Foundational Skills for Systems Engineers in 2030

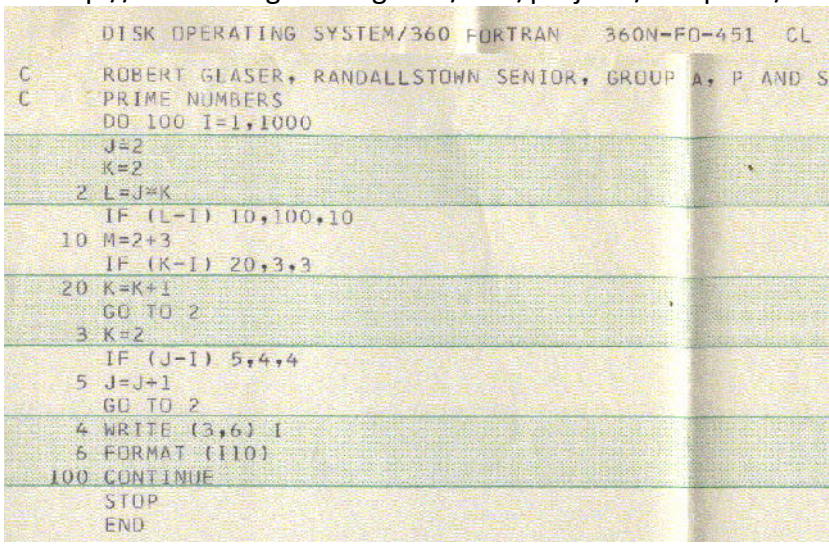
Paul Collopy
Professor and Department Chair, Industrial and Systems Engineering & Engineering Managment
University of Alabama in Huntsville (USA)
paul.collopy@uah.edu

The Past

ge f110-129 http://www.ausairpower.net/TE-F-111-Upgrades-1998.html

http://en.wikipedia.org/wiki/Computer_programming#/media/

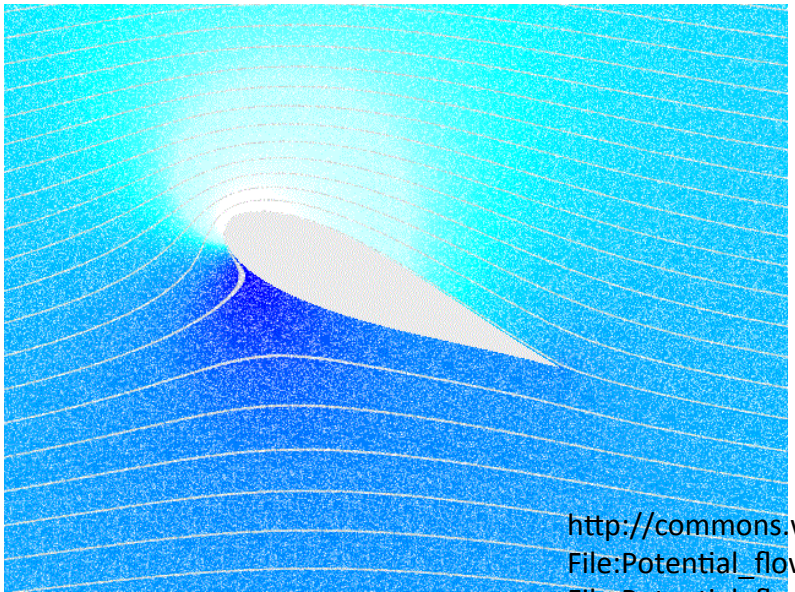
http://www.icengineering.com/n3ic/projects/computer/



```
      DISK OPERATING SYSTEM/360 FORTRAN   360N-FO-451  CL
C     ROBERT GLASER, RANDALLSTOWN SENIOR, GROUP A, P AND S
C     PRIME NUMBERS
      DO 100 I=1,1000
      J=2
      K=2
    2 L=J*K
      IF (L-I) 10,100,10
   10 M=2+3
      IF (K-I) 20,3,3
   20 K=K+1
      GO TO 2
    3 K=2
      IF (J-I) 5,4,4
    5 J=J+1
      GO TO 2
    4 WRITE (3,6) I
    6 FORMAT (I10)
  100 CONTINUE
      STOP
      END
```

