

Georgia Institute of Technology

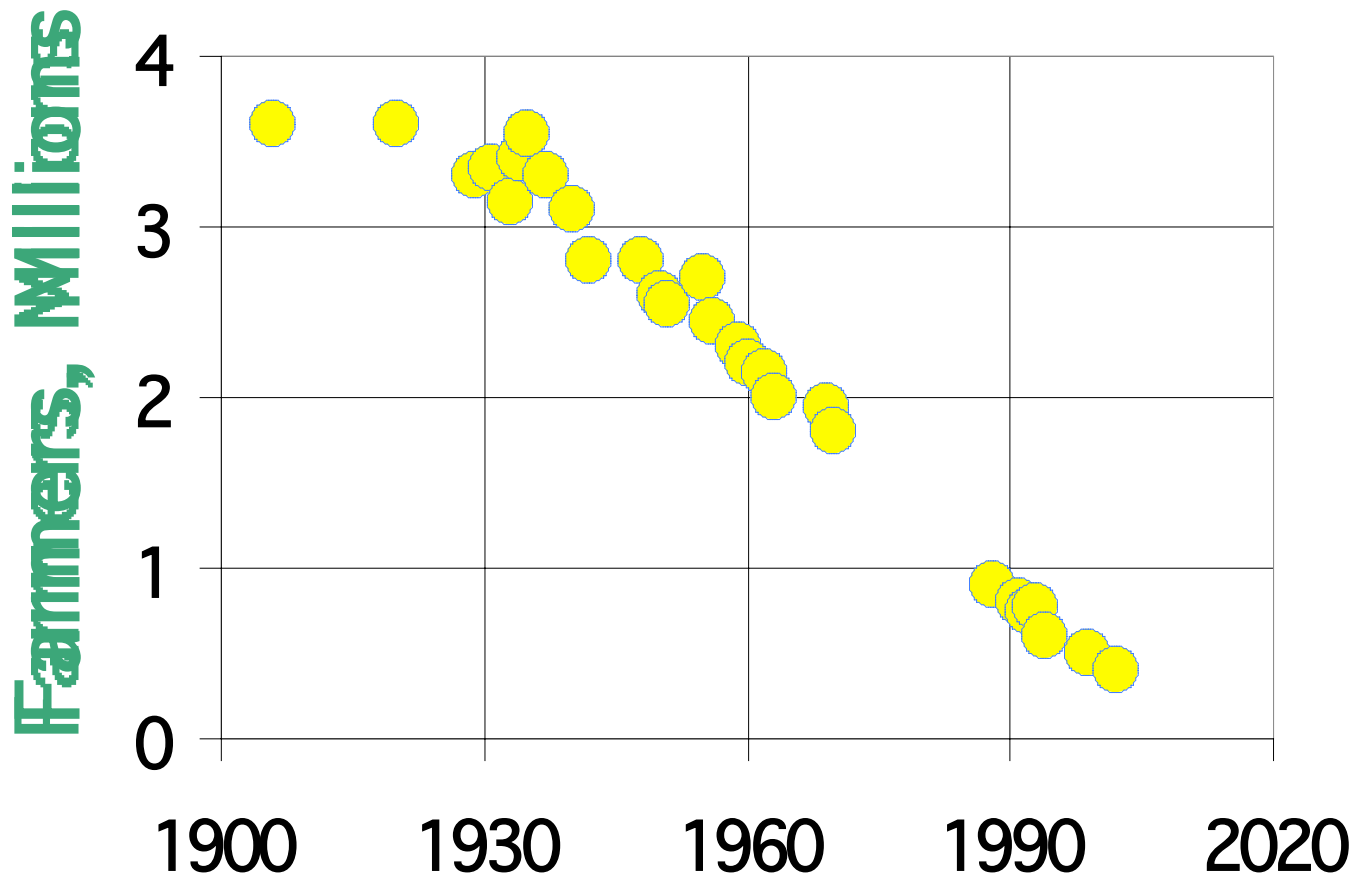
September 24, 2008

**DESIGNING NEW  
CHEMICAL PRODUCTS**

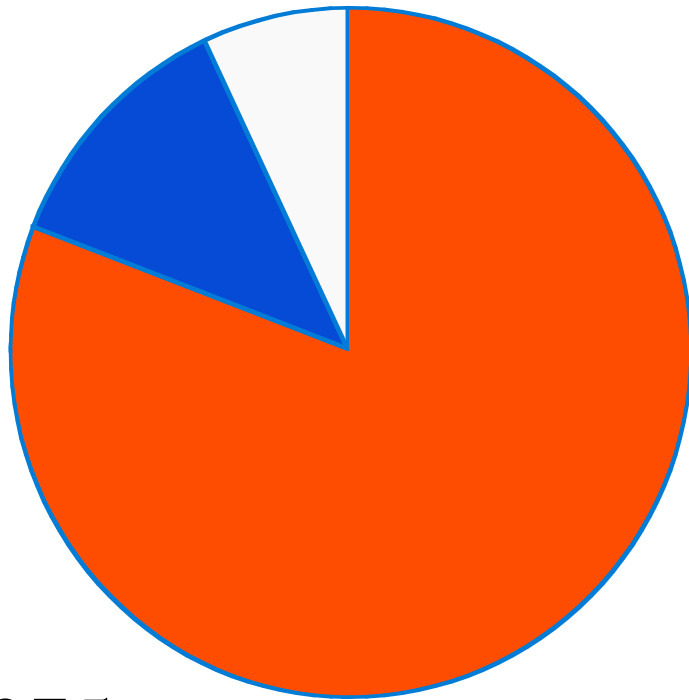
