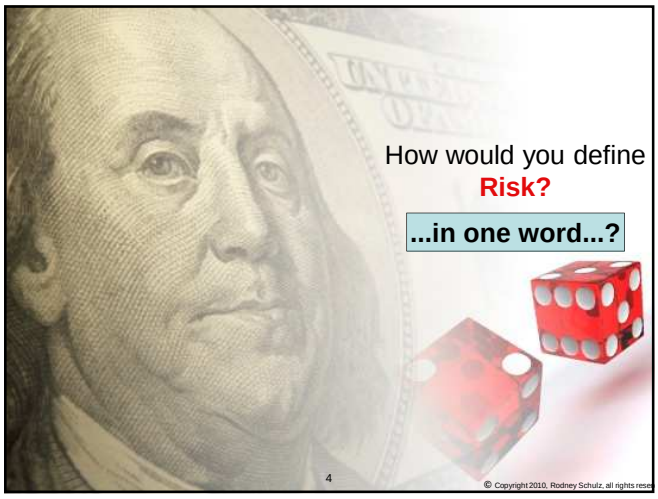
Oil & Gas Economics And Uncertainty

SPE
Webinar
by
Rodney Schulz

Poll Question:

What best describes your current occupation?

What is **money ?**



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Poll Question:

How long have you been in the industry?

5

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Section 2

Strengths & Weaknesses
of
Traditional Econometric Analysis Methods

1) Internal Rate of Return

2) Payback

3) Profitability Index

4) Net Present Value

Source of Critique:
Principles of Corporate Finance, 10th addition, McGraw-Hill
•Richard A. Brealey, Professor of Finance at the London Business School, former president of the European Finance Association
•Stewart C. Myers, Professor of Finance at MIT's Sloan School of Management, past president of the American Finance Association
•Franklin Allen, Professor of Finance at the University of Pennsylvania's Wharton School of Business, past president of the American Finance Association

6

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Section 2

Internal Rate of Return
Lending or Borrowing?

Year	Case 1	Calculation @50%	Calculation Result
0	$ (1,000)	(-1000)/(1+.5)^0	$ (1,000)
1	$ 1,500	(1500)/(1+.5)^1	$ 1,000
NPV @ 50%			$ -

IRR = 50%

NPV @ 10% = $364

Excel IRR = 50%

Year	Case 2	Calculation @50%	Calculation Result
0	$ 1,000	(1000)/(1+.5)^0	$ 1,000
1	$ (1,500)	(-1500)/(1+.5)^1	$ (1,000)
NPV @ 50%			$ -

IRR = 50%

NPV @ 10% = -$364

Excel IRR = -33%

What do IRR, NPV, Payback and PI have in common?

7 7

Section 3

A BRIEF Review of Statistics

1) Discovery of the discipline

2) Variance and standard deviation

3) Bell curves

4) Uncertainty in means and variance

5) Hypothesis testing

6) Statistics software

8 8

Poll Question:

Where and When was statistics discovered?

9 9

Statistics:
Variance and Standard Deviation

Key Point:

Don't simply look at the mean, the average

Rather,

Consider the number of numbers

and

the spread of the numbers

Statistics:
Bell curves

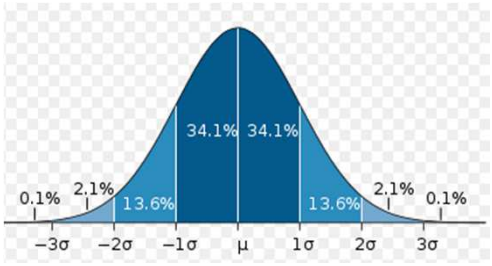


Figure Source: www.Wikipedia.com

Statistics: Hypothesis Testing
(made simple)

The following example is from Schulz & Harms' SPE Paper No. 117433:

SPE 117433

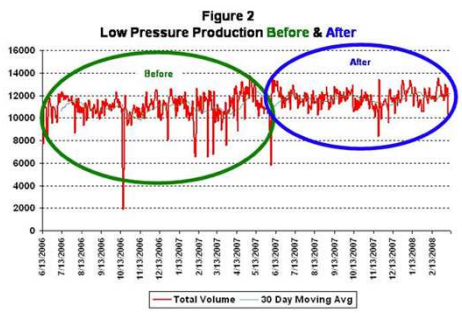
An Unconventional But Definitive Analysis of a Field's Production Improvement

Rodney Schulz/ConocoPhillips; Larry Harms/ConocoPhillips

This paper was prepared for presentation at the 2008 SPE Eastern Regional/AAPG Eastern Section Joint Meeting held in Pittsburgh, Pennsylvania, USA, 11–15 October 2008.

