

Risk Analysis of Unconventional Plays

William J. Haskett¹

Search and Discovery Article #80084 (2010)

Posted April 9, 2010

*Adapted from oral presentation at AAPG International Conference and Exhibition, Rio de Janeiro, Brazil, November 15-18, 2009.
Please refer to related article, entitled “Operational and Business Efficiency in Unconventional Projects,” [Search and Discovery Article #80083 \(2010\)](#).

¹Decision Strategies Inc., Houston, TX (bhaskett@decisionstrategies.com)

Abstract

The valuation and assessment of unconventional or “continuous resource” opportunities is not feasible using traditional probabilistic, volumetric-based methods. While a fully stochastic business, value-chain model is the best way to assess the potential of an unconventional play, we continue to lack a solid definition of Chance elements similar to what we have traditionally applied to conventional accumulations (Container: Reservoir, seal, trap and Contents: source and migration, with subtle variances from company to company).

In Unconventional projects, there are two primary technical risks... That the formation will not produce, and that the production will be inconsequential. As such, Productivity and Materiality become the linchpins for Chance and Uncertainty Management in unconventional plays.

“Productivity” is the probability that a given formation will be able to flow a sustained gas stream. This Chance element is tied to, but not dependent on, completion technology.

“Materiality” is the probability that the sustained production will be large and consistent enough, and extend over a large enough area to constitute a viable play based on local or world analogues. Essentially, Productivity is flow-based $P(G)$ and Materiality is $P(S)$.

Each will have sub-elements which may be tied to technology, local economics, or marketing aspects. The commercially oriented nature of the Materiality Chance is due to the business-decision centered approach required in unconventional plays. Conventional methods tend to hold commerciality and economics separate from technical risking, but this is impractical if not dangerous in unconventional resource plays due to the fact that the majority of the business uncertainty arises from production profile uncertainty.

In an integrated business assessment of unconventional opportunities, we start with an assessment of the potential of the play. We assess the

Expected Ultimate Recovery, the Production Profile, the costs for the pilot facility, pilot wells, early experimental wells, factory phase development wells, facilities costs, learning, price volatility, operating costs, and rig and facility timing. It is a low-margin business and we need to be able to identify where our efforts will have the most reward.

References

Haskett, W.J., and P.J. Brown, 2005, Evaluation of unconventional resource plays: SPE Annual Technical Conference and Exhibition, Dallas, Texas, SPE 96879.

Vanorsdale, C.R., 1987, Evaluation of Devonian shale gas reservoirs: SPE 14446, 8 p.
(http://www.pe.tamu.edu/wattenbarger/public_html/Selected_papers/--Shale%20Gas/SPE14446.pdf) (accessed February 20, 2010)



Risk Analysis of Unconventional Projects

Bill Haskett
Senior Principal
Decision Strategies Inc.



Decision Strategies

Risk Occurs in Three basic categories

P_g

Productivity

The probability that the play will produce sustainable production

P_s

Materiality

The probability that the sustained production will be large enough and consistent enough to constitute a viable play

P_c

Above Ground

Access, environmental, water availability and handling, egress, liquids handling, sales, internal capabilities

Unfortunately...
Most technical teams stop with these elements

Think again...

Above Ground

Access, environmental, water
availability and handling, egress, liquids
handling, sales, internal capabilities...

If you think, as an Upstream person that this is
“not my problem”...

Your project is doomed from the beginning.

Identifying and mitigating these risks gives
you leverage, control, ***Competitive Advantage!***

Is it There?

Productivity

In Conventional, if it is there
it is going to produce.