E.L. Cussler

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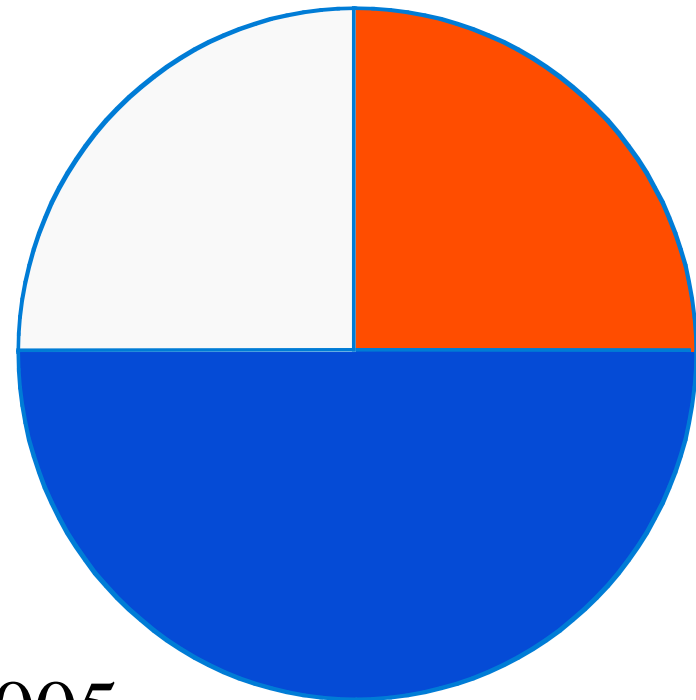
# Where the Jobs Are: Farmers = Engrs. + 100 Years



