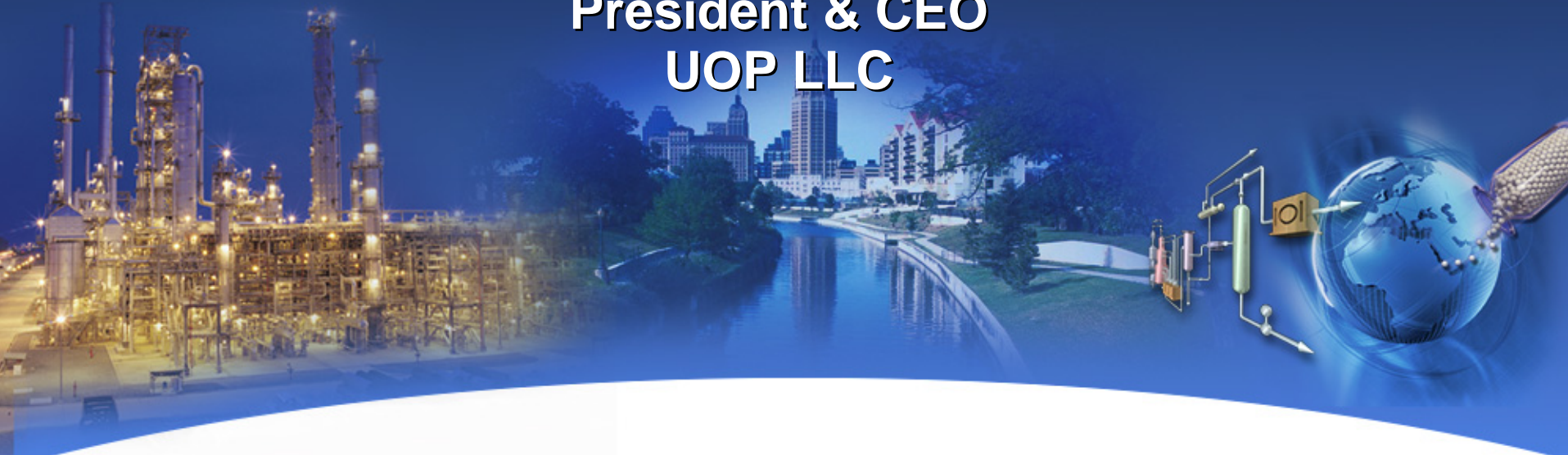


Chemical Engineering:

Once Again Poised to Shape the Future of the Petroleum and Petrochemical Industry

**Carlos A. Cabrera
President & CEO
UOP LLC**



**AIChE 2007 Spring National Meeting
April 23**

Uop
A Honeywell Company

How the World has Changed Since 1973



How Chemical Engineering has Changed

It's always been great to be
a Chemical Engineer
It's even better now!

Big Challenges!
New Enablers!
Better Money!



CHALLENGES

- Availability, price and declining quality of crude
- Other feedstock availability
- Changing product slates and quality specifications
- New capacity needed to meet forecast demand growth
- Increasing costs of capital projects
- Maintain profitability in a cyclical industry

