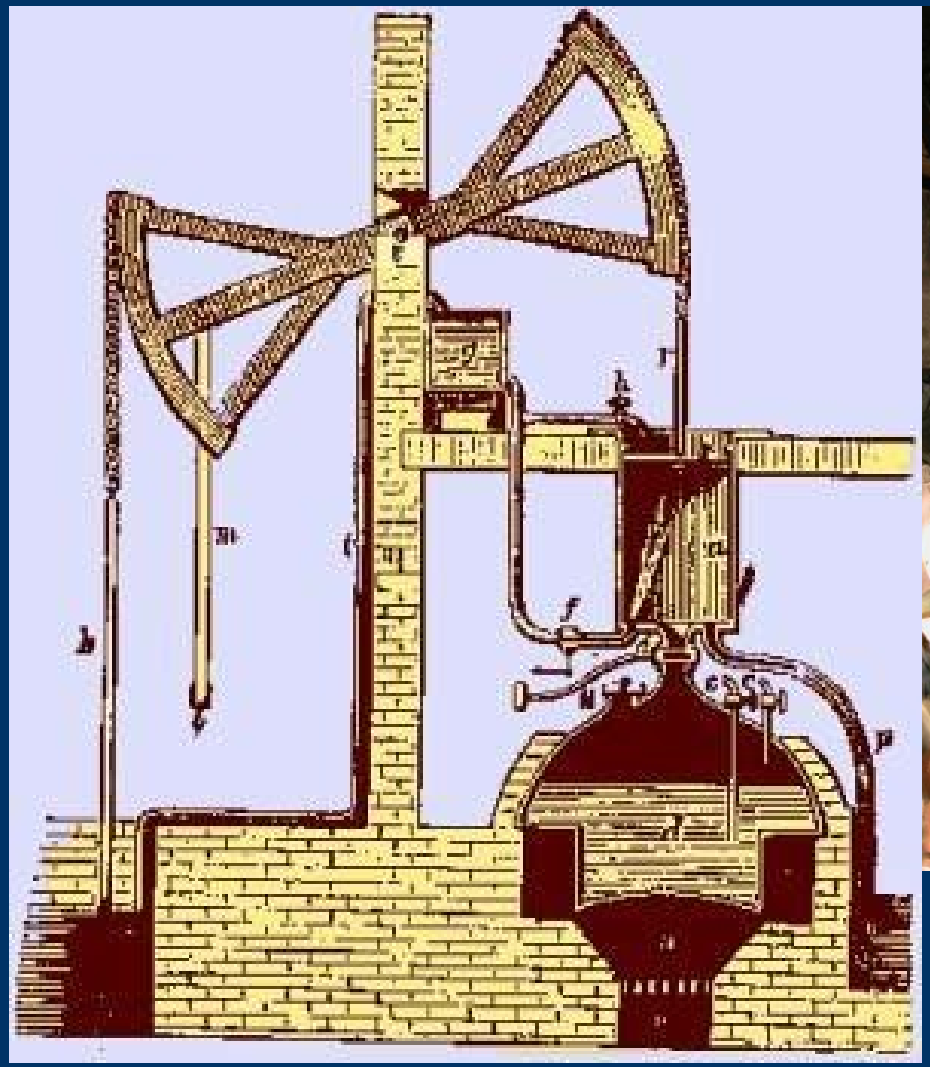
Toward Instant Manufacturing

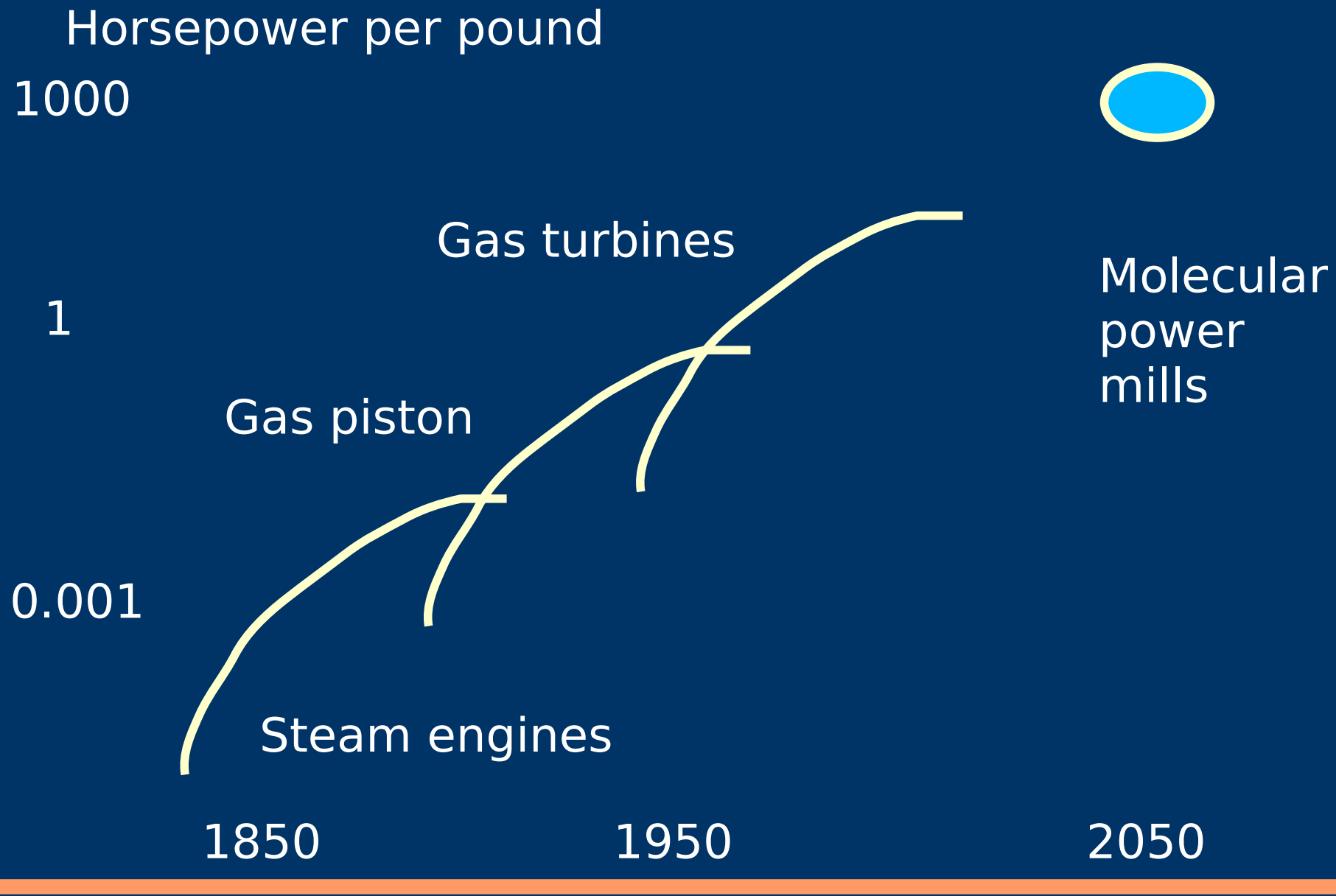
J Storrs Hall

Engines



http://inventors.about.com/library/inventors/blnewcomen.htm

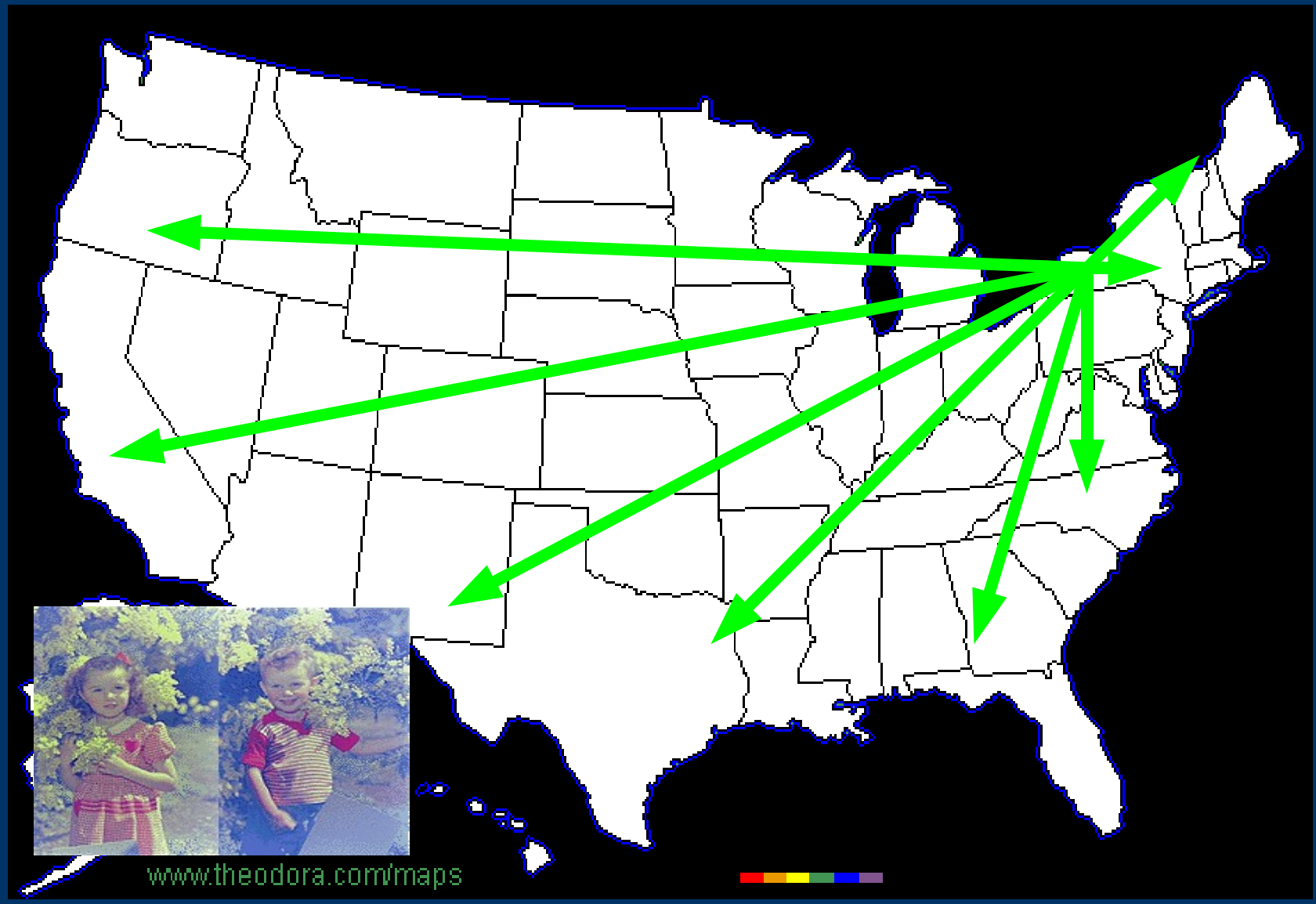
Trend Curves



Snapshots