# Where the Jobs Are



1975



2005



# What Are Chemical Products?

Commodities

Molecules

Microstructures

Key

Cost

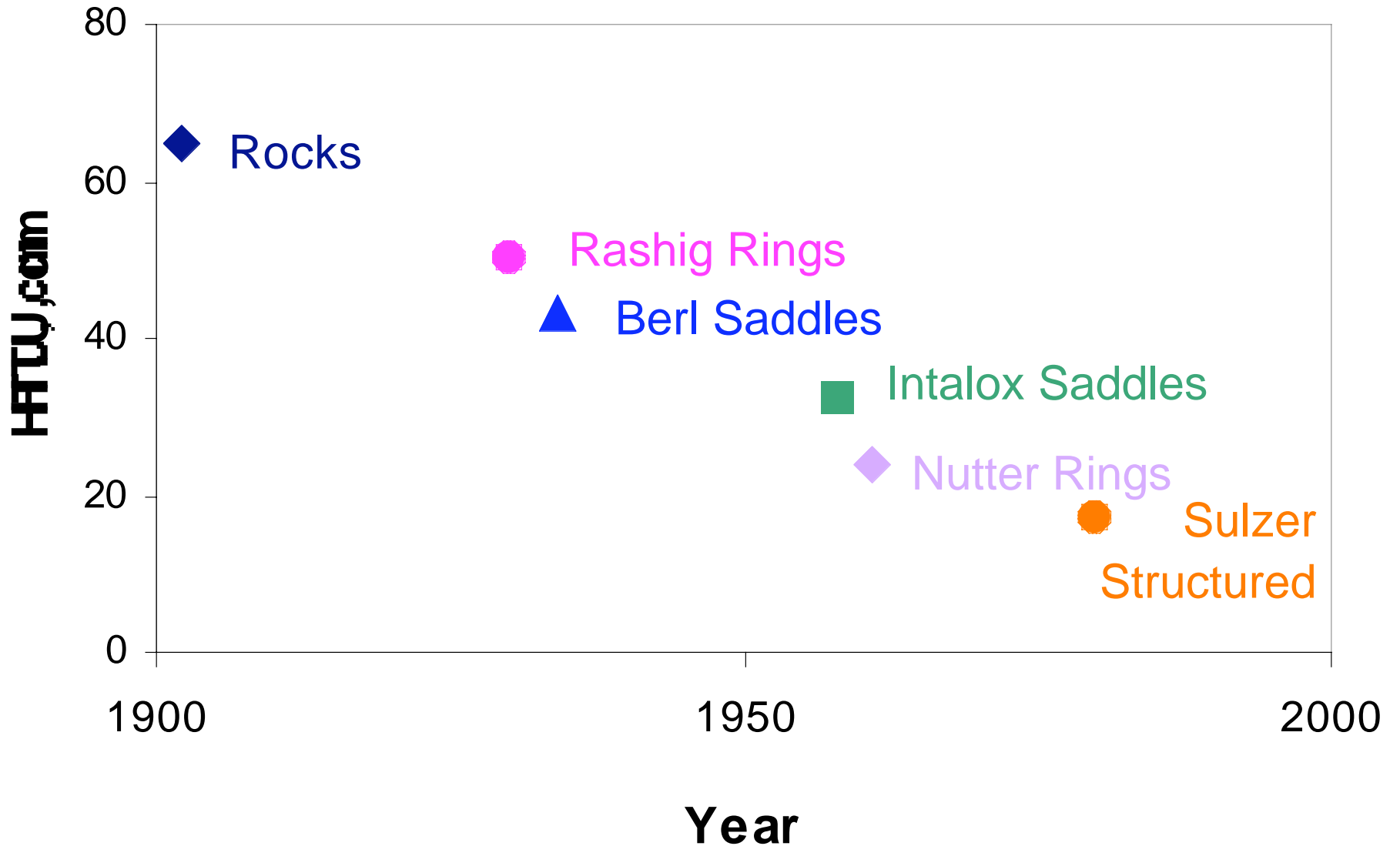
Speed

Function

