Portfolio Analysis Decision Making
With Spotfire® and BlitzPort™
Dr. Stephen M. Rasey, Director and CFO, WiserWays, LLC
February 10, 2004 – Spotfire Energy Forum – Houston, TX
Investment Opportunities

- Projects where you have an opportunity to invest capital with estimated, but uncertain, profitable returns in the future.
- Example here: Exploration Projects

```
Invest?  NPV = 0
G&G
Drill?
Expl Wells
Develop
Produce
Tax
Fail
Write Off G&G & DH
Estimated but Uncertain Success
NPV > 0
Cash Flow > 0
Earnings > 0
```

The Prize!
Decisions in the Portfolio Management Process

- What Projects should we consider for investment?
- Which Projects have data good enough to trust building Portfolios?

→ A Prospect Inventory

→ Data Quality Control
WiserWays BlitzPort™ Process for Portfolio Analysis

What Strategies create Portfolios that deliver the best results measured by
– Short Term Requirements – Long Term Goals – High Confidence Results

Prospect Inventory Database

RIGS
CAPEX
PERFORMANCE

Minimum Acceptable Results

A list of Projects funded in the good Portfolios.

DECIDE !

ACT !

Economics

Make Thousands of Portfolios Per HOUR!

Strategies

Apply Constraints

A Few Good Portfolios

Spotfire Energy Forum, Feb. 10, 2004
## Building a Candidate Portfolio

<table>
<thead>
<tr>
<th>ProjectID</th>
<th>Acquire</th>
<th>Prob Success</th>
<th>100% MMBOE</th>
<th>100% NPV</th>
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</table>

More
Confidence of At Least X Reserves

A 1 well Portfolio

WiserWays Confidence Curve Calculator
a tool that will quickly compute
the inverse cumulative probability curve
(a “Confidence Curve”)
of 1 or more wells of a portfolio.
Confidence of At Least X Reserves

A 3 well Portfolio

Note big high side at low probability
### Confidence of At Least X Reserves

#### ProjectID | Prob Success | 100% MMBOE | 100% NPV | Fail
<table>
<thead>
<tr>
<th></th>
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</table>

An 8 well Portfolio, but notice: we also have each portfolio leading to this one – 8 portfolios at different funding levels.
Portfolio Risk and Reward

“Confidence Curve”

Cumulative Probability Curve

“Downside RISK”
How much you miss the Reward & Probability you miss it.

Mean Media “REWARD”

Performance Measure (Reserves, NPV, Prod.)

Candidate Portfolio

Prosp 1
Prosp 2
Prosp 5
Prosp 7
Prosp 8
Prosp 11
Prosp 13
Prosp BB
Prosp 21
Prosp 25

P99
P90
P50
P10
P01
We Plot the Portfolio as ONE POINT (Risk, Reward)

Higher is better

DS BOE

Lower is better

Performance Measure (Reserves, NPV, Prod.)

“Confidence Curve”
Cumulative Probability Curve

“Downside RISK”
How much you miss the Reward & Probability you miss it.

Mean Media “REWARD”

C. BOE Mean

0 50 100 150 200 250
0 250 500 750 1000 1250 1500 1750 2000

RISK

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Definitions

- **Efficient Portfolio:** A portfolio that provides the greatest **expected return** for a given level of **risk**.
- **Which is Lowest Risk for a given expected return.**

(Source: http://www.investorwords.com)
Definitions

- **Efficient Frontier:** The line on a risk-reward graph comprised of all efficient portfolios.

This is the Frontier for all portfolios with Capex limited to under 500 MMUSD.

So the Frontier is dependent on Budget and Goals.

(Source: http://www.investorwords.com)
A common measure of Portfolio Risk is to Integrate the Area between the Confidence Curve and the Mean Value

Call this “Downside Risk”
Plot (Mean, Downside Risk) as an (X,Y) Pair

(352, 111)
Risk Reward Plot for an 8 well Portfolio Trace

Each stacked curve has its own \((X, Y)\) Risk Reward point.

