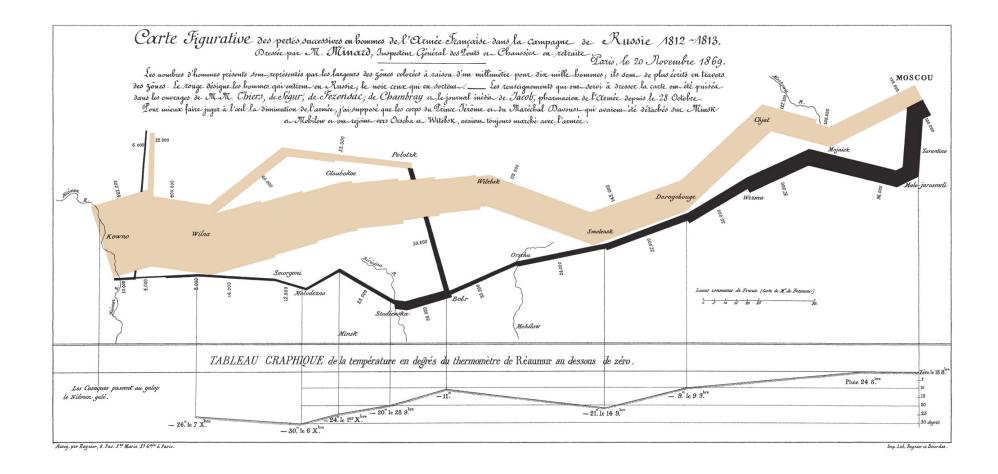
Float valves are part of modern toilets, automatically controlling the water flowing into the storage tank.



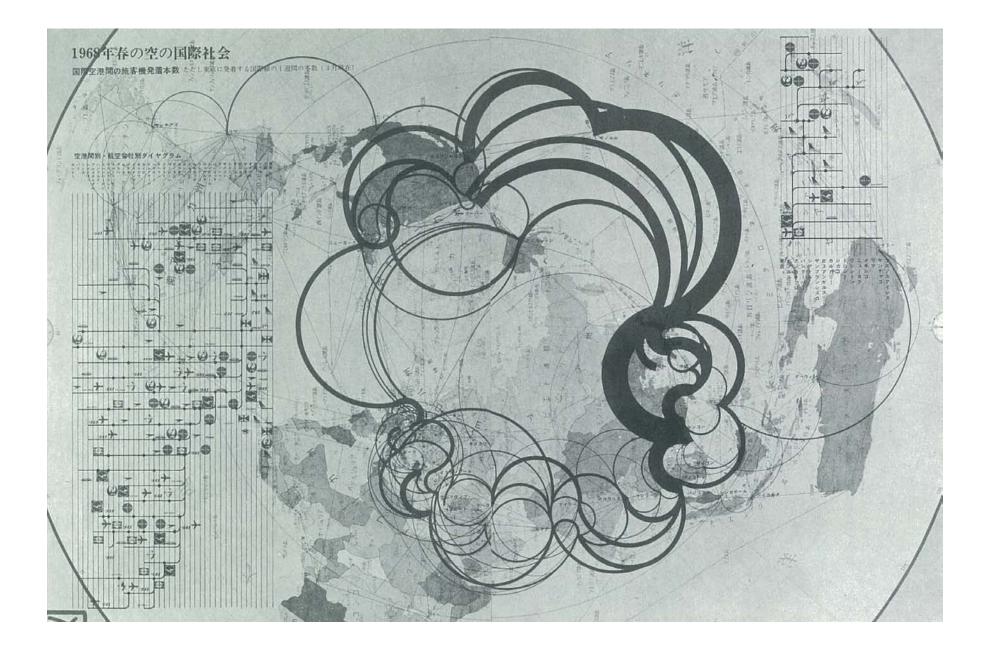
Stocks-and-flows diagrams can be used to model many kinds of systems:

- Populations
- Production and sales of goods
- Shipping
- Finances

Minard's model of Napolean's march to Moscow.

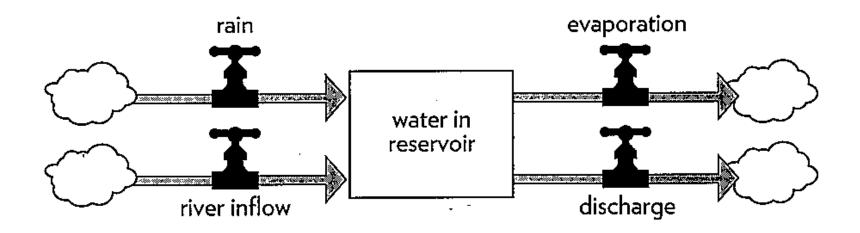


Flight density between international airports.

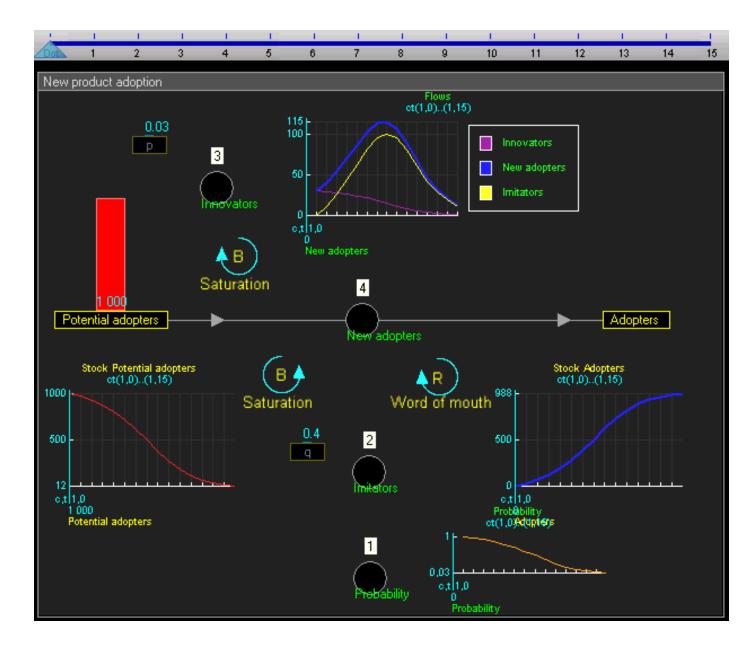


Stocks and flows can be represented in a number of visual forms.

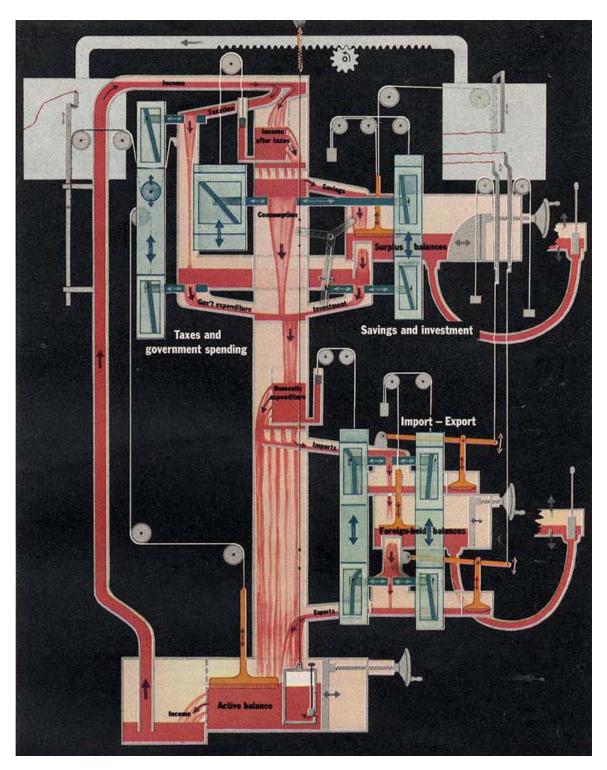
From: Donella Meadows, *Thinking in Systems*