Basis

Risk

# Commodities Still Improving





# What Are Chemical Products?

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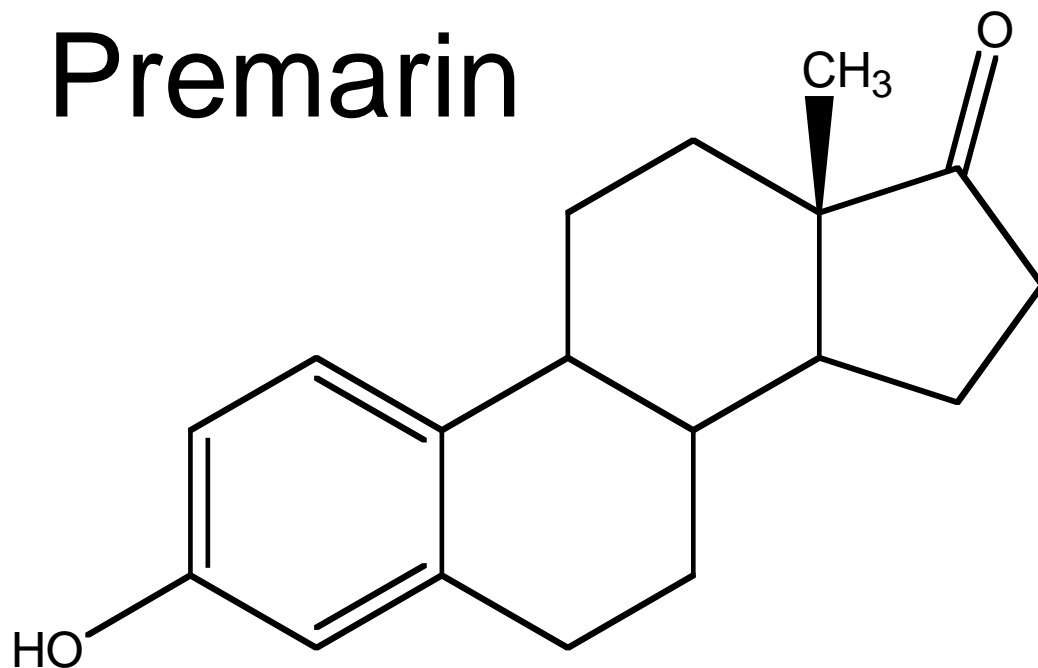
Unit Ops