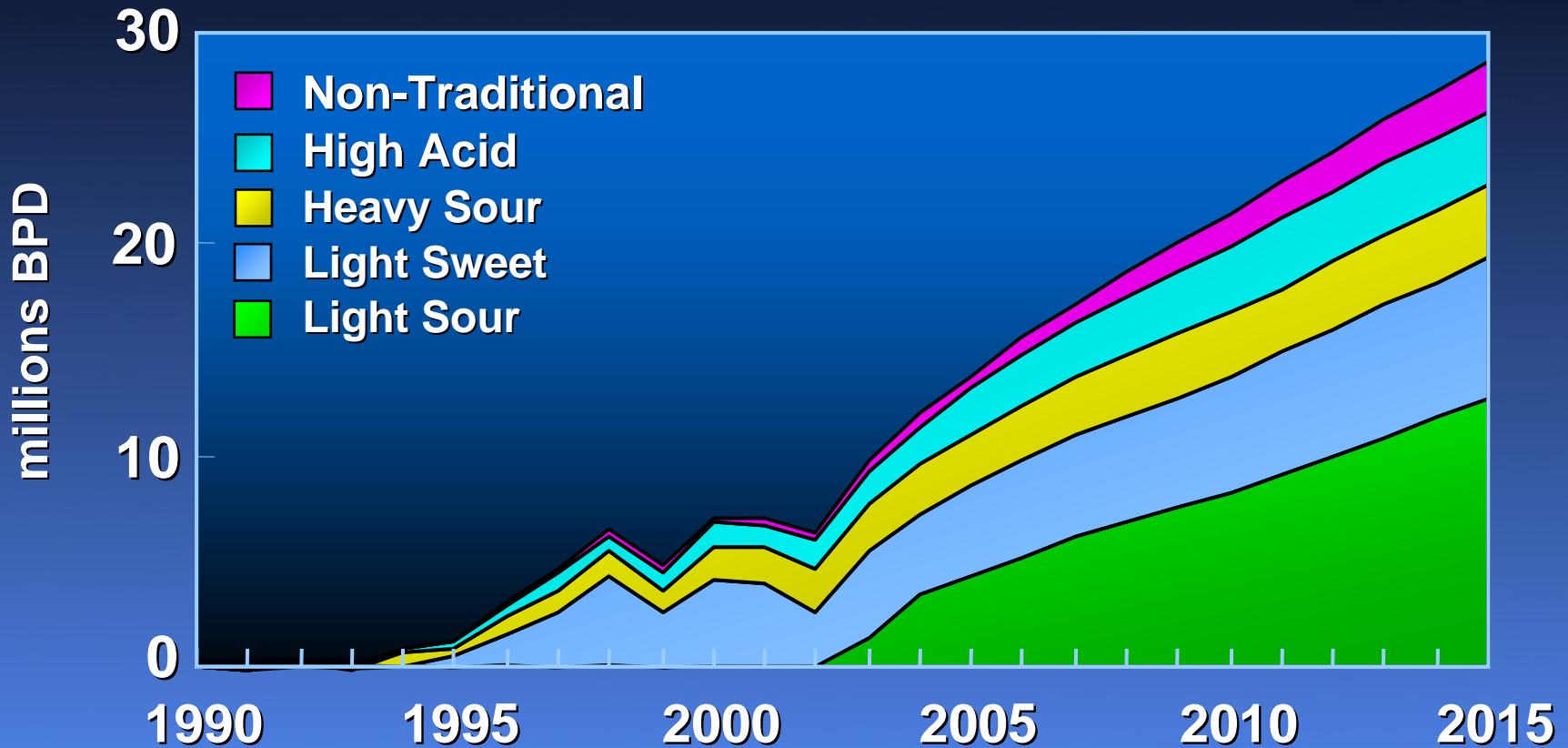


The Big Issues Facing the Industry

- **Customers want higher quality products**
- **Governments want to meet the CO₂ challenge**
- **Demand is growing**
 - We need to discover more sources of oil
 - We need better conversion
- **Supply is strongly affected by geopolitics**
 - Creates pressure to use alternative fuels