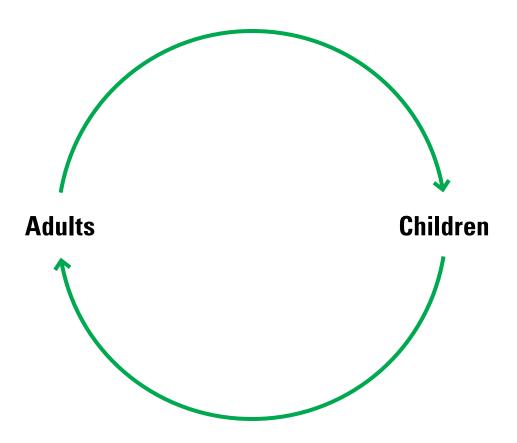
Stocks and flows can also be represented mathematically and in computer simulations.



The MONIAC or Phillips Hydraulic Computer represents the UK economy with stocks and flows of water.

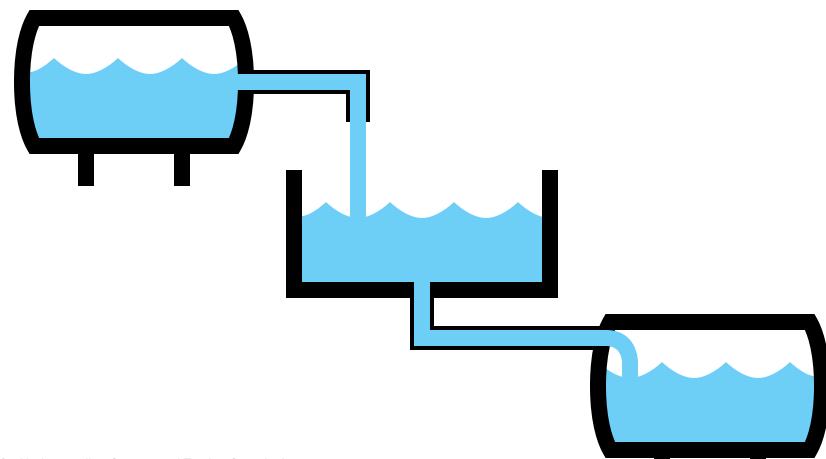


Living systems also form growth loops or virtuous cycles; adults beget children who may become adults.

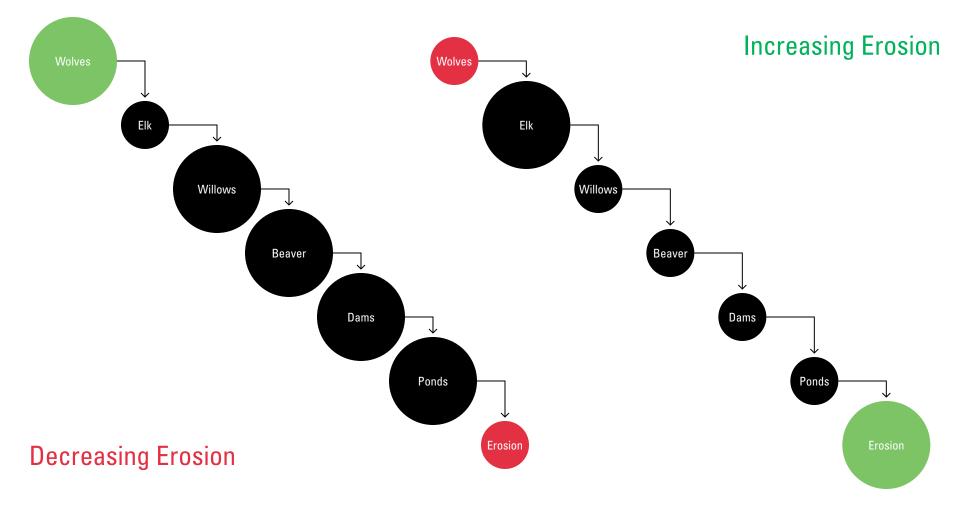


Without constraints, such as predators, disease, or food shortages, growth loops will cause populations to explode.

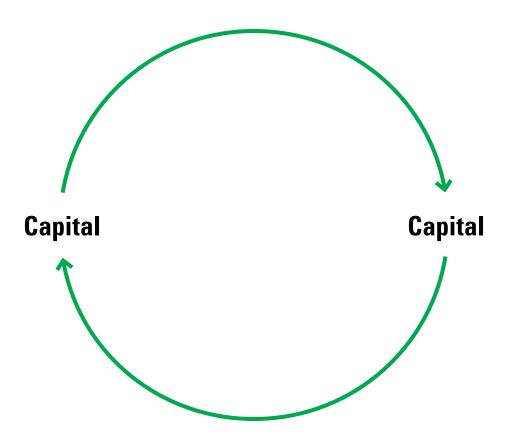
Mature ecosystems reach points of dynamic equilibrium; populations remain stable the number of births = the number of deaths.



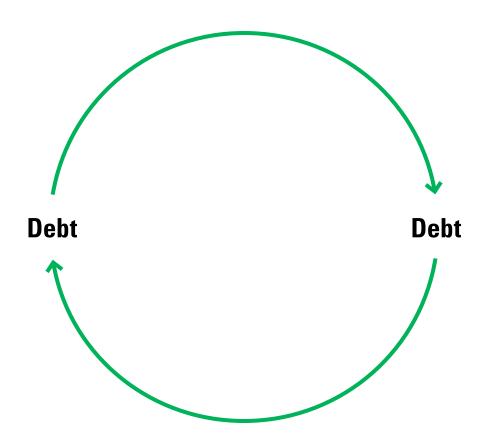
Disturbances from outside the system may throw it out of balance and result in a new, much different point of equilibrium, often with drastic consequences for existing population stocks.



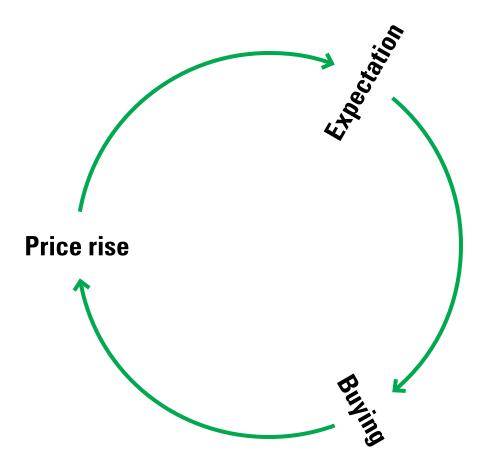
Interest paid on stocks of money also forms a growth loop; capital leads to more capital.



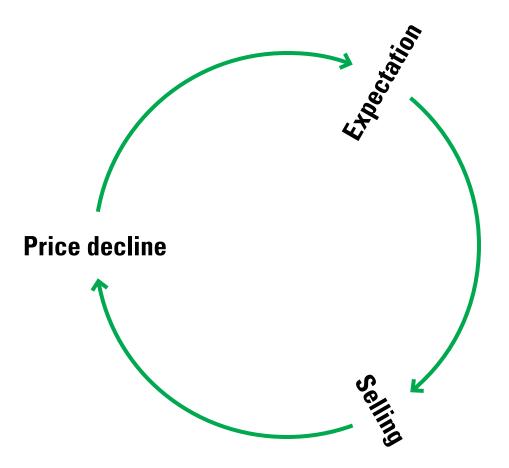
Likewise debt can lead to more debt, forming a collapse loop or vicious cycle.