Risk

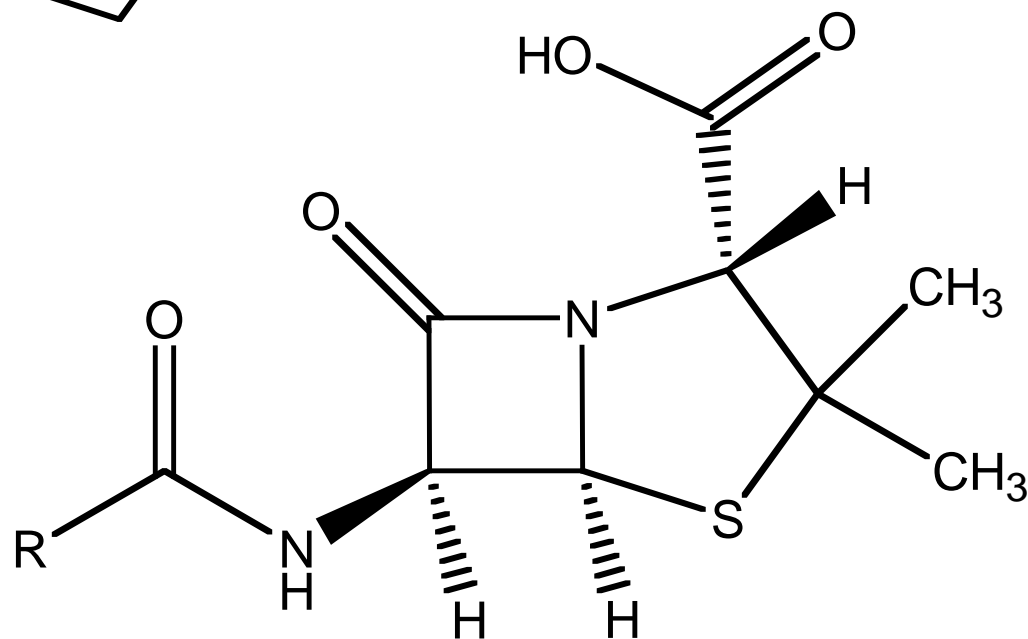
Feedstock

# Molecular Products: Drugs

Premarin

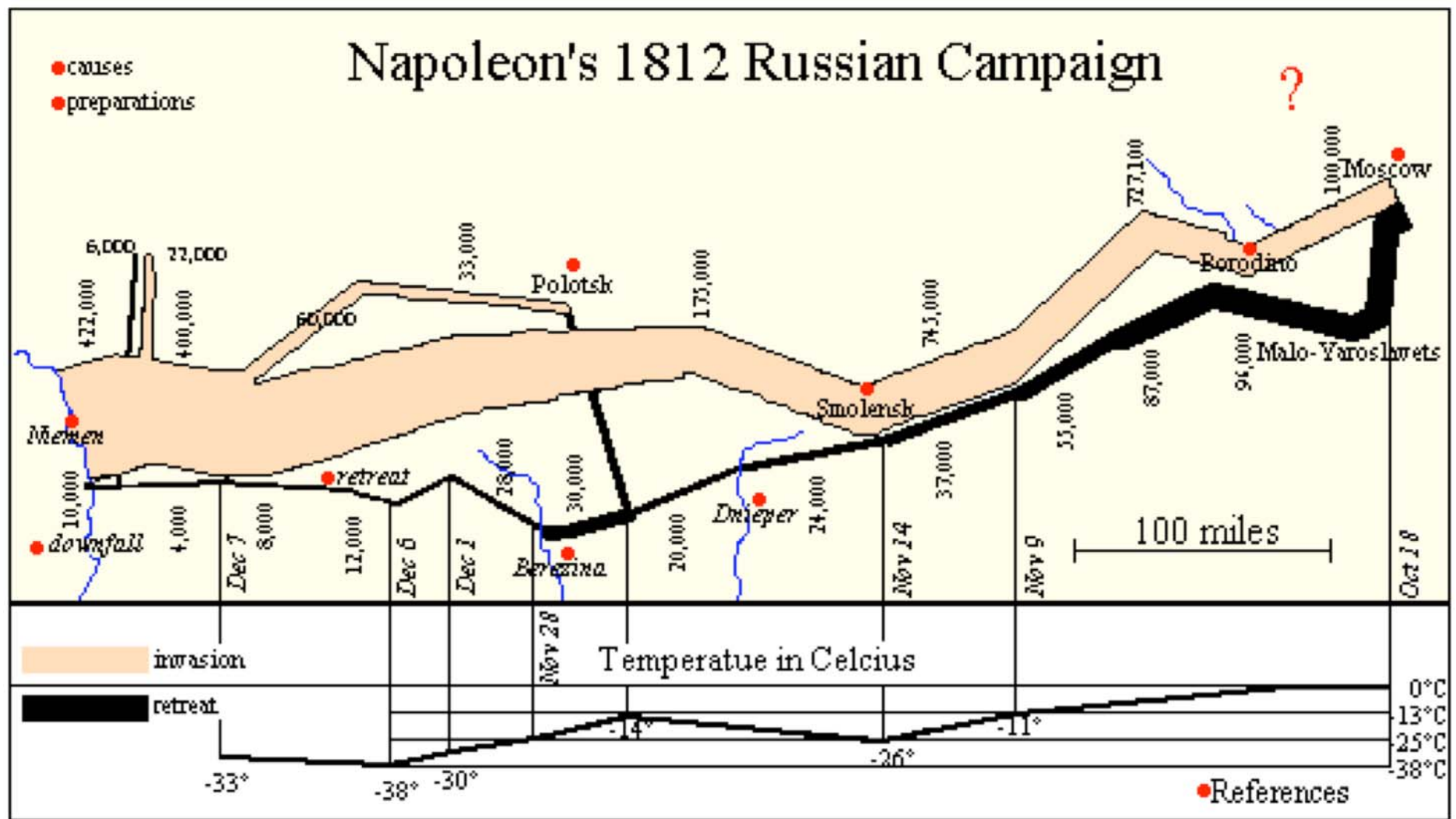


Penicillin





# Molecular Products = Napoleon in Russia



# What Are Products?

Commodities

Molecules

Microstructures

Key

Cost

Speed

Function

Basis

Unit Ops

Chemistry

Risk