Statistics: Hypothesis Testing
(made simple)

First order of business: re-Plot the data:



Section 3

For the record, it was a mature gas lease of ~80 wells producing an average of ~110 MCFPD per well.

What did we do?

a) Added an extra compressor so that we had EXCESS compression capacity;

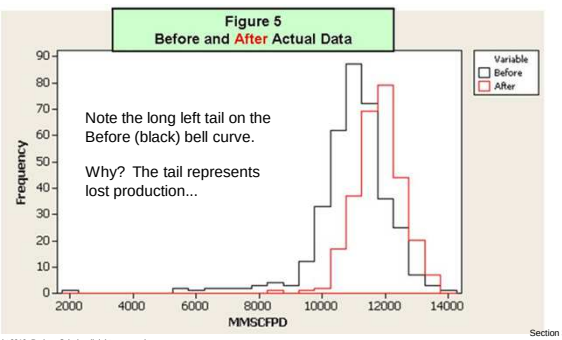
b) Automated well shut-ins so that they began shutting in immediately when a compressor went down;

c) Reduced the bottlenecks in the gathering system;

d) Other things to reduce variation/uncertainty

Statistics: Hypothesis Testing
(made simple)

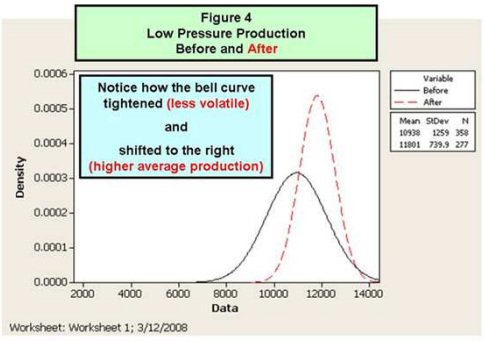
For whom the bell tolls...



Section 3

Statistics: Hypothesis Testing
(made simple)

...it tolls for thee...



Statistics: Hypothesis Testing
(made simple)

The quantifiable amount:

Table 1
Comparison of Before and After Statistics
(All Figures in MMSCFPD)

	Before	After
Average	10.9	11.8
Standard Deviation	1.3	0.7
95% Probability Range	8.3 – 13.5	10.4 – 13.2

LESSON: If you reduce variation, you will usually get a mean shift for free.

And yes, the project did have a strong IRR/ROI.

Poll Question:

Why was statistics invented?

Poll Question (NO CHEATING):

Did you get:

Section 5

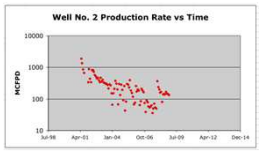
Risk and Return

Preview:

- Credit & discount rate questions
- Information from the bond and equity markets
- β and the Capital Asset Pricing Model (CAPM)
- Some more recent thoughts

Section 5
Risk and Return

Similarly, you're Medium Oil's CFO and the following two projects come to you for financing, both from the same engineer:



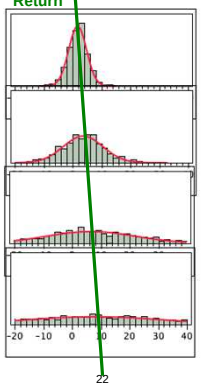
Well No. 1:
- Well has downhole problem ABC and production has gone to zero
- Total cost to repair is $150,000
- Estimated production improvement is 150 MCFPD
- IRR is 35%

Well No. 2:
- Well has downhole problem ABC and production has gone to zero
- Total cost to repair is $150,000
- Estimated production improvement is 150 MCFPD
- IRR is 35%

Would you "loan" money to each project at the same discount rate?