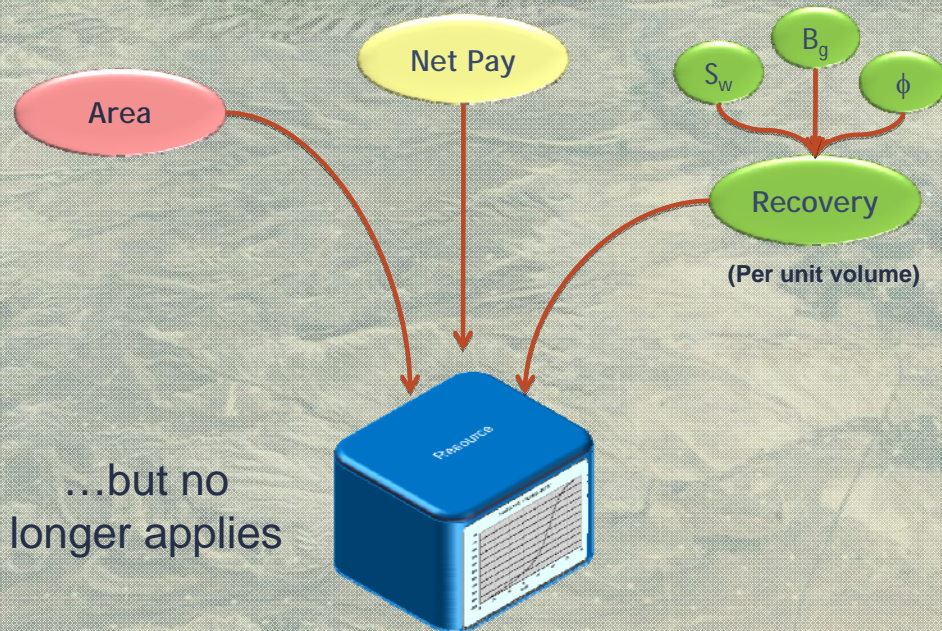
Not so with Unconventional.

P_g

Probability of Hydrocarbon
presence in a large enough
quantity that sustainable
flow is achieved.

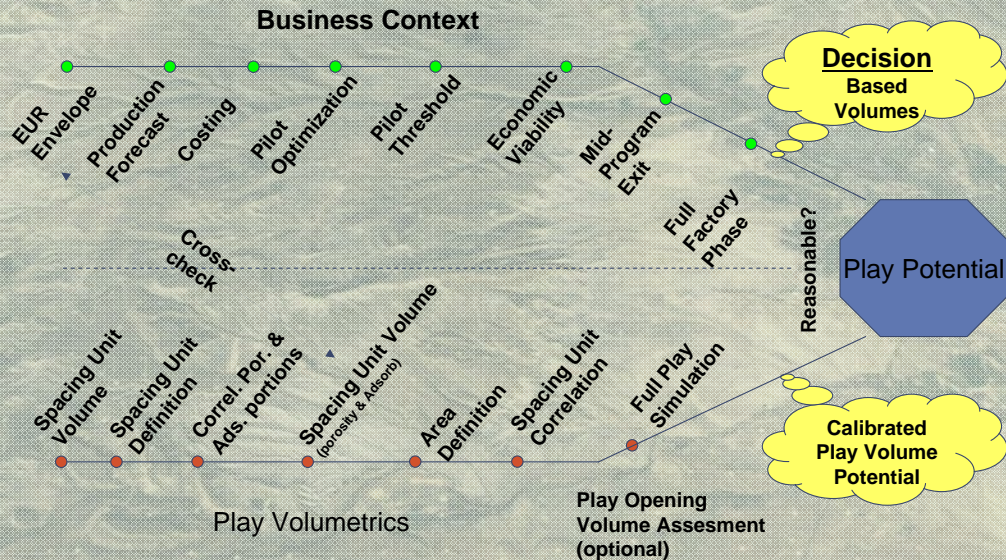
This is usually 100%, but can
be less in frontier areas.

Conventional seemed straight-forward...

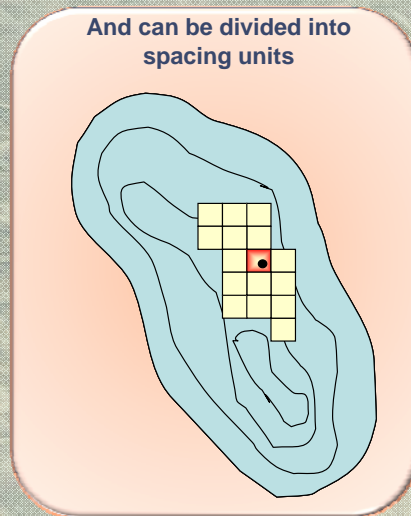
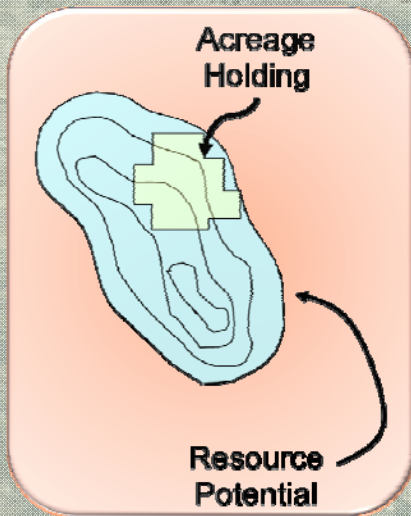