http://www.kodak.com/US/en/corp/kodakHistory/1930_1959.shtml

Snapshots



http://www.kodak.com/US/en/corp/kodakHistory/1930_1959.shtml

Snapshots

One-hour photo shops

http://www.katesonehourphotoandstudio.com/

Instant photography

http://www.hilary.com/reviews/polaroid.html

Convenient Photography

http://www.steves-digicams.com

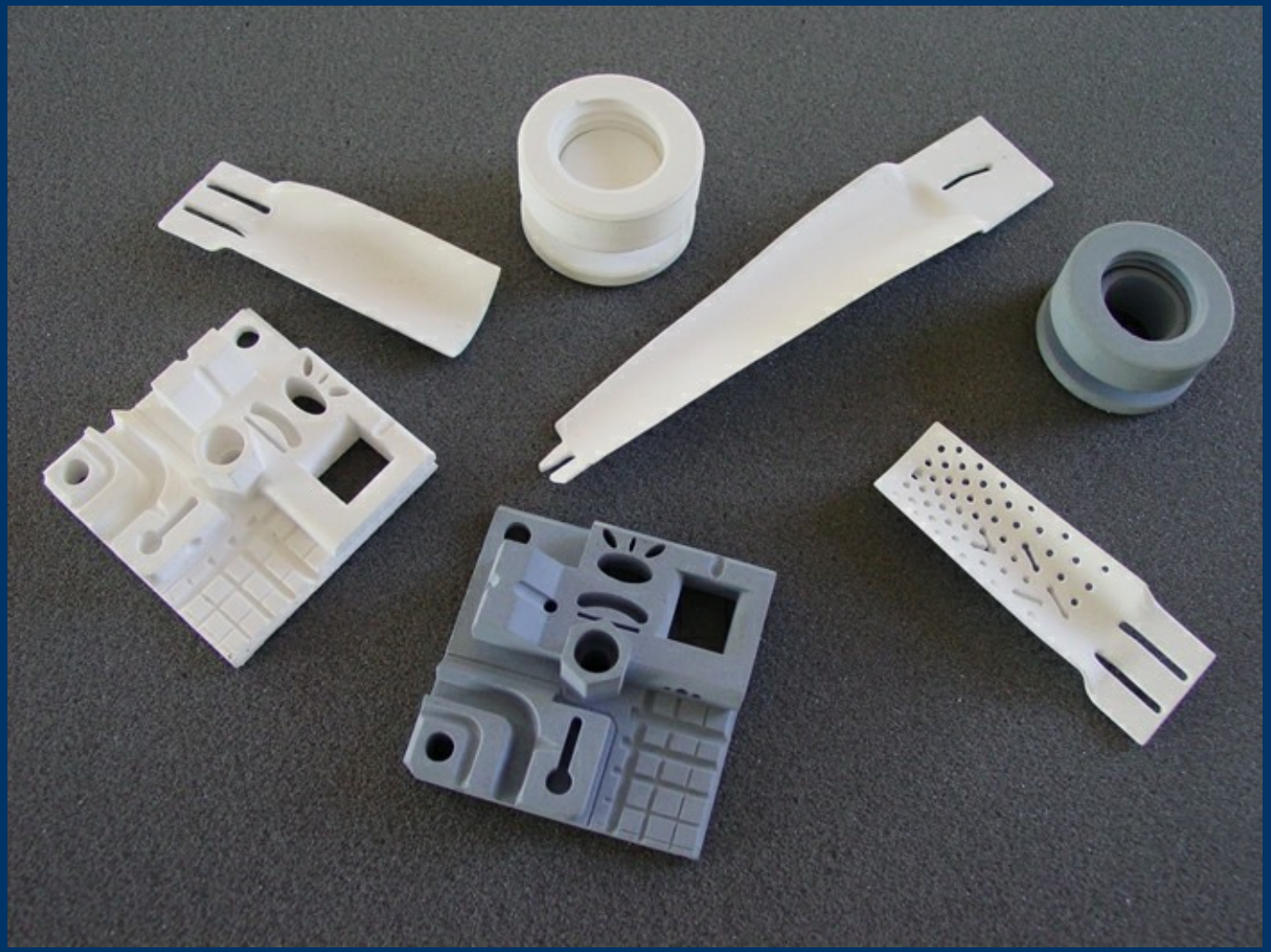
No, Really instant

http://www.motorola.com/motoinfo

http://www.ccrane.com/images/large/nikon-coolpix-s1-digital-camera-screen.jpg

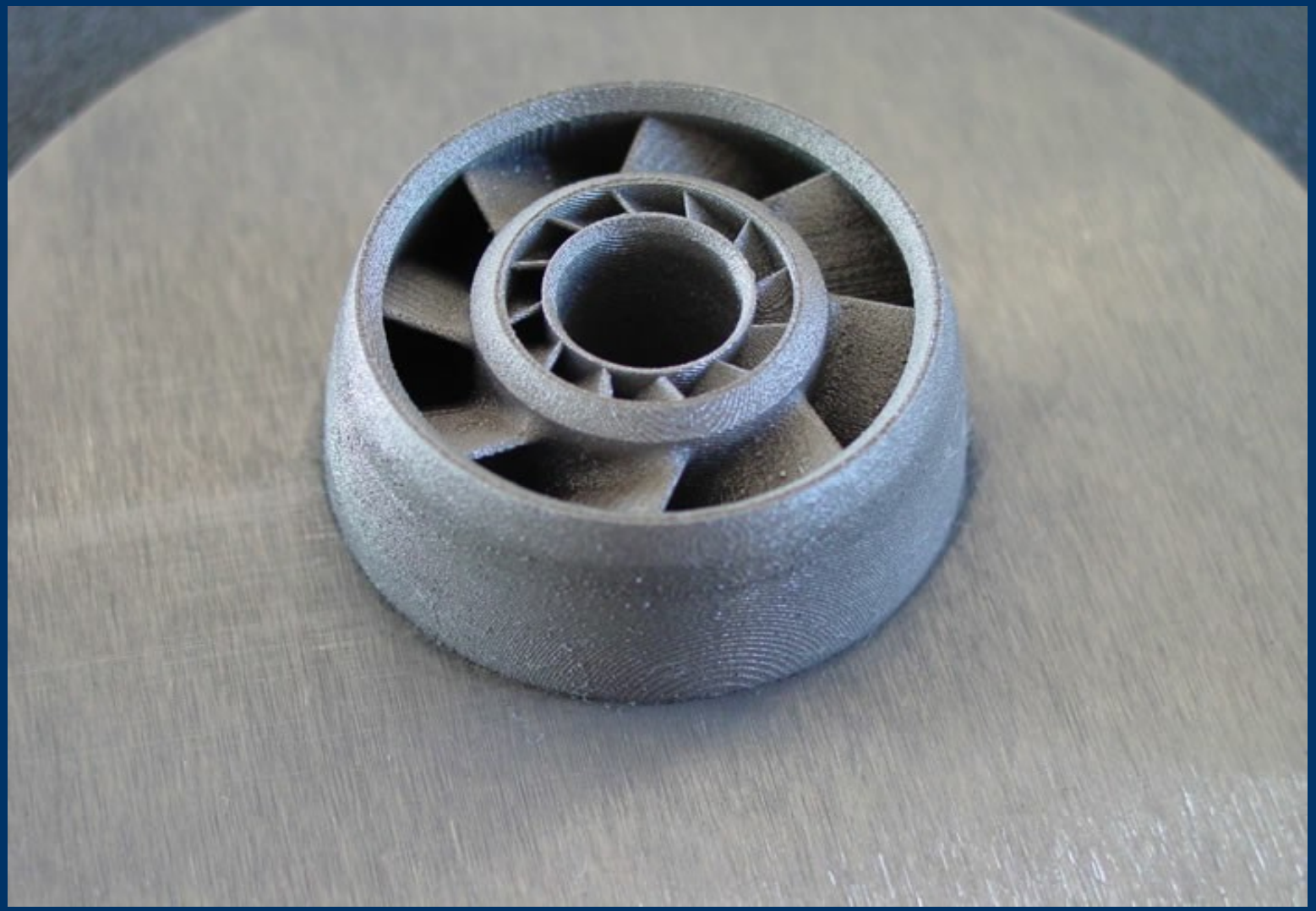
