Future Directions for Capture Technology: Alternative Visions

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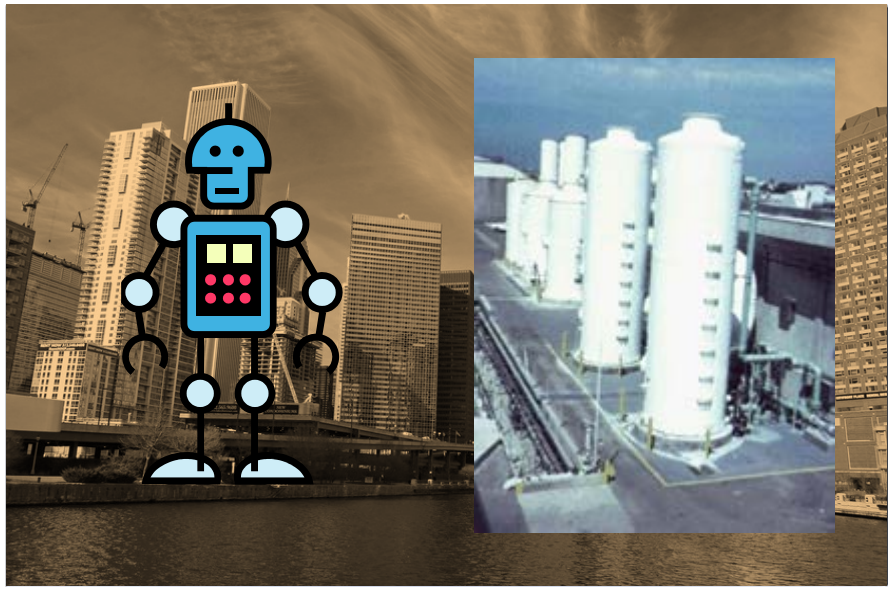
What does the future of capture look like?

Asimov

(Robot Series)

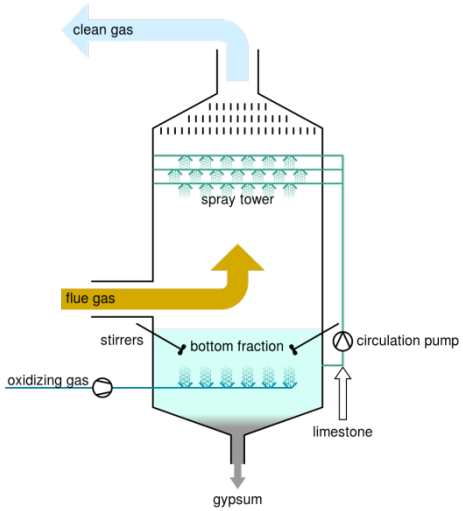


Roddenberry

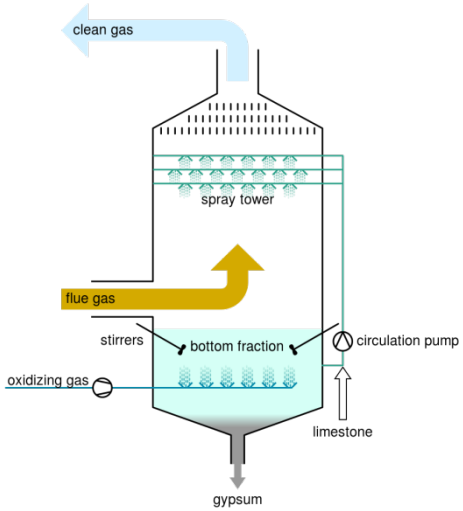
(Star Trek)

Asimov's Argument

- **Certain things don't change (much).**
  - Asimov: People
  - Capture: Laws of Thermodynamics
- **History teaches us a lot about the future.**