...but no
longer applies

Unconventional Play Work Flow

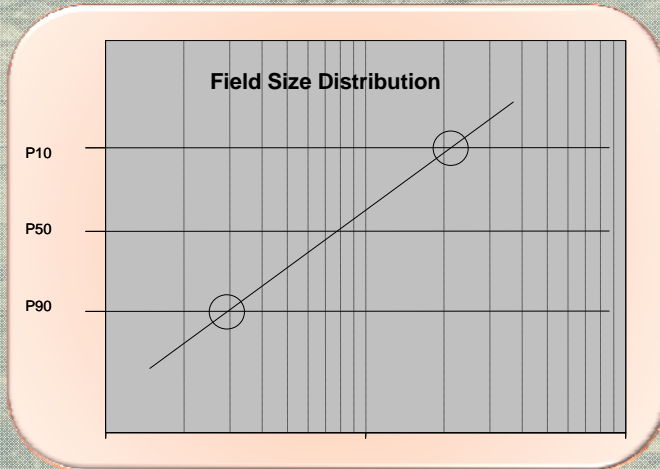


In Unconventional, the area of potential is usually big.



The collection of spacing units forms a "Pseudo-Field"

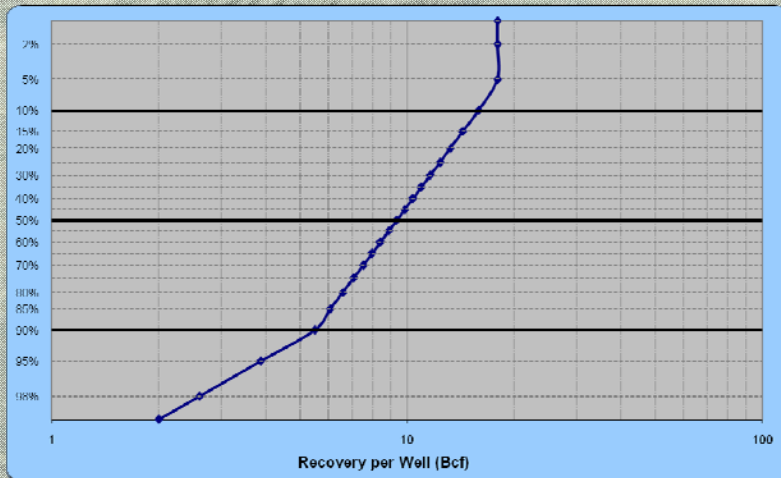
“Conventional” uses Field Size Distributions



**But
remember...
each field is a
collection of
wells... or
spacing units**

See Haskett and Brown (2005), SPE 96879 For a more detailed explanation

Meet the Well Size Distribution



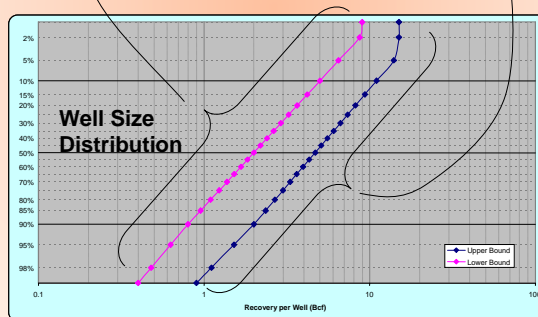
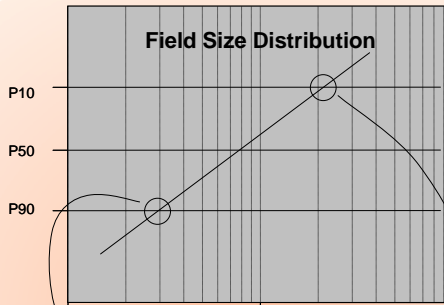
Every field has a family of wells. Good wells... and bad wells

Our quest is to efficiently determine what we have.

The Correct Approach is an Envelope

An unconventional opportunity will have a resource unit distribution someplace in between the bounds

If there is any uncertainty about what you will find on average... You need an Envelope!



Is it Big Enough to Matter?

