Future MPD Opportunities

a Drilling Contractor's Perspective

AADE
AMERICAN ASSOCIATION of DRILLING ENGINEERS

Transocean

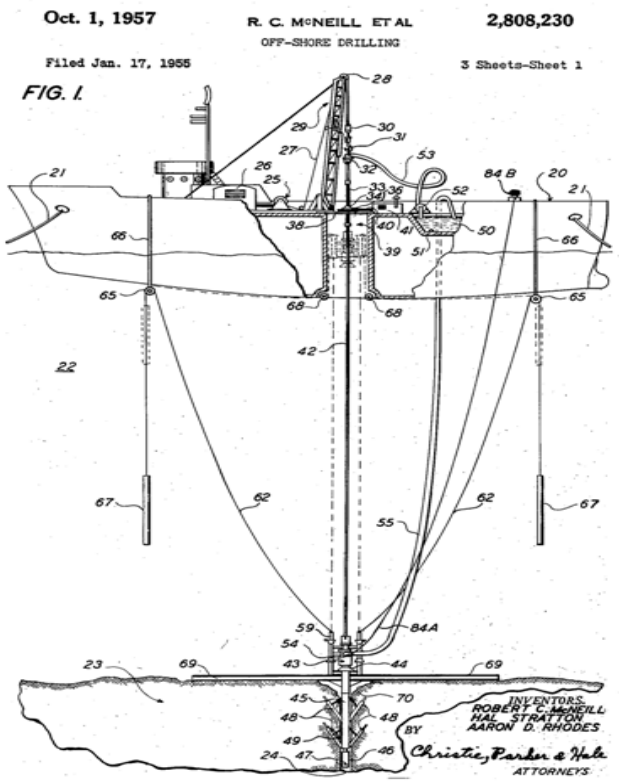
Agenda

- Background
- Transocean's past MPD Efforts
- Recent Experience
- Current Initiatives
- Future Opportunities

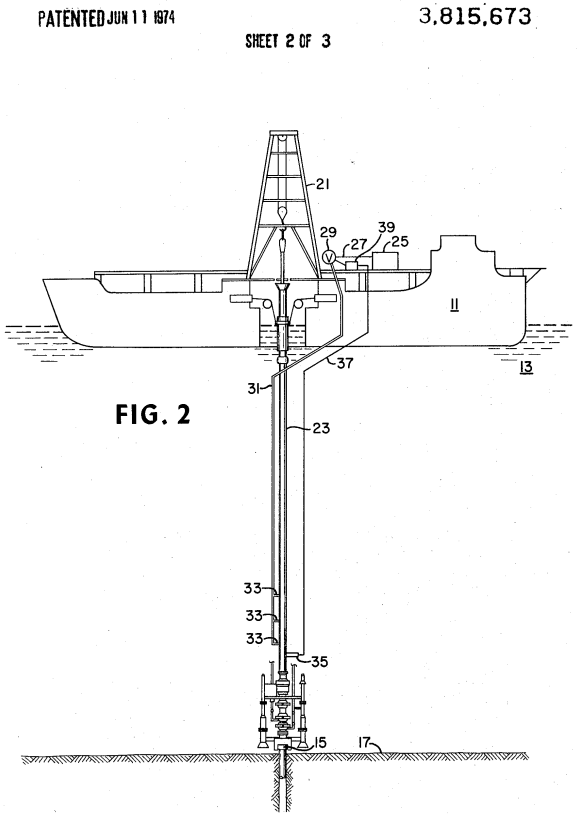
MPD - Why do we need it?

- Common Drivers
  - Improve HSE
  - Mitigate Well Construction Challenges
  - Mitigate Operational Risk
  - Improve Performance
  - Create Opportunities

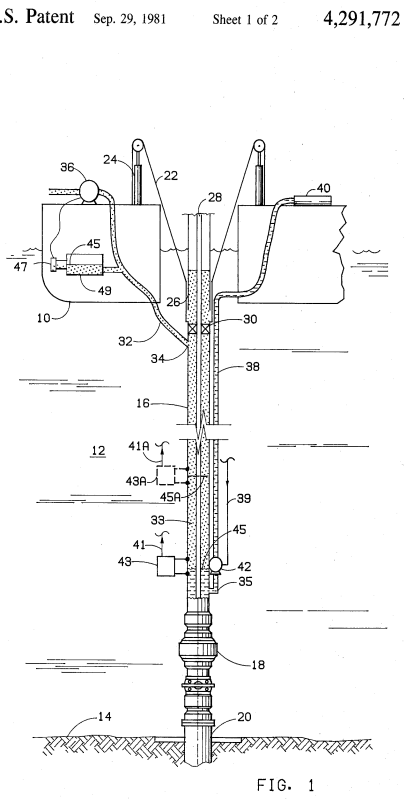
Not a new idea



"Riserless" mud recovery



Gas Lifted Riser

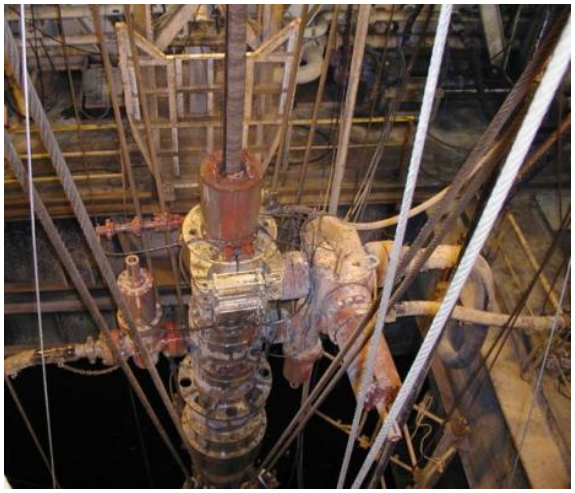


Pumped Riser Return

Transocean's past MPD Efforts

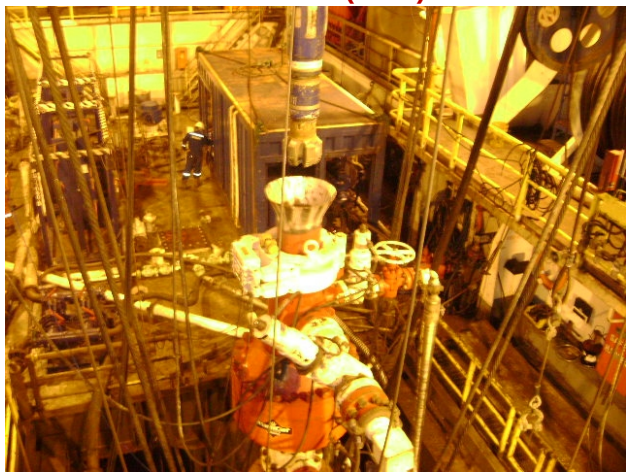
Transocean's past MPD Efforts – Benign Environments

Sedco 601 SBOP (2004) - PMCD

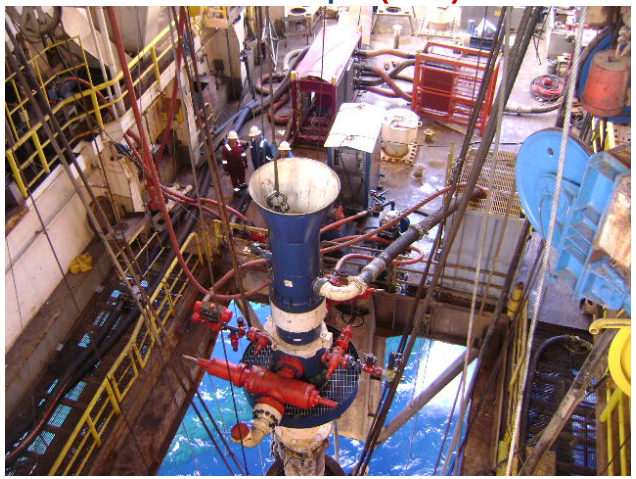


Sedco 601 RiserCap™ (2006) - PMCD

DWF (2007) Concentric Casing



Actinia (2008) Concentric Casing



Actinia (2011)