Flue Gas Desulfurization
1974



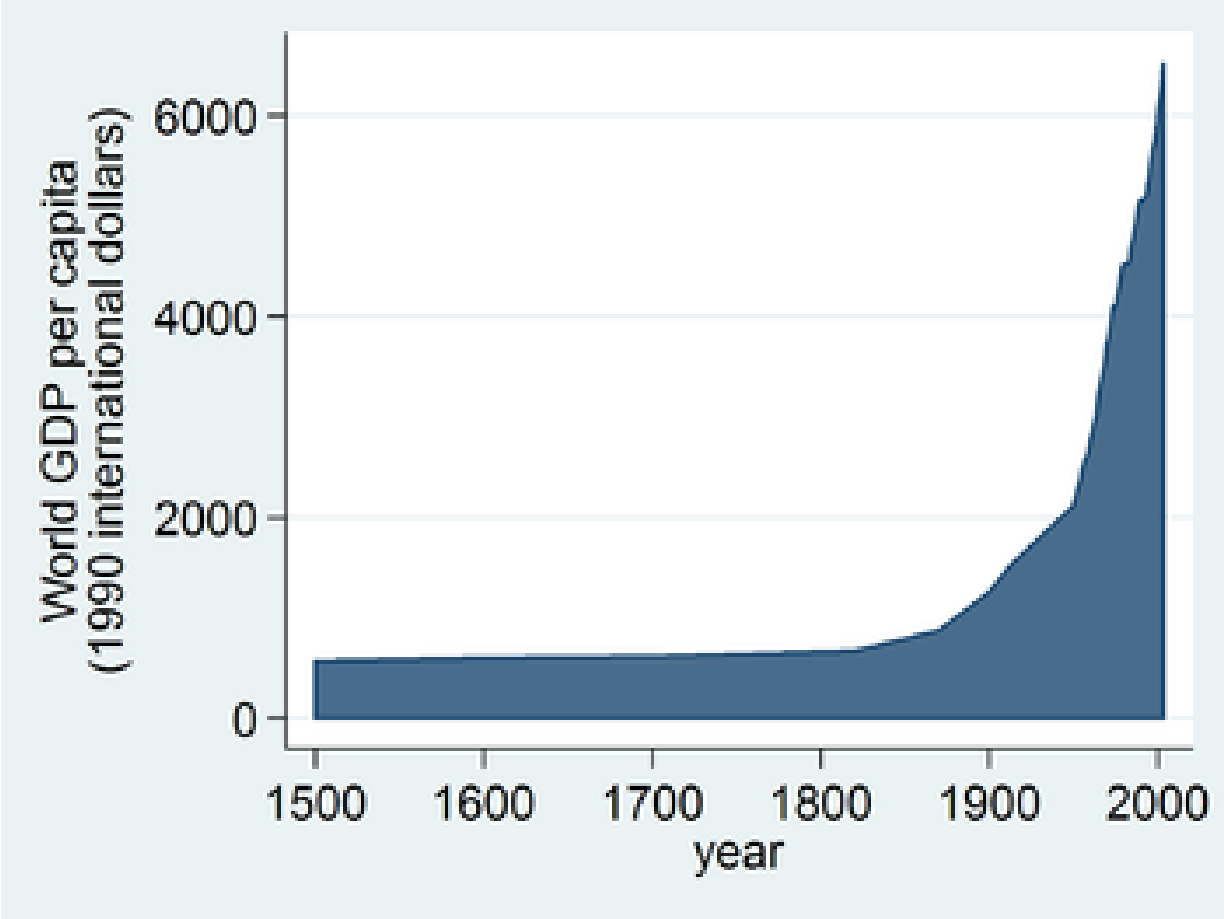
Flue Gas Desulfurization
2014

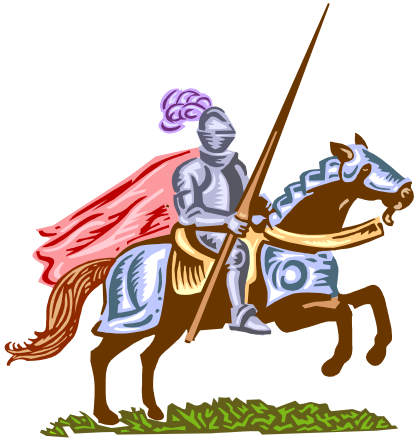
Roddenberry's Argument

- **Things change (sometimes drastically).**

Roddenberry's Argument

- **Things are changing faster all the time.**





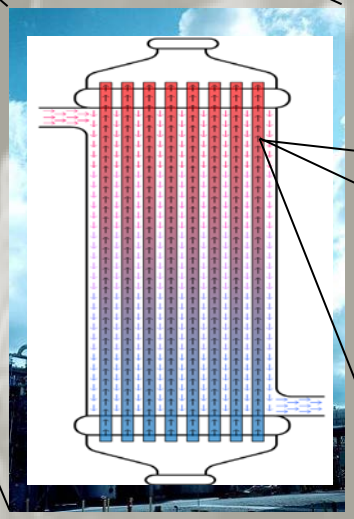
http://en.wikipedia.org/wiki/World_economy