Materiality

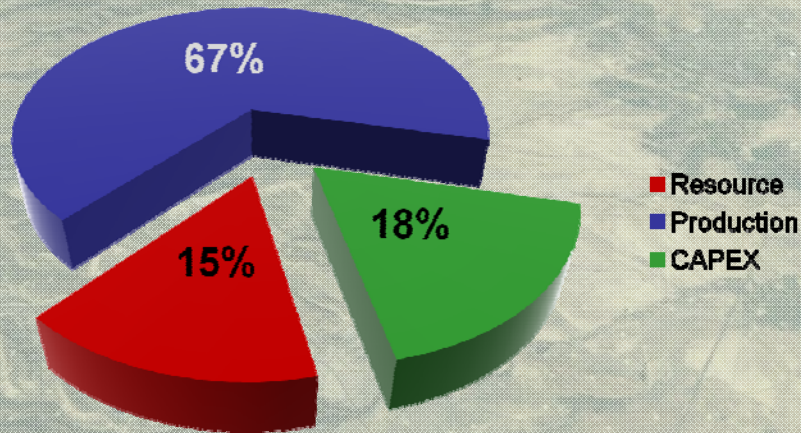
The probability that the sustained production will be large enough and consistent enough to constitute a viable project

P_s

Is Rate and Profile based

Resource assessment forms the foundation but there is much more...

Contribution to NPV Uncertainty*



*Typical Gas Shale Play

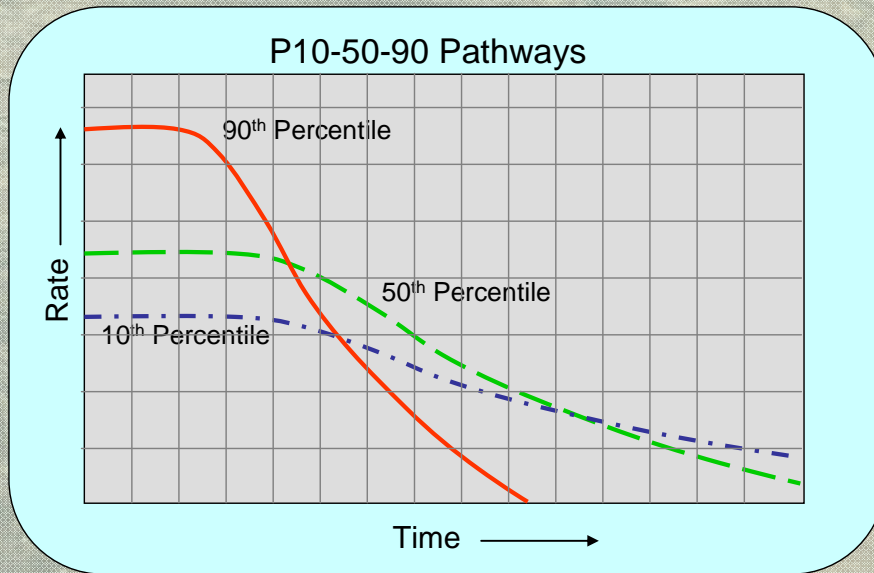
Work on What Matters

A decision centric approach provides a better assessment

- **Create a Learning Plan**
 - Pilot objectives
 - Production testing
 - Capital Efficiency
- **Recognize what would change your decision**
- **Ensure Project Management Skills**
 - Are in place
 - Are appropriate for Learning and Factory phases