Average Annual Return

Scales
x (annual return) = -20 to 40
y (number of hits) = 0 to 150
1000 trials total



Cash μ = 1.81% σ = 3.09%

Inv Grade Bonds μ = 3.74% σ = 6.66%

High Yield Bonds μ = 7.17% σ = 15.23%

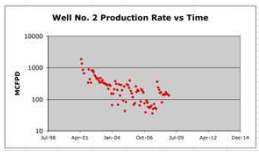
Large Growth Stocks μ = 9.20% σ = 23.70%

Yes! It appears that risk and return are definitively related

Data source: Morningstar's Principia software, as modeled on JMP

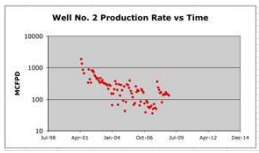
Poll Question:

If these two wells have the same current production rate, operating cost, reserves, royalty, etc., which well would you rather have?



Poll Question:

If these two wells have the same current production rate, operating cost, reserves, royalty, etc., which well would likely bring the higher price?



Consistency adds value

Poll Question:

What is the annual standard deviation of the S&P 500?

NOTE:

Volatility is not constant and will tend to ebb and flow.

Section 4
Oil and Gas Prices & Forecasting

1) The efficient market hypothesis

2) Empirical evidence supporting the efficient market hypothesis

3) Its application to oil and gas prices

4) Quantifying the uncertainty

28

Poll Question:

What is the MONTHLY standard deviation of the oil price?

NOTE: annual std dev =~(monthly std dev) x $(12)^{1/2}$

29

29

Section 4
Oil and Gas Prices & Forecasting

Parts of this section are from Schulz's March 2007 Guest Editorial article in SPE's Journal of Petroleum Technology (JPT)

Fama recently won the Nobel Prize in Economics.

"The only thing certain about the future is uncertainty"

Harry Markowitz
Nobel Prize winner in economics and the father of modern portfolio theory

What constitutes an efficient market?

- A market that incorporates all publicly available information [almost] instantaneously
- Price movements follow a "random walk" model

What this does NOT say:

- Efficient markets are always "right"

Section 4
Oil and Gas Prices & Forecasting

SPE 130104

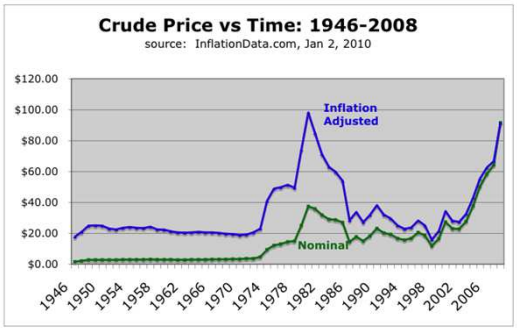
Risk, Reward, Metrics and Volatility
Rodney Schultz, Schultz Consulting

This paper was prepared for presentation at the SPE Hydrocarbon Economics and Evaluation Symposium held in Dallas, Texas, USA, 8–9 March 2010.

Parts of the following information are from the above SPE presentation.

34

Section 4
Oil and Gas Prices & Forecasting



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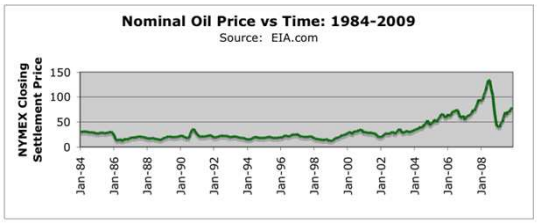
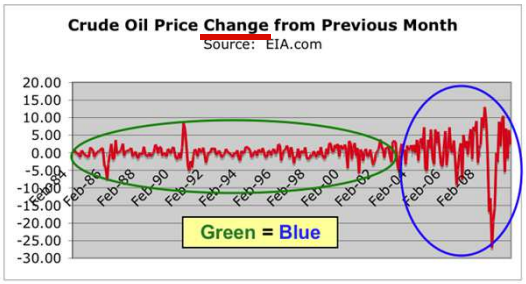
Section 4
Oil and Gas Prices & Forecasting



