Skills Required for Today’s Changing Petroleum Industry

Moderator:
Jerry Schuyler, Chairman & CEO Gastar Exploration LLC

Panelists:
Ken Beattie, COO & Senior Vice President CrownQuest Operating, LLC
Gary Kolstad, President & CEO Carbo Ceramics Inc.
Dr. Burt Todd, Department Head MT Tech Petroleum Engineering

April 12, 2019
Global Energy Consumption by Source

The transition to a lower carbon fuel mix continues...

Source: BP Energy Outlook, 2018 edition
Global Supply and Demand

Annual World Liquids Supply and Demand

Source: EIA
The World’s Top Liquids Producers

Top 15 in 2018 (MMBbl/d)

- **United States**, 17.9
- **Saudi Arabia**, 12.1
- **Russia**, 11.4
- **United Arab Emirates**, 3.4
- **Brazil**, 3.4
- **Kuwait**, 3.2
- **Canada**, 5.3
- **Iran**, 4.1
- **Angola**, 1.8
- **Nigeria**, 1.9
- **Kazakhstan**, 2.0
- **Venezuela**, 1.7
- **Mexico**, 2.1
- **Algeria**, 1.2
- **Other**, 23.7

100.5 MMBbl/d Total

Big Three 41% of World Liquids Production

Source: EIA
U.S. Oil Production

Source: EIA

Unconventional Production Begins

U.S. Avg. Daily Oil Production

Source: EIA
LNG Exports and Imports

LNG increases the global availability of gas...

Source: BP Energy Outlook, 2018 edition
Skills Required for Today’s Changing Petroleum Industry

Montana Tech Panel Discussion
April 12, 2019
Ken Beattie
Well-Defined Inventory of Domestic Oil & Gas Development

**Permian Basin – Long Term Growth**
- Total Acreage: ~13 MM acres
- Daily Oil Production: ~3.6 MMBoe/d
- Daily Gas Production: ~12.4 Bcf/d
- Active Horizontal Rigs: 438 (51 Vertical Rigs)
- # of Core Oil Locations: ~525,000+
- Hydrocarbon Mix: Oil-weighted
- Years of Core Inventory: 50+

**DJ Basin**
- Total Acreage: ~2 MM acres
- Daily Production: ~1.5 MMBoe/d (44% oil)
- Active Horizontal Rigs: 28
- # of Core Oil Locations: ~5,000+
- Hydrocarbon Mix: Gas-weighted
- Years of Core Inventory: <10

**Uinta Basin**
- Total Acreage: ~5 MM acres
- Daily Production: ~0.2 MMBoe/d (38% oil)
- Active Horizontal Rigs: 3
- Hydrocarbon Mix: Gas-weighted

**San Juan Basin**
- Total Acreage: ~5 MM acres
- Daily Production: 1.4 Bcfe/d (92% gas)
- Active Horizontal Rigs: 3
- Hydrocarbon Mix: Gas-weighted

**NGL Market**
- Permian will provide future growth

**SCOOP / STACK**
- Total Acreage: ~5 MM acres
- Daily Production: 2.6 MMBoe/d (54% oil)
- Active Horizontal Rigs: 78
- # of Core Oil Locations: ~150,000+
- Hydrocarbon Mix: Liquids-weighted
- Years of Core Inventory: 10+

**Appalachia & associated gas from oil plays will dominate gas production**

**Bakken – Intermediate Growth**
- Total Acreage: ~6 MM acres
- Daily Production: 1.8 MMBoe/d (77% oil)
- Active Horizontal Rigs: 56
- # of Core Oil Locations: ~4,000+
- Hydrocarbon Mix: Oil-weighted
- Years of Core Inventory: 10+

**Marcellus / Utica – Gas Growth**
- Total Acreage: ~30 MM acres
- Daily Production: 30 Bcfe/d (97% gas)
- Active Horizontal Rigs: 73
- # of Core Gas Locations: ~14,500
- Hydrocarbon Mix: Gas-weighted
- Years of Core Inventory: 10+

**Gas Inventory**

**Eagle Ford / South Texas – Intermediate Growth**
- Total Acreage: ~4 MM acres
- Daily Production: 9.8 Bcfe/d (97% gas)
- Active Horizontal Rigs: 51
- # of Core Gas Locations: ~7,500
- Hydrocarbon Mix: Gas-weighted
- Years of Core Inventory: 10+

**Haynesville – Gas Growth**
- Total Acreage: ~4 MM acres
- Daily Production: 9.8 Bcfe/d (97% gas)
- Active Horizontal Rigs: 51
- # of Core Gas Locations: ~7,500
- Hydrocarbon Mix: Gas-weighted
- Years of Core Inventory: 10+

**SCOOP / STACK**
- Total Acreage: ~6 MM acres
- Daily Production: 1.8 MMBoe/d (32% oil)
- Active Horizontal Rigs: 60
- # of Core Oil Locations: ~10,000+
- # of Core Gas Locations: ~15,000+
- Hydrocarbon Mix: Liquids-weighted
- Years of Core Inventory: 15+

**Marcellus / Utica – Gas Growth**
- Total Acreage: ~30 MM acres
- Daily Production: 30 Bcfe/d (97% gas)
- Active Horizontal Rigs: 73
- # of Core Gas Locations: ~14,500
- Hydrocarbon Mix: Gas-weighted
- Years of Core Inventory: 10+