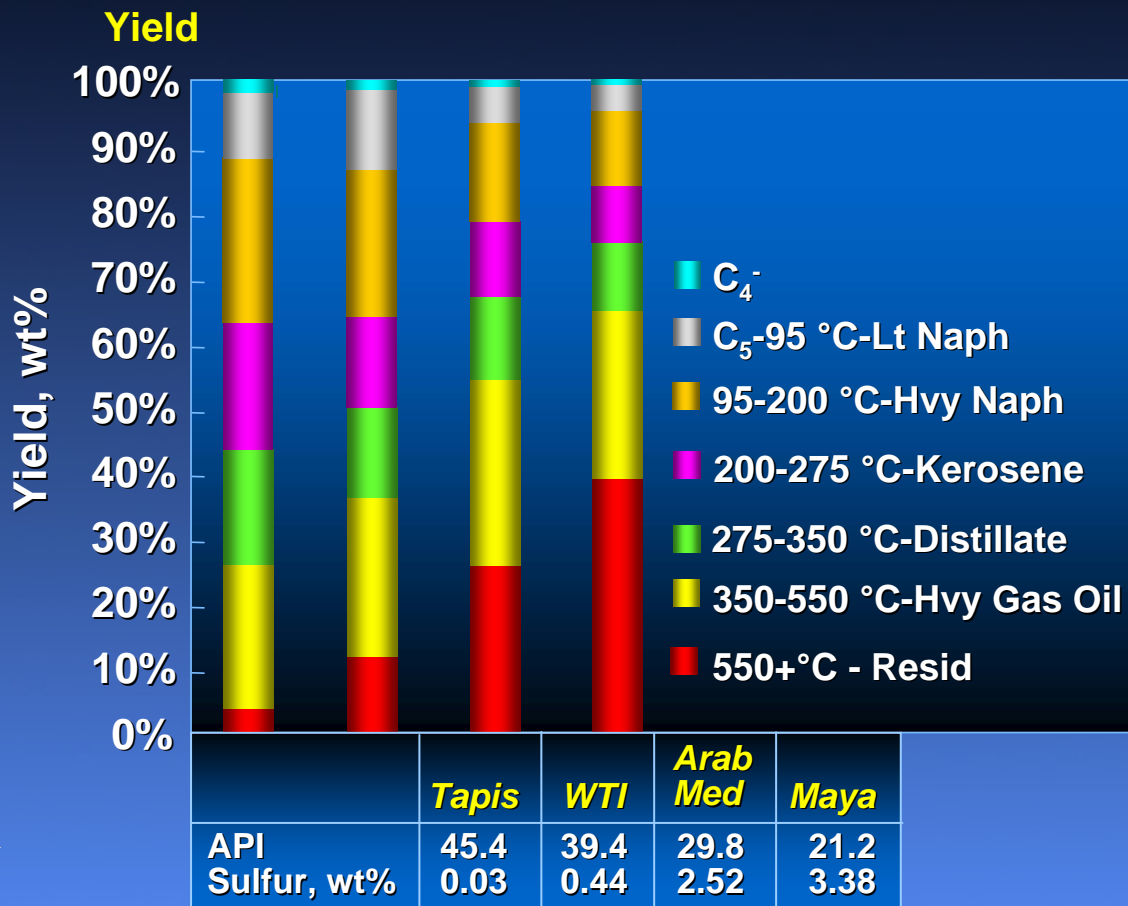
Incremental Global Crude Oil Supplies



Data supplied by Purvin & Gertz

10% of the Growth over the Next 10 Years will be Filled with Non-Traditional

More Conversion Needed to Process Heavy Crudes

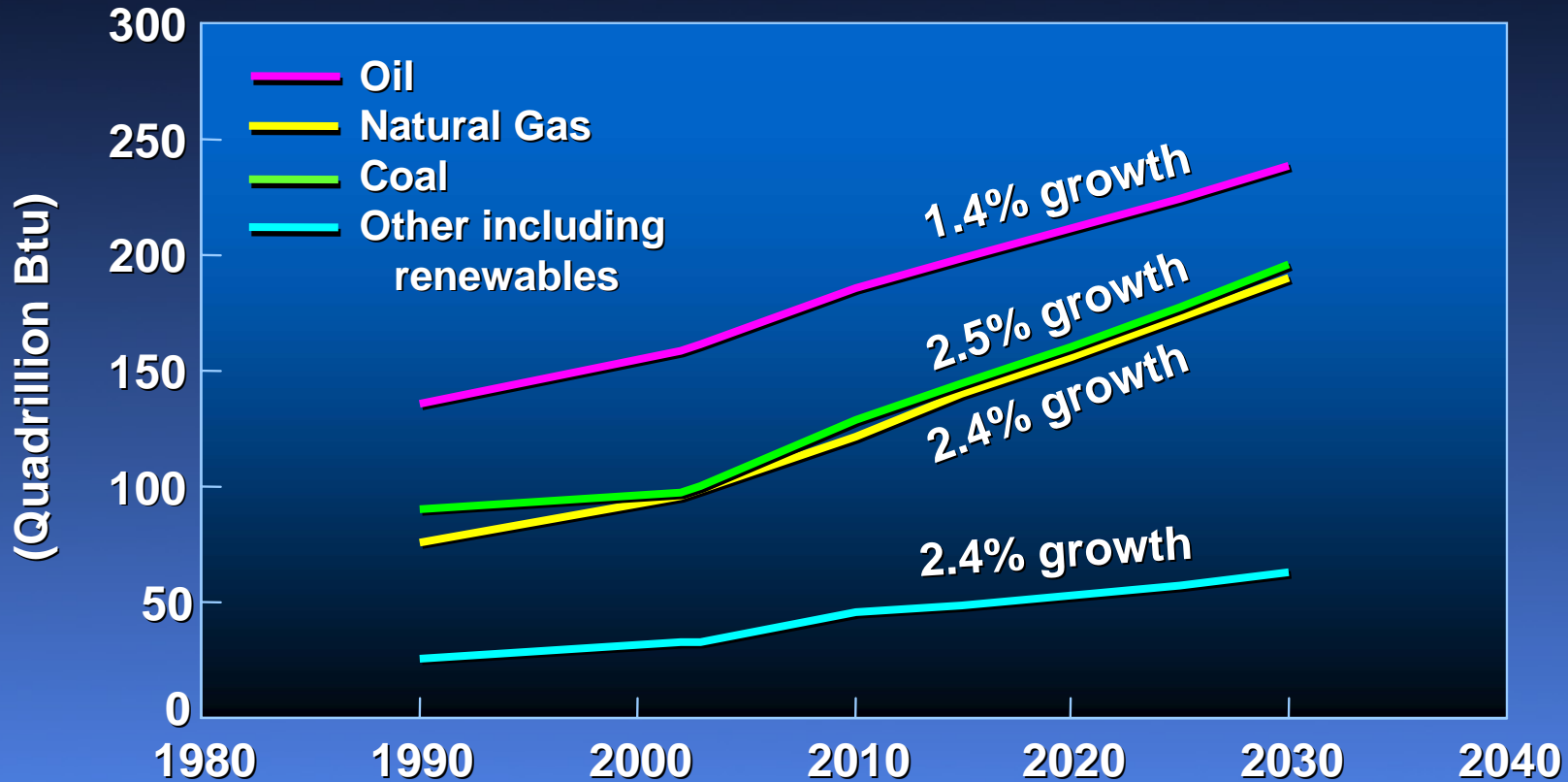


- Heavier crudes yield less gasoline and distillate
 - Maya < 30%
 - Tapis > 70%
- Add conversion capacity to meet product demand
- Heavier crudes require hydrogen addition to meet distillate fuel quality

