SPE DISTINGUISHED LECTURER SERIES

is funded principally
through a grant of the

SPE FOUNDATION

The Society gratefully acknowledges
those companies that support the program
by allowing their professionals
to participate as Lecturers.

And special thanks to The American Institute of Mining, Metallurgical,
and Petroleum Engineers (AIME) for their contribution to the program.
Acknowledgment

• Aera Energy LLC
  – Providing time for these lectures
  – Supporting innovation efforts
Innovation in the Oil Field – YOU can do it!

Phiroze Patel
Aera Energy LLC
SPE Values

From the SPE.org website:

- Excellence
- Integrity
- Professionalism
- Life-long Learning
- Diversity
- Volunteerism

- Innovation
- Social Responsibility
Innovation in the Oil Field – YOU can do it!

Outline

• Contrasting systems: Innovation and “business”

• Need for communication tools
  • Strategy, process, database, measures, goals
  • Example: The 4 rules of Innovation!

• Portfolio fit

• Lessons learned: adapting to YOUR situation
Many Upstream Oil Production Companies Are Naturally Conservative

- Huge capital exposure
- Huge environmental exposure
- Two products with a ready market
  - Oil and natural gas
- No end-product marketing creativity

Keep the machine running with no foul-ups!
Systems Thinking – How Innovation Fits in a Typical Oil Company

CLOSED SYSTEM
• Stability
• Hierarchical control
• “Good of the Whole”
• Doesn’t like change

OPEN SYSTEM
• Participatory
• Collaborative
• Balances Whole and Individual
• Process tyranny

RANDOM SYSTEM
• Exploratory
• Informal structure
• Rapid Innovation
• Anarchy

After William Isaacs, “Dialogue”
"Of course I support Innovation in my company!"
To Sustain Innovation You Must:

• Recognize System differences
• Satisfy needs of the dominant System

INNOVATION STRATEGY AND PROCESS
• Manage new idea inflow
  • What to pursue; when to stop
  • What not to pursue
• Measures, goals
• Portfolio fit
• Provide documentation

Keep it simple
“Innovation will set you free!”
One Innovation Strategy

- Rapidly funnel many ideas into a few large, implementable projects
- Focus on breakthroughs rather than continuous improvement
- Extensive externalization
- Implement pilots as required to establish viability
- Minimize traditional research due to long lead time
A Simple but Workable Innovation Process

1. New Idea
2. Compare
3. Application
4. Parameters
5. Quick Economics
6. Develop Project
7. Economics
8. Approve
9. Do Project
10. Implement

STAGES OF R&D IDEAS

- # of Ideas
- Stage #
- Mothballed
- Working

Graphical representation of the innovation process with stages and decision points.
Example Project – Make Cheaper Steam

Fuel Cost Predominates

Steam Costs MM$

2000 2001 2002 2003 2004 2005

Fuel Cost

Use alternative fuel
Ways to Use Alternative Fuel

1999
Cogenerating Electricity

2003
Cogenerating Upgraded Oil

2006
Burning Waste
Burning Alternative Fuels

- Fluidized Bed Combustor
  - Tires
  - Manure
  - Coke, coal

- Novel process

- Make residuum

- Cogens
Ways to Use Alternative Fuel

1999 Cogenerating Electricity

2003 Cogenerating Upgraded Oil

2006 Burning Waste
Technology Transfer Between Industries

Food Industry  Petroleum Industry

Courtesy Ivanhoe Energy
Rapid Thermal Processing (RTP™) Heat Recovery for Steam
Ways to Use Alternative Fuel

1999
Cogenerating Electricity

2003
Cogenerating Upgraded Oil

2006
Burning Waste
Latest Process to Make Cheaper Steam

- Use waste wood as fuel
  - Ample supply in area
  - Current disposal problems

- Burner from dryer technology
  - Similar to existing steam generators
  - Tested and used widely

Courtesy ONIX
Using the Process to Communicate

New Idea

Brainstorm

COMPARE

APPLICATION

PARAMETERS

QUICK ECONOMICS

DEVELOP PROJECT

ECONOMICS

IDEA

SPREAD SHEET

STAGES OF R&D IDEAS

Mothballed

Working

STAGE #

# OF IDEAS

0 5 10 15 20 25

1 2 3 4 5 6 7 8

1 2 3 4 5

DO PROJECT

APPROVAL

IMPLEMENT

SCALE UP

NO

NO

NO

NO

NO

NO

NO

NO
Learnings from the Example

THE 4 RULES OF INNOVATION

• Reduce time spent: quick analyses
• Align with decision makers
• Be persistent
• The simpler the better!
Innovation in the Oil Field – YOU can do it!

Outline

• Contrasting systems: Innovation and “business”

• Need for communication tools
  • Strategy, process, database, measures, goals
  • Example: The 4 rules of Innovation!