**Gas Inventory**

**Permian**
- Total Acreage: ~525,000+
- # of Core Oil Locations: ~15,000+
- Hydrocarbon Mix: Gas-weighted
- Years of Core Inventory: 15+

**All Others**
- Total Acreage: ~45,000+
- # of Core Oil Locations: ~15,000+
- Hydrocarbon Mix: Gas-weighted
- Years of Core Inventory: 15+

**Oil Inventory / # Locs**
- Permian: ~525,000+
- All Others: ~45,000+

**Note:** Statistics based on Baker Hughes Rig Count as of December 7, 2018, EIA and Jefferies estimates.

(1) Represents Anadarko Basin statistics.
U.S. Will be Key Contributor to Meeting World Oil Demand

Crude and NGL Production

1. Eastern Europe = primarily Russia and other former Soviet Union countries
Permian Basin is a World Class Oil Resource

Comparison of Net Recoverable Oil from Global Resource Plays

<table>
<thead>
<tr>
<th>Resource</th>
<th>Net Recoverable Oil (BBo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaware Basin</td>
<td>212</td>
</tr>
<tr>
<td>Midland Basin</td>
<td>165</td>
</tr>
<tr>
<td>Ghawar (Saudi Arabia)</td>
<td>160</td>
</tr>
<tr>
<td>Eagle Ford Shale</td>
<td>28</td>
</tr>
<tr>
<td>Prudhoe Bay</td>
<td>13</td>
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<tr>
<td>Bakken Shale</td>
<td>10</td>
</tr>
<tr>
<td>Thunder Horse (GoM)</td>
<td>2</td>
</tr>
</tbody>
</table>

Total Permian Basin is 2.4x Ghawar

Source: Jefferies and Pioneer Natural Resources June 2015 Investor presentation.
(1) Jefferies estimate.
U.S. Gas Supply Dominated by Shale Development

Natural Gas Production by Region

NOTES: Series depict estimates after December 2018. "Other areas" include Niobrara and Bakken. SOURCE: Energy Information Administration.
What does this mean for required skills?

- **Shale development is labor & logistics intensive.** The domestic industry needs organized, proactive leaders who can implement.

- **Gauging shale development success is largely empirical.** Understanding statistics is important.

- **Energy is seldom harvested in the Earth’s most beautiful places.** Be willing to go where the action is!
Skills Required for Today’s Changing Petroleum Industry

Montana Tech Panel Discussion
April 12, 2019
Gary Kolstad
**Personal Success Skills**

- Keep learning throughout life. Be positive, curious, and able to adapt to change... quickly.

- Develop strong people skills. It is critical in a ever-changing world, to be able to lead others by aligning and motivating them.

- Build a broad skills foundation. The O&G industry is cyclical, this will help you survive downturns. (Example skills: Technical, Financial, Marketing, Sales, HR, etc.)

- Dream big - Your career should be something you love to do. Do not be afraid to change your career, if you are being held back from personal growth and challenge.

**Business Skills**

- Be able to manage for both short and long term business results, seek out new technology and processes

- Be adept at being able to determine financial returns, and manage a P&L

- Look at the big picture..... Think Energy, not necessarily just Oil & Gas
  - Society is demanding less carbon/more climate control, so be open minded on alternate energy, it is growing fast
  - Software and data management (AI), industrialization, etc...... are trends that will not reverse
Industry Feedback to Montana Tech

• Montana Tech students have one great industry recognized strength…. they have a great work ethic

• Balance teaching fundamental engineering skills, with a working knowledge of today’s modern technology tools and equipment
  – Get companies to come to the campus to teach technology for a day, or teach on-line (Example: Software programs)
  – More practical ‘hands on’ versus theory

• Teach students a fundamental working knowledge of finance needed to live and work in today’s world. This includes personal investment, business investment, return calculations, P&L, etc.

• Continue to teach them how to solve problems, work on teams, and project management
Skills Required for Today’s Changing Petroleum Industry

Montana Tech Panel Discussion
April 12, 2019
Dr. Burt J. Todd
Head, Montana Tech Petroleum Department
What Has Changed

• BS Pet Engineering – 1979
  – 144 Total Credits
  – 35 credits of Petroleum Courses
  – Courses like Drilling, Production, Reservoir Engineering, and Logging

“We’ll teach you everything that is known. You will figure out the rest of it on the job.”

• BS Pet Engineering – 2019
  – 136 Total Credits
  – 40-46 credits of Petroleum Courses
  – New Courses like Reservoir Characterization, Well Completions, Reservoir Simulation, Well Control, etc.

“We’re just scratching the surface.”

Clearly, the body of petroleum knowledge has expanded greatly in 40 years.
What Has Not Changed

• Oil is still valuable, and Petroleum Engineering is still important!
• Engineering Students are still in their late teens/early 20’s!
  – Exploring their life/career/identity for the first time
  – Beer/sex/fun remain as attractive as ever!

• Conclusion: Doubling the engineering content in the curriculum is not an option! We still have to teach the basics!
What Montana Tech is Doing

- Expansion of Elective courses
- New minor in Data Analytics
- Clubs
  - SPE
  - AADE
  - Society of Women Engineers
  - Finance Club
  - Hockey Team
  - Choral Music
- A developing on-line presence
- Masters of Engineering
- Ethics/Professionalism training
- Teaching Pedagogy
  - Less lecture/more hands-on
  - Understanding error and precision
  - Renewed emphasis on programming
- Integrating with the Green Movement
  - Responsible operations
  - Oil = plastics
  - Environmental/lighter cars
  - Swing energy for electricity