Trend Curves

Rapid Prototyping



http://www.phenix-systems.com/produits/pm_250.htm

Rapid Prototyping



http://www.phenix-systems.com/produits/pm_250.htm

“Polecat” UAV

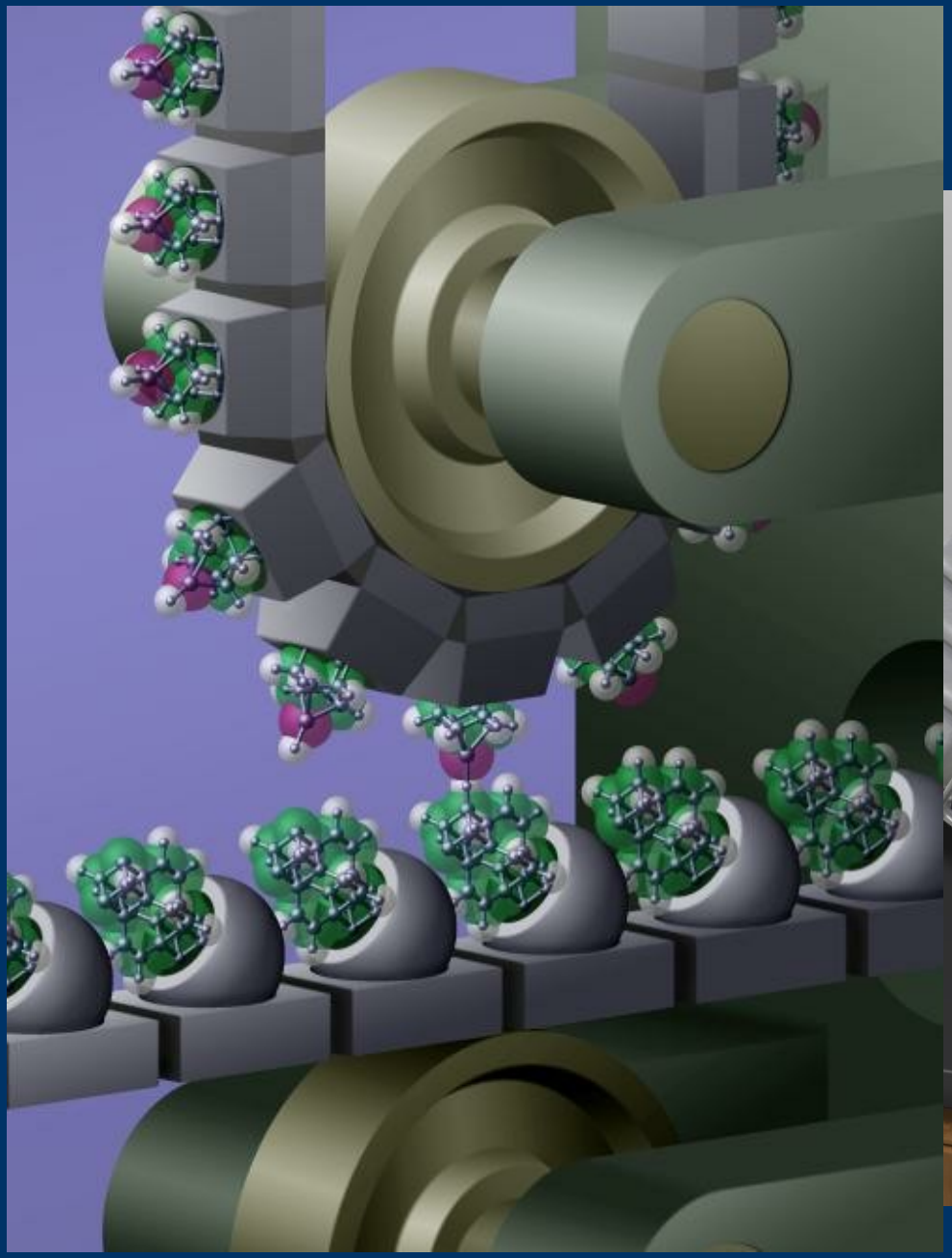
http://www.newscientisttech.com/channel/tech/dn9602.html