The Present

http://ro.wikipedia.org/wiki/Airbus_A380#/media/File:Airbus_A380_inbound_ILA_2006.jpg



http://commons.wikimedia.org/wiki/File:Potential_flow_around_a_wing.gif#/media/

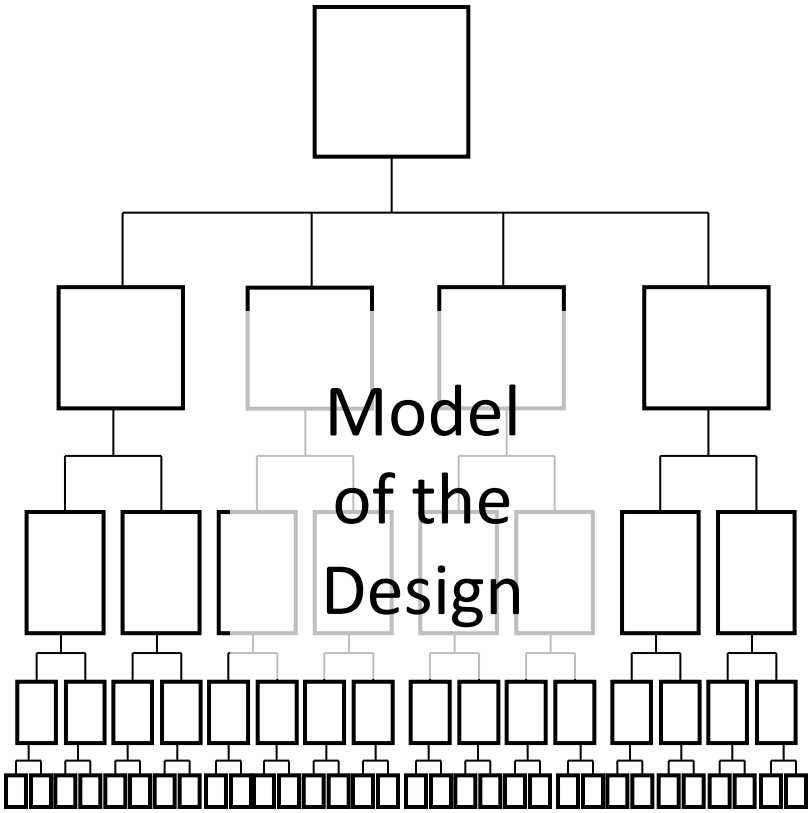
The Future

http://www.msc.navy.mil/annualreport/2008/pm1.htm

http://de.wikipedia.org/wiki/Cockpit#/media/File:Airbus-319-cockpit.jpg

Value Model

User Model



Model of the Environment