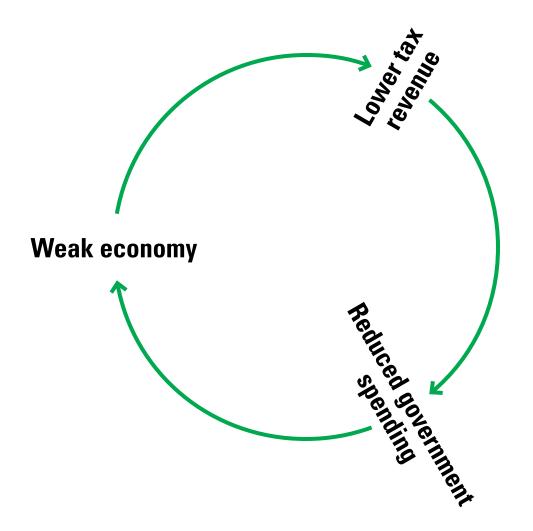
Speculative bubbles inflate in a similar way; a price rise leads to expectations of further rises, which lead to buying, which leads to price rises.



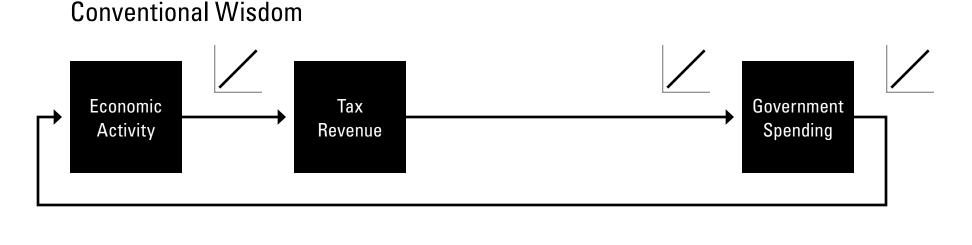
Bubbles crash as expectations of price declines lead to selling, which leads to price declines, reinforcing expectations.

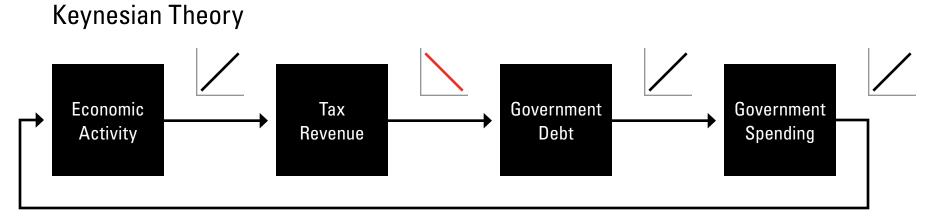


A recession reduces tax revenue, which may reduce government spending, which further weakens the economy, creating a collapse loop, e.g., the Great Depression.



Keynes showed that increasing government spending during a recession (by taking on debt) can improve the economy, which avoids a collapse and puts the system back into balance. As the economy improves, tax revenues increase, and government debt can be paid down.





Key ideas from systems dynamics

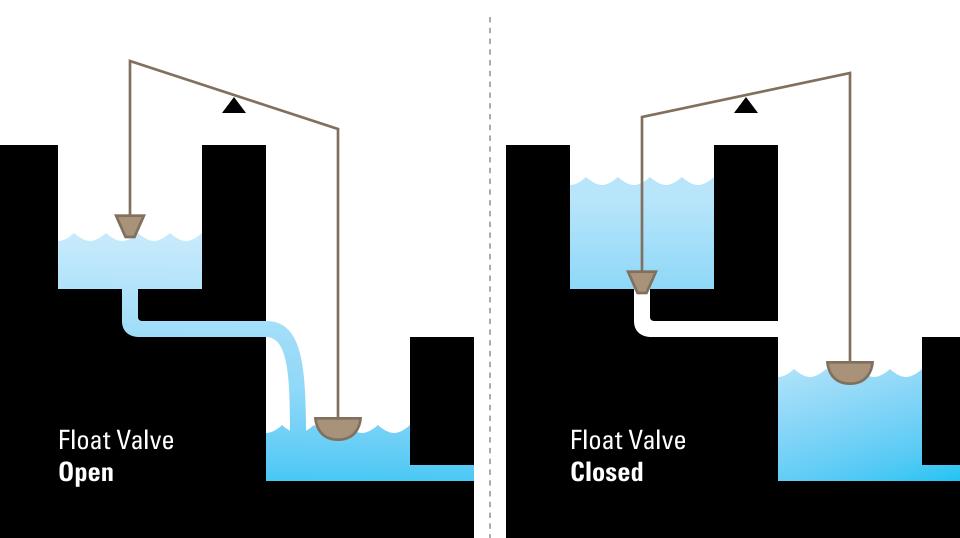
- Source, flow rate, stock, flow rate, sink
- no original sources
 - or ultimate stocks
- dynamic equilibrium
- -virtuous and vicious cycles

PART THREE

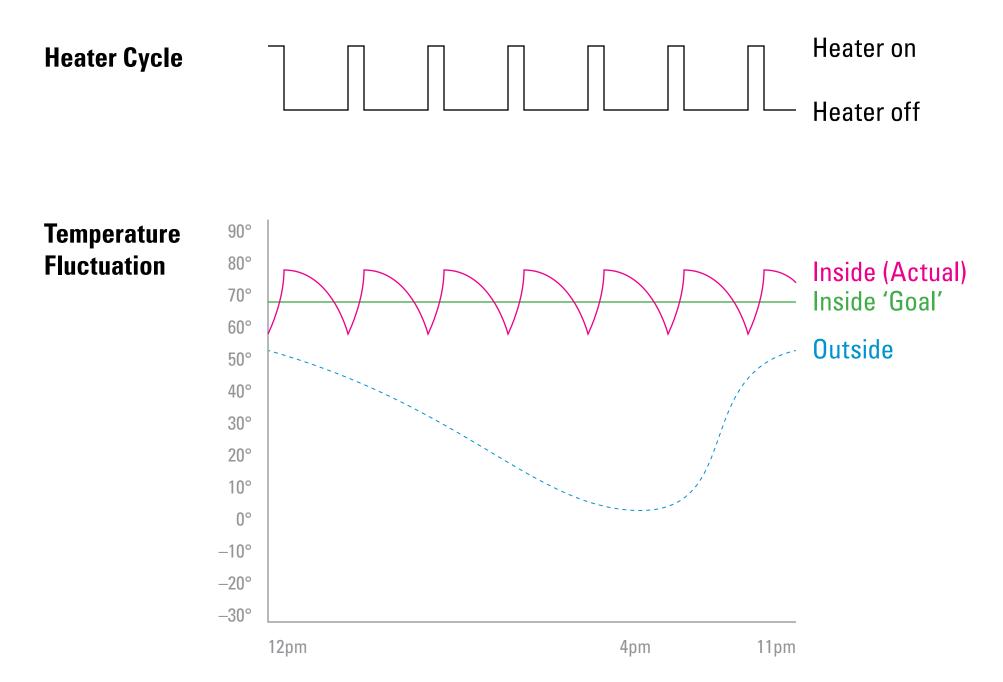
Control systems

Dynamic equilibrium is maintained by feedback

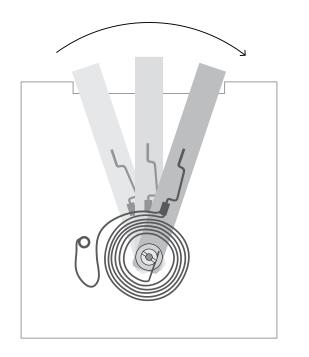
Measuring the effect of an action, comparing it with a goal (maintaining the level of water in the reservoir) and acting to correct differences



A thermostat maintains a constant temperature.