Transocean's past Efforts – moving towards environment independent closed circulating systems

Concentric riser (DP)

(US patent: 6,273,193)

2007

Integrated RCD (Moored)
Above **T**ension **R**ing

2008 -09

Integrated RCD (DP)
Below **T**ension **R**ing

2009

Concentric riser (DP)
Above **T**ension **R**ing

(US Patent 7,866,399)

2008-09

Transocean 's involvement from the very beginning

From Land and Jackup RCDs to custom build Offshore RCDs

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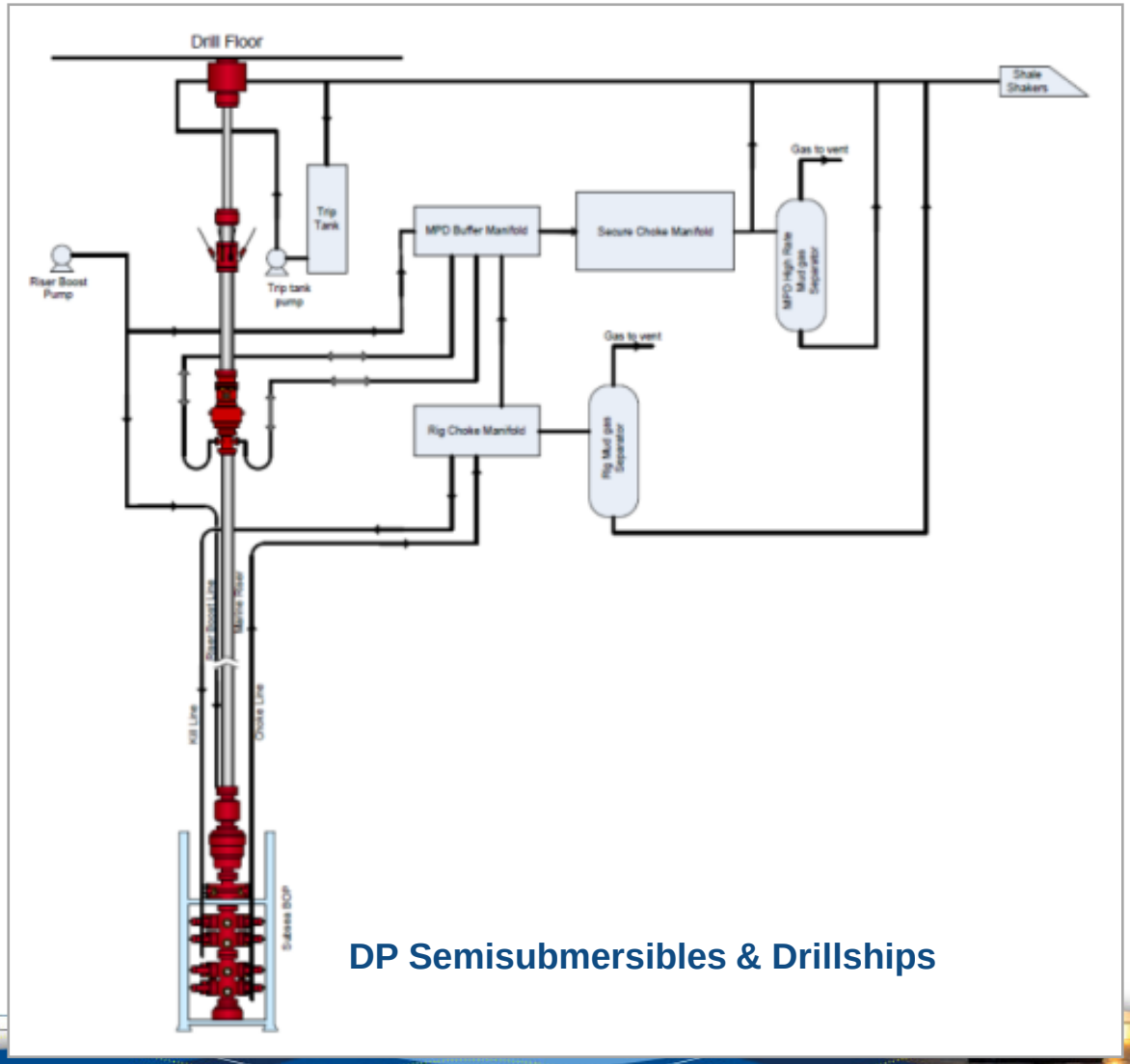
Preferred MPD equipment configuration

- **Surface Pressure control**
  - RCD
  - Annular
  - Flow Spool
  - Riser PRV / Vent Line
  - Redundant Flow Lines
  - MPD/Drilling manifold
  - Dedicated Mud Gas Separator
- **Complete Annulus return**
  - Via existing rig slip joint
  - Via multi purpose MPD pup joint