Manufacturing Model

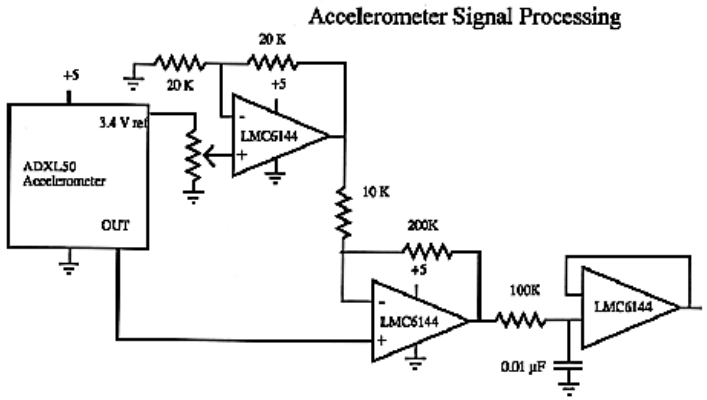
Engineer Goggles

Mockup by Boeing. Photograph by Boeing

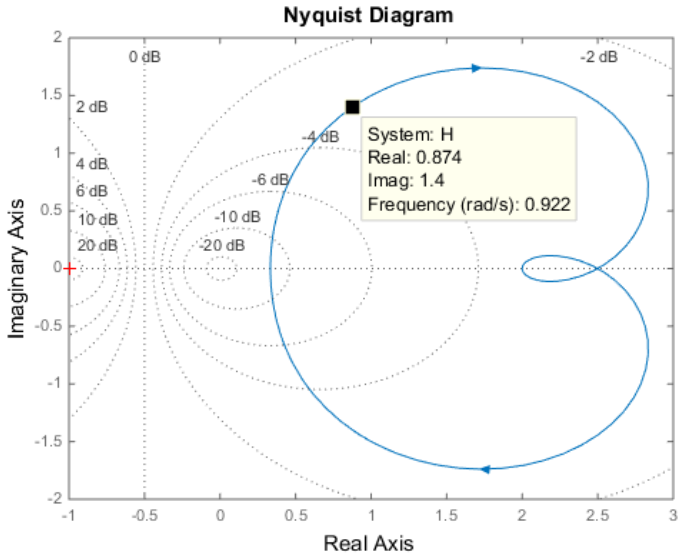
pixshark.com

Photograph by Michael Tercha, Chicago Tribune

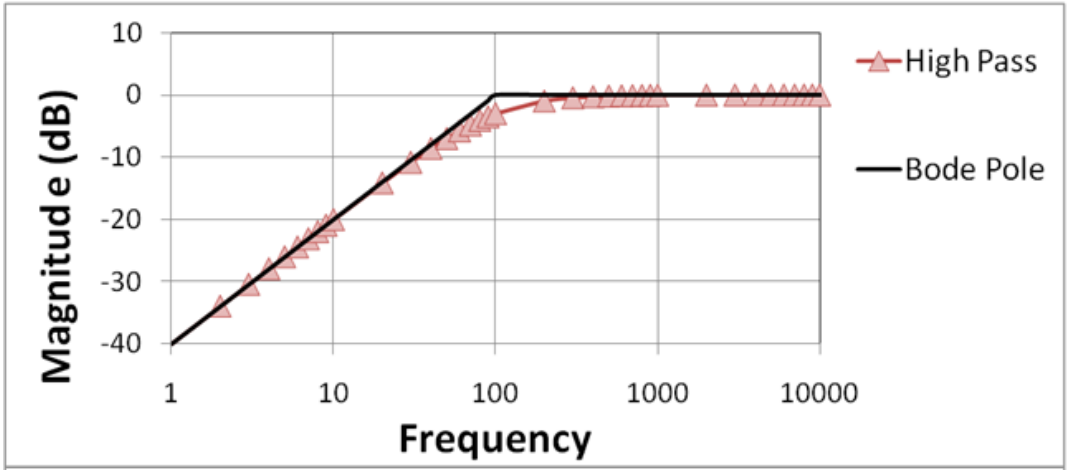
Seeing the World through Models



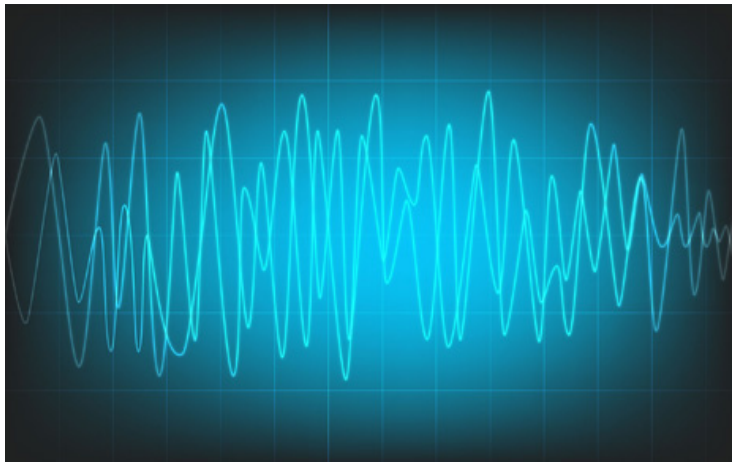
http://web.stanford.edu/class/me220/data/lectures/lect09/lect_5.html