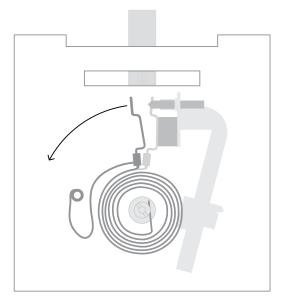


As the room cools, a bi-metal coil contracts closing a circuit; as the room heats, the coil expands breaking the circuit.



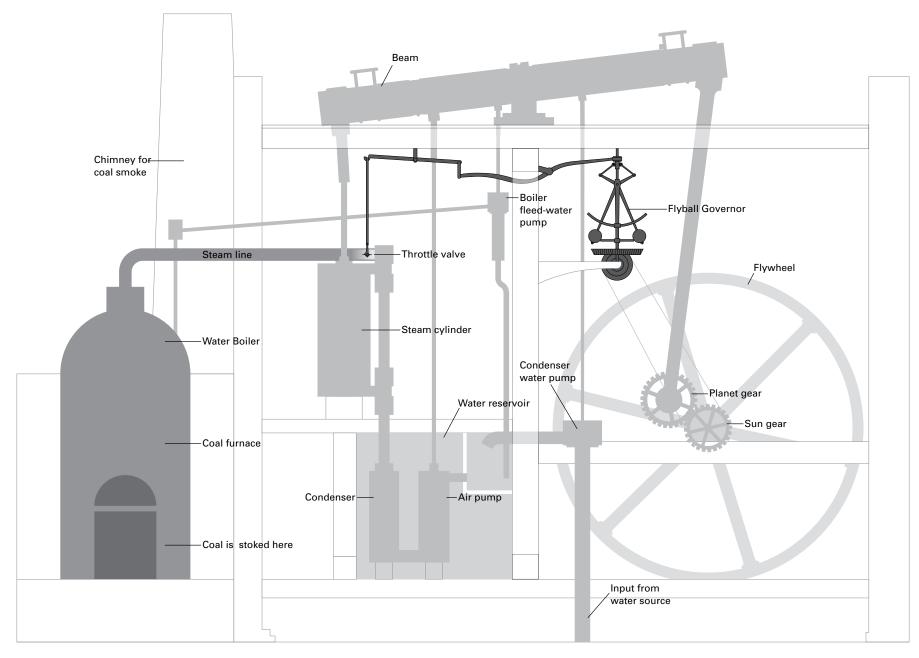
Moving the temperature control lever moves the bi-metal coil

The bi-metal coil bends towards the contact screw as it cools

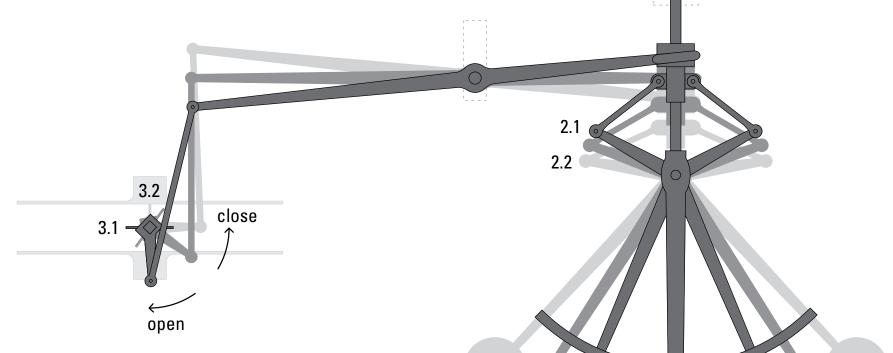


The bi-metal coil bends away from the contact screw as it warms

A flyball governor maintains constant pressure in a steam engine.



Increasing speed closes a valve; decreasing speed opens the valve.



1.2

1.1

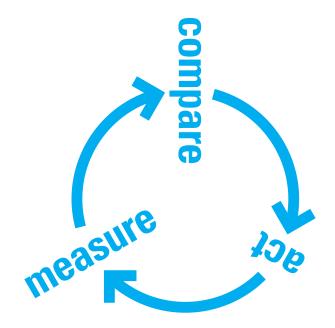
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- 0 Through a system of gears and pulleys the speed of the steam engine is transferred to the gear at the base of the flyball governor—causing it to rotate.
- 1.1 At low speed, the flyweights remain close to the spinning central axis
- 1.2 As speed increases, the flyweights swing outward, and upward.
- 2.1 At low speed, the scissor mechanism pushes the lever arm up
- 2.2 At high speed the scissor mechanism pulls the lever arm down
- 3.1 At low speed, the lever arm pushes the throttle valve open; increasing the flow of steam
- 3.2 At high speed, the lever arm pulls the throttle valve closed; reducing the flow of steam

This feedback loop is a structure common to all control mechanisms: act, measure, compare to goal, act to correct differences

self-regulating system

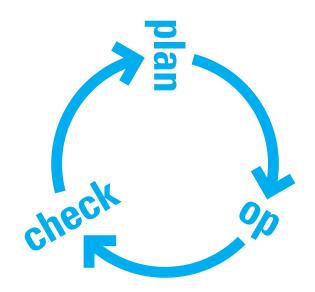
Like a self-regulating system, the creative process is a classic feedback loop. Measure an essential variable; compare it to a goal; and act to eliminate any difference.



This process is similar to the Shewart-Deming PDCA (plan-do-check-act) process.

quality cycle

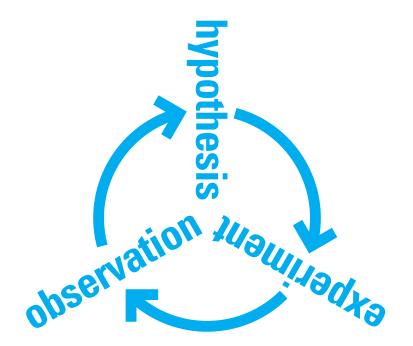
The creative process is startlingly similar to the quality cycle (Shewart, 1939), popularized in business circles by the quality management movement (Deming, 1982).



It's also an analog to the design process and the scientific method.

scientific method

Forming a hypothesis is a special type of creative act. Framing the creative process as "experimenting" shows the close tie it has with the domain of science.



Tracking by itself is only useful if you can make correlations.