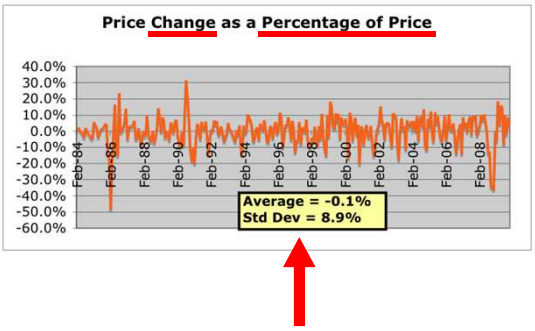
36

Section 4
Oil and Gas Prices & Forecasting



37

Section 4
Oil and Gas Prices & Forecasting



38

Section 4
Oil and Gas Prices & Forecasting

What's the take away?

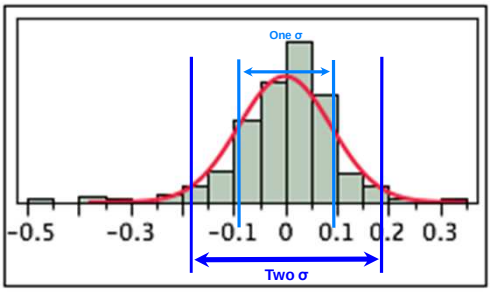
The monthly σ
of the crude oil price is

of the crude oil price.

39

Section 4
Oil and Gas Prices & Forecasting

How about a bell curve of this data?



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Section 6
Revenue Forecasting Under Uncertainty

Preview:

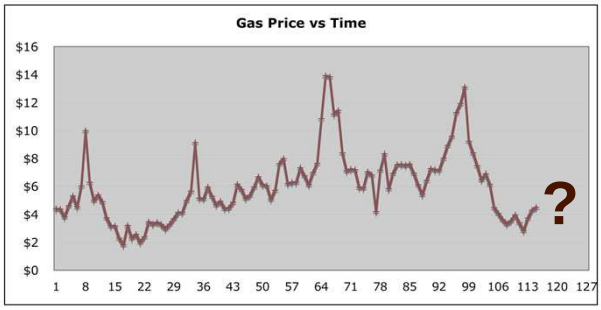
- Based on Schulz's July 2011 JPT article, "Three Steps to a Risked Revenue Forecast"
- JMP Exercise

41

41

Section 6
Revenue Forecasting Under Uncertainty

Would you like to forecast the next twelve data points?



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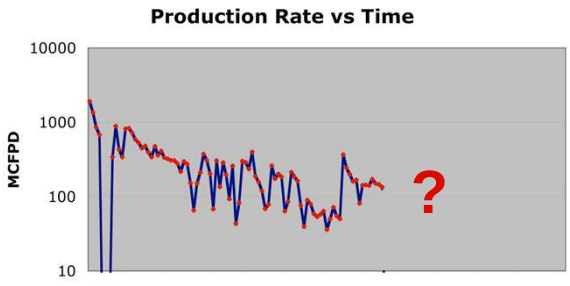
42

Section 6
Revenue Forecasting Under Uncertainty

How about forecasting the next twelve data points from this well?



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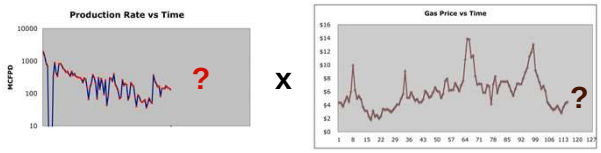
Section 6
Revenue Forecasting Under Uncertainty

What about forecasting the *PRODUCT* of these two forecasts?



= ? x ? = ?