Luebke's Argument

- **Technologists are pretty bad at predicting the future.**
  - "The Americans have need of the telephone, but we do not. We have plenty of messenger boys."—Sir William Preece, chief engineer, British Post Office, 1876
  - "When the Paris Exhibition [of 1878] closes, electric light will close with it and no more will be heard of it." – Oxford professor Erasmus Wilson, 1877
  - "Fooling around with alternating current is just a waste of time. Nobody will use it, ever." — Thomas Edison, 1889
  - "There is not the slightest indication that nuclear energy will ever be obtainable. It would mean that the atom would have to be shattered at will." — Albert Einstein, 1932

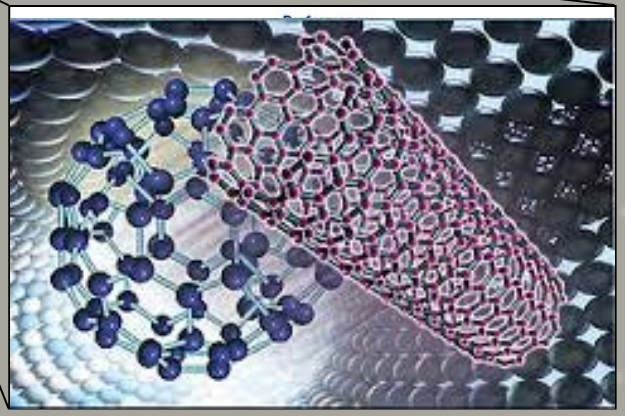
How do we build the Enterprise for capture?

Plant Scale



Device Scale

Integrated Materials Development



Materials Scale

Process Scale

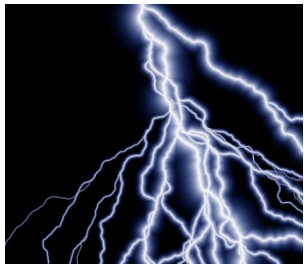
Fundamental Process Changes

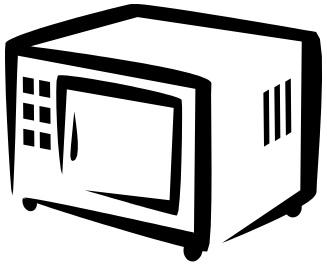
- **Oxy-fuel Combustion**
- **Chemical Looping Combustion**
- **Pressure Gain Combustion**