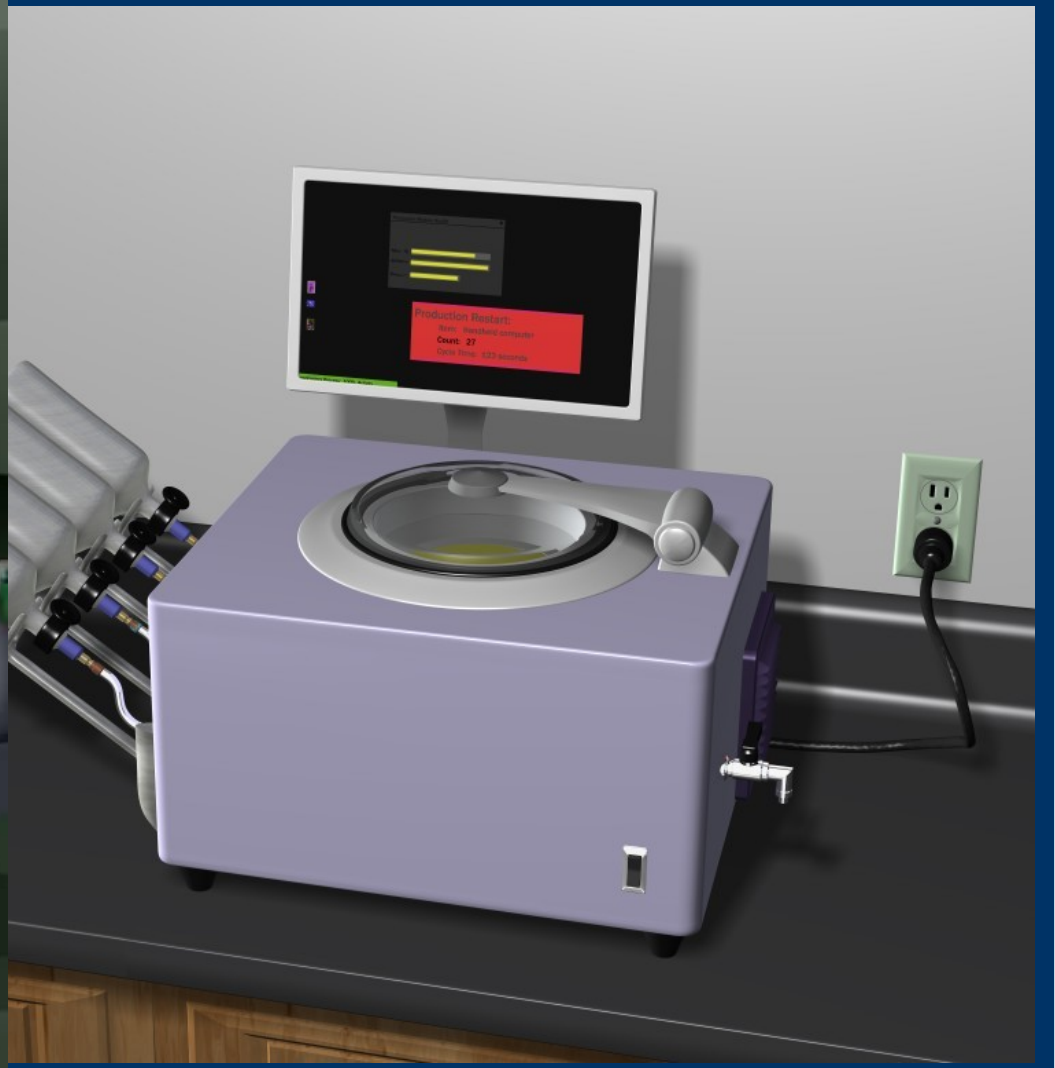
... to 3D printers

http://www.3dsystems.com/products/sla/viperHA/index.asp

http://www.3dsystems.com/products/multijet/invision/index.asp

Nanofactories



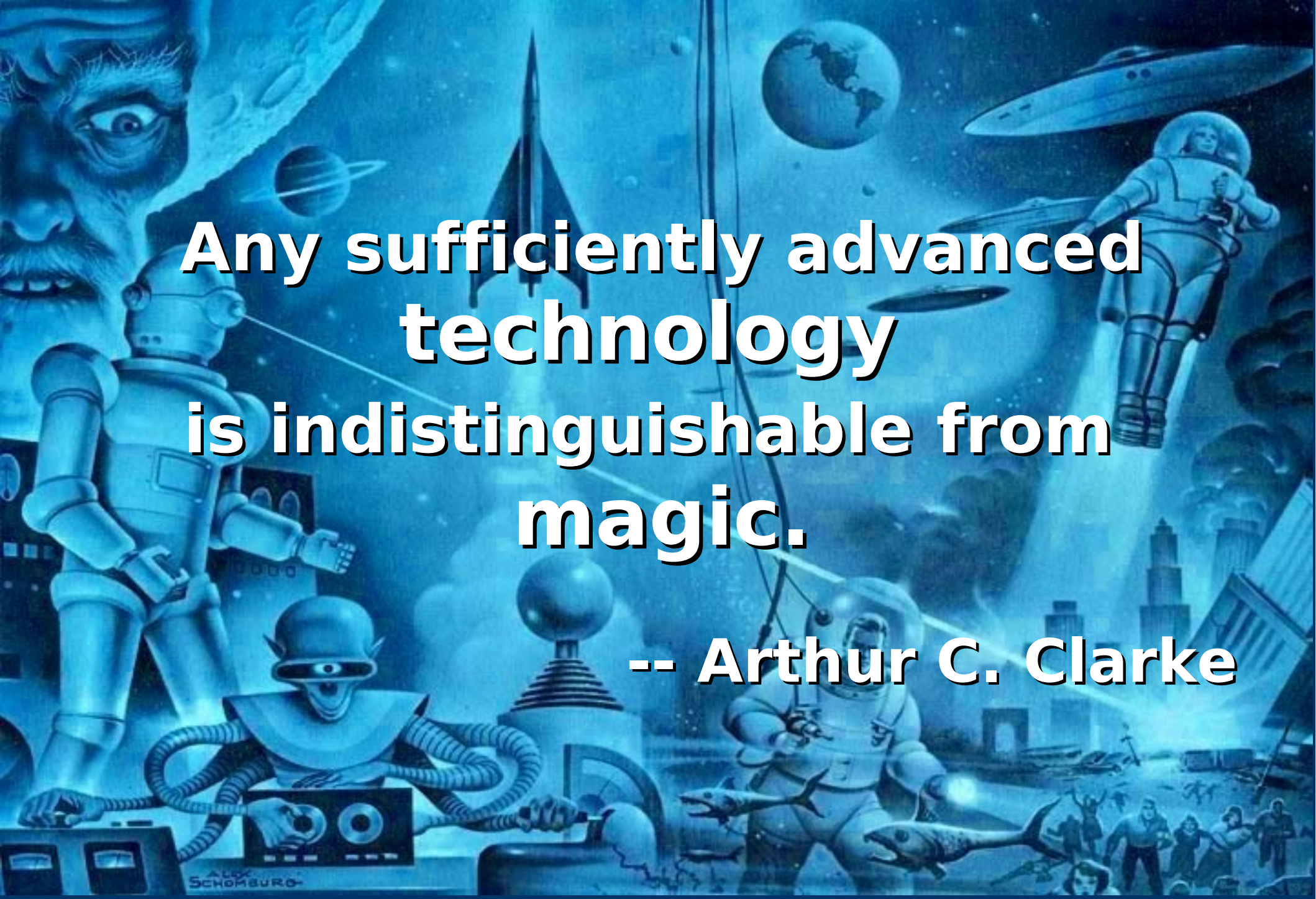


http://www.lizardfire.com/html_nano/nano.html

Trend Curves

No, <u>Really</u> instant manufacturing

- As fast and convenient as the digital camera
- As available and ubiquitous as the cell-phone camera
- Not just hand-held widgets: we want
  - Furniture
  - Architecture
    - Not just door openers – door makers
  - Vehicles
  - Cities


Any sufficiently advanced
technology
is indistinguishable from
magic.
-- Arthur C. Clarke