http://www.mathworks.com/help/control/ref/nyquist.html



http://en.wikipedia.org/wiki/Bode_plot#/media/File:Bode_High-Pass.PNG



http://www.recordingconnection.com/courses/audio-engineering/audio-lesson-14/

Seeing the World through Models

http://www.futuretechnology500.com/index.php/future-virtual-reality/

Representing the World in Models

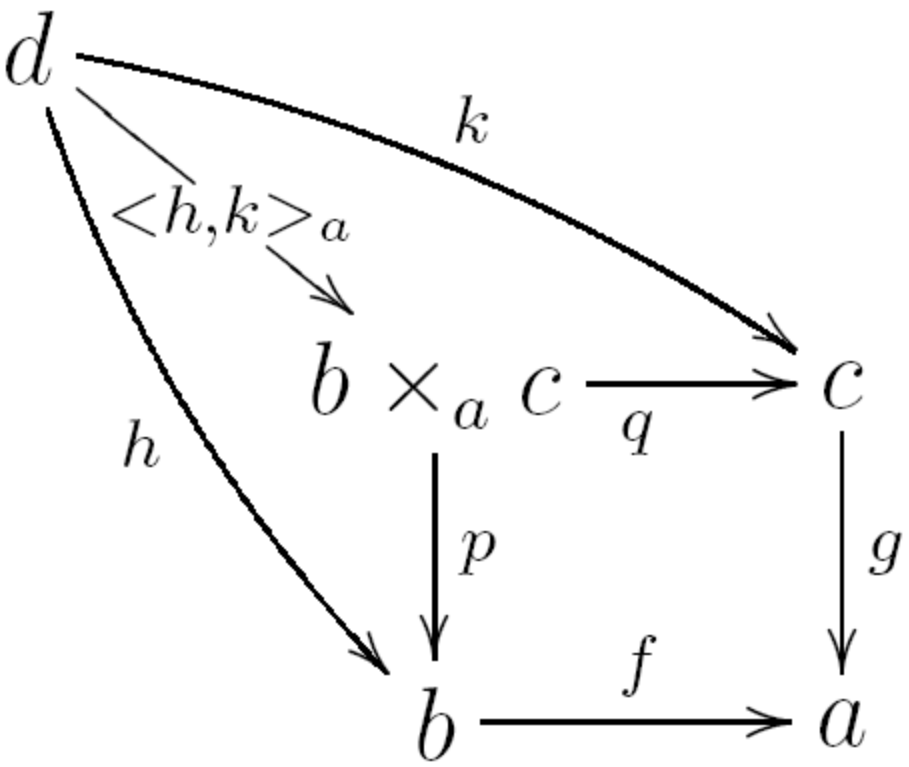
Faculty of Technology,
Policy and Management
TU Delft