• Portfolio fit

• Lessons learned: adapting to YOUR situation
One Innovation Strategy

- Rapidly funnel many ideas into a few large, implementable projects
- Focus on breakthroughs rather than continuous improvement
- Extensive externalization
- Implement pilots as required to establish viability
- Minimize traditional research due to long lead time
Portfolio Fit

Pure Research

Rock Rubbleization
Solvent Injection
Seismic Stimulation
Backpressure Reduction
Cheap Steam
Repair kinked wells
BCX Corrosion Control

Pure Development
**REAL RESULTS**
Upper dogleg: 314 ft (96 m)
Lower dogleg: 636 ft (194 m)

**What fits one portfolio...**
- Basic research done
- Tested
- Engineering thought through
- Competent vendor

... and what does not.
- Research stage
- No physical, tangible results
- Needs all engineering done
- No vendor

Courtesy Weatherford
What we wouldn’t have tried:

- Steam generation without natural gas
- “Solvent” with steam injection
- Water treatment
- Extracting iodine from produced water
- Bio-competitive exclusion technology
- Pressure pulse well stimulation
- Fixing kinked wells
- Pumping kinked wells
- Steam zone delineation method

+ More
Lessons Learned

• Realize organizational “Systems” conflicts and resolve them upfront
Systems Thinking – How Innovation Fits in a Typical Oil Company

CLOSED SYSTEM
- Stability
- Hierarchical control
- “Good of the Whole”
- Doesn’t like change

OPEN SYSTEM
- Participatory
- Collaborative
- Balances Whole and Individual
- Process tyranny

RANDOM SYSTEM
- Exploratory
- Informal structure
- Rapid Innovation
- Anarchy

After William Isaacs, “Dialogue”
Lessons Learned

• Realize organizational “Systems” conflicts and resolve them upfront

• Set a strategy, construct a process, and use to develop AND reject projects
- Rapidly funnel many ideas into a few large, implementable projects
- Focus on breakthroughs rather than continuous improvement
- Extensive externalization
- Implement pilots as required to establish viability
- Minimize traditional research due to long lead time

**Stages of R&D Ideas**

- Rapidly funnel many ideas into a few large, implementable projects
- Focus on breakthroughs rather than continuous improvement
- Extensive externalization
- Implement pilots as required to establish viability
- Minimize traditional research due to long lead time

**IDEA SPREAD SHEET**

- **STAGES OF R&D IDEAS**
  - Idea Brainstorm
  - **New Idea**
  - **Comparator**
  - **Application**
  - **Parameters**
  - **Quick Economics**
  - **Develop Project**
  - **Economics**
  - **Approval**
  - **Do Project**
  - **Implement**
  - **Scale Up**

**Legend**
- **Mothballed**
- **Working**
Lessons Learned

• Realize organizational “Systems” conflicts and resolve them upfront

• Set a strategy, construct a process, and use to develop AND reject projects

• Analyze (fast!), Align, Persist, Simplify

• YOU can do it! – big or small company
EXTRAS
Engage the Organization

• The “Closed” and “Open” Systems with process, measures …

• Engineers and geologists with “brainstorm”
  – Opportunity to be heard
  – More ideas are related to “better” idea
  – Help develop their own project
  – Implementation
“Brainstorm” Session

- Select diverse participants
- Spend time organizing and tabulating

1. Brainstorm Solution
2. Brainstorm “Needs”

Probability of Success*

- Brainstorm “Needs” → Find Solution
  - 68.8%
- 1. Brainstorm Solution → Fit “Need” to Solution
  - 87.5%

* From Goldenberg et al.
### Example “Brainstorm” Session

- Select diverse participants
- Spend time organizing and tabulating

<table>
<thead>
<tr>
<th>THEME</th>
<th>TECHNOLOGY OR SOLUTION</th>
<th>NEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>GETTING INFORMATION FROM SMALL SPACES DOWNHOLE</td>
<td>Down hole fiber optics for chemical analysis</td>
<td>CSTL7. Pinpoint water injection, direct to unswept</td>
</tr>
<tr>
<td>D1.</td>
<td>Passive seismic</td>
<td>CSTL11. Inexpensively ID production/injection communication</td>
</tr>
<tr>
<td>D4.</td>
<td>Technology of Cold</td>
<td>CSTL21. Improved vertical inj conformance</td>
</tr>
<tr>
<td>D6.</td>
<td>Cool</td>
<td>CSTL26. ID swept zones in reservoir</td>
</tr>
<tr>
<td></td>
<td>Drill mud while drilling</td>
<td>CSTL27. Hunt Beach needs better way to get injection profiles</td>
</tr>
<tr>
<td>D7.</td>
<td>Use Cold as tracer</td>
<td></td>
</tr>
<tr>
<td>D14.</td>
<td>Piezoelectric properties of Xtals</td>
<td>B8. Image fluids in reservoir by zone</td>
</tr>
<tr>
<td>D15.</td>
<td>Technology to put memory sensors on tubing and gather when pull tubing</td>
<td>B12. Injection profiles survey capability for doglegged injectors</td>
</tr>
</tbody>
</table>