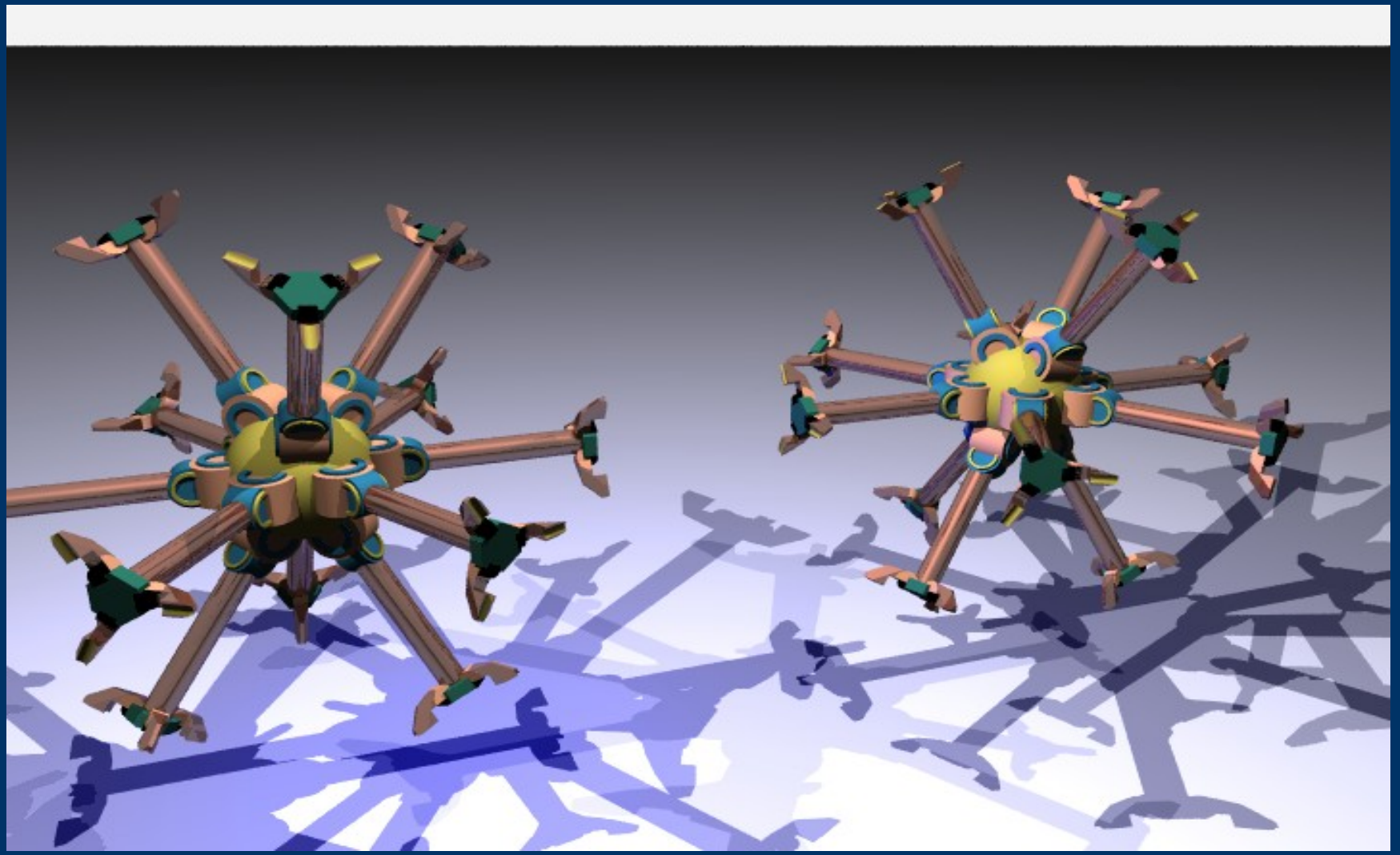
The Basic Idea

- Utility Fog is a substance with programmable physical properties
- It can simulate many materials to a fidelity that fools human senses
- It can flow from one shape to another
- It can do things “dumb matter” cannot, such as being solid in one dimension and liquid in another

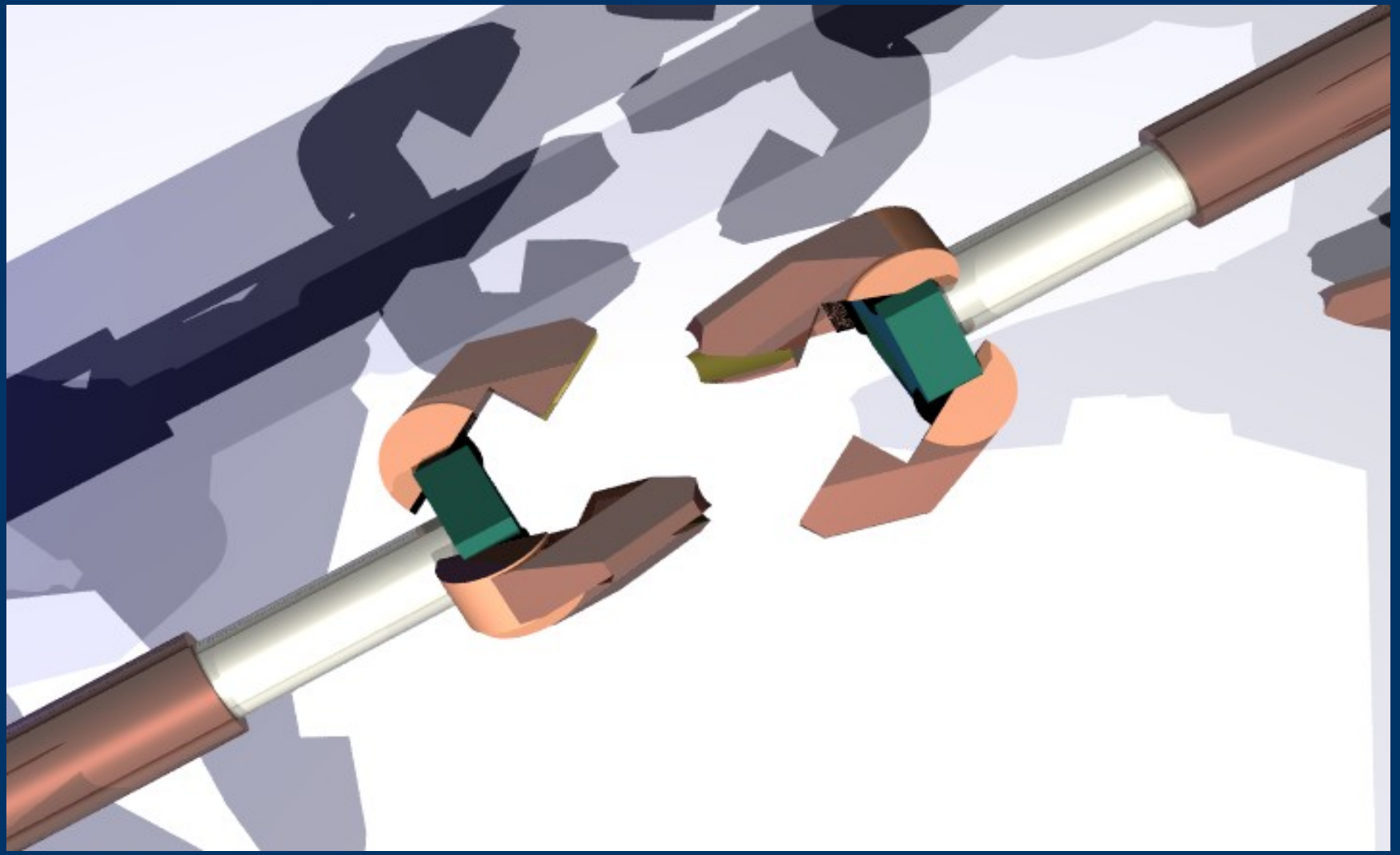
How it works

- It's a robotic aerogel
- A pile of tiny robots, the size of human cells, that can push or pull each other
- The program they run determines whether the mass acts like solid, liquid, or gas