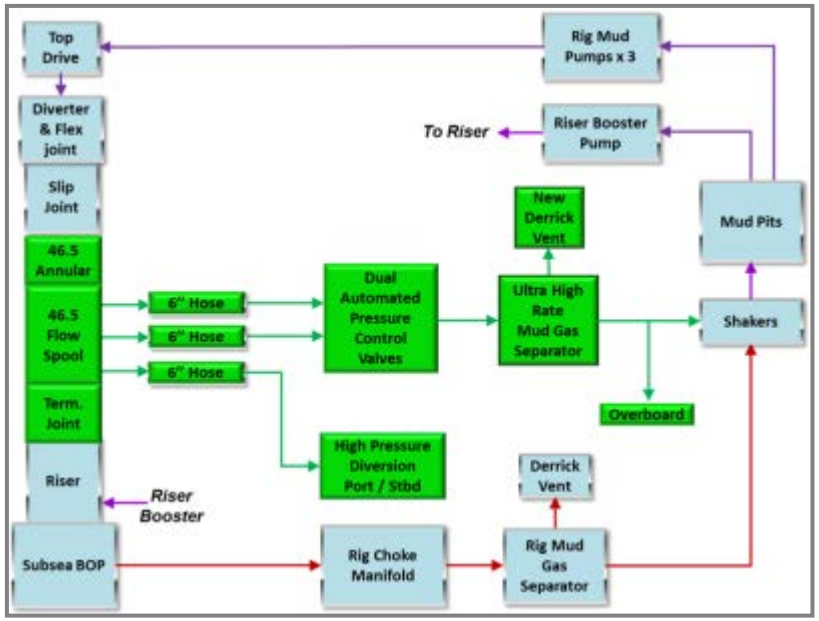


Transocean MPD & RGH Experience

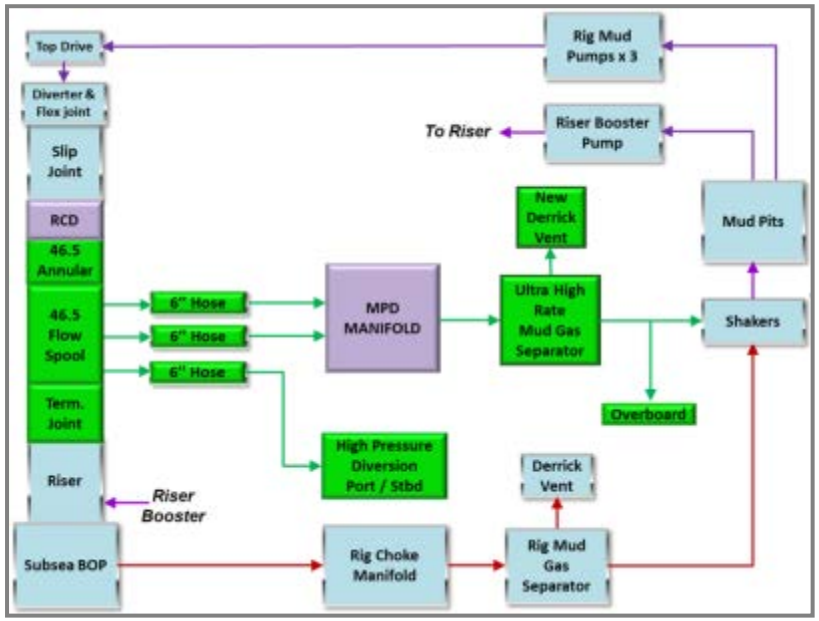
Rig Name	Rig Type	Location	Customer	Year	Application	Status
Trident 8	Jack Up	Angola	Cabinda Gulf	2003	PMCD	Completed
Sedco 601	Semi Sub	Indonesia	Santos	2004	PMCD w/ Surface BOP	Completed
Sedco 601	Semi Sub	Indonesia	Santos	2005 - 2006	PMCD w/ Risercap™	Completed
Roger W. Mowell	Jack Up	Malaysia	Talisman	2006 - 2007	CBHP	Completed
Constellation II	Jack Up	Egypt	BP	2007	CBHP, HPHT	Completed
High Island VII	Jack Up	Gabon	Total	2007	CBHP, HPHT	Completed
Deepwater Frontier	DP Drillship	India	Reliance	2007	CBHP, Concentric Riser	Completed
Actinia	Semi Sub	India	Reliance	2008	CBHP, Concentric Riser	Completed
Arctic III	Semi Sub	Libya	ENI	2008 - 2009	ECD, HPHT, Reconfigurable Riser	Completed
Harvey H. Ward	Jack Up	Malaysia	Talisman	2009	CBHP	Completed
Shelf Explorer	Jack Up	Malaysia	Talisman	2009	CBHP	Completed
Trident IX	Jack Up	Indonesia	Pearl	2010	UBD (Low Head Drilling)	Completed
Sedco 601	Semi Sub	Malaysia	Petronas	2010	CBHP	Completed
GSF Explorer	DP Drillship	Indonesia	MSEC	2010 - 2012	CBHP, PMCD, Riser Degassing	Completed
GSF Rig 135	Semi Sub	Nigeria	Addax	2011 - 2012	CBHP, HPHT	Completed
Actinia	Semi Sub	Malaysia	Petronas	2011 - 2012	PMCD w/Risercap™	Completed
Monarch	Jack Up	Demark	Maersk	2011 - 2012	CBHP	Completed
Marianas	Semi Sub	Ghana	ENI	2012	CBHP, HP; EKD/CC	Completed
HH Ward	Jack Up	Malaysia	Petronas	2012	PMCD	Completed
Compact Driller	Jack Up	Thailand	Chevron	2012	CBHP / Re-entry	Completed
Monarch	Jack Up	Denmark	Maersk	2012 - 2013	CBHP	Completed
Constellation 1	Jack Up	Indonesia	Total	2013 - 2014	PMCD, EKD	Completed
MG Hulme	Semi Sub	Malaysia	Petronas	2015	CBHP, PMCD	Completed

Current Efforts - Riser Gas Handling and MPD

Riser Gas Handling



MPD



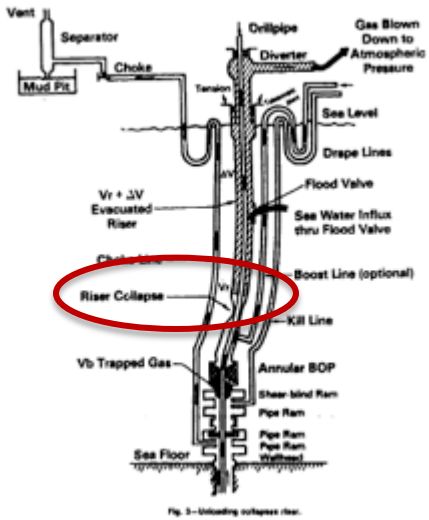
RGH equipped rig has 90% of equipment needed for MPD

Riser Gas Handling - Previous Systems

RGH systems are not new

The first systems were developed in the early 1980's.

Fig 1; after SPE 11394



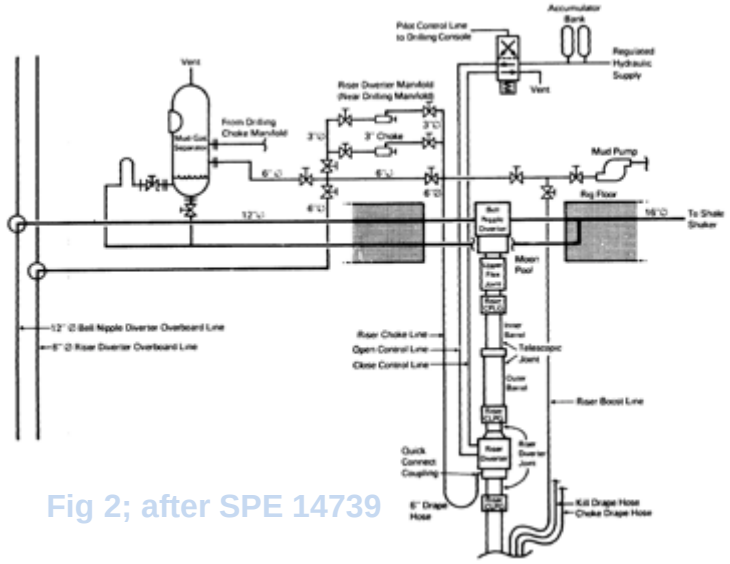
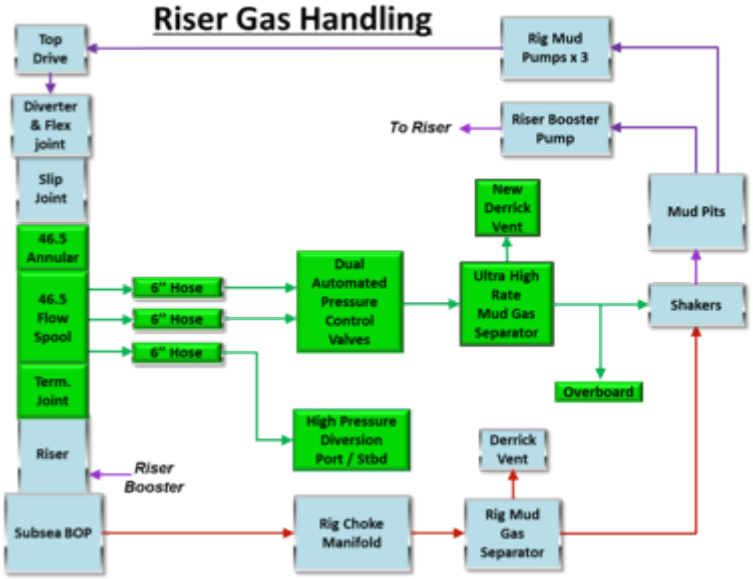


Fig 2; after SPE 14739

The motivation for these early systems was to prevent riser collapse.

RGH System Design Basis

Gas Influx volume	:= 100bbls (above BOP)
System Back Pressure range	:= 250psi – 750psi (in RGH mode)
Gas migration velocity	:= ~ 8,900 ft./hr (~149 ft/min)
Liquid rate	:= ~ 2,400 gpm
Design Safety Factor	:= 1.25
Design Liquid rate	:= ~ 3,000 gpm
Liquid Density range	:= 8.56 ppg (SW) – 18 ppg
RGH reaction time	:= <5s <=15s