I call this cumulative Portfolio Build a Portfolio Trace.

Each point is a Portfolio at increasing Capex.
Confidence of At Least X Reserves

To do Portfolio Analysis, we must change which projects are funded and their working interests.
Confidence of At Least X Reserves

We calculate a set of confidence curves for a new portfolio in under 10 seconds! This allows us to build THOUSANDS of candidate portfolios cheaply.

<table>
<thead>
<tr>
<th>ProjectID</th>
<th>Prob Success</th>
<th>100% MMBOE</th>
<th>100% NPV</th>
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<tr>
<td>373</td>
<td>0.102</td>
<td>97</td>
<td>145</td>
</tr>
</tbody>
</table>
WiserWays BlitzPort™ Confidence Curve Calculator

- The largest version can handle
  - a 5000 Project inventory,
  - Up to 150 funded at any one portfolio
  - Up to 3 discrete working interest per project
  - “Rank and Cut” driven by customizable strategies and goals.
- Each trace calculates has up to 150 Portfolio points.
- Each Portfolio point has FIVE confidence curves at isotiles (every 5%) written to the database.
- Process time: 15 seconds per trace including writing to the Database. -- 10 Portfolios per second. (2.4Ghz Pentium IV)
- Confidence Curves calculated directly without simulation
- Available for sale from WiserWays.
WiserWays MultiField Confidence Curve Calculator
Superior to Monte Carlo Simulation

• Calculation speed is 20 seconds. Monte Carlo simulation could take 200 to 2000 seconds.

• Repeatable. No random numbers used.

• Output of Monte Carlo simulation always have a statistical uncertainty in the result. MultiField has no such error.

• MultiField automatically writes results to a database. Most Monte Carlo applications use manual processes to write to separate spreadsheets.

• Input Distributions are not limited to Log-Normal assumptions.
Confidence Curves in Excel and Spotfire

**Excel (rotated)**

Confidence of At Least X Reserves

**Spotfire Profile Chart**

MMBOE Conf

Portfolios at
- 400 MMUSD
- 300 MMUSD
- 200 MMUSD
MMBOE Risk Reward Trace 1007
Each Portfolio Point on the Risk Reward Plot
Maps to a Confidence curve
Efficient Frontiers can also compare trade-offs between conflicting goals.

Here we compare Return on Capital Employed in 2006 vs Portfolio NPV (in 2003).

The selected points (red-blue) are constrained by CumCapex between 450 and 515 $MM.
Are there any Companies using this Portfolio System?

¡Sí!

At the April 2002 AAPG Convention, Pemex presented their processes for Risk Analysis and outlines of their Prospect Inventory. They reported they had over 1000 prospects.

Brett Edwards of Custer Resources saw a version of this Portfolio Analysis presentation from the May 2003 London Spotfire User’s Conference. We made a proposal to Pemex Exploration Executive Management on July 20. We got an immediate go-ahead.

By October 8 we generated over 1,500,000 portfolios.
Case Study: Select 2003 Exploration Portfolios based upon Reserves, Finding Cost, Development Capex and Production.
Out of Millions of Portfolios in the database, Find 2000-60000 Portfolios to analyze
T2S1: 1. Select a Named Set of Portfolios to send to Spotfire

Send Portfolio Data to Spotfire (T2S1)

Project Queries Available

- T1J6: Portfolio: Weights, 5 ConfCurves, 4 Profiles
- T2C5: Portfolio: 5 Conf Curves, Projects Funded (140 m)
- T2C6: Testing: Weights, 5 Conf Curves, Projects Funded
- T2J6: T2J6\weightsConfCurveFlows
- T2C5\colsConfCurveProj
- T2C6\weightsConfProj

Spotfire Templates Available

- T2C6: 030929 case
- T2C6: 030929 case
- T2J6: 030929 case
- spot\T2C6.sfs
- spot\T2C5.sfs
- spot\T2J6.sfs

Portfolio Set Name to Run:

Connection and Query String:

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<tr>
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</table>
T2S1 – Step2: Choose Canned Queries to send to Spotfire

Choose the Query

Choose a Spotfire Template that is compatible with the query

Launch the Query

Use an existing instance of Spotfire or create a new one

Choose the Set of Portfolios to Plot
Case Study: Select 2003 Exploration Portfolios based upon Reserves, Finding Cost, Development Capex and Production.