*Processing Costs Increase
New Investment Required*

Non Traditional Fuel & Chemical Sources

World Total Energy Consumption



Sources: EIA, Annual Energy Outlook 2006, DOE/EIA-0383(2006)

*Coal, Gas and Renewables
all Growing Faster than Oil*

- Escalating fabrication and construction costs affecting investment returns

**New 200 kb/d
Cracking refinery**

\$4bn investment

**10% Internal Rate
of Return**

**~ \$6+/bbl average margin
for 20+ years required**

Investment Risk Must be Addressed

- **Feedstock and product flexibility**
 - “Opportunity” feedstocks
 - Optimal upgrading & conversion
 - Maximize value addition
 - Prosper from cyclical markets
- **Operational efficiency**
 - Economies of scale
 - Energy
 - Control & optimization

**Leading-Edge
Technology**

Flexibility, Efficiency, Integration

How Can Chemical Engineers Respond?

- **Challenges call for technical and business solutions**
- **New technologies will be created using chemical engineering core skills**
 - Better catalysis
 - Better reaction engineering
 - Enhanced separation processes
- **Core chemical engineering skills are now enhanced by many new approaches**

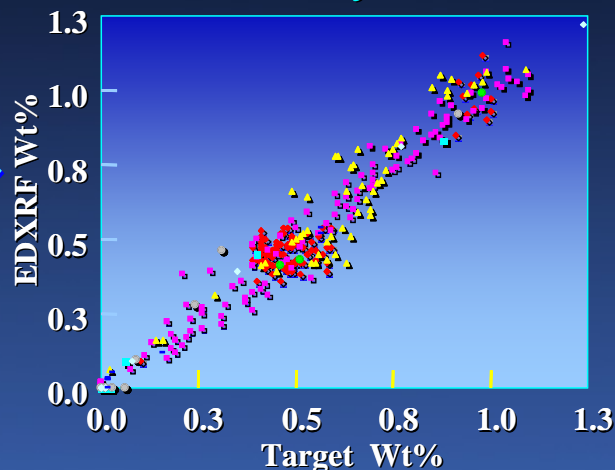


Enablers: Combinatorial Chemistry

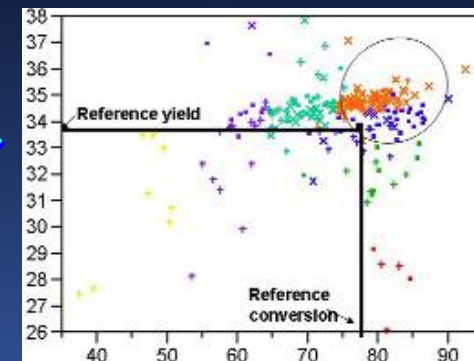
Prepare Catalysts



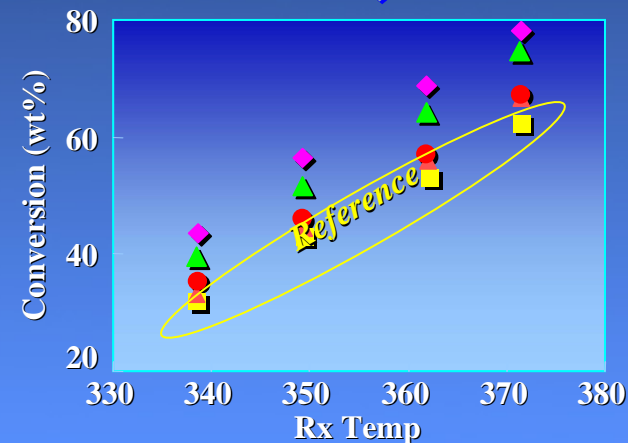
Analyze



Combi Test

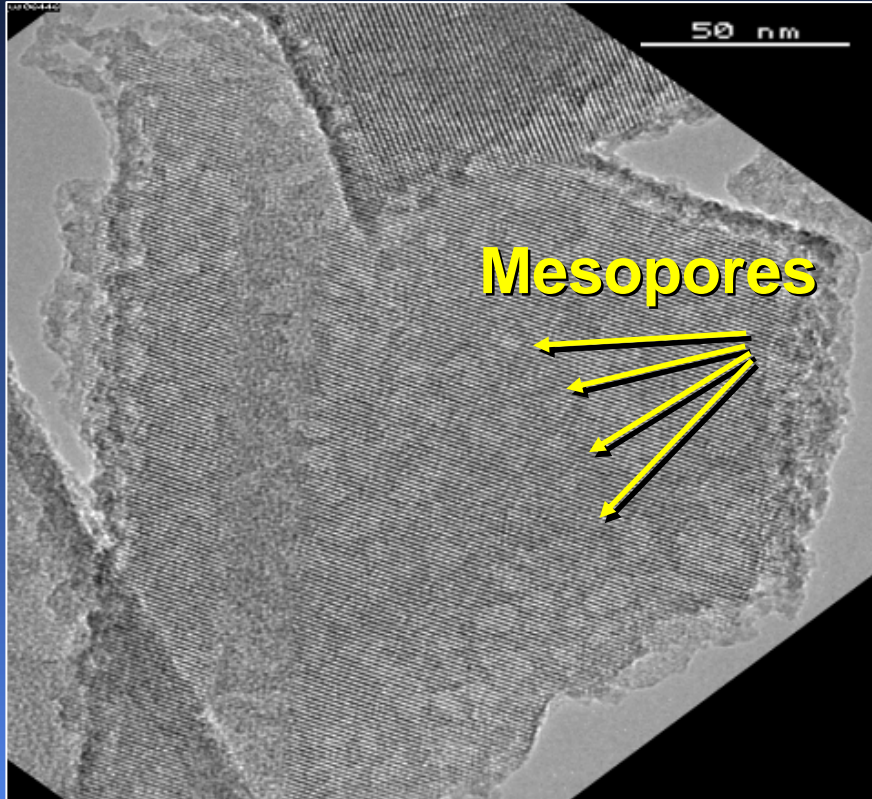


PP Test



<i>In 1 Month</i>	<i>Conventional</i>	<i>Combi</i>
Preparation	40 impregnations	480 impregnations
Characterization	120 analyses	1860 analyses
Testing	8 Pilot Plant Tests	240 High Throughput Reactivity Tests

Unique Capability to Rapidly Screen Catalyst Leads



TEM Photo of Stabilized Y Zeolite

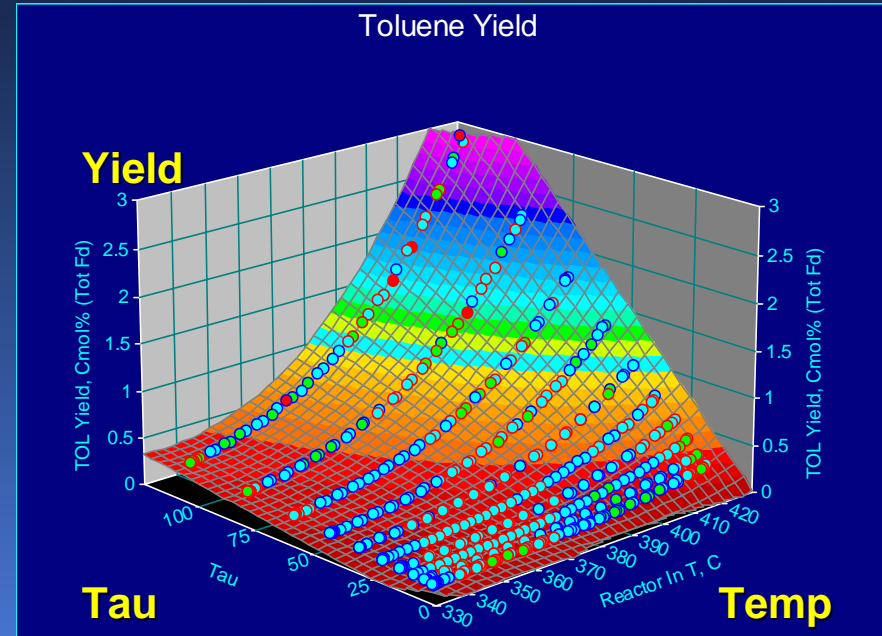
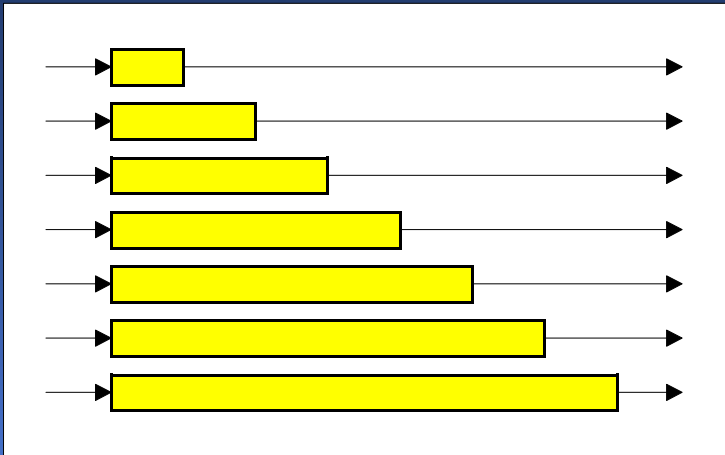
- Catalyst design becoming more precise
 - Visualize using high resolution microscopy
- Design acid function
 - Strength and distribution of acid sites
- Design hydrogenation function
 - Product quality
 - Stability
 - Selective ring opening
- Control residence time at active sites
 - Porosity and channel dimensions
 - Catalyst shape and size