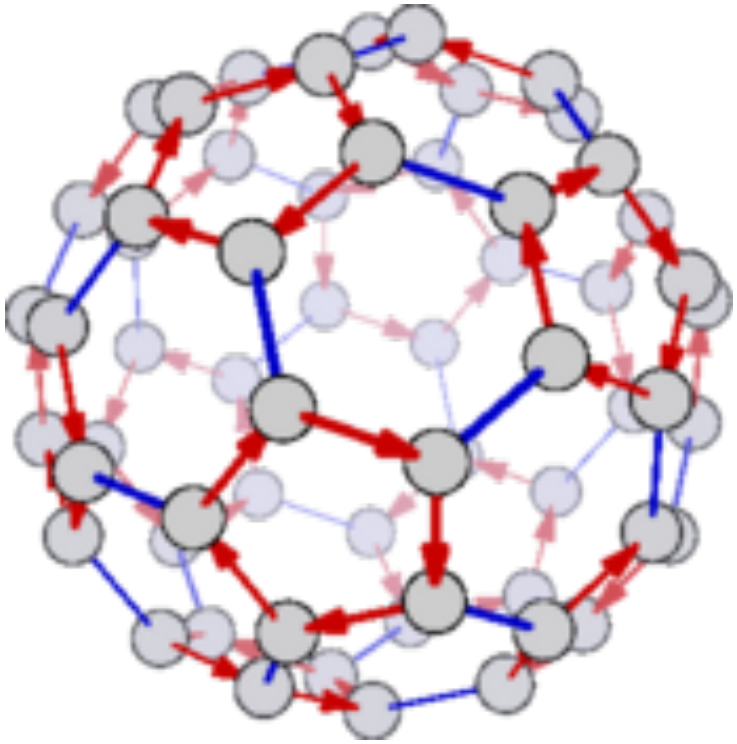
TU Delft

Delft University of Technology

photo by Wayne Curtis

New Mathematics for Modeling

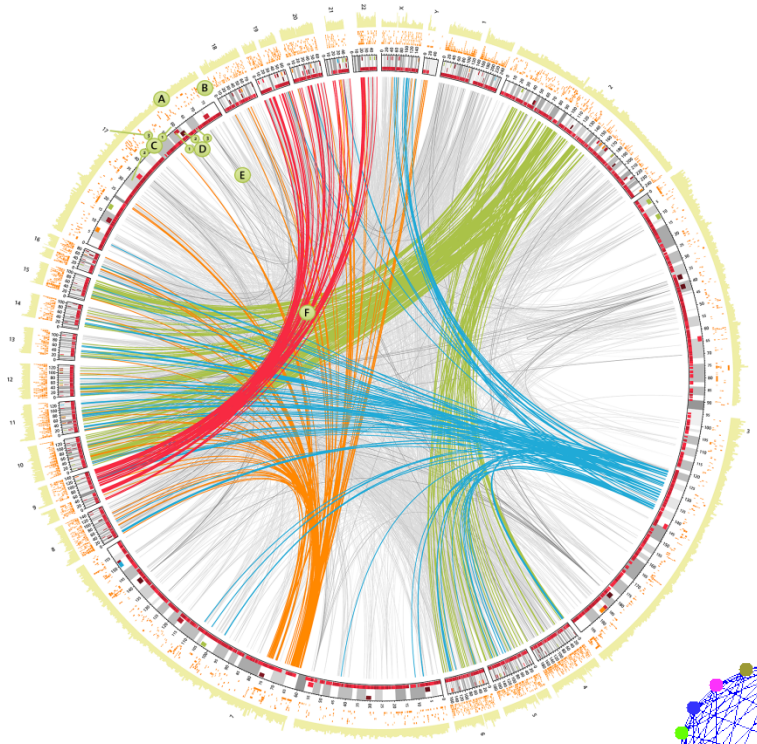




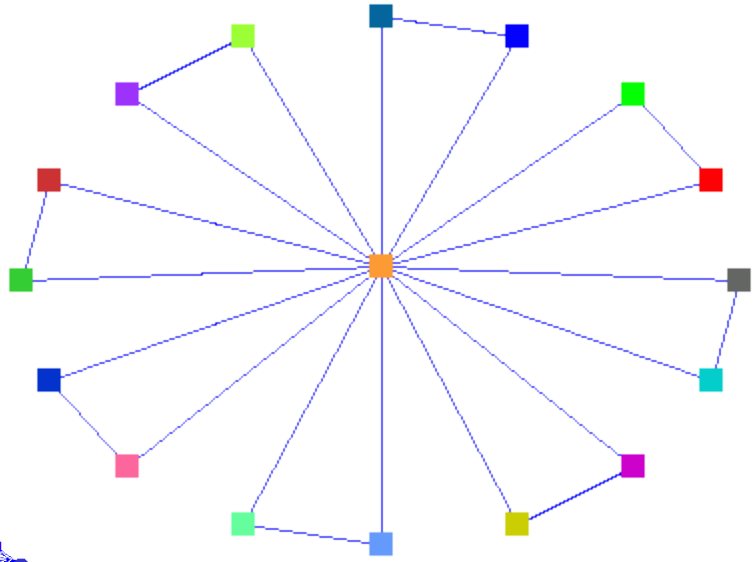
What can category theory do for philosophy? David Corfield http://www.kent.ac.uk/secl/philosophy/jw/reasoning/2013/category/