Feedstock

Discovery

# Microstructures: Tooth Whiteners



# Microstructure Studies Estranged



# What Are Chemical Products?

Commodities

Molecules

Microstructures

Key

Cost

Speed

Function

Basis

Unit Ops

Chemistry

Recipe

Risk

Feedstock

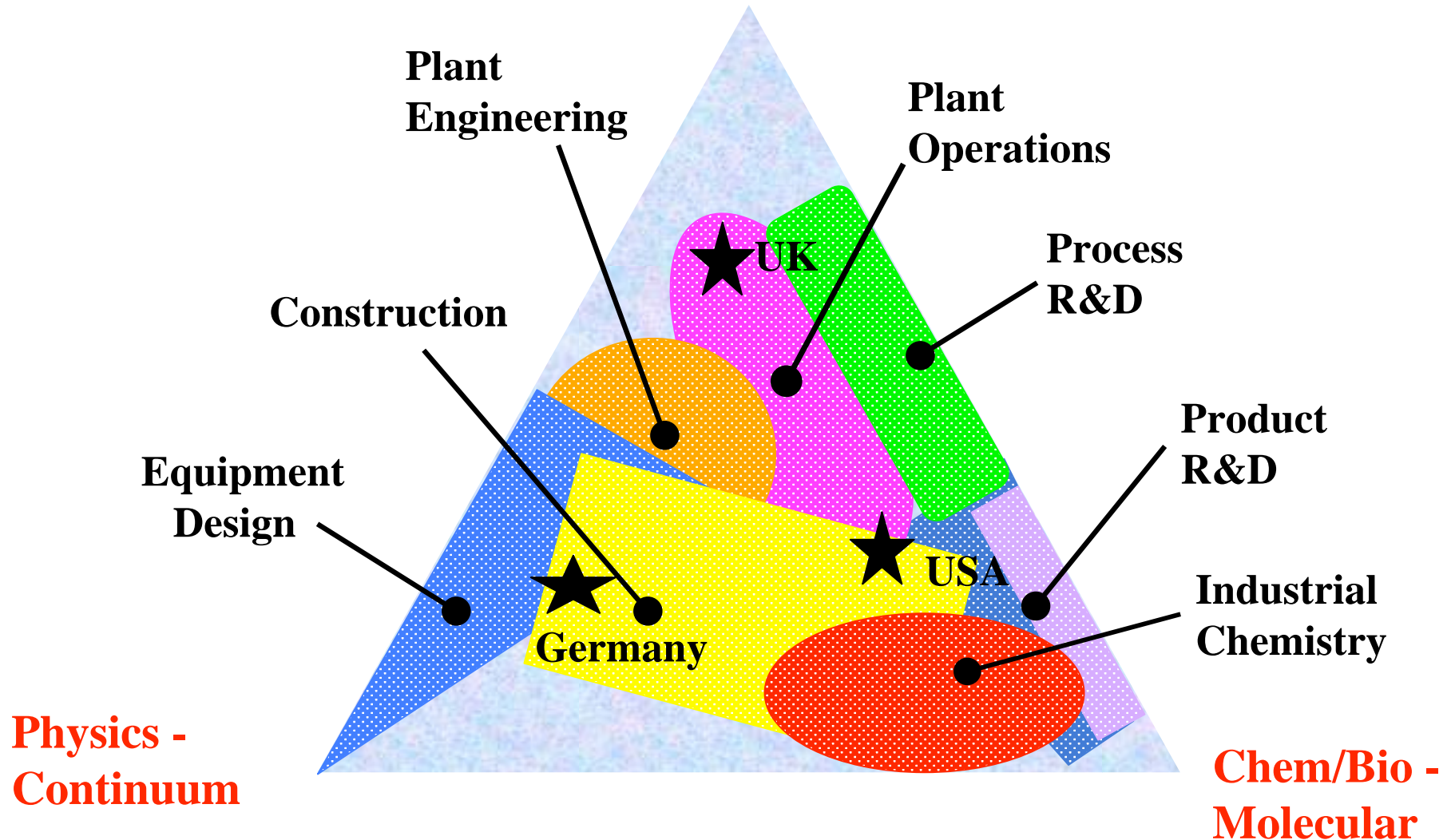
Discovery

Science

Tools for Design ?