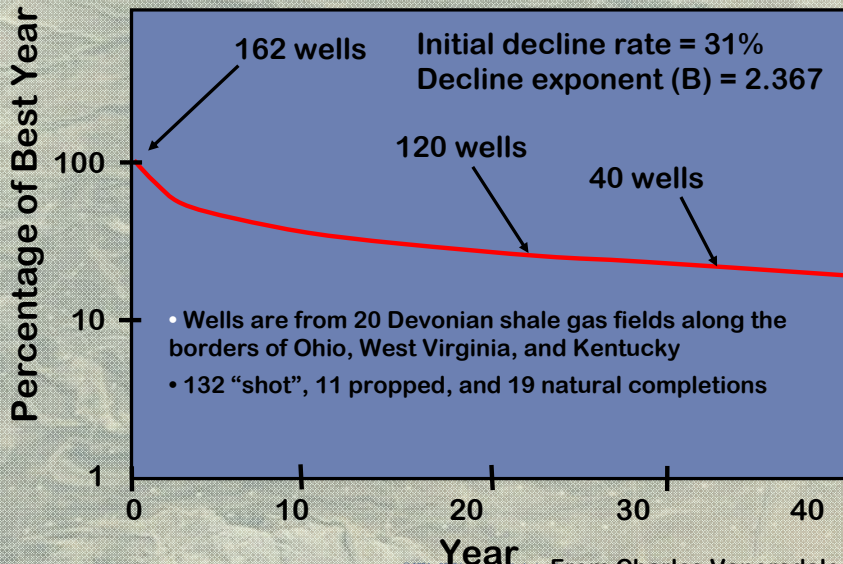


Probabilistic Production Profiles, Not Time Anchored Type Curves



Decline Curves

- Appalachian basin example

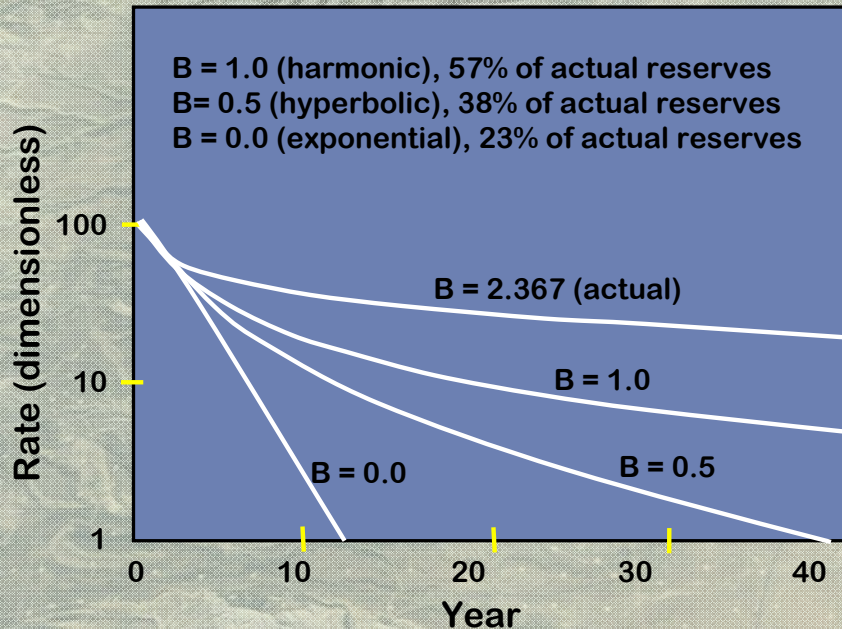


© 1998 - 2007 by American Petroleum Institute

From Charles Vanorsdale, SPE 14446

Presenter's Notes: Traditionally, reserves in shale gas reservoirs have been estimated using decline curve analysis. The reservoirs are very tight; the wells are widely spaced, and the wells remain in transient flow for many many years. As a result the decline exponent, or B factor, as it is called, is quite high. In the case shown here for 162 wells in Devonian gas shales in eastern U.S., the B factor was 2.367.

Significance of High B Values



© 1994 - 2009 by Decision Strategies

From Charles Vanorsdale, SPE 14446

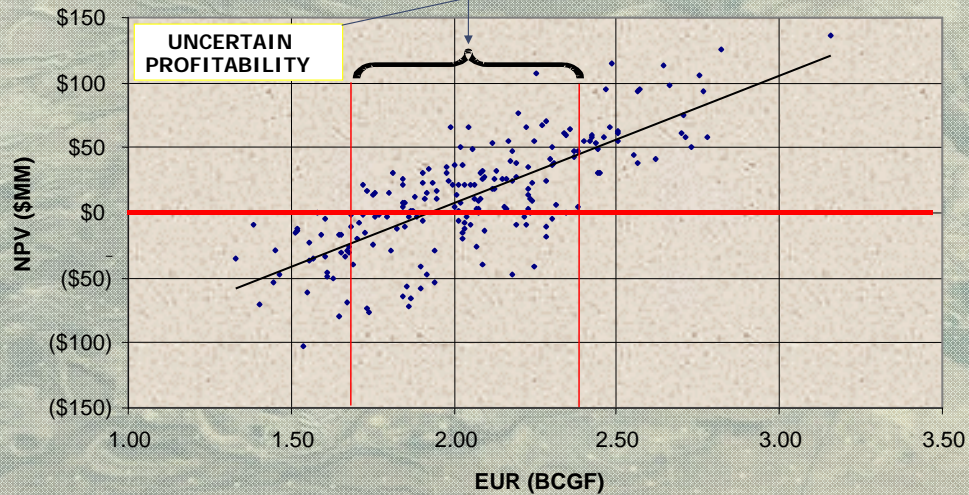
Presenter's Notes: Now, the concern is, if you start drilling these wells closer together, they're not going to remain in transient flow over their entire life. They eventually sense the nearby wells and the decline steepens.