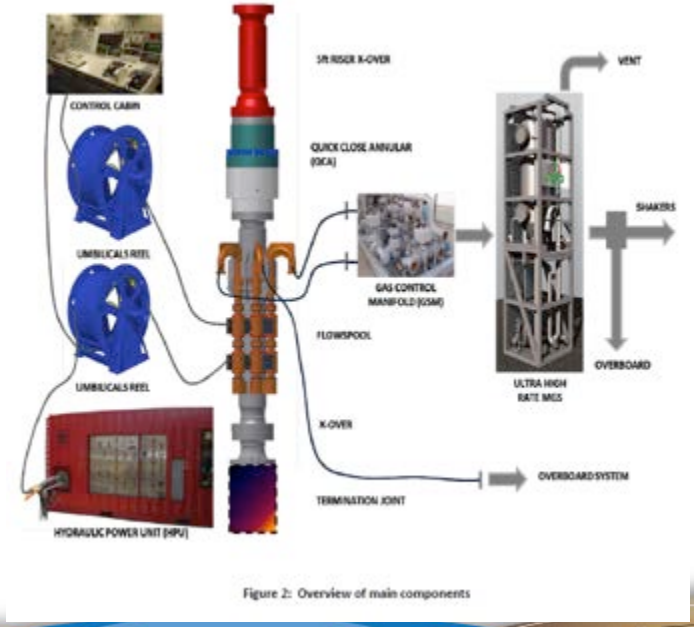
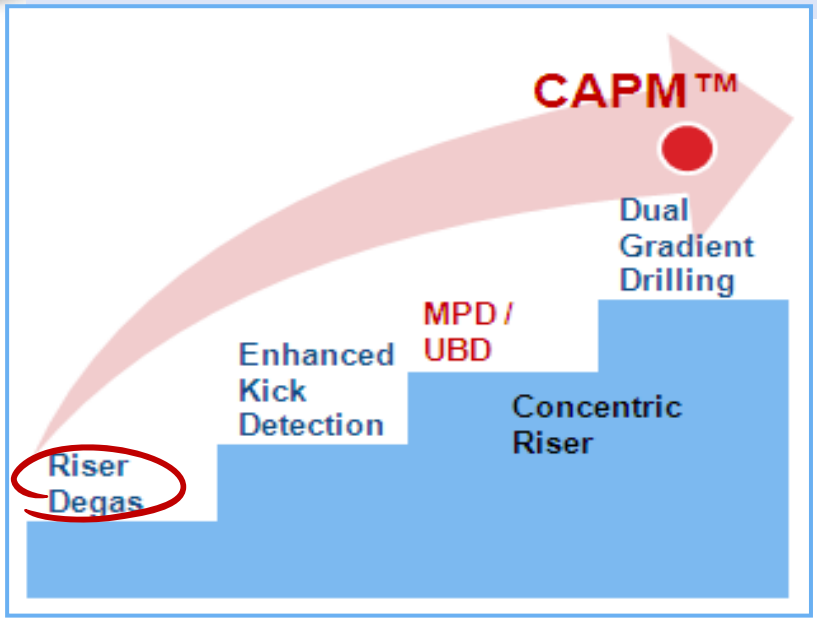
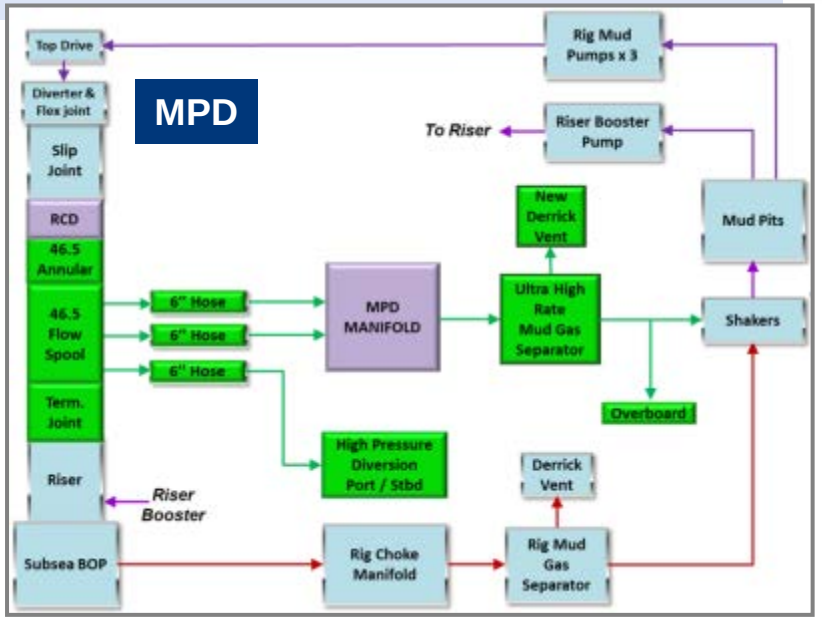


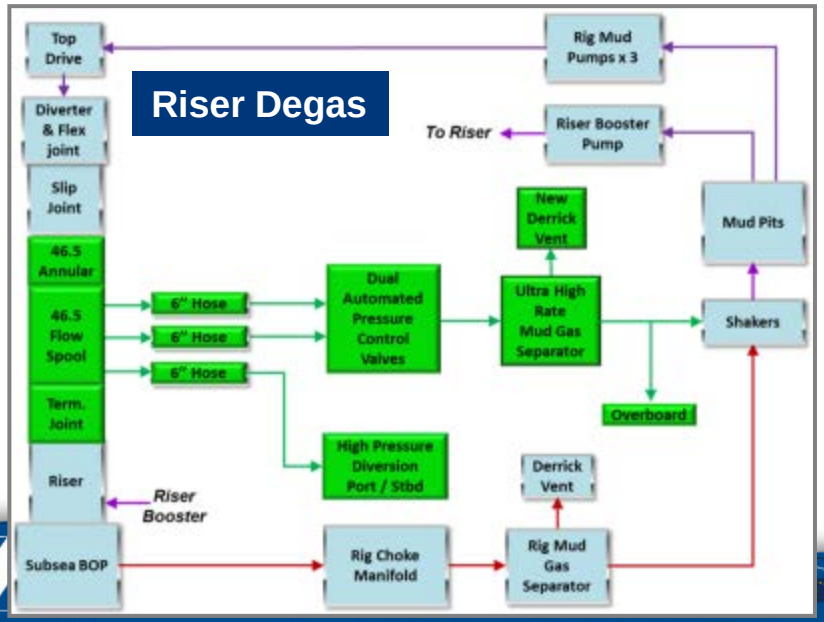
Figure 2: Overview of main components

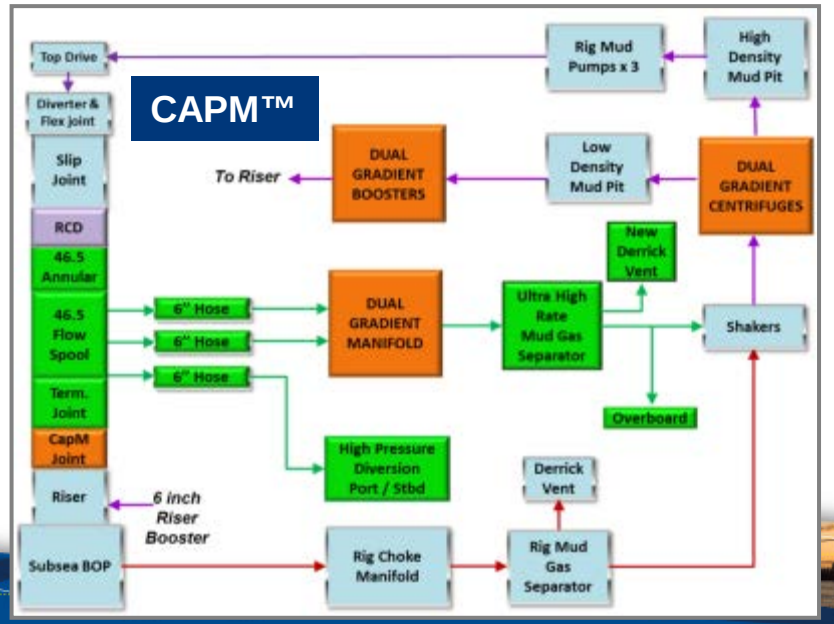
RGH Quick closing annular

Current Efforts – Integrated Approach





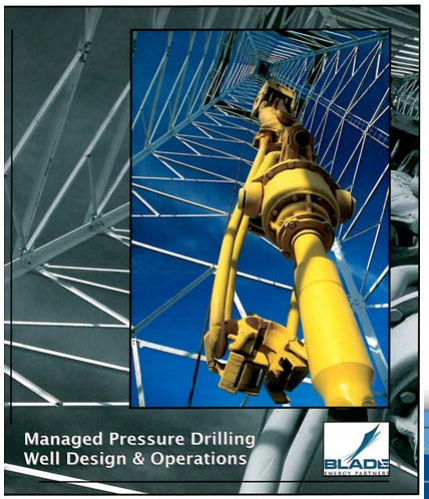




MPD Operational Considerations

- **HAZID & HAZOP**
- **Procedures**
  - MPD Equipment Install & Remove Procedures
  - MPD Operational Procedures
  - MPD Contingency Procedures
- **MPD Project Specific Training**
- **Lessons Learned**