44 44

Solve the problem in sequential steps:

a) **Quantify and model the production uncertainty**

b) **Quantify and model the price uncertainty**

c) **Combine the two**

d) **Yes, you can easily add other uncertainties such as operating costs, etc.**

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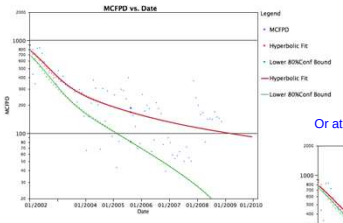
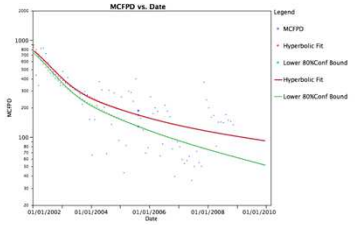
Section 6
Revenue Forecasting Under Uncertainty

Fine tuning the graph we can get (80% confidence level):



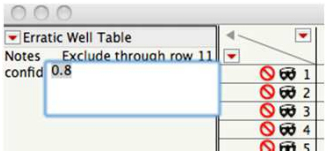
Or at the 65% confidence level we get:



46

Section 6
Revenue Forecasting Under Uncertainty

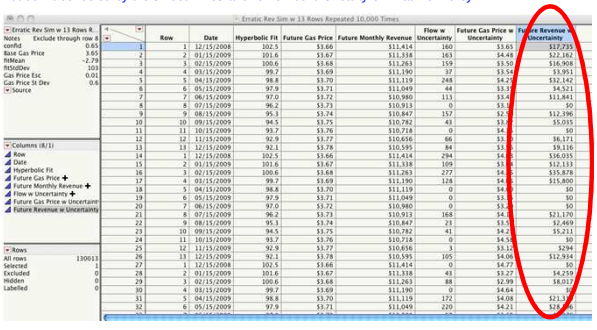
Note that changing the confid value (just double click on the number and enter the desired value) will automatically update the confidence interval column.



47

Section 6
Revenue Forecasting Under Uncertainty

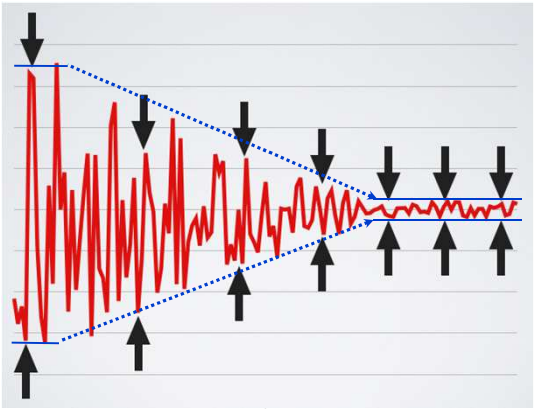
But don't be fooled by the smooth lines and remember the reality of what we live by:



48

Section 7

What is Volatility Reduction?



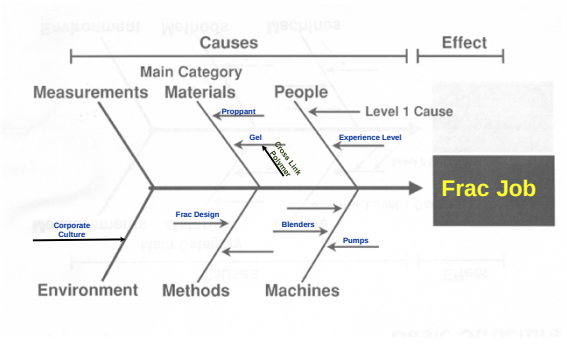
Go about volatility reduction (commonly known as "quality" in world class manufacturing circles) by systematically applying the appropriate tools.

Three of these tools (a *fishbone chart*, a *flow chart* and a *Pareto chart*) will be briefly demonstrated.

Resist the natural upstream oil and gas urge to throw money at the project.

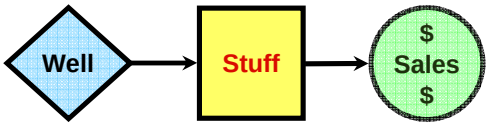
Section 7
Volatility Reduction Techniques

Frac Job Example:



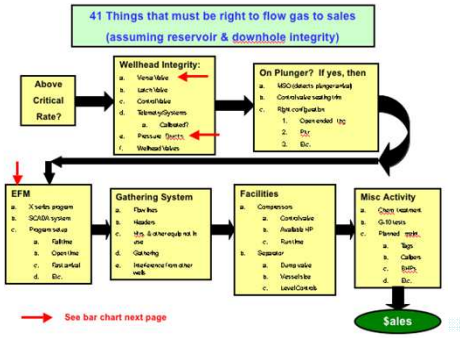
Section 7
Volatility Reduction Techniques