How it works



How it works



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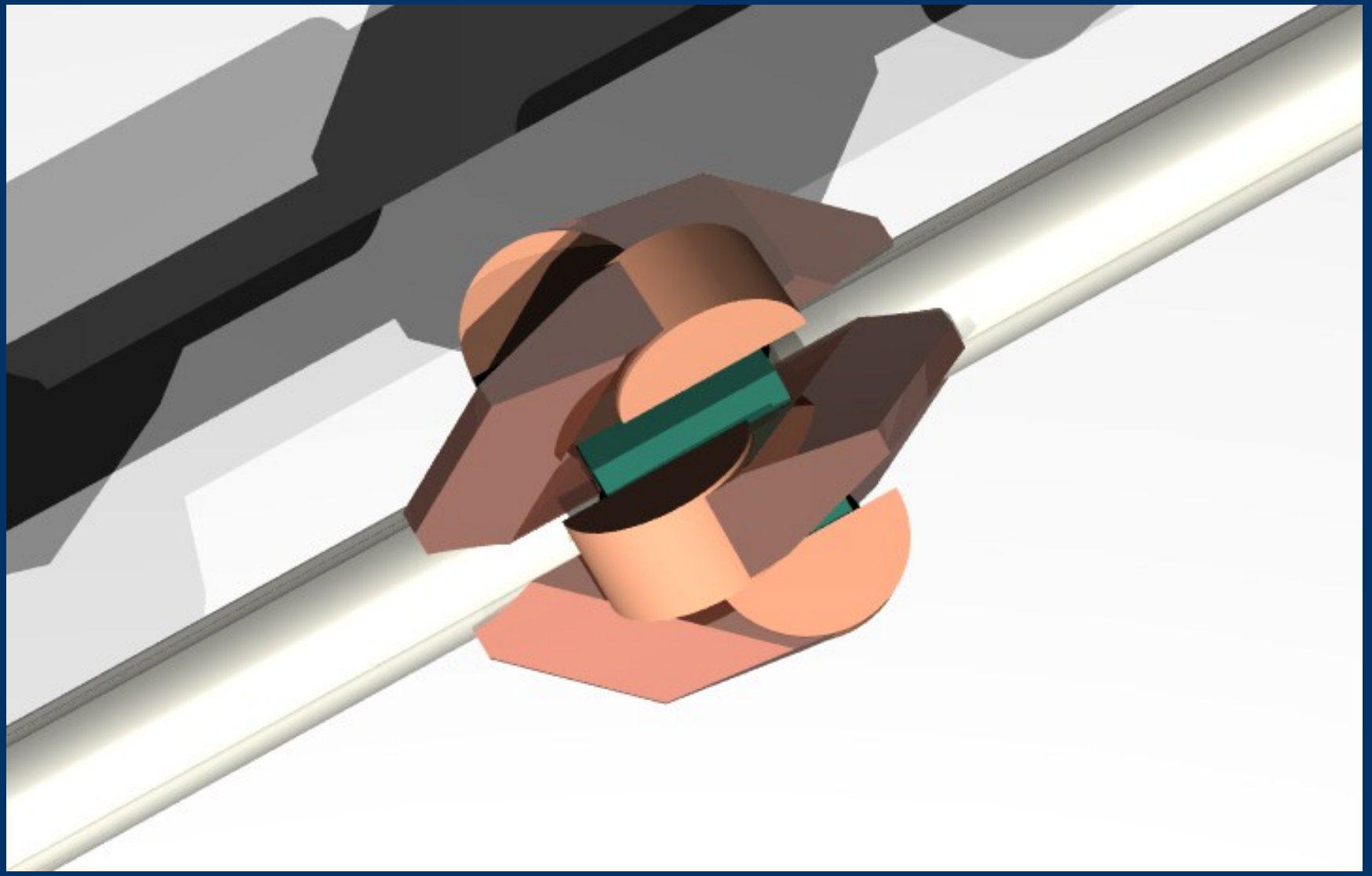

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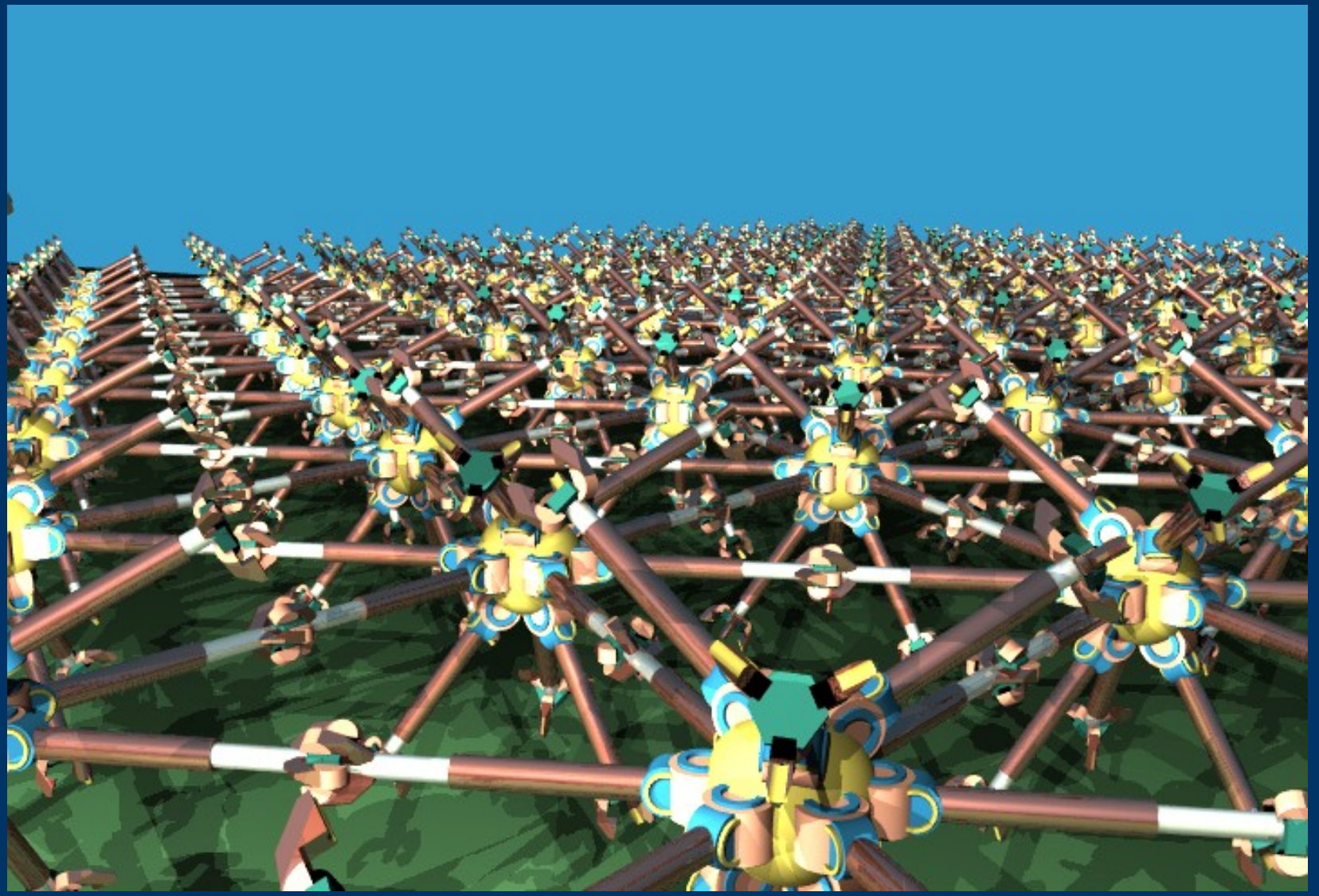


Material Properties

- Approximately the strength and density of balsa wood
- Can simulate air
  - Powered assist makes it easy to move
- Can simulate water
  - Powered drag makes it harder to move: apparent density and viscosity are programmable
- Solids: soft, hard, brittle, ductile, rough, smooth, sticky, crumbly, etc.