<table>
<thead>
<tr>
<th>MMBOE Mean Conf.</th>
<th>NPV Mean $MM</th>
<th>ROCE 2007</th>
<th>Gas Prod BCF 2007</th>
<th>Oil Prod MMBO 2007</th>
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<tr>
<td>Capex $MM</td>
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<td>Finding Cost $/BOE</td>
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<tr>
<td>Capex $MM Dev Cost $/BOE</td>
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<table>
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<th>Cash Flow AT $MM</th>
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<th>Confidence</th>
<th>Finding Cost $/BOE</th>
<th>Capex $MM</th>
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<table>
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<th>Total Expl Findn.</th>
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<th>Contour Prod 100b</th>
<th>Binned CumCapex</th>
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<tr>
<td>0.67%</td>
<td>2.11%</td>
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Orientation: What are the Plots in the Display?
MMBOE and NPV vs Cumulative Capex

Y axis: Mean Portfolio Risked Net Present Value ($MM 2004)
X axis: Exploration Drill Capex (cumulative) ($MM)
Color by 90% Confidence NPV (Low Red, High Green)

Having “Binned” the CumCapex, we show only Portfolios between 600 and 700 MM Drill Capex.
We show “deselected” portfolios in a pale green

Y axis: Mean Portfolio Reserves Discovered (MMBOE)
X axis: Exploration Drill Capex (cumulative) ($MM)
Color by 90% Confidence MMBOE (Low Red, High Blue)
Orientation: What are the Plots in the Display?

ROCE-2007 vs NPV; 2007 Gas Production vs Oil Production

Y axis: Return on Capital Employed in 2007
X axis: Mean Portfolio Risked Net Present Value ($MM 2004)

Color by 90% Confidence NPV (Low Red, High Green)

Y axis: Mean Gas Production in 2007 (BCF/yr)
X axis: Mean Liquid Production in 2007 (MMBO/yr)

Color by 90% Confidence NPV (Low Red, High Green)
Orientation: What are the Plots in the Display?
Finding Cost vs Capex; Finding Cost vs Development Cost

The Y-axis of these two plots are the same. The left one shows a potential trade off between Exploration Finding cost per BOE and the Development Cost per BOE.
Orientation: What are the Plots in the Display?
Cash Flow by Year; NPV Confidence

A Cash Flow Profile Plot:
Y axis: Cash Flow After Tax ($MM)
X axis: Year
Color by NPV mean (Low: Cyan, High: Blue)
Note: in a Profile Plot, one Portfolio shows up as a LINE.

The NPV Confidence Curve
Y axis: Risked NPV ($MM 2004)
X axis: The Confidence level that we will exceed the Y value.
Color is constant pale blue. Deselected portfolios are NOT shown.
Step 1: Display all the available Portfolios.  (Ctrl-R)
Step 2: Apply a minimum Mean Reserves Required.
Step 3: If we require portfolios with a 99% Confidence of >0 NPV, are there good portfolios?

**Yes.**
Step 3: If we require portfolios with a 99% Confidence of >0 NPV, are there good portfolios? YES.
Step 4: Require that 99% Confidence of NPV > 0
Step 4: Require that 99% Confidence of NPV > 0

Applying a constraint to a measure at a specific confidence level is hard to impossible in most optimization processes.