Tracking measuring + recording, perhaps correlating measurements Open loop system, no feedback

Tracking + acting = managing

Managing measuring, comparing to goal, + acting to correct differences Closed loop system, feedback enables dynamic equilibrium (homeostasis) —first order

Trackingmeasuring + recording, perhaps correlating measurementsOpen loop system, no feedback

Managing may lead to learning

Learning anticipating disturbances + affects of actions Studying the system, developing a model of the feedback loop —second order

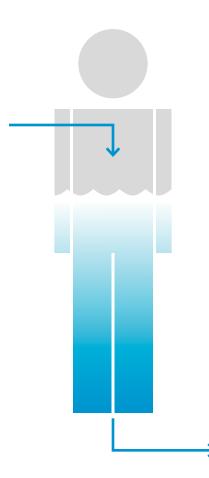
- Managing measuring, comparing to goal, + acting to correct differences Closed loop system, feedback enables dynamic equilibrium (homeostasis) —first order
- Trackingmeasuring + recording, perhaps correlating measurementsOpen loop system, no feedback

Learning may lead to experimenting

Innovating recognizing patterns, proposing causes, + testing hypotheses Studying the environment, experimenting to see how the system connects to other systems

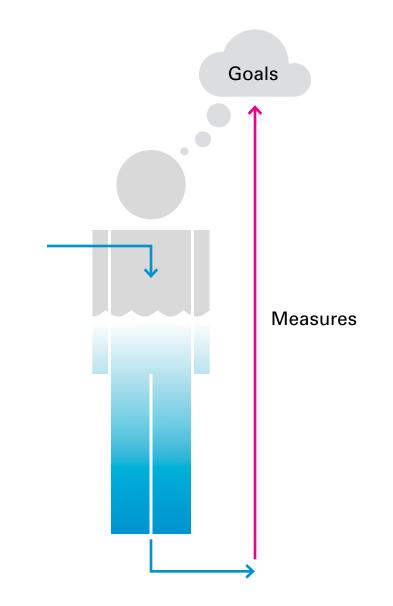
- Learning anticipating disturbances + affects of actions Studying the system, developing a model of the feedback loop —second order
- Managing measuring, comparing to goal, + acting to correct differences Closed loop system, feedback enables dynamic equilibrium (homeostasis) —first order
- Trackingmeasuring + recording, perhaps correlating measurementsOpen loop system, no feedback

Living systems must maintain dynamic equilibrium (homeostasis) to survive

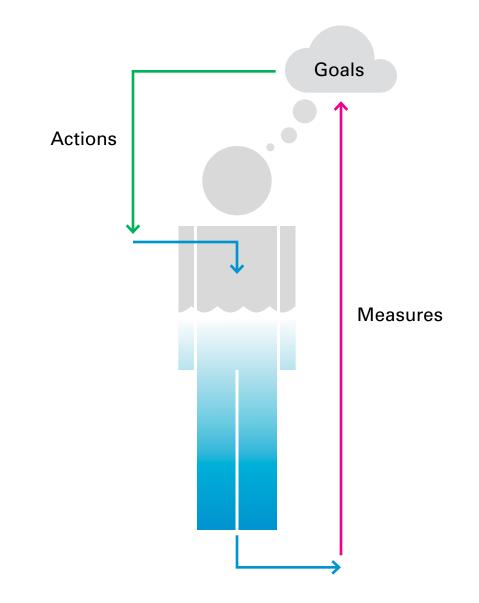


A patient's vital signs measure important elements of homeostasis

Variable	Goal range
Body temperature	97.25°F – 99.5°F
Heart rate	60 – 80 bpm
Blood pressure	< 120 / < 80 mm Hg
Respiratory rate	10 – 14 bpm



Maintaining homeostasis requires 'closing the loop' on many variables simultaneously



PART FOUR

Resources

Karl Gerstner *Designing Programmes*

Karl Gerstner: Designing Programmes

Programme as morphology Programme as logic Programme as grid Programme as photography Programme as ilterature Programme as music

Programme as typeface Programme as typography Programme as picture Programme as method

Arthur Niggli Ltd.

Donella Meadows *Thinking in Systems*

Thinking in Systems

A Primer

Donella H. Meadows

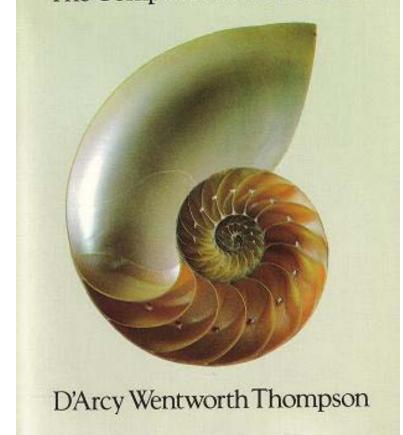
Edited by Diana Wright. Sustainability Institute

Ross Ashby An Introduction to Cybernetics

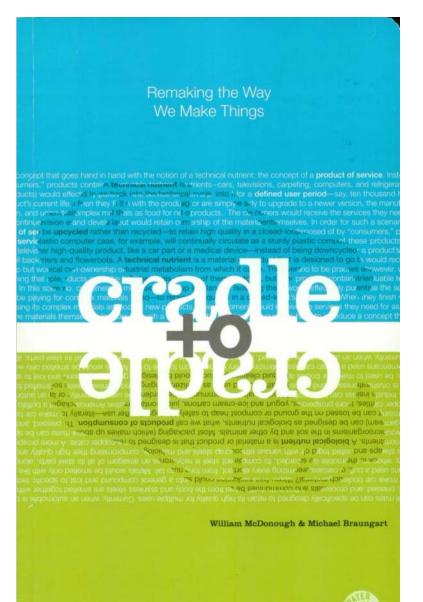


D'Arcy Thompson On Growth and Form

ON GROWTH AND FORM The Complete Revised Edition



William McDonough & Michael Braungart *Cradle to Cradle*



PART FIVE

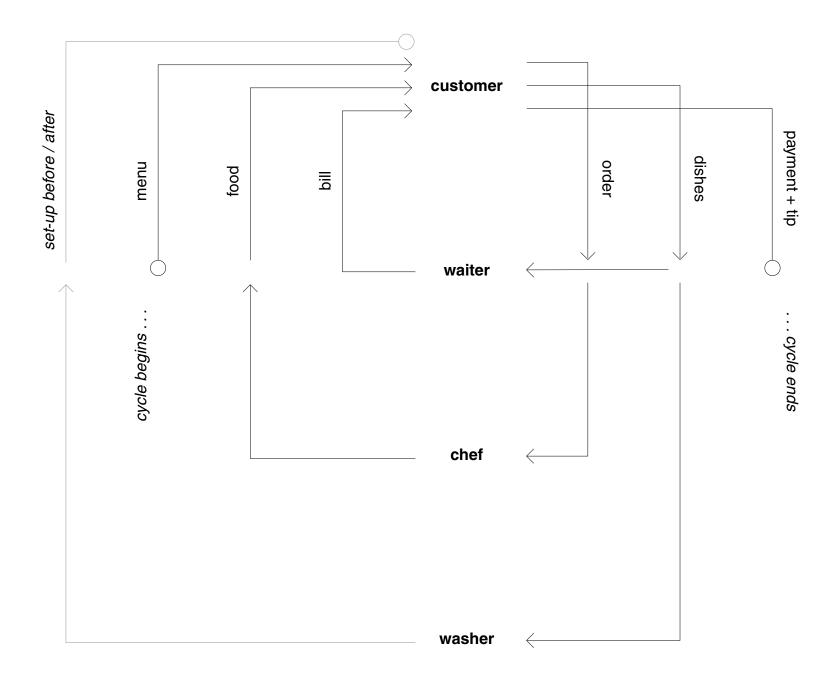
Assignments

Assignment:

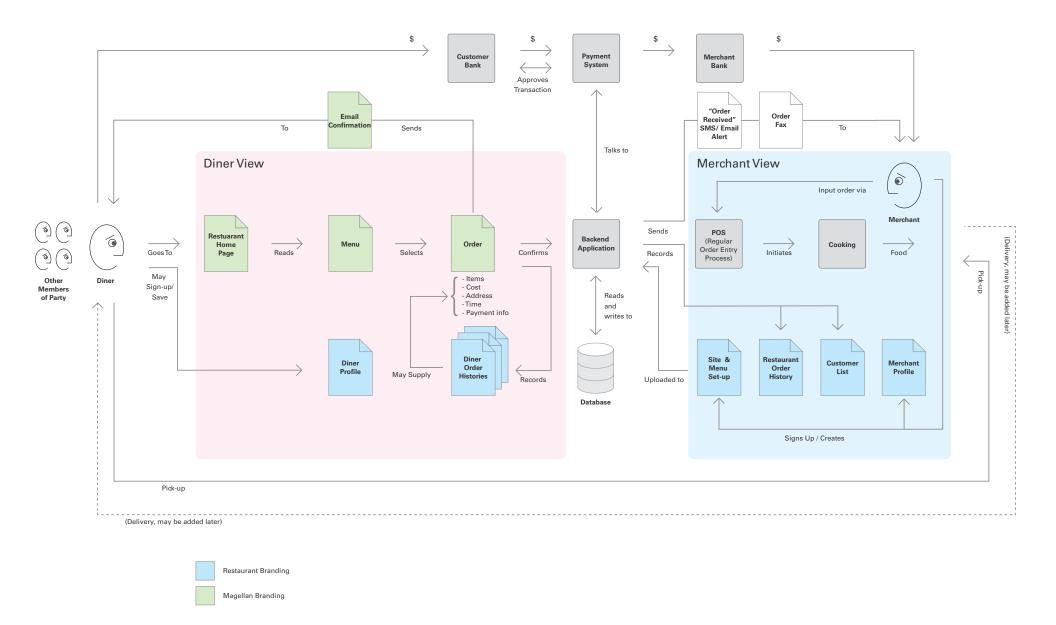
Consider a restaurant as a set of systems.

Represent them in a map or diagram.

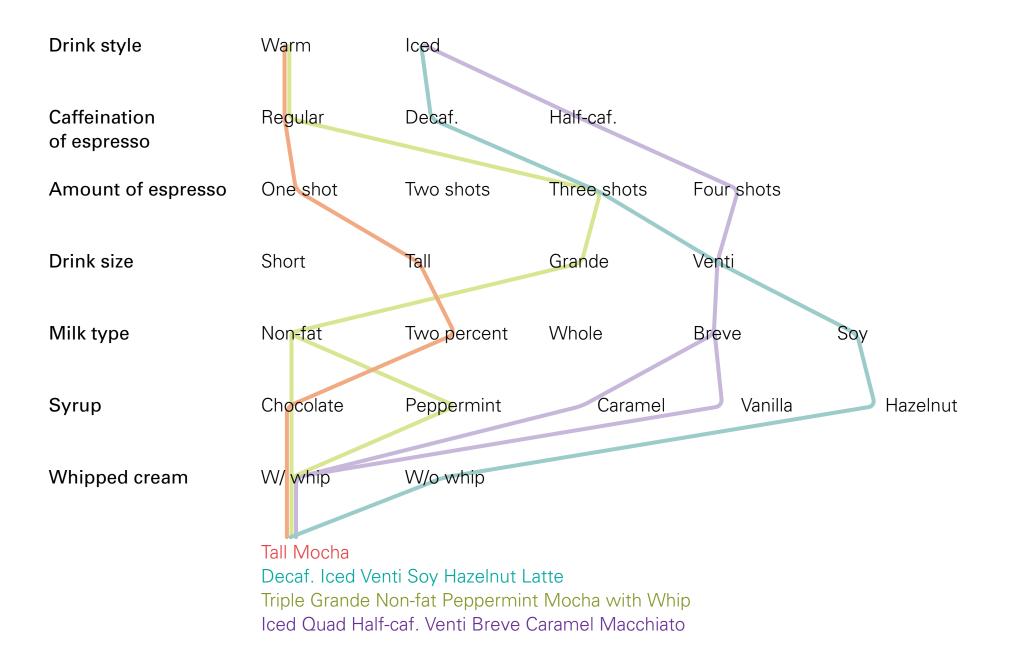
A Model of a Restaurant: Basic Meal Cycle



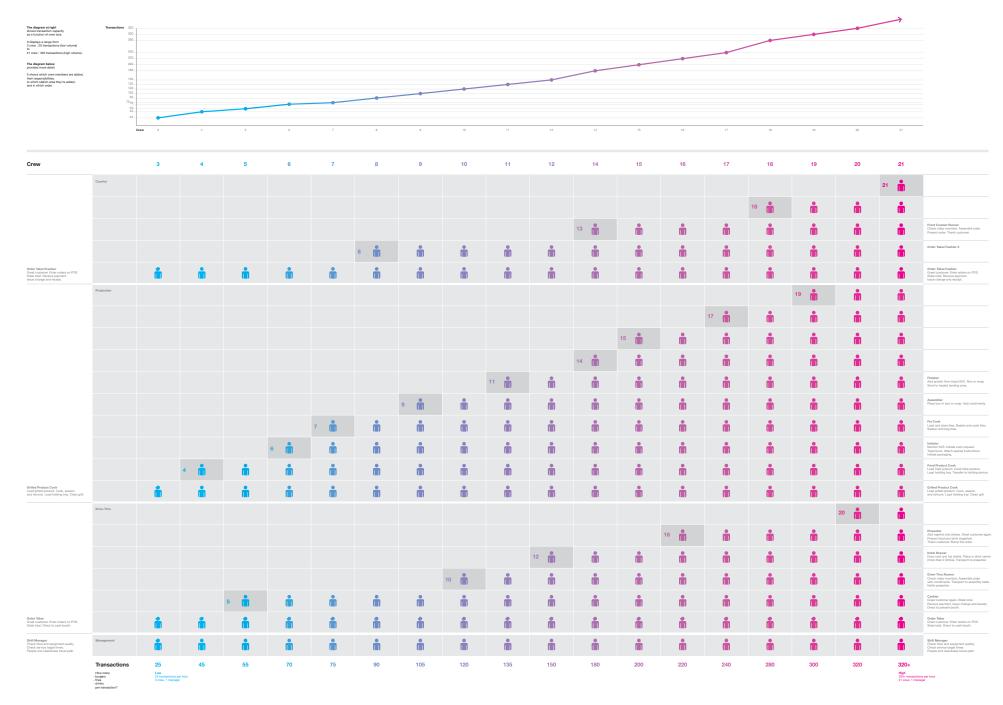
Online Meal Ordering: Service Model



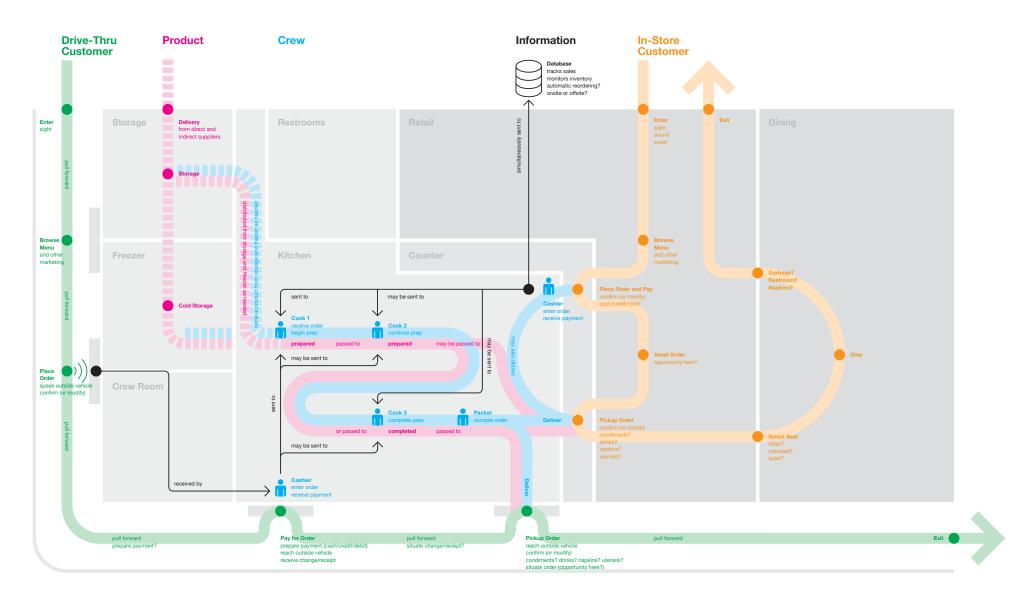
Starbuck's latte framework



McDonald's: Staffing Levels.