South Texas Gas Well Example using a Flow Chart and a Pareto Chart:



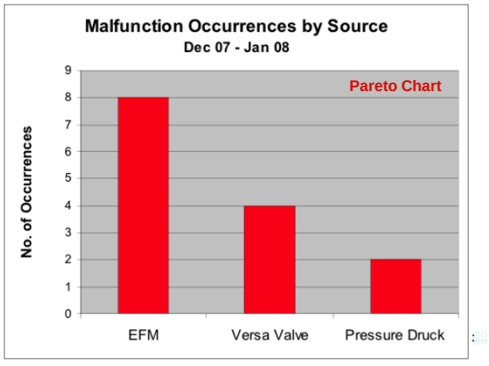
Section 7
Volatility Reduction Techniques

South Texas Gas Well Example - REALITY:



Section 7
Volatility Reduction Techniques

What goes wrong most often?



Section 8

Hedging: Futures, Options and Swaps

Preview:

- Futures
- Options
- Swaps
- Accounting considerations
- Matching the hedge to production

Section 8

Hedging: Futures, Options and Swaps

What's this "*standardized futures contract*" all about?

Corn Futures

Contract Size	5,000 bushels (~ 127 Metric Tons)	
Deliverable Grade	#2 Yellow at contract Price, #1 Yellow at a 1.5 cent/bushel premium #3 Yellow at a 1.5 cent/bushel discount	
Pricing Unit	Cents per bushel	
Tick Size (minimum fluctuation)	1/4 of one cent per bushel ($12.50 per contract)	
Contract Months/Symbols	March (H), May (K), July (N), September (U) & December (Z)	
Trading Hours	CME Globex (Electronic Platform)	6:00 pm - 7:15 am and 9:30 am - 1:15 pm central time, Sunday - Friday Central Time
	Open Outcry (Trading Floor)	9:30 am - 1:15 pm Monday - Friday Central Time
Daily Price Limit	$0.30 per bushel expandable to $0.45 and then to $0.70 when the market closes at limit bid or limit offer. There shall be no price limits on the current month contract on or after the second business day preceding the first day of the delivery month.	
Settlement Procedure	Physical Delivery	
Last Trade Date	The business day prior to the 15th calendar day of the contract month.	
Last Delivery Date	Second business day following the last trading day of the delivery month.	
Product Ticker Symbols	CME Globex (Electronic Platform)	ZC C=Clearing
	Open Outcry (Trading Floor)	C
Exchange Rule	These contracts are listed with, and subject to, the rules and regulations of CBOT.	

Section 8

Hedging: Futures, Options and Swaps

For an example, lets' move over to the crude oil contract:

Light Sweet Crude Oil Futures

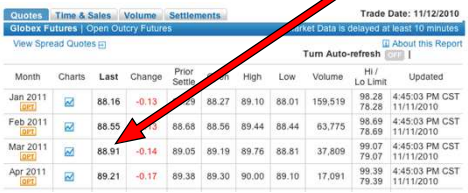
Product Symbol	CL	
Venue	CME Globex, CME ClearPort, Open Outcry (New York)	
Hours (All Times are New York Time/ET)	CME Globex	Sunday - Friday 6:00 p.m. - 5:15 p.m. New York time/ET (5:00 p.m. - 4:15 p.m. Chicago Time/CT) with a 45-minute break each day beginning at 5:15 p.m. (4:15 p.m. CT)
	CME ClearPort	Sunday – Friday 6:00 p.m. – 5:15 p.m. (5:00 p.m. – 4:15 p.m. Chicago Time/CT) with a 45-minute break each day beginning at 5:15 p.m. (4:15 p.m. CT)
	Open Outcry	Monday – Friday 9:00 AM to 2:30 PM (8:00 AM to 1:30 PM CT)
Contract Unit	1,000 barrels	
Price Quotation	U.S. Dollars and Cents per barrel	
Minimum Fluctuation	$0.01per barrel	