Process Scale

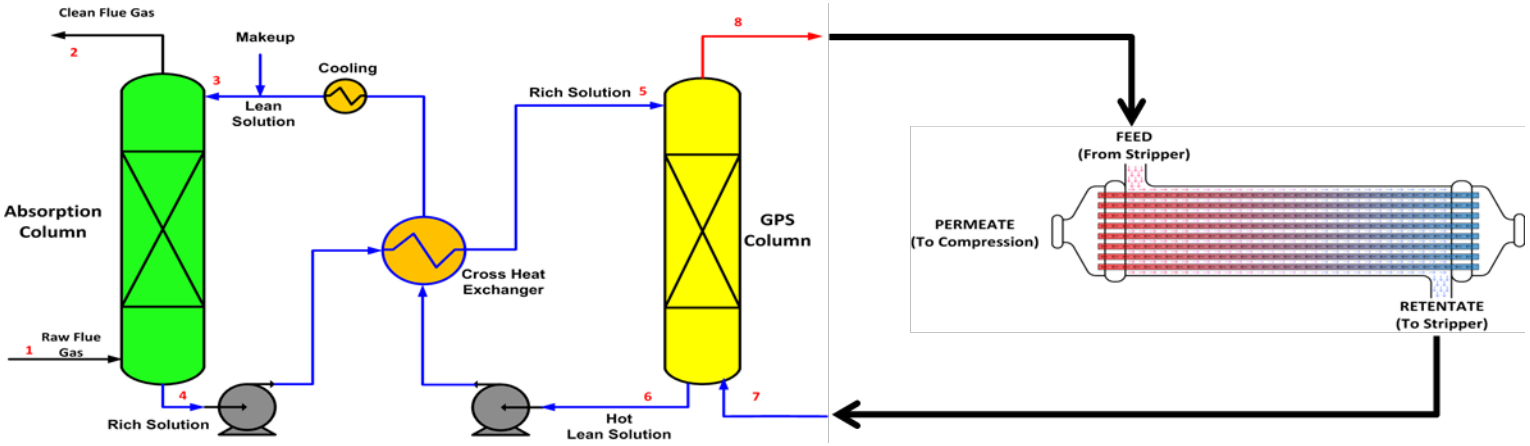
Capture Island Changes

- **Alternative Driving Forces**





- **Hybrid Capture Schemes**



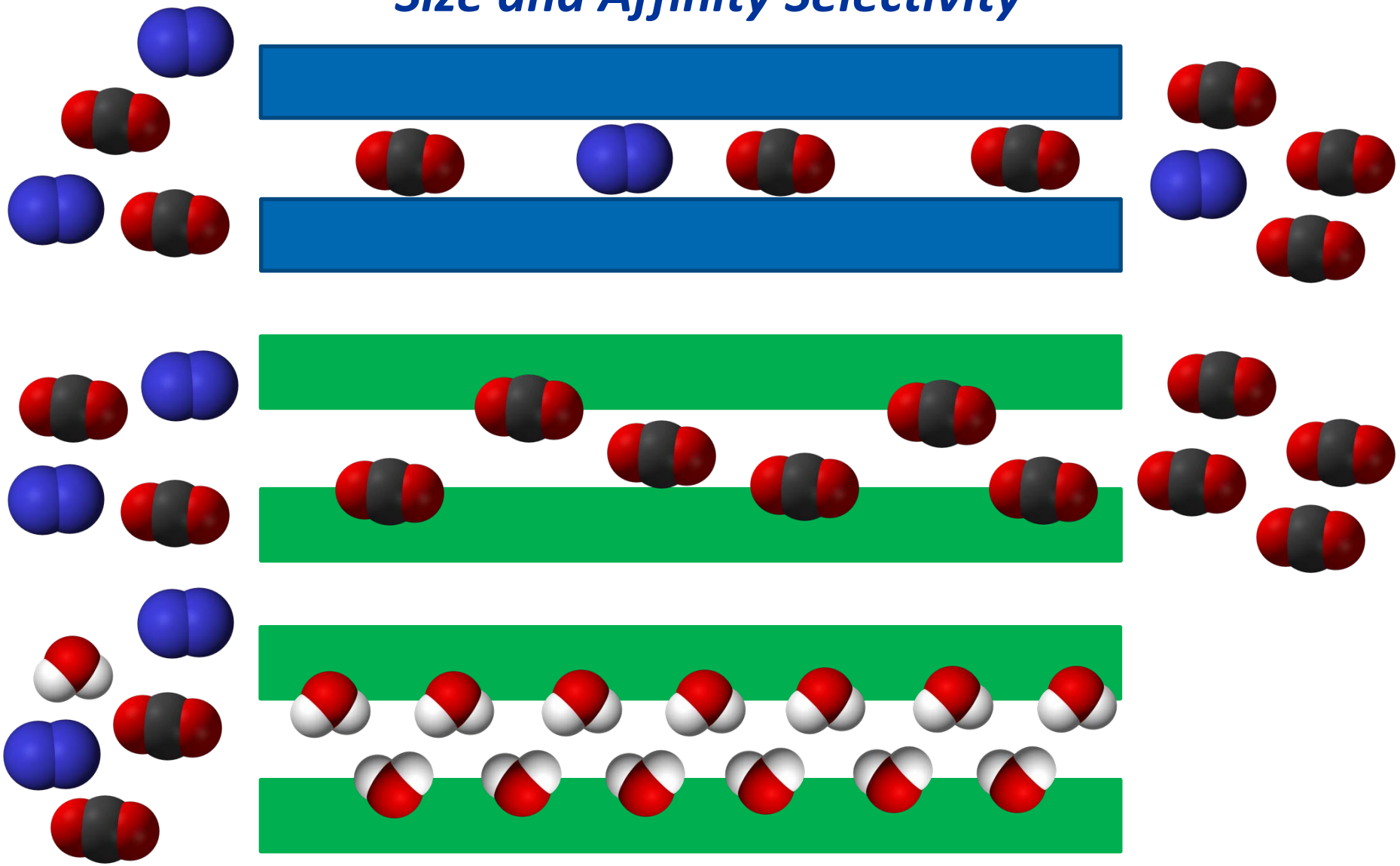
Materials Scale

Nano-engineering – Building the Right Molecule Shape, Size, and Affinity Selectivity

- **Tuned Chemical Affinity**
- **Size Selectivity**
- **Shape Selectivity**
- **All Three at Once**
- **All Three at Once in Realistic Environment**

Materials Scale

Size and Affinity Selectivity



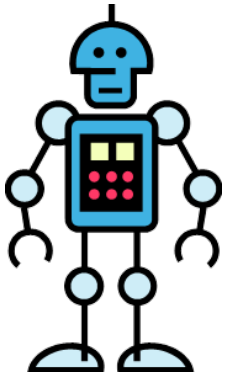
How do we get there?