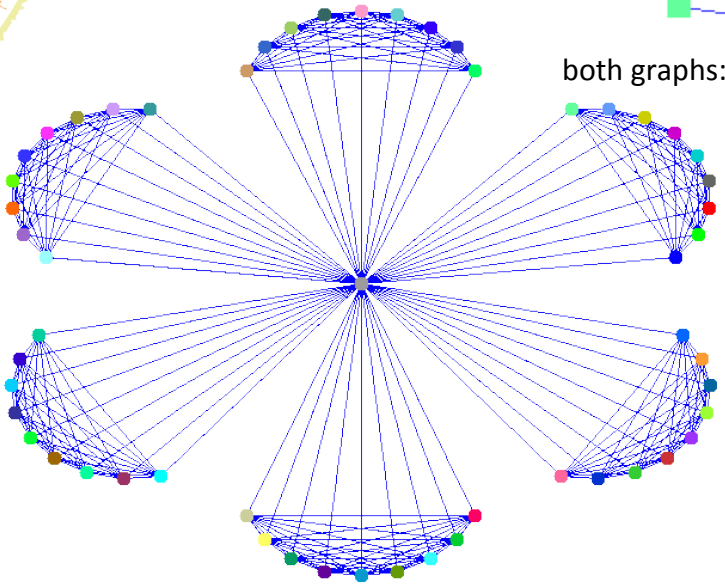
http://halgebra.math.msu.su/groups/

Seeing Relationships



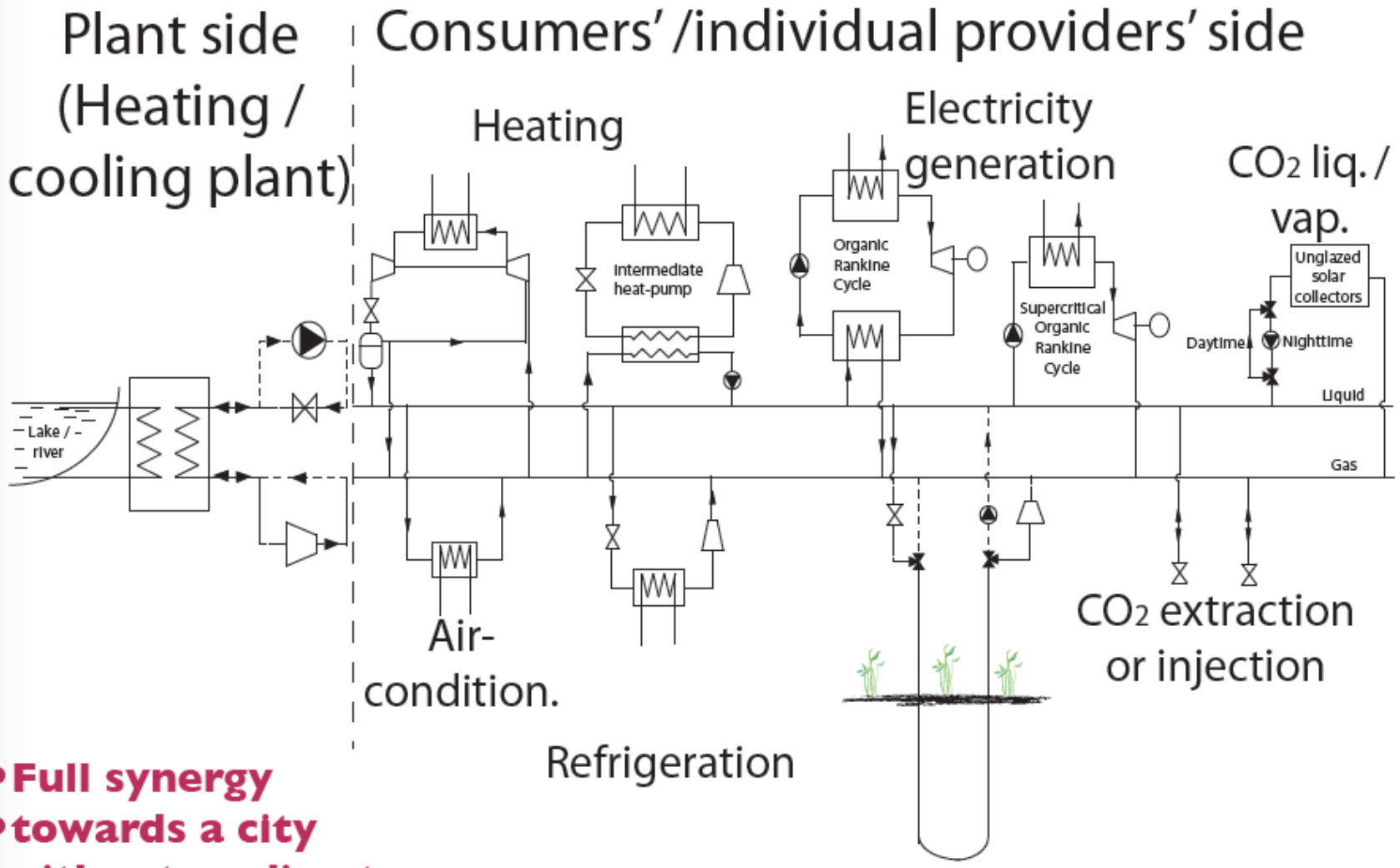
http://circos.ca/intro/genomic_data/img/circos-conde-nast-large.png