Influx indicators		Volume Gain	<Surface back pressure plus 150psi	>Surface back pressure plus 150psi <Back pressure limit (800psi)	>Back pressure limit (800psi)
	No influx	0	None. Continue drilling	Stop drilling, Increase back pressure, pump rate, mud weight, or a combination of all. circulate out any influx prior to resuming operations	Stop drilling, shut in well on rig BOP's and evaluate next action
	Operating Limit	0 - 3bbls	Stop drilling, Increase back pressure, pump rate, mud weight, or a combination of all. circulate out any influx prior to resuming operations	Stop drilling, Increase back pressure, pump rate, mud weight, or a combination of all. circulate out any influx prior to resuming operations	Stop drilling, shut in well on rig BOP's and evaluate next action
	< Planned Limit	3 - 5bbls	Stop drilling. Increase back pressure, pump rate, mud weight or a combination of all, circulate out any influx prior to resuming operations.	Stop drilling, shut in well on rig BOP's and evaluate next action	Stop drilling, shut in well on rig BOP's and evaluate next action
	≥ Planned Limit	> 5bbls	Stop drilling, shut in well on rig BOP's and evaluate next action	Stop drilling, shut in well on rig BOP's and evaluate next action	Stop drilling, shut in well on rig BOP's and evaluate next action



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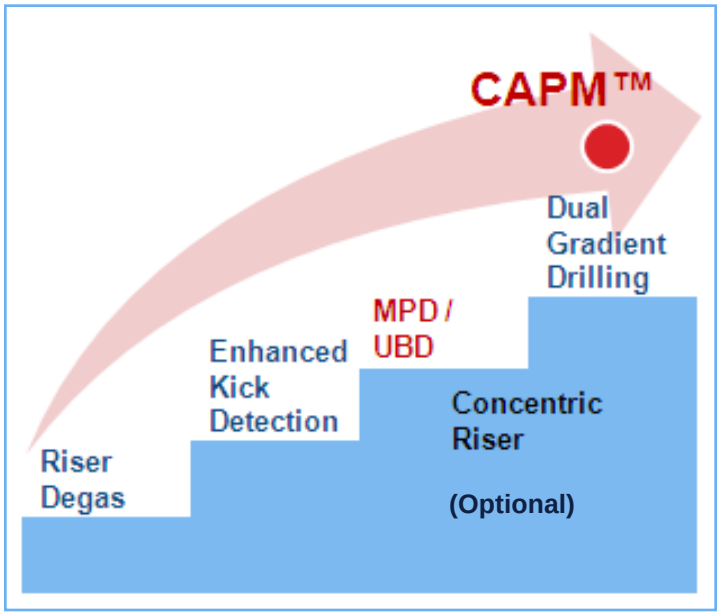
Technology Evolution



MPD = Managed Pressure Drilling
UBD = Under Balanced Drilling

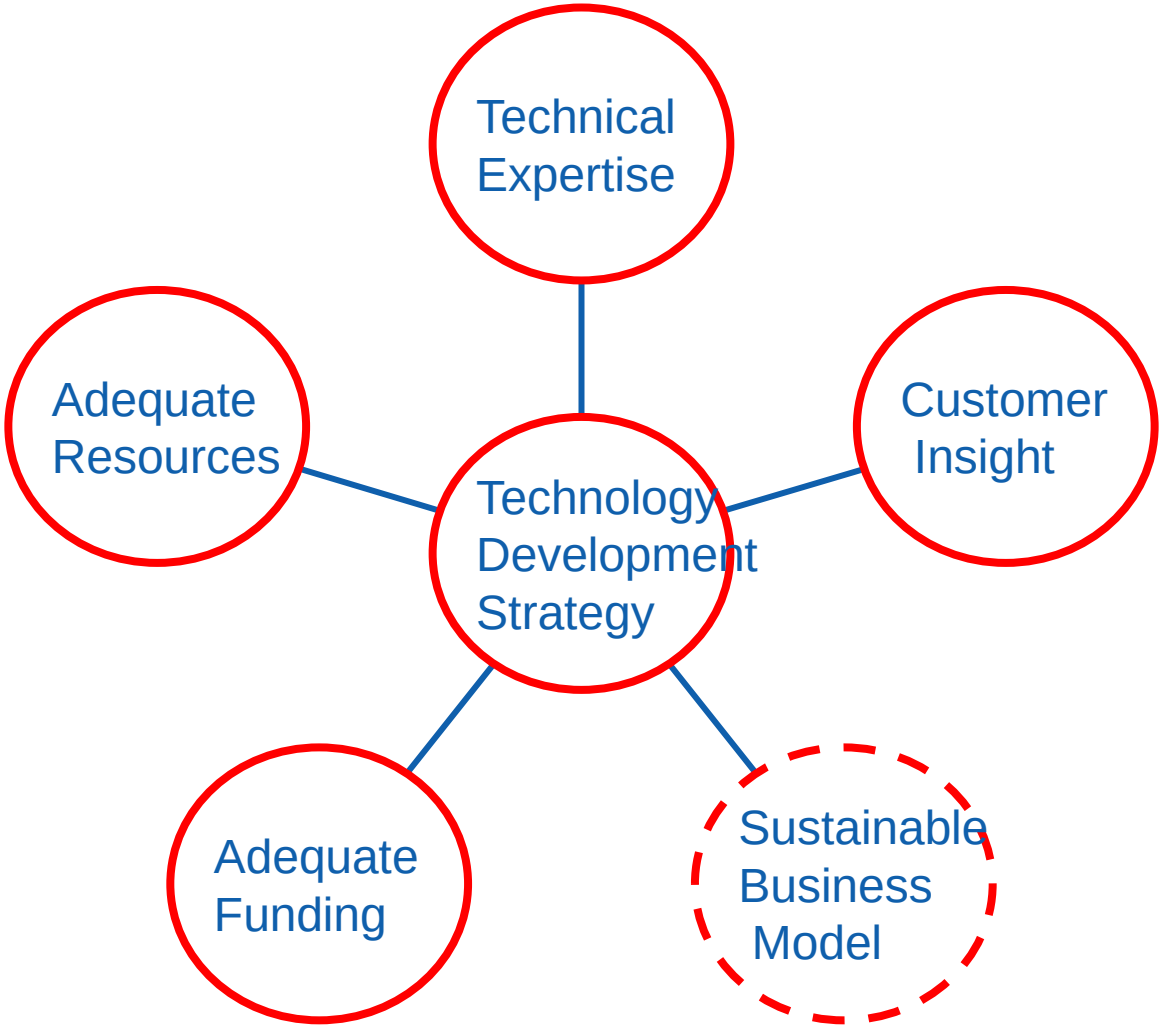
How do we encourage broader adoption of MPD methods

Are the objectives of the Technology Development Effort

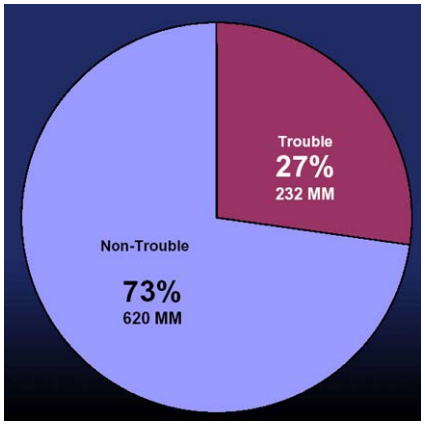
Aligned

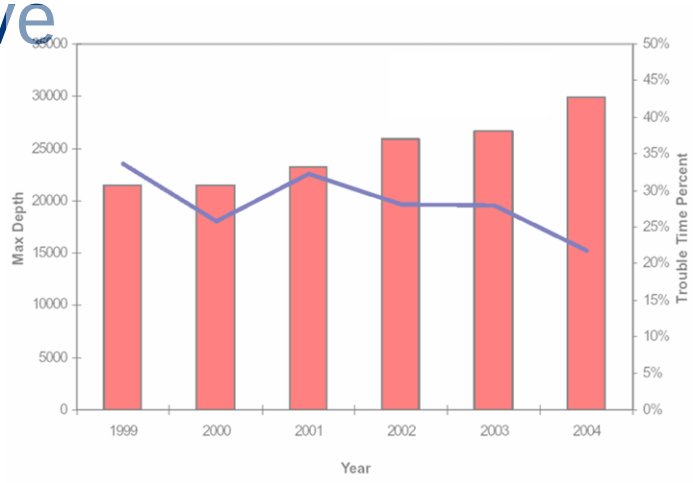
To an effective Technology Development Strategy?