We keep doing what we're doing.

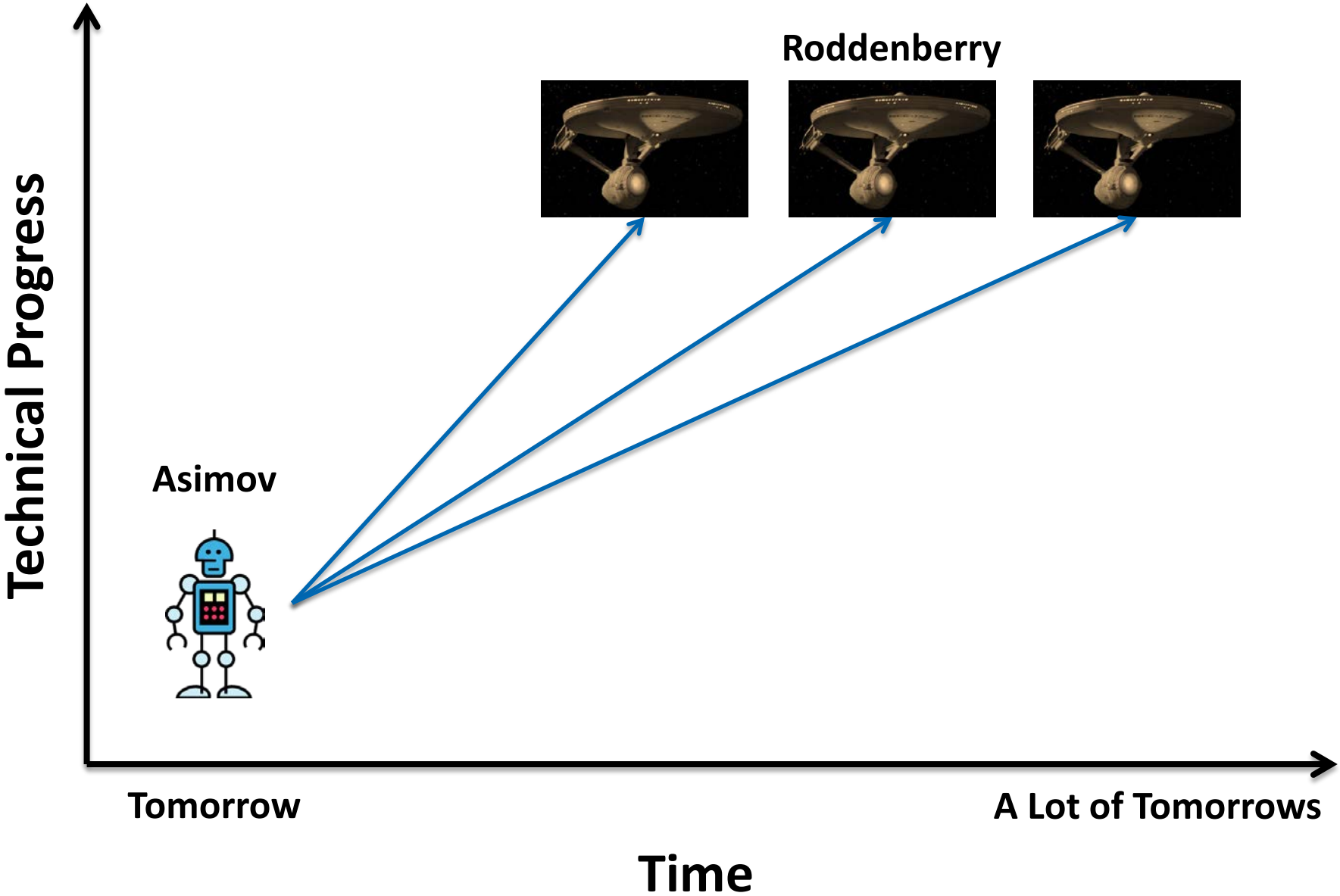
- **Accurate Computational Modeling**
  - Molecular
  - Fluid Dynamics
- **Precision Synthesis and Fabrication**
- **Rapid, Detailed Characterization**
  - Realistic Environments

- **Fundamental Understanding**
- **Rapid Optimization Tools**

"Carbon Capture: Beyond 2020" -- http://science.energy.gov/~/media/bes/pdf/reports/files/CCB2020_rpt.pdf



-or-

Who’s right?

Everyone's right.