# Current Skill Set is Good

## Chemical Engineering - Empirical



# Process Skills: How to Make?

## Process Design

1. batch vs. continuous
2. input/output
3. recycles
4. separation/heat

# Product Skills: What to Make?

## Process Design

1. batch vs. continuous
2. input/output
3. recycles
4. separation/heat

## Product Design

1. customer need
2. idea generation
3. selection
4. manufacture



# 1. Needs

**Reformed as specifications**





1. Needs

2. Ideas

**How many frogs must you kiss . . .**

1. Needs

2. Ideas

3. Selection

**Cheapest Wasn't Best....**



1. Needs

2. Ideas

3. Selection

4. Manufacture

# Which Step is Hardest?

## Process Design

1. batch vs. continuous
2. input/output
3. recycles
4. separation/heat

## Product Design

1. customer need
2. idea generation
3. selection
4. manufacture

# “Devices” Replaces “Commodities”

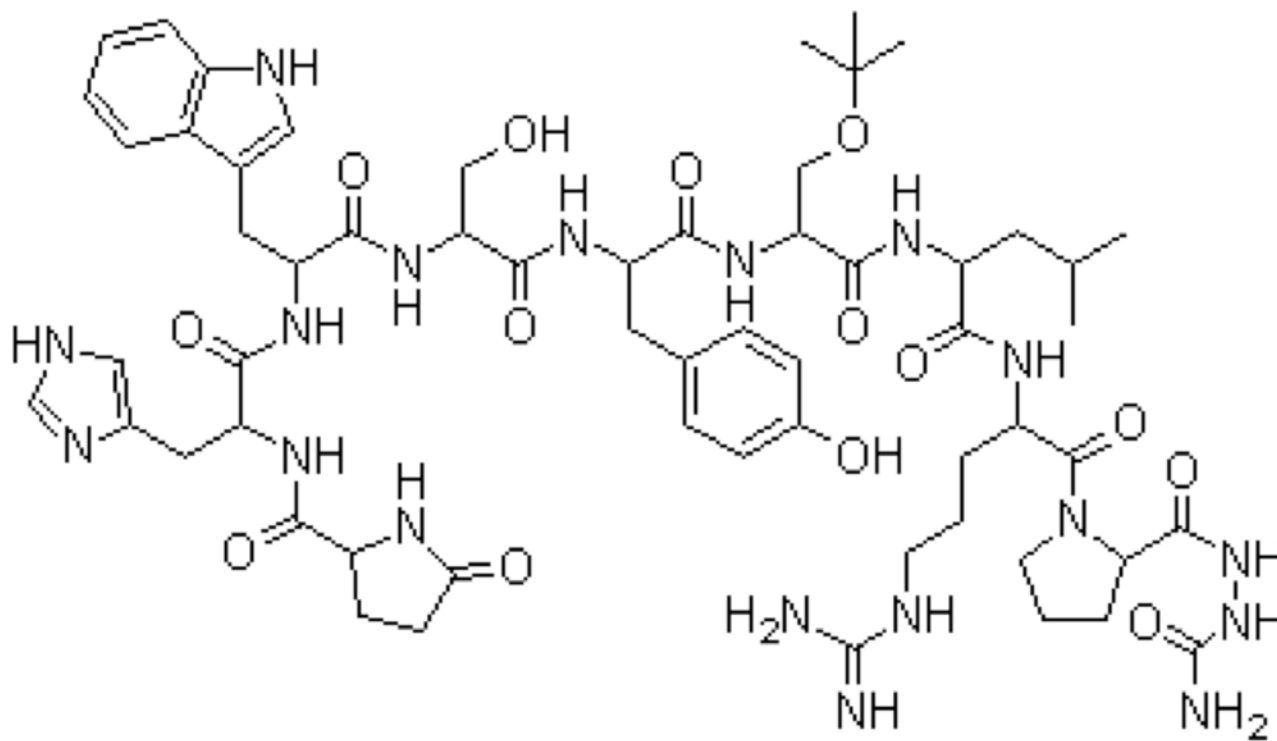


# For Molecules, Selection is Hardest

	<u>Devices</u>	<u>Molecules</u>	<u>Microstructures</u>
<u>Key</u>	Convenience	Speed	Function
<u>Tools</u>	Unit Ops	Unit Ops	
<u>Typical</u>	Adsorb	Crystallize	

# Select Molecules with Unit Ops

**46 Kilos = \$800M**



Pyr-His-Trp-Ser-Tyr-D-Ser(tBu)-Leu-Arg-Pro-Azagly-NH<sub>2</sub>



# For Microstructures, Needs is Hardest

	<u>Devices</u>	<u>Molecules</u>	<u>Microstructures</u>
<u>Key</u>	Convenience	Speed	Function
<u>Tools</u>	Unit Ops	Unit Ops	?
<u>Typical</u>	Adsorb	Crystallize	