Enablers: Kinetics

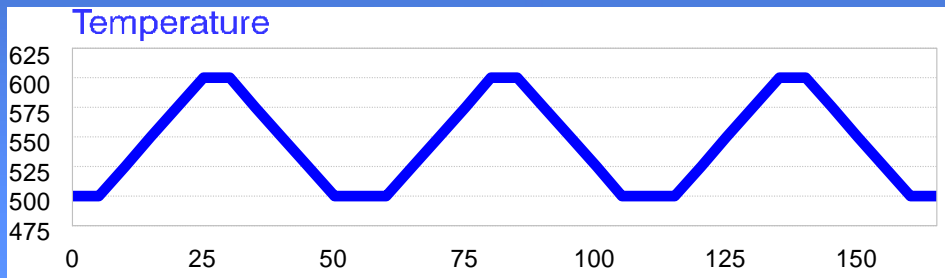
Temperature swing reactor maps reaction surface in single experiment

- *Wide range of process conditions*
- *Wide range of feed compositions*

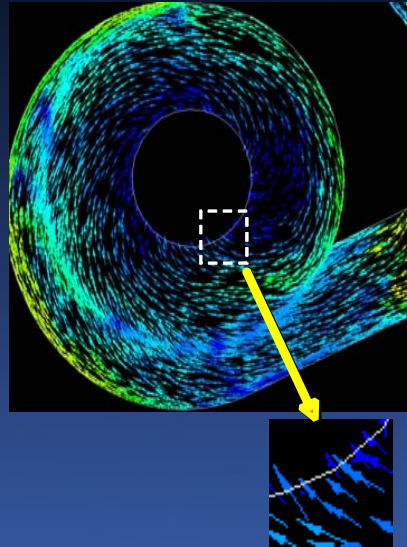
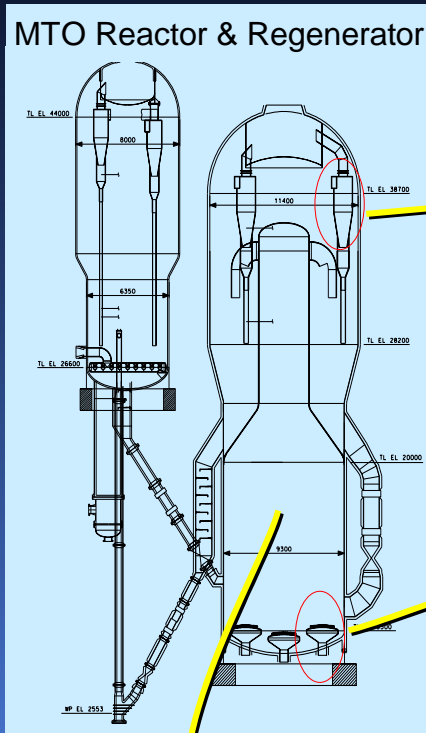
Scan Range of Space Velocities



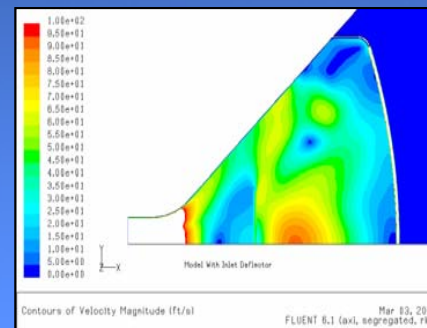
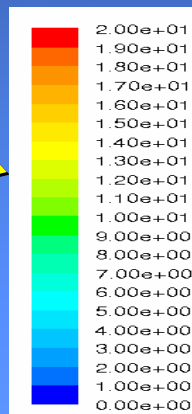
Ramp Temperatures