McDonald's: Intersecting Journeys.



Back Front

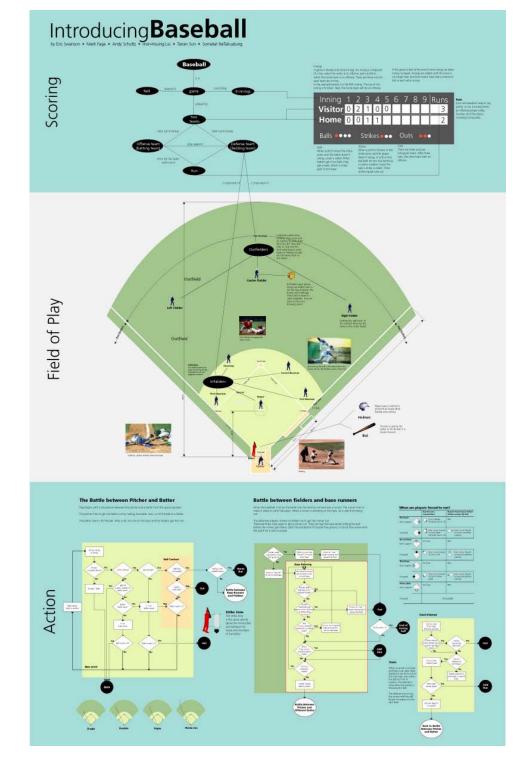
Assignment:

Create a concept map explaining how to play baseball.

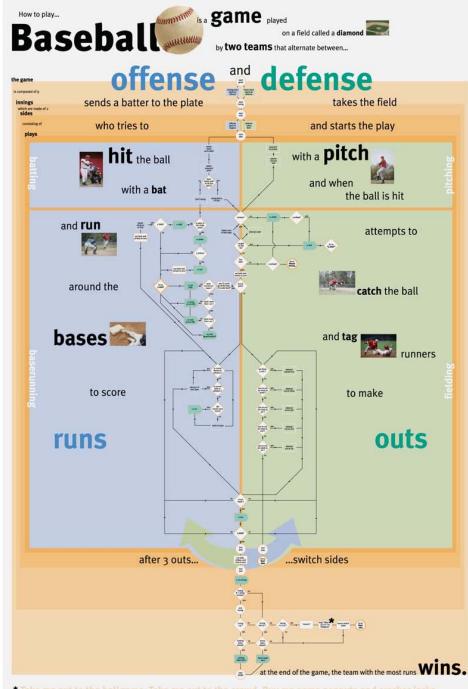
Create a process flow diagram for a game of baseball.

Integrate the concept map and the process flow diagram.

Baseball diagram 1.



Baseball diagram 2.



* Take me out to the ballgame, Take me out to the crowd. Buy me some peanuts and cracker jacks, I don't care if I ever get back. Cause it's root, root, root for the home team, If they don't win it's a shame. For it's one, two, three strikes you're out, at the old ballgame.

Team Line-Up Matthew Beebe | Lee Crugman | Miguel Cano | Tim K. Murphy | Ryan Powell Institute of Design Diagram Development Spring 2000

Assignment:

Select a story from the front page of the New York Times.

Identify a system in one of the stories.

Make a list of components of the system.

Pick the most important components, not more than 12.

Represent the components and their relationships.

Label both the components and the relationships.

Assignment:

Find a system; represent it.

Late Edition The New York Times The Area and Area an "All the News That's Fit to Print' Veather map appears on Page D

NEW YORK MONDAY FEBRUARY 25 2008

VOL CLVII No 54 231 @ 2008 The New York Time

POLITICAL MEMO In Memories of a Painful Past, Hushed Worry About Obama

By JEFF ZELENY DALLAS — There is a hushed those recollections and image are often invoked by older voters who watch his candidacy with fascination, as well as an uneasy air of apprehension, as Demo-crats inch closer to selecting their manine. worry on the minds of many supporters of Senator Barack Oba

porters of Senator Barack Oba-ma, echoing in conversations from state to state, rally to rally: Will he be safe? In Colorado, two sisters say they pray duily for his safety. In New Mexico, a daughter says she persuaded her mother to still vote for Mr. Obama, even though Mr. Obama has had Secret Service agents surrounding him since May 3, the earliest a candisince May 3, the earliest a candi-date has ever been provided pro-tection. (He reluctantly gave in to the insistent urging of Senator Richard J. Durbin, Democrat of Illinois, and others in Congress.) As his rallies have swelled in size his security has increased, com

nois, said in an interview, repris ing a line he tells supporters who raise the issue with him. "So stop worrying." Yet worry they do, with the

spring of 1968 seared into their memories, when the Rev. Dr. Martin Luther King Jr. and Sena-tor Robert F. Kennedy were as-sassinated in a span of two months. Mr. Obama was 6 at the time,

has only read about the violence that traumatized the nation. But

the mother feared that winning the mother reared that winning would put him in danger. And at a rally here, a woman expressed worries that a message of hope and change, in addition to his race, made him more vulnerable race, made him more vuinerable to violence. "I've got the best protection in the world," Mr. Obama, of Illi-

> ate. Three years ago, she said sh dreaded the day her husband received Secret Service protection because it would mean serious threats had been made against

rarely mentions. "It's not something that I'm and like many of his admirers, he

Secret Service agents with Senator Barack Obama last month

Conservative Distrust of McCain

WASHINGTON — Back in maker as the Republican nomi-2005, Senator John McCain d Ari-nee under any circumstances. Sona and fellow members of the Other conservatives still resent it so-called Gang of 14 were halded as herces in sone quarters when they fashioned an unusual pact of the Gang of 14, it leaves a bad that averted a Senate voice on take in their mouths," sidd Plat banning filbusters against judi-Gr Community Values, Based in Community Values, Based in

n that effort, which cleared the Even some colleagues nov way for confirmation of some backing Mr. McCain consider th

conservative jurists, is cited as judicial agreement a sore subject. one reason for lingering distrust "We had the votes to put both

of him among many conserva-tives. The power to appoint fed-is president, Republican or Dem-

eral judges is seen as one of the most crucial presidential roles by many on the right, and some con-down," said Senator Orrin G.

McCain's role in the bipartisan Gang of 14 in his announcement that he could not support the law-his last run. Page A15.