# For Microstructures, Needs is Hardest



# For Microstructures, Needs is Hardest

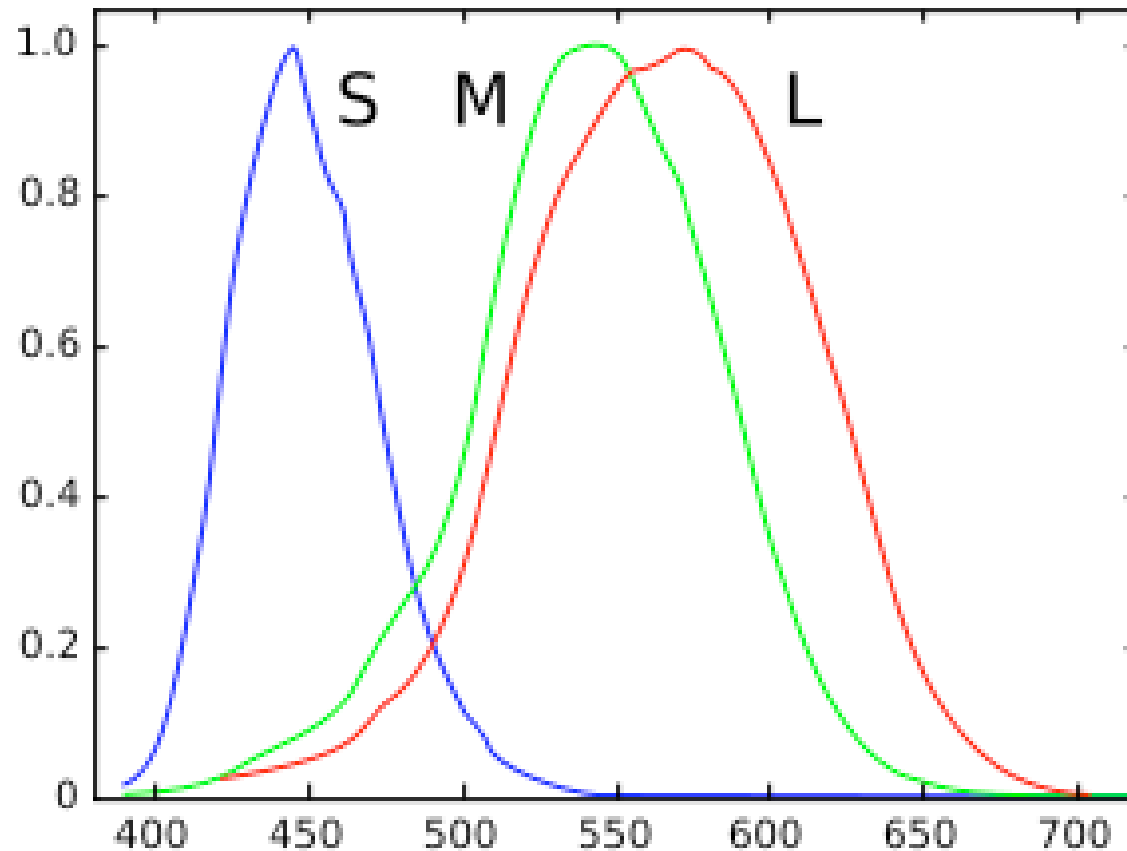




# Color Matching, Not Spectra Matching



# Color Matching, Not Spectra Matching



# For Microstructures, Needs is Hardest



# Microstructure Models Incomplete

Stimuli

Sensation

Perception

Vision

Spectra

Wavelengths

Color

Touch

Food, Cloth

Forces

Texture

Taste

Chemicals

Fluxes

Odor/Flavor

# Why Design Different: CIA Exam

(Culinary Institute of America)

- 4 Rabbits
- 5 Skate
- 0.5 kg Scallops
- 2 Lobsters
- Bacon
- Tomatillos
- Bosc Pears
- Dried Cherries
- Red Beans
- 1 Pineapple



# **Conclusion: To Add Value,**

- **Decide What to Make**
- **“Selection” Often Key**
- **“Needs” Microstructure Key**