Enablers: Modeling

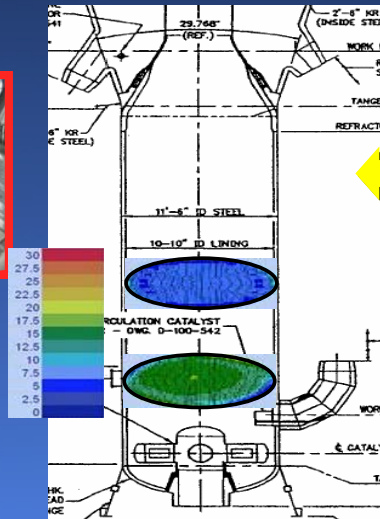


- Tools like CFD allow designs to be tested before they are built



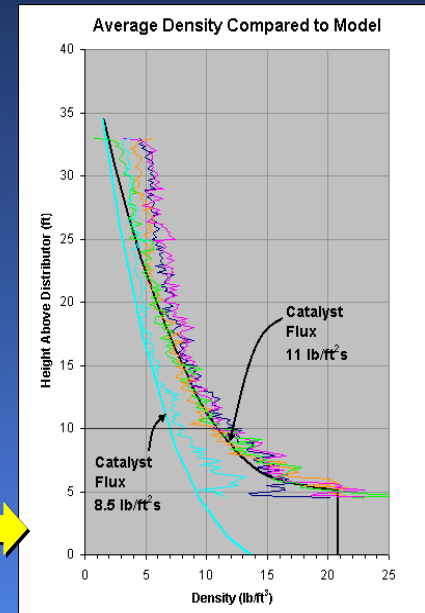
Enablers: Tomography

- See inside operating plant in real time
- Test designs against commercial data

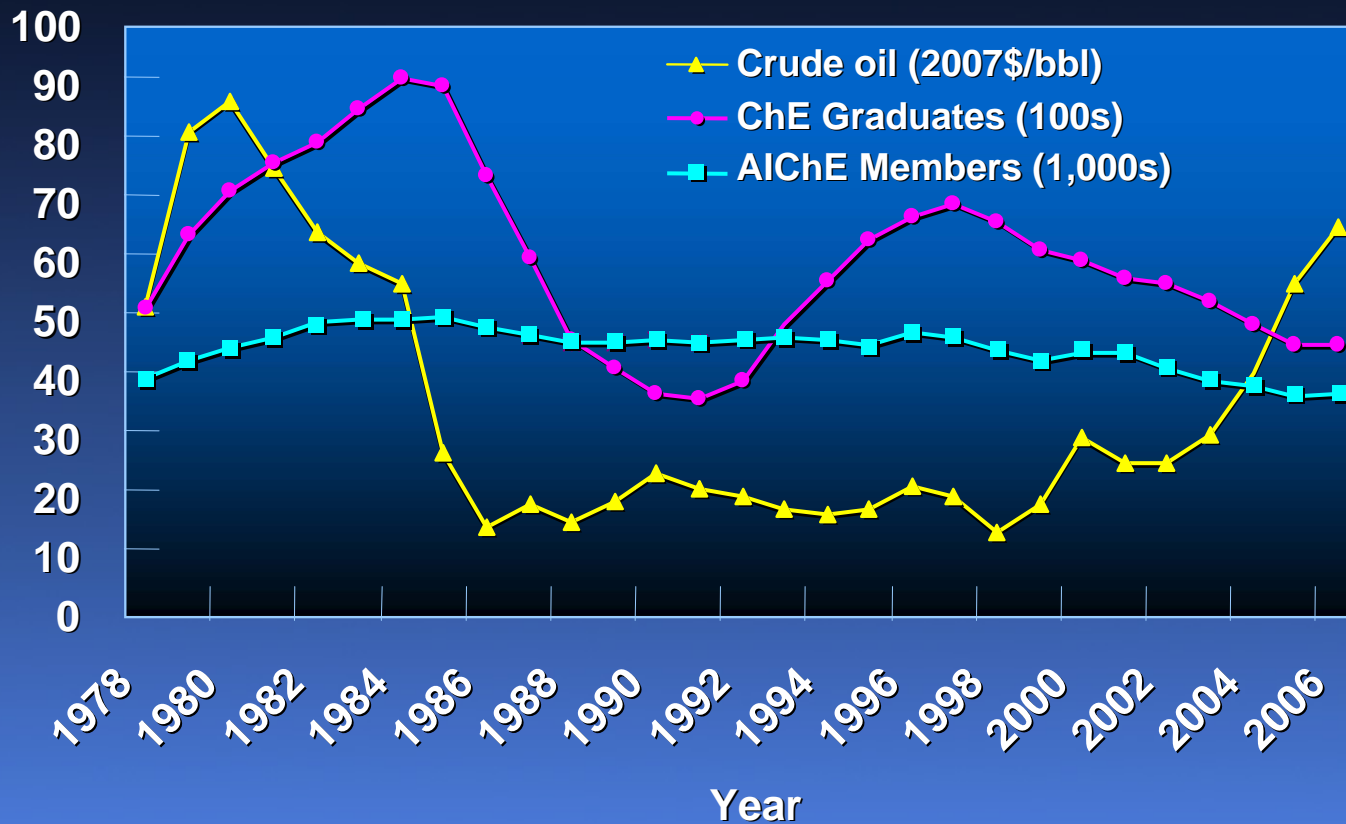


Cat Scanning of FCC regenerator to validate MTO reactor catalyst distribution

Gamma scanning to validate axial catalyst density Profile in FCC regenerator