To Some Relief, Fewer Youths

Jump Behind the Wheel at 16

cial nominees. for C Now Mr. McCain's central role Ohio in that effort, which cleared the

eral judges is seen as one of the most crucial presidential roles by many on the right, and some con-tinue to believe the agreement undermined the Republican lead-ership at the precise moment the ability to use procedural tactics to block judges. James C. Dobson, an influential conservative leader, noted Mr.

onservative leader, noted Mr

Lingers Over '05 Deal on Judges By CARL HULSE

ing close to rivaling that given to a sitting president. His wife, Michelle Obama. voiced concerns about his safety before he was elected to the Sen

Among friends and adviser anger is something Mr. Obama

spending time thinking about day Continued on Page A15



BORDER CROSSINGS DUBLIN - Cork-born and proud of it, George-Jordan Dimbo is top to toe the Irish lad. He studies Gaelic, eats rashers, plays hurl-

Iad. He studies Gealic, eats rashers, plays huri-ing, prays to the saints, papers his walls with parochial school awards, and spends Satur-days at the telly watching Dustin the Turkey, a wisceracking pupper, mock the powerful. If the Irish government has its way, he may soon be living in Africa.

may soon be living in Africa. George, II, is an Irish citizen and has been since his birth when Ireland, alone in Europe, still gave citizenship to anyone born on its soil. His mother and father, Ifedinma and Ethelbert Dimbo, are illegel impigrant from Ningria Dimbo, are illegal immigrants from Nigeria, who brought him back to Ireland three years

ago, judging it the best place to raise him. ago, juoging it the best place to raise him. Since then, the unusual trio — the Irish schoolboy and his African parents — have shared a single room in a worn Dublin hostel while facing a prospect dreaded by children on both sides of the Atlantic, a parent's deporta-

tion. "Dear justice minister," George wrote when he was 9. "I heard my Mommy and Daddy whispering about deportation. Please do not deport us." ember," he added, "I am also an Irish child."

Thousands of Irish children face similar

Bomber Kills Dozens in Iraq Domber Nulls JOZens in Iraq At least 40 people were killed and 100 wounded when a suicide bomber ran into a highway rest stop crowded with Shite pilgrims about 45 miles south 61 Baghdad, shouted "God is great" and deto-nated explosives, Iraqi officials said. PAGE A11

Sharp Reactions, in Russian Some readers called it blatant ropaganda from the West. Othwed it as a depressing exosé that rang true. These were me of the reactions of Russians o an article in The New York imes on Sunday, translated into Russian, describing the crack-

down on democracy under Presi-dent Vladimir V. Putin. PAGE A9 Power Passes to 2nd Castro Raúl Castro be-

came Cuba's new president, ending his brother Fidel's

49-year rule. The new leader made it

clear that he would

make no radical

changes and prom-

511

By MARY M. CHAPMAN and MICHELINE MAYNARD

Hatch, Republican of Utah and a former Judiciary Committee Continued on Page A13

Another Try for Nader

Ralph Nader will seek the pres

DETROIT — For generations, driver's licenses have been tick-ets to freedom for America's 16-vate driving academies. year-olds, prompting many to line up at motor vehicle offices the parents who are willing to chauf-Velicicolis prohibying many owner to time this, expense serves and to with the server of the serv

erv important decision. PAGE A10 eral Highway Administration cense. She said she nla



George-Jordan Dimbo, 11, is an Irish citizen, but his father, Ethelbert, is not

Born Irish, but With Illegal Parents

In a Changing Land, Deportation Threatens Families

By JASON DePARLE

Diversity in Ireland risks, living in a country where one or both

risks, living in a country where one or both parents do not legally reside. Their stories find abundant parallels in the United States, where an estimated free million children — including three million American citizens — have par-ents who are lilegal immigrants. New efforts to catch them make fear of deportation a growing inves that make infants instant citizens. The battle over the "LB.C.S" — Irishborn children — strens from ... decode of hoads. children - stems from a decade of head

INSIDE



Oscar Country for the Coen Brothers

Ethan, left, and Joel Coen shared the Oscar for best director, and their film "No Country for Old Men" won best picture and two other honors at the 80th annual Academy Awards. Complete coverage in-cludes fashion hits and misses, a report from the Carpetbagger and TV Watch by Alessandra Stanley. THE ARTS, BAGE EL



County hamlet of New Cassel, was taken to a hospital for phys-ical and mental examinations, the police said. Late Sunday evening, she was charged with the murder of all three children. Neither the police nor the county medical examiner said what caused the death of the chil. hat caused the death of the chil

turning change that has brought this island of red-haired Marys and blue-eyed Seans the red-haired Marys and blue-eyed Seans the demographic version of an extreme makeover. For centuries, Ireland was a racially ho-mogenous land do emigrants, whose share of the population, I percent, is nearly as high as that in the United States. Years of Irish prosperity have drawn Pol-ish plumbers, Lithuanian nannies, Lavian form workness. Elitiona nurse: Oblass tradeets farm workers, Filipino nurses, Chinese traders, and sub-Saharan asylum seekers. The town of Portlaoise about 40 miles southwest of Dublin has the country's first African-born mayor. The Continued on Page A6

and once dreamed of sending his children to private school. "We're not really middle class anymore not really middle class anymore; we're at the poverty level." Some governments have tried to soften the impact of high prices by increasing wages or subsidies on foods. Jordan, for in-stance, has raised the wages of public-sector employees earning less than 300 dinars (\$423) a month by 50 dinars (\$70), For these accurate many theory 200 di

\$1.25

RISING INFLATION

PROMPTS UNEASE

HIGH OIL PRICES A CAUSE

Strikes and Boycotts as Area's Middle Class

Feels Squeezed

By RORERT F. WORTH

AMMAN, Jordan — Even as it enriches Arab rulers, the recent oil-price boom is helping to fuel an extraordinary rise in the cost of food and other basic goods that is squeezing this region's middle class and setting off strikes, dem-onstrations and occasional riots from Morocco to the Persian Gulf. AMMAN Jordan - Even as it

Gulf. Here in Jordan, the cost of maintaining fuel subsidies amid the surge in prices forced the government to remove almost all the subsidies this month, sending the price of some fuels up 76 per-cent overnight. In a deveatating domino effect, the cost of basic foods like some notaroose and en

foods like eggs, potatoes and cu-cumbers doubled or more. In Saudi Arabia, where infla-tion had been virtually zero for a

tion had been virtually zero for a decade, it recently reached an of-ficial level of 6.5 percent, though unofficial estimates put it much higher. Public protests and boy-cotts have followed, and 19 promi-nent clerics posted an unusual statement on the Internet in De-cember warning of a crisis that

cember warning of a crisis that would cause "theft, cheating, armed robbery and resentment

armed robbery and resentment between rich and poor." The inflation has many causes, from rising global demand for commodilies to the monetary constraints of currencies pegged to the weakening American dol-lar. But one cause is the skyrock-eting price of it itself, which has quadrupled since 2002. It is help-ine nuch many ordinary becopie

quadrupled since 2002. It is help-ing push many ordinary people toward poverty even as it stim-ulates a new surge of economic growth in the gull. "Now we have to choose: we either eat or stay warm. We can't do both," said Abdul Rahman Ab-dul Raheem, who works at a clothing shop in a mall in Amman and more dressmed of earnither his

Gulf.

IN MIDDLE EAST

those earning more than 300 di-nars, the raise was 45 dinars, or \$64. But that comp only a fraction of the price i Continued on Page A8 Mother Is Held

In L.I. Slaving Of 3 Children

By ROBERT D. McFADDEN and ANGELA MACROPOULOS

A Long Island woman de-scribed as emotionally disturbed and afraid of losing custody of her children called the police on Sunday and led officers into a lood-spattered bedroom whe her young daughter and two small sons lay slain on a bed, in-vestigators said.

The woman, Leatrice Brewer, 27, who lived with the children in

an apartment in the Nassau County hamlet of New Cassel

Special thanks to Michael Gallagher Paul Pangaro Louise Sandhaus

Presentation posted at www.dubberly.com/presentations/aigasystemsworkshop.pdf

hugh@dubberly.com