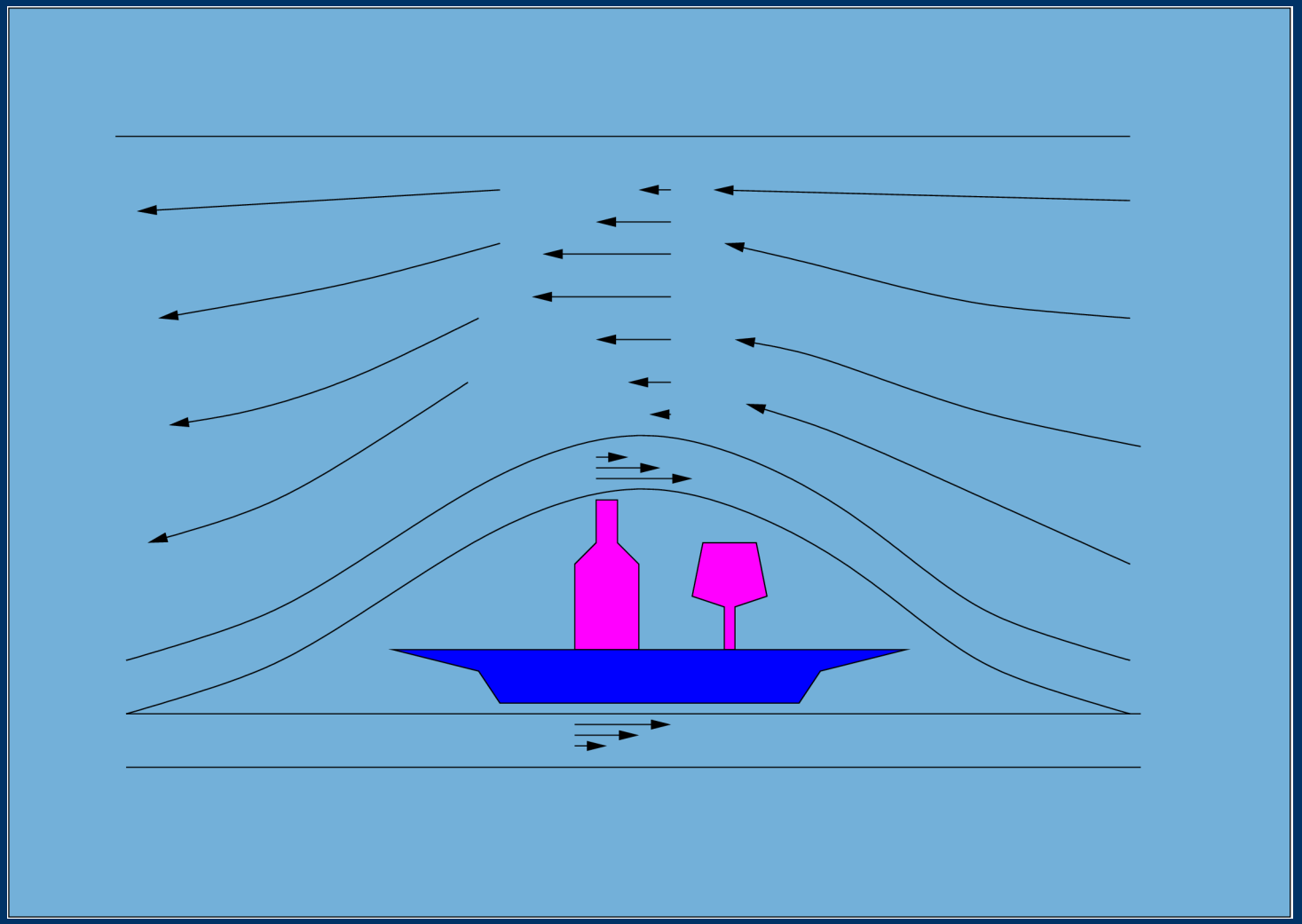
Naive Mode objects

- Ordinary object made of Fog
- Can change from one to another by flowing from shape to shape
- Easy to simulate surface properties
- Hard to simulate strength and weight

Fog Mode objects

- Fill the whole room with Fog
- You are immersed in it – it normally simulates air
- Objects can appear and disappear instantly by changing the program
  - Cf how pictures appear on TV screen
- Weight and strength easy to simulate
- Surface appearance needs some help

Real objects in Fog Mode



Telepresence

- The Fog you're in simulates some other location
- Fog at the other location simulates you
- Various properties of the location, scale, temperature, illumination, gravity, atmosphere, etc, can be mapped to more congenial ranges
- Virtual Reality: the other location is in some computer's imagination

Universal Infrastructure

- Utility Fog will handily generate on demand:
  - Buildings, roads, vehicles
  - Furniture, appliances, tools
  - Sporting goods from balls to campers
  - Office equipment and computers
  - Clothing, makeup, personal effects
  - Valets, housemaids, groundskeepers, masseurs, and other servants

What it CAN'T do

- Direct physical emulation of
  - Sharp edges or points
  - High (metal melting) heat
  - High density (like metal)
  - High strength (like metal or composites
- Chemistry
  - It can't do chemistry
  - Can't substitute, e.g., for food
- Self-Reproduce!!!!

A Day in the Life

- I dropped over to Fred's place
- He looked like the very Devil
  - I shifted to Frosty the Snowman as I circumnavigated his lava pits
- We decided to breakfast at La Belle Maison on the way to the zoo
- Took a leisurely fly through the park
- Went shopping in Emerald City

Getting from Here to There

- We can build the robots now
  - But they're too big;
  - And too expensive
- We can start on the software now
  - Watch out for bugs
  - Probably won't be ready until after the hardware is!

Our revels are now ended. These our actors ... are melted into air, into thin air. And like the baseless fabric of this vision, The cloud-capped tow'rs, the gorgeous palaces, the solemn temples, ... shall dissolve, and like this insubstantial pageant faded, leave not a rack behind. We are such stuff as dreams are made on, and our little lives are rounded in a sleep.

-- William Shakespeare