Delivery	*(A) Delivery shall be made ratably at any pipeline or storage facility in Cushing, Oklahoma with pipeline access to TEPPCO, Cushing storage or Equilon Pipeline Company LLC Cushing storage. Delivery shall be made in accordance with all applicable Federal executive orders and all applicable Federal, State and local laws and regulations. For the purposes of this Rule, the term F.O.B. shall mean a delivery in which the seller:* • provides light "sweet" crude oil to the point of connection between seller's incoming and buyer's outgoing pipeline or storage facility which is free of all liens, encumbrances, unpaid taxes, fees and other charges; • in the event of the buyer's election to take delivery by interfacility transfer ("pumpover") to either TEPPCO, Cushing or Equilon Pipeline Company LLC, Cushing, from seller's delivery facility, bears the lesser of the pumpover charge applicable for pumpover from seller's delivery facility to TEPPCO or Equilon Pipeline Company LLC; • retains title to and bears the risk of loss for the product to the point of connection between the buyer's outgoing and the seller's incoming pipeline or storage facility. *(B) At buyer's option, such delivery shall be made by any of the following methods:* • By interfacility transfer ("pumpover") into a designated pipeline or storage facility with access to seller's incoming pipeline or storage facility. • By in-tank transfer of title to the buyer without physical movement of product; if the facility used by the seller allows such transfer, or by in-line transfer or book-out if the seller agrees to such transfer. *(C) All deliveries made in accordance with these rules shall be final and there shall be no appeal.* (D) Any seller delivering less than 5 contracts for one customer shall deliver out of storage at the Equilon Pipeline Company LLC facilities, unless the buyer and seller mutually agree to exempt the seller from this requirement.
Delivery Period	(A) Delivery shall take place no earlier than the first calendar day of the delivery month and no later than the last calendar day of the delivery month.

Section 8
Hedging: Futures, Options and Swaps

Situation:

Olivia's Oil Company is producing 12 BOPD and plans to sell 1000 BO in late February 2011. Being happy with a futures price of $88.91 per BO, Olivia's Oil Company sells short one NYMEX crude oil contract for March 2011.



Quotes | Time & Sales | Volume | Settlements — Trade Date: 11/12/2010
Globex Futures | Open Outcry Futures — Market Data is delayed at least 10 minutes
View Spread Quotes — About this Report
Turn Auto-refresh

Month	Charts	Last	Change	Prior Settle	Open	High	Low	Volume	Hi / Lo Limit	Updated
Jan 2011		88.16	-0.13	88.29	88.27	89.10	88.01	159,519	98.28 / 78.28	4:45:03 PM CST 11/11/2010
Feb 2011		88.55	-0.13	88.68	88.56	89.44	88.44	63,775	98.69 / 78.69	4:45:03 PM CST 11/11/2010
Mar 2011		88.91	-0.14	89.05	89.19	89.76	88.81	37,809	99.07 / 79.07	4:45:03 PM CST 11/11/2010
Apr 2011		89.21	-0.17	89.38	89.30	90.00	89.10	17,091	99.39 / 79.39	4:45:03 PM CST 11/11/2010

Total value of the contract: $88,910 (1000 x $88.91)

58

Section 8
Hedging: Futures, Options and Swaps

Remember, the monthly standard deviation of the oil price is 9 percent, which yields **a daily standard deviation of 2%** (0.09/sqrt[20 trading days per month]).

What does all this mean? Look out...

- Approximately **one out of three days** the oil price will **move more than** .02 x $88.91, or **$1.78**
- 19 out of 20 days (one month of trading days), the oil price will move less than 2 x .02 x $88.91, or $3.56.
- However, one can expect **one day a month** (5 percent of the time) the oil price will **move more than $3.56**.
- But keep in mind that market volatility is not constant, as it continually changes over time.
- Also, anecdotally, big price changes tend to come in waves.

59

Section 8
Hedging: Futures, Options and Swaps

And so it goes until her contract expires with oil at $85.00 per barrel:

No. of Contracts:		1		
Barrels under contract:		1000		
Day	**Oil Price**	**Gain (Loss)**	**Account Balance**	**Required Additions**
0	$ 88.91		$ 5,063.00	
1	$ 87.91	$ 1,000.00	$ 6,063.00	
2	$ 89.91	$ (2,000.00)	$ 4,063.00	
3	$ 91.41	$ (1,500.00)	$ 2,563.00	$ 1,187.00
x				$ (1,187.00)
Expiration	$ 85.00	$ 3,910.00	$ 8,973.00	

What happens upon expiration?