So in the case of the Devonian wells in the eastern U.S., if the B factor drops to 1, which is harmonic decline, you'll only have 57% of the reserves you originally had. And if the B factor drops to 0, which is exponential decline, you'll have 23% of the reserves you originally had.

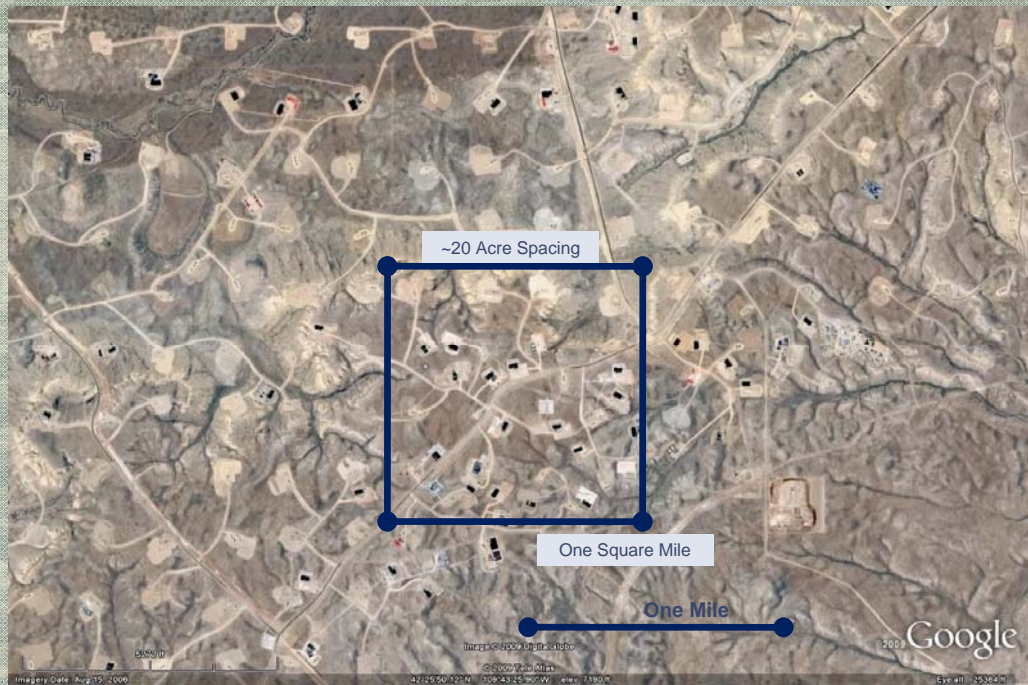
So some people, particularly Tom Blasingame at Texas A&M, are quite concerned that we may be overestimating reserves by using this technique to extrapolate early time data in closely spaced wells.