both graphs: http://www.mathcove.net/petersen/lessons/get-lesson?les=23

Innovative concept: a 2 pipe CO_2 heating and cooling network

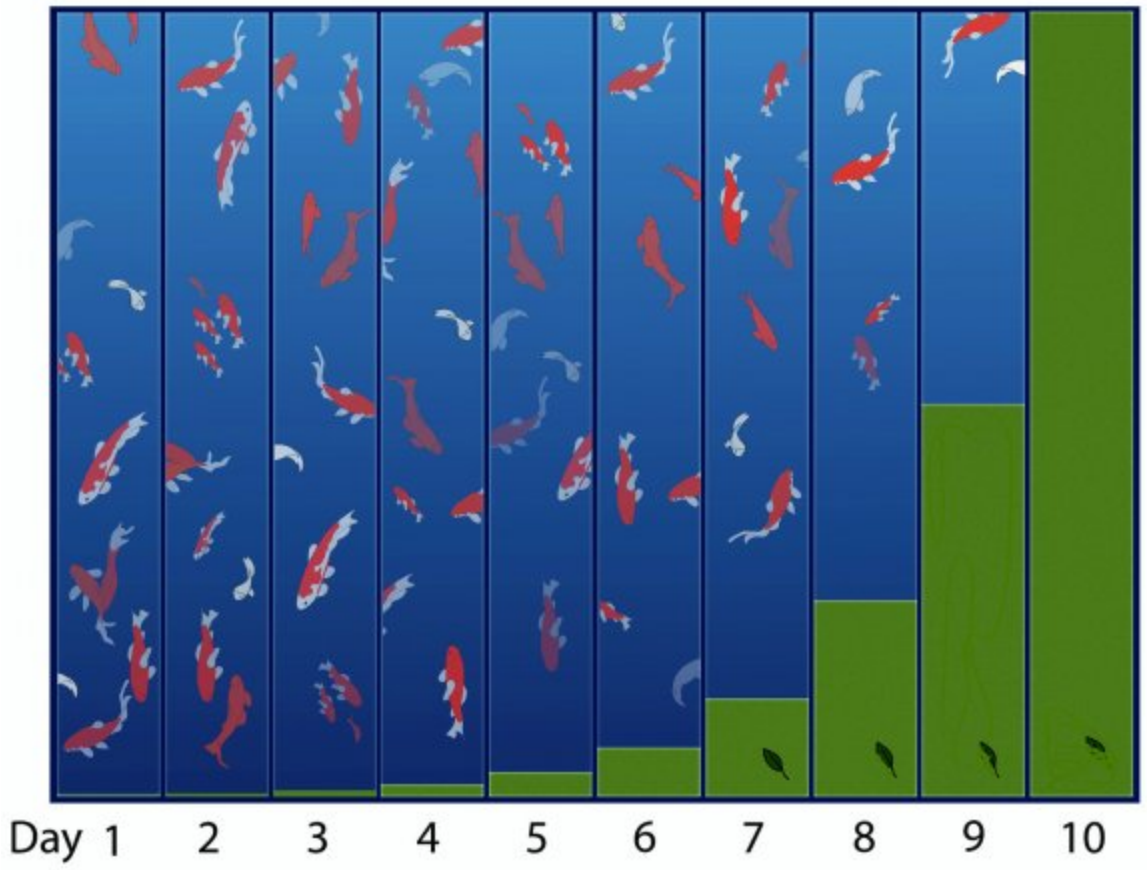


- **Full synergy**
- **towards a city without cooling tower without chimneys**

Daniel Favrat
LENI / EPFL

Learning Mathematics through Models

Exponential growth of pond algae choking out fish



http://new-universe.org/zenphoto/Chapter5/Illustrations/Abrams52.jpg.php Nancy Abrams and Joel Primack

http://www.institute-for-competitive-intelligence.com/

Conclusion

- Models will bring about a major change in Systems Engineering practice, and therefore in Systems Engineering Education
- The focus of Systems Engineering Education is likely to be on using, creating, and critiquing mathematical models
- Many conventional courses and lessons will drop from the curriculum