What constitutes an effective Technology Development Strategy?

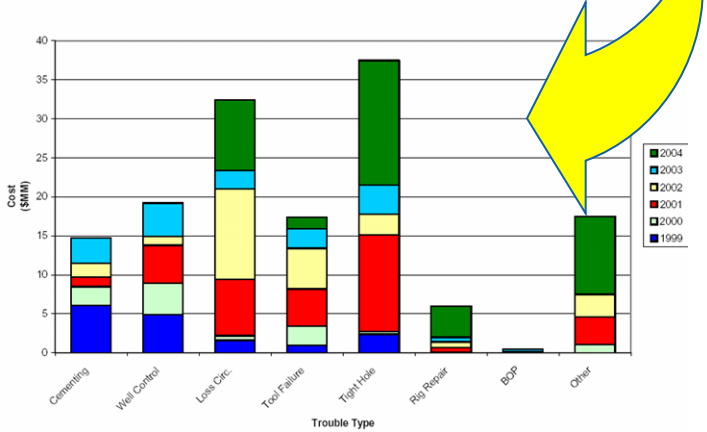


Operational Efficiency - One Operator's Perspective





Approximately 25% total NPT
Approximately 27% total Cost



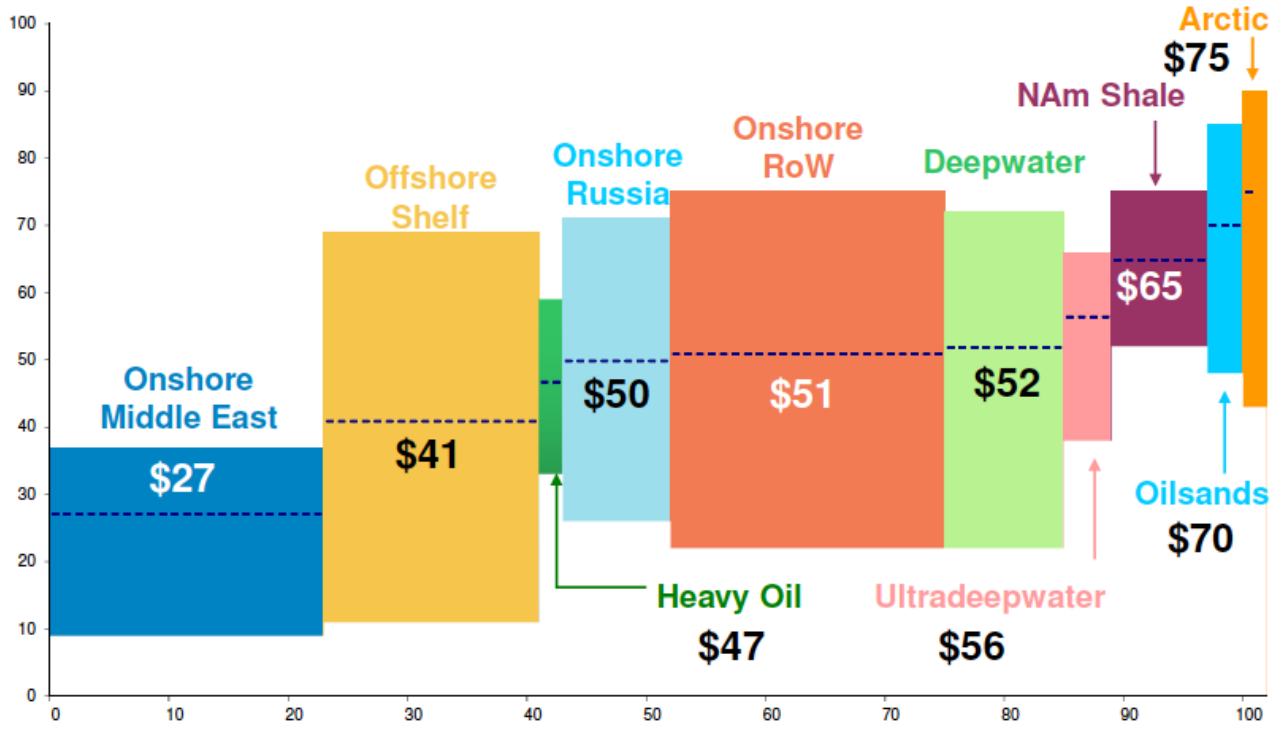
232 million dollars NPT cost in 6 yrs

This is only in the GOM

Its Primarily WB stability related

And its not unique

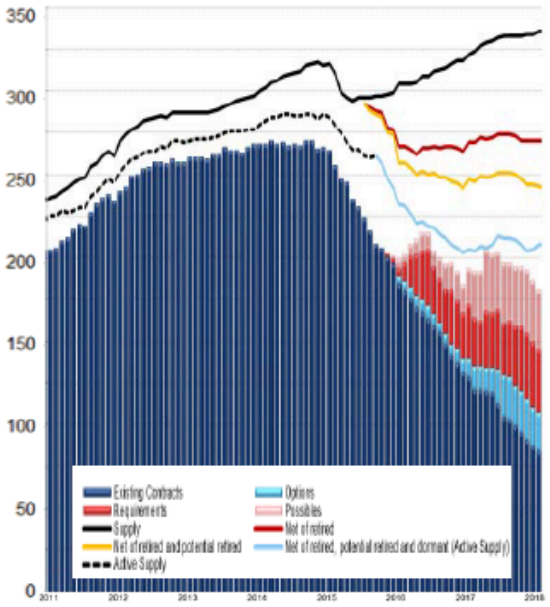
Market Environment



(1) Average IEA crude oil import price
Source: Morgan Staley Equity Research

Offshore Rig Market

Contract Status & Expected Demand 2011-2018
All Floaters - Worldwide



Fearnley Offshore ©2015

Active Supply Market Factors

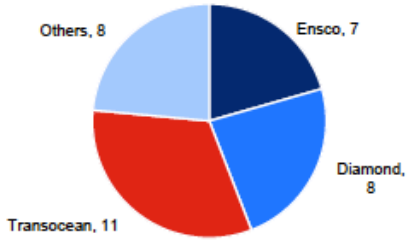
Reduce Supply: (+) for RIG

1. Delayed newbuild deliveries
2. Scrapping of lower specification units
3. Bankruptcies of weaker contractors
4. Temporary stacking of older high specification units (modified cold stacked rigs)