The BlitzPort approach using Spotfire allows us to set and adjust a NON-LINEAR constraint (NPV.C99>0) very quickly and easily.
Step 5: Top quartile performance means
Exploration Finding Cost must be <= 1.25
Step 5: Top quartile performance means Exploration Finding Cost must be <= 1.25

We have a Portfolio that spends $400 MM (Drill cost) that meets these requirements so far:
Step 6: Place Limits on Total Negative Cash Flow

We look at some new plots (overlaid on the other profile plots)

- Mean Oil Production (MMBO by Year)
- Mean Gas Production (BCF by Year)
- Cumulative Mean After Tax Cash Flow ($MM by year)
Step 6: Place Limits on Total Negative Cash Flow

Suppose we limit mean cumulative Cash Flow to be no worse than $1500 MM
Step 6: Place Limits on Total Negative Cash Flow

Suppose we limit mean cumulative Cash Flow to be no worse than $-1500 MM
OUCH! That does not leave us many options. Let’s relax it to $-2000
Step 6: Place Limits on Total Negative Cash Flow

That’s better. We may have to tweak some schedules later, but good enough to continue.

Now constrain Year 2006 to >-2500
Step 6: Place Limits on Total Negative Cash Flow

Let's also insist that the mean Cash Flow in 2007 is Positive.
Step 6: Place Limits on Total Negative Cash Flow

Now zoom into some of the plots to see the portfolios in greater detail. Also, let's establish minimums on 2007 Production.
Step 7: Zoomed in.
Choose Best 2007 Production requirements

Of the Portfolios that are left, we choose the best half in terms of near term production: 2007 Oil and Gas
Step 7: Zoomed in.
Choose Best 2007 Production requirements

Select These (Ctrl-M)
Now choose the best half for NPV vs Capex.
Step 8: Zoomed in.
Choose Best half of NPV vs Capex

Now choose the best half for NPV vs Capex.
Step 8: Zoomed in.
Choose Best half of NPV vs Capex
Step 9: Zoomed in.
Choose Best half of Reserves vs Capex

Choose the best half of these (Lowest Capex for the same Reserves).

We are show Reserve confidence.
Step 9: Zoomed in.
Choose Best half of Reserves vs Capex

Select these.
Finally of the remaining, choose the best ROCE.
Step 10: Zoomed in.
Choose Best half of ROCE vs NPV

Select these.
Step 11: Zoomed in.
Choose the Best Portfolios at different capex levels
Step 12: Use the Project Census tool find which Projects are funded in the selected portfolios.

<table>
<thead>
<tr>
<th>Capex:</th>
<th>635</th>
<th>547</th>
<th>501</th>
<th>465</th>
<th>423</th>
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### Expl. Capex where Opportunity was funded By Portfolio Trace

<table>
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<th>Capex:</th>
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<td>1610</td>
<td>1514</td>
</tr>
</tbody>
</table>

### We will zoom into this part of the table to describe it in detail.
What the Project Census Drill down tells us….

The Census is an Excel workbook with VBA subroutines that reads which records are marked in Spotfire. It then creates an SQL query to retrieve the funded projects for those portfolios, organizes and formats the report.

<table>
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<tr>
<th>Oport Clave</th>
<th>Oportunidad</th>
<th>Count</th>
<th>Expl. Capex where Opportunity was funded By Portfolio Trace</th>
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<th>Oport Clave</th>
<th>Oportunidad</th>
<th>Count</th>
<th>Expl. Capex where Opportunity was funded By Portfolio Trace</th>
<th>CumCapex</th>
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What the Project Census Drill down tells us….

Portfolios (by Trace Number and Capex)

Ordered by NPV descending left to right

- Expl. Capex where Opportunity was funded
- By Portfolio Trace

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<th>Oport Clave</th>
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The 5 Portfolio points come from 4 Portfolio Traces.

Trace 614 was picked at two Portfolios with different Capex Levels.
What the Project Census Drill down tells us….

Portfolios (by Trace Number and Capex)

Ordered by NPV decending left to right

<table>
<thead>
<tr>
<th>Oport Clave</th>
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<th>Count</th>
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</table>

Projects are in Rows

The cells show the Capex level where that Project is funded in that Portfolio.

The Lower the number