Ultimately we must make our decisions based on a Full Value-Chain approach

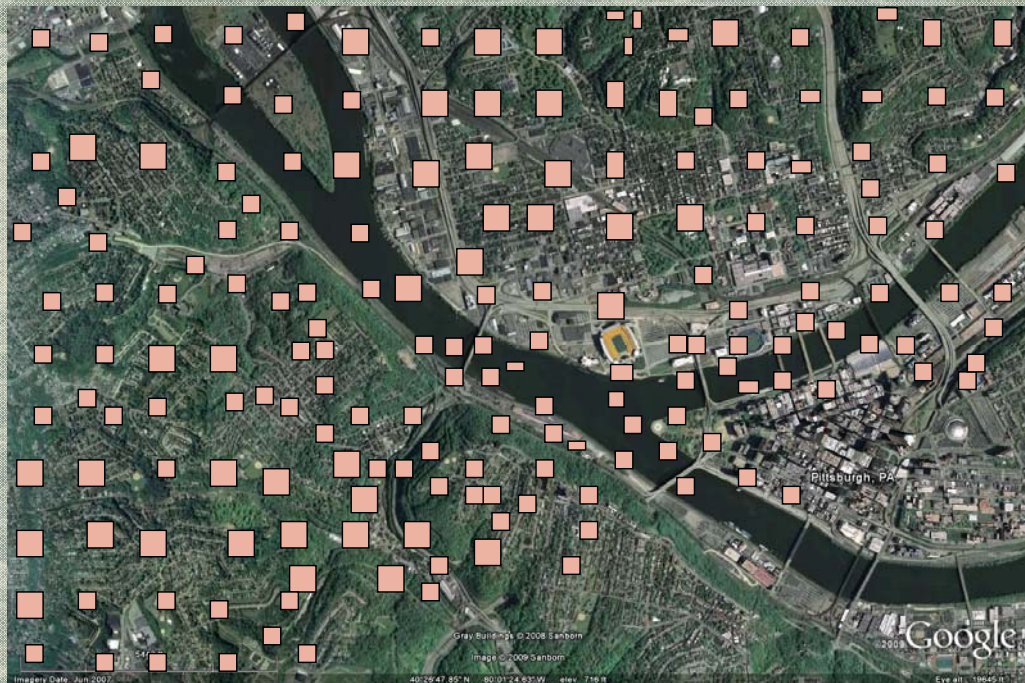
Full Project NPV versus Average EUR



Jonah Field Wyoming – (Majority vertical wells)



Jonah Well Density Superimposed on Pittsburgh



Intelligent Horizontals will significantly reduce pad density

Above Ground Risk Matters

Above Ground

Access, environmental, water availability and handling, egress, liquids handling, sales, internal capabilities...

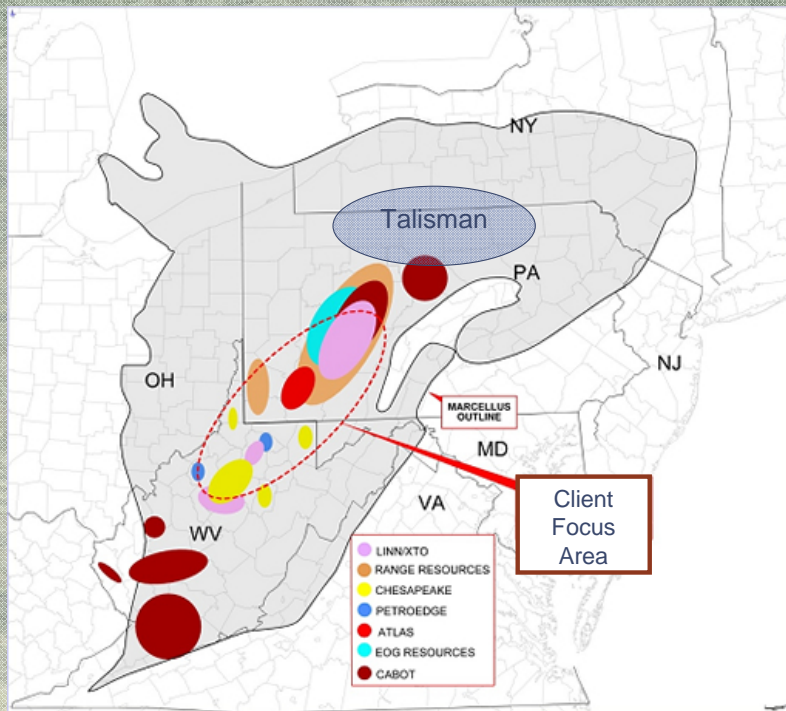
Identifying the Business Pinch Points is critical.

A Business Pinch Point is any element along the value chain that is scarce or could become scarce if the competition was involved.

Competition and Business Pinch-points

IDENTIFY

- Competitors
- Positioning and Strategies
- Business Pinch-Points
- Value of Control



Geological and Production Uncertainty allow you to Manage Above Ground Risk... And Optimize

How much
land and
when?

How large
a pilot
program?

How many
rigs and
when?



It enables you to create an efficient **Learning Plan**

How many pilot wells do you drill?

Pilot Effectiveness

	Pilot Good Proj. Good	Pilot Good Proj. Bad	Pilot Bad Proj. Good	Pilot Bad Proj. Bad	Pilot Effective
1 well	61%	6%	31%	3%	64%
2 wells	71%	6%	21%	2%	73%
3 wells	76%	6%	16%	2%	78%
4 wells	77%	6%	14%	3%	80%
5 wells	81%	7%	11%	2%	82%
6 wells	83%	7%	8%	2%	85%
7 wells	86%	7%	5%	1%	87%
8 wells	87%	8%	4%	1%	88%
9 wells	87%	8%	4%	1%	88%
10 wells	89%	8%	2%	1%	90%
11 wells	90%	8%	2%	1%	90%
12 wells	90%	8%	2%	0%	90%
13 wells	89%	8%	2%	0%	90%
14 wells	91%	8%	1%	0%	91%
15 wells	91%	8%	0%	0%	92%
16 wells	91%	8%	0%	0%	91%
17 wells	91%	8%	0%	0%	92%
18 wells	91%	8%	1%	0%	91%
19 wells	91%	8%	1%	0%	91%
20 wells	91%	9%	1%	0%	91%