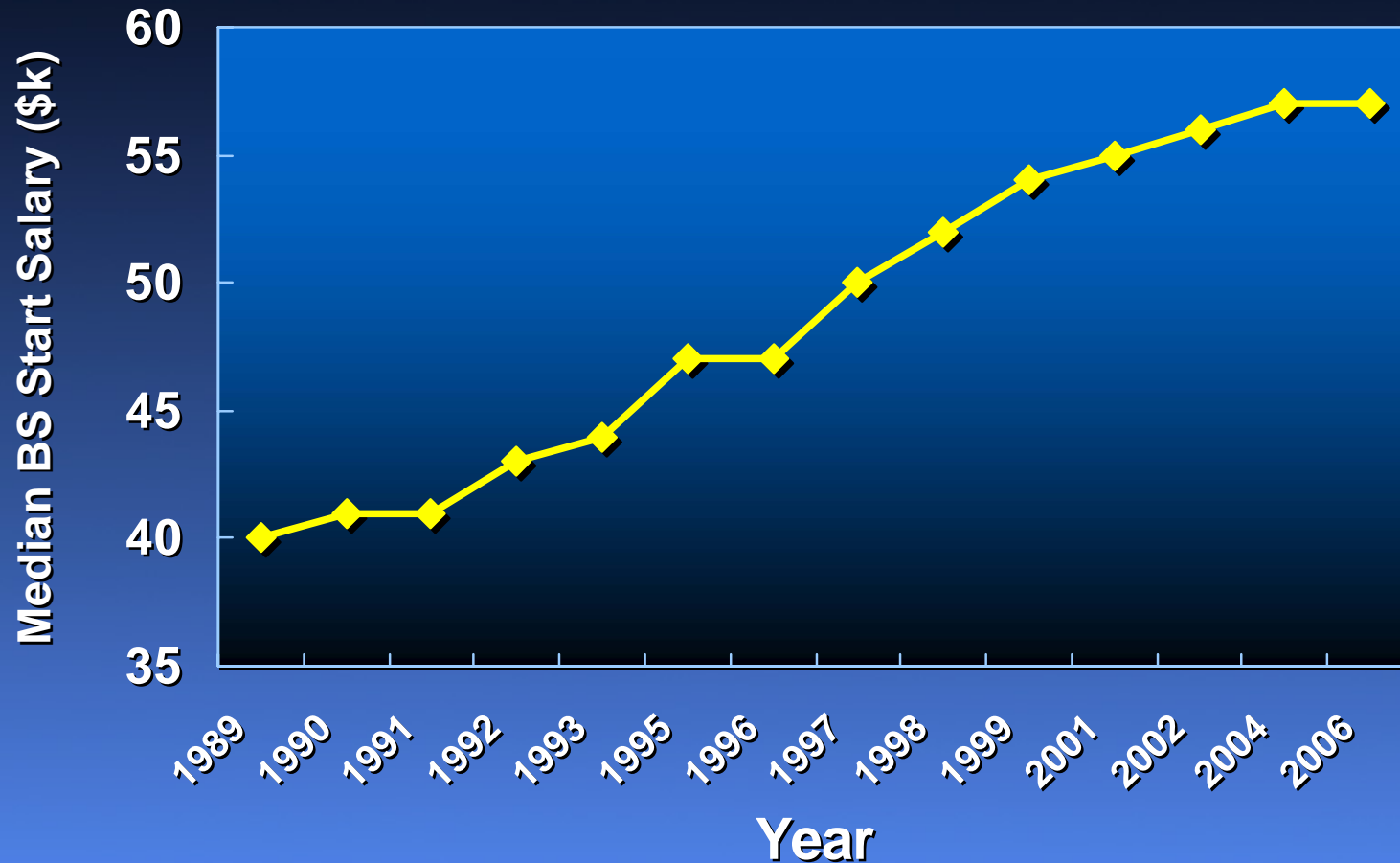


The Demographics Challenge



- Graduate numbers need to increase to replace retiring baby boomers
- The industry will face a hiring and training crunch

A Great Time to Enter the Profession



Source: Median BS ChE start salaries for Petroleum and Coal industries from NACE

*It's always been great to be
a Chemical Engineer*

It just keeps getting better!



Q & A