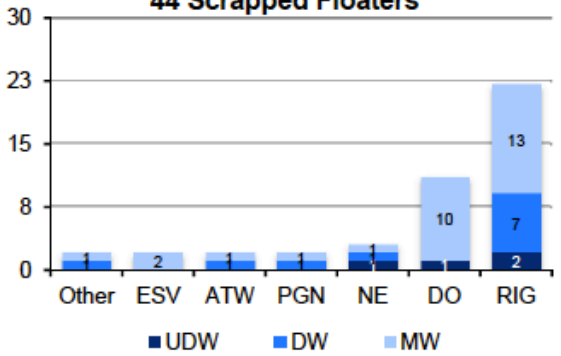
Increase Supply: (-) for RIG

1. Contract terminations increase available supply
2. Operators with excess capacity seeking farmout opportunities

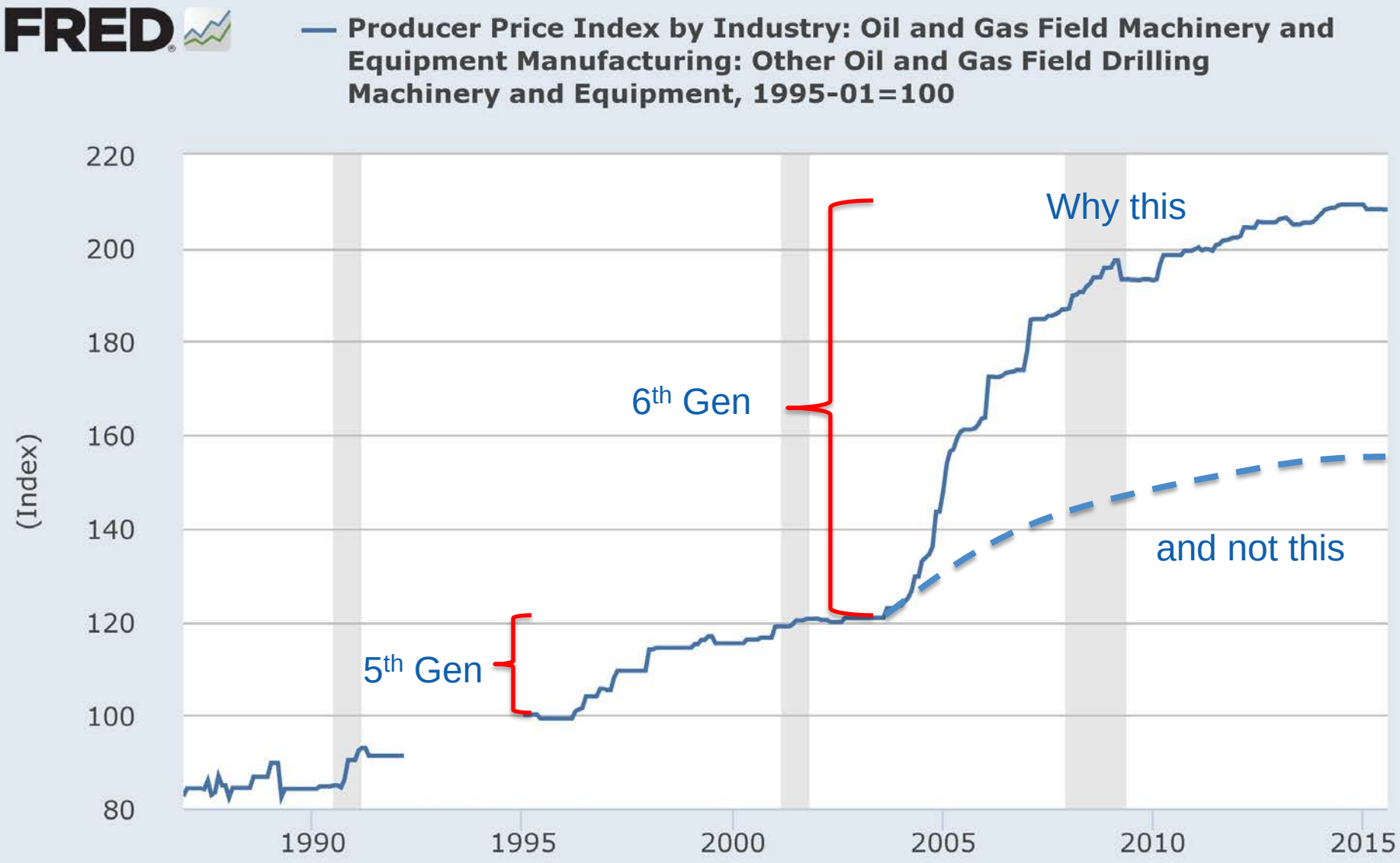
34 Cold Stacked Floaters



44 Scrapped Floaters



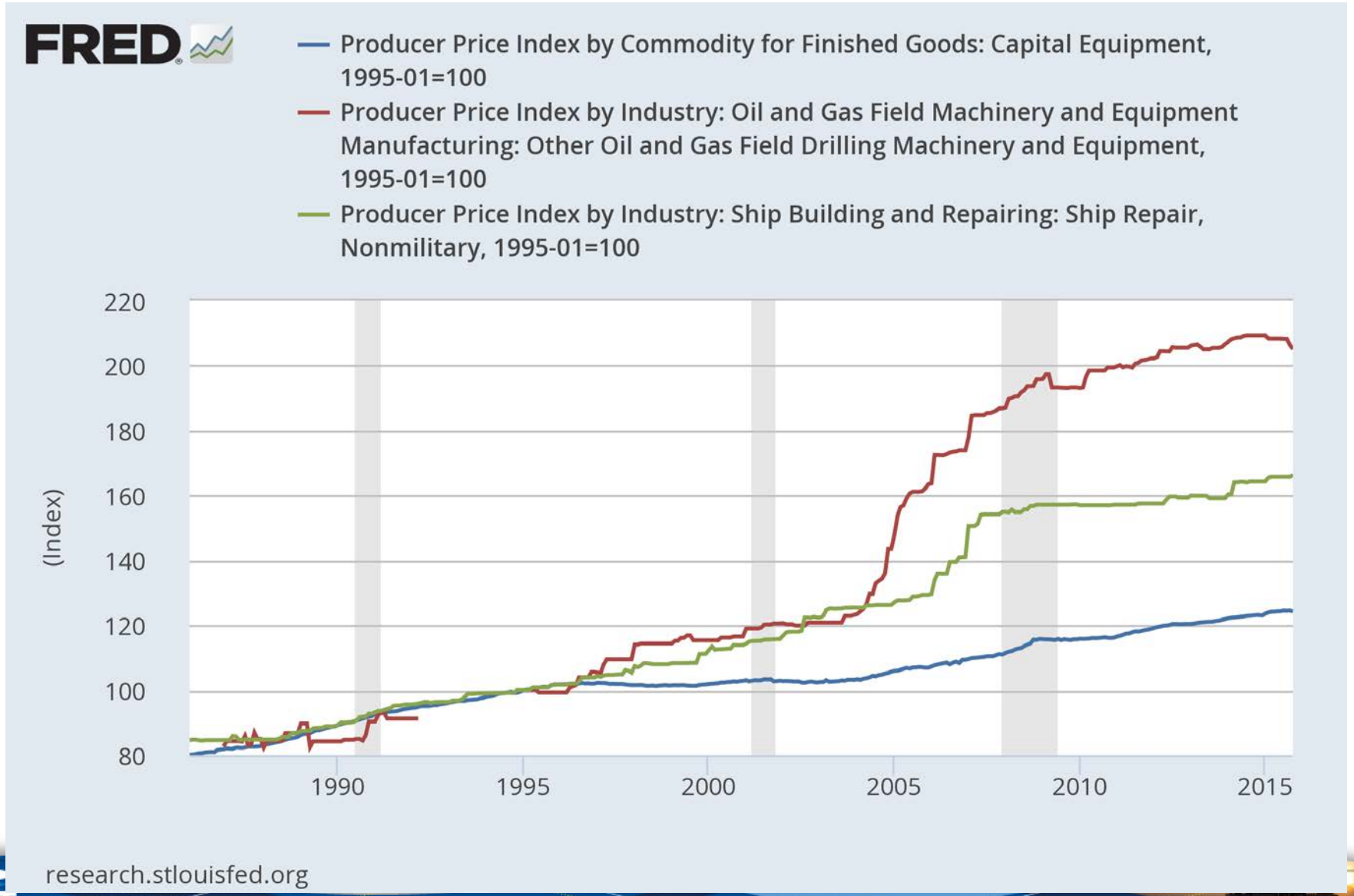
* cost evolution 1985 – 2015,



Source: US. Bureau of Labor Statistics

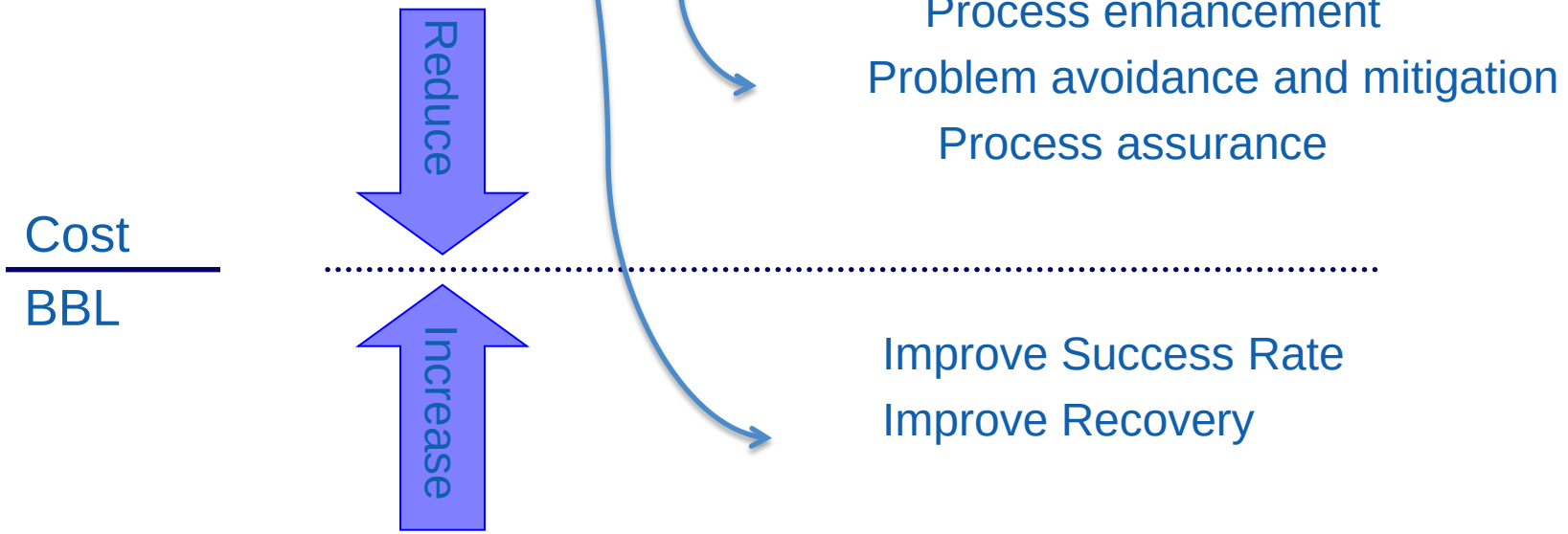
Shaded areas indicate US recessions - 2015 research.stlouisfed.org

* cost evolution 1985 – 2015,



Business Driver - Improving Capital Efficiency

MPD can help with both



Improve Operational Efficiency
Process enhancement
Problem avoidance and mitigation
Process assurance

Improve Success Rate
Improve Recovery

However there are challenges

- Problem Diversity
  - Diversity of regions, fields / challenges and working relationships makes uniform approach to Technology based solution deployment difficult.

    No Universal Single Solution
- Lack of focus
  - Diversity of Technical challenges and many potential solutions results in lack of focus and potentially waste of resources

    e.g. Wide variety of MPD & Dual Gradient initiatives

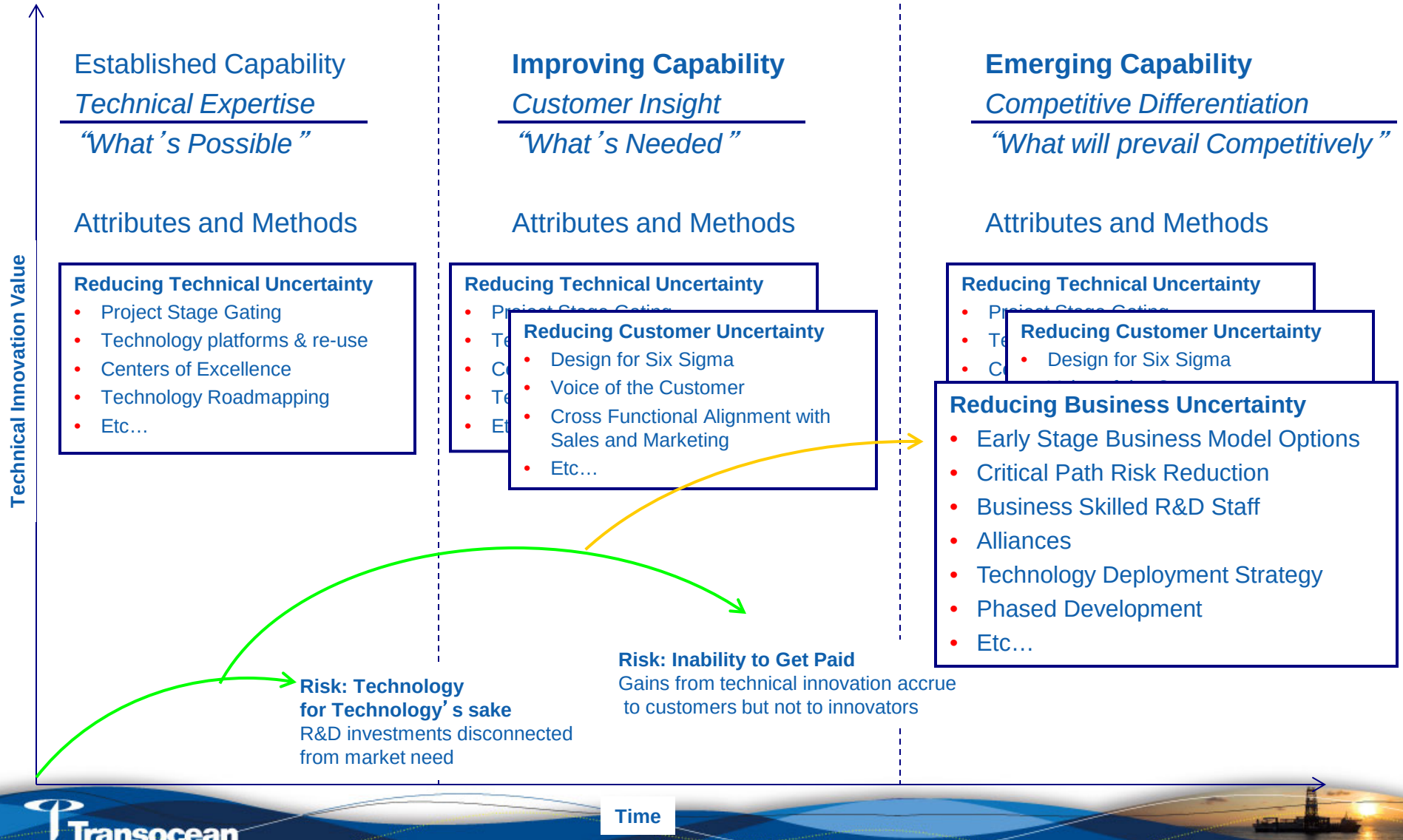
What we want

Alignment

Operator	Contractor
Predictability	Utilization
Reserves	Backlog
Minimal Cost	Adequate Dayrates
Minimal Risk	Minimal Risk
Sustainable ROCE	Sustainable ROCE

Reduction of uncertainty

Technology Development Strategy



After: Research & Technology Executive Council, Embedding Competitive Advantage in the R&D Pipeline

Concluding Remarks

- Advances in the management of Technology R&D have ensured that the petroleum industry can efficiently deliver these technologies
- Challenges occur when the technology is not simply a "drop in"
- Integrating and commercializing technology often fails as a consequence of an inappropriate business framework / model preventing broad commercial adoption of new technologies, resulting in a de facto "do nothing" strategy
- Accepting this strategy has an opportunity cost equivalent to foregone potential improvements in cost and risk reduction afforded by technology.

In effect the industry "pays" for Technical Innovation whether it benefits from it or not

Thanks

The Pace of Technology Development

iPad Jan 2010

TelePresence 2007

Now, What we really want!!!

Operator's View

Contractor's View

Bottom Line = **$$ Billions**