% outcomes that are full-cycle positive

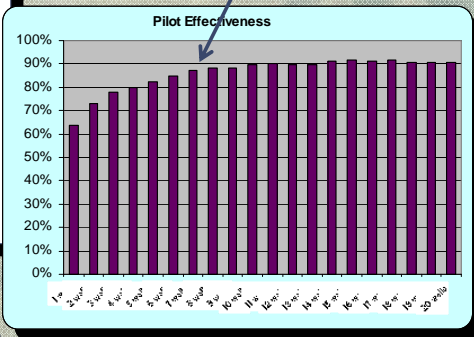
91%

'True
Positives'

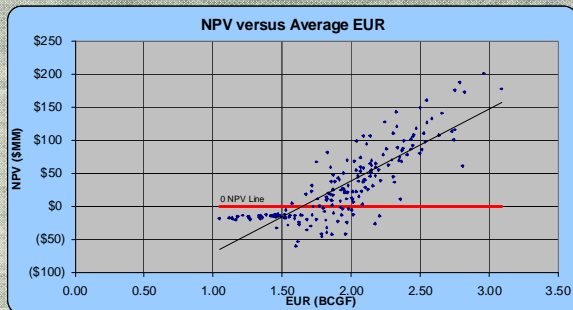
'True
Negatives'

Diminishing learning
with additional drilling

"Optimal" Wells



PA Horizontal Dry Gas



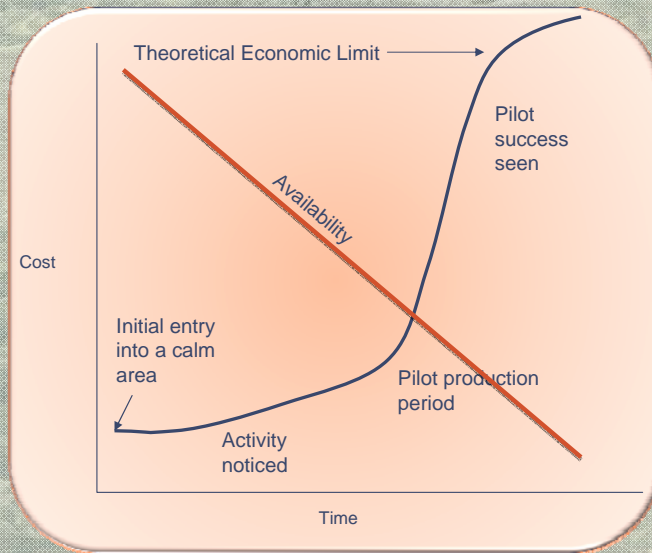
- 10,000 acre Pseudo-Field
- First assess what the reservoir will do
- Determine critical thresholds
- Program is stopped if Pilot fails to show sufficient EUR
- Optimize pilot program and land given strategy and objectives

RESULTS OF SIMULATION

Net NPV (\$MM, AFTER TAX)					
	P90	P50	P10	MEAN	
Full Project	-\$20	\$19	\$107	\$30	Probability
Pilot Success	-\$24	\$37	\$111	\$43	
Full Development Success	-\$22	\$38	\$113	\$45	
Mid-Program Failure				-\$19	
Pilot Failure				-\$12	3%
					22%

Success Case Discounted Investment, \$MM				
	P90	P50	P10	MEAN
Gross	\$392	\$419	\$445	\$419
Net	\$392	\$419	\$445	\$419
Success F&D (\$/BOE)	\$13.54	\$11.74	\$9.70	\$11.73
Pilot Failure F&D (\$/BOE)				\$31.31
Success ATAX Disc P/I	-0.05	0.10	0.28	0.11
Post Learning Well Cost (\$MM)	\$2.99	\$3.28	\$4.29	\$3.46

How much land do you secure before the pilot result is known?



- High early purchase risks stranding capital or direct loss from pilot failure

- Both Risk and Cost based optimization

- Potential competition reduces land availability for late acquisition

- Increased competition elevates price for late acquisition

Entry and development decisions

Exploration
Success

P_g

Is there Resource?

Pilot Success

P_p

Is it recoverable?

Mid-Program
Check

Was the Pilot
Truthful?

Development
Success

P_c

Is it profitable?



Risk Analysis of Unconventional Projects

Bill Haskett
Senior Principal
Decision Strategies Inc.

bhaskett@decisionstrategies.com

+1 (713) 526-2420



Decision Strategies

www.decisionstrategies.com