1. She delivers her physical barrels in Cushing and receives $85.00 per barrel, for a total of $85,000.

2. She closes her margin account and deposits $3910 into her bank account, thus netting $88,910, or $88.91 per barrel.

60

Section 9
Common Sense Economics

Preview:

- **Common Sense Economics**
- An Example Project
- Data Collection
- Presentation of Results

61

Poll Question:

Do you participate in Peer Reviews?

62

62

Section 9
Common Sense Economics

This section is built primarily on Schulz's October 2009 JPT article in the Management section of the JPT.

The example used is a South Texas property currently under redevelopment consideration from Schulz and others in the industry.

63

63

Section 9
Common Sense Economics

What's a key weakness of aforementioned economic analysis models?

- They all require an oil and/or gas price assumption.

Can we get away from this?

- Yes!

How?

Section 9
Common Sense Economics

Consider using other stand-alone factors such as:

- Average first year production rate
- Total reserves added
- Total post five year reserves
- Estimated cost

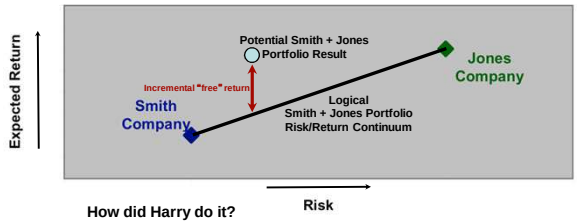
Section 10
Portfolio Design & Management

Preview:

- Background & history
- **What Markowitz discovered**
- An illustration
- Application to oil and gas

Section 10
Portfolio Design & Management

Risk vs. Expected Return

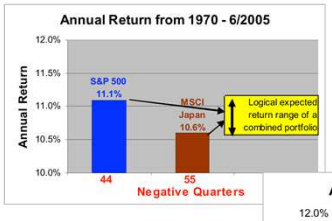


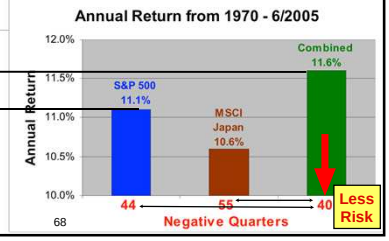
How did Harry do it?

- By combining **statistical covariance** and **linear programming**.
- The combination is called "**mean variance optimization**", or MVO
- And yes, he won a Nobel Prize for it...40 years later...

Section 10
Portfolio Design & Management

A simplified "real world" example, combined with portfolio rebalancing:





Free extra return

And thus, Dr. Markowitz won the Nobel Prize in Economics... 40 years later.

Poll Question:

Imagine it's February 2012. The average U.S. wellhead gas price is $2.46 (per EIA) and the price for WTI is $102.20. Which do you believe is more likely to happen in the next 1-3 years?

Poll Question:

Again, imagine it's February 2012. The average U.S. wellhead gas price is $2.46 (per EIA) and the price for WTI is $102.20. Which do you believe is more likely to happen in the next 1-3 years?

Remember, there's a hard bottom of $0.00.

Summarizing Thoughts:

- **Conventional econometrics (IRR, NPV, etc.) have shortcomings.**
- **We live in an uncertain world and it will behoove one to incorporate statistics into his/her analysis and decision making.**
- **The monthly standard deviation of WTI is 9%.**
- **Through statistical methods, we can incorporate production volume, product price and operational cost uncertainties into our forecasts.**
- **Tools exist to help reduce production and cost variation.**
- **Financial tools exist that can reduce price uncertainty.**
- **One can easily improve the peer review process.**
- **Keep portfolio management in mind and don't let your emotions drive myopic decisions.**

Thank you for attending.

I appreciate your precious time and attention.

I hope I've challenged a few of your paradigms and given you a tool or two, along with some general knowledge, that you can take back to your job and apply.

For me, it was a privilege to share some thoughts with you.

Special thanks also to Steve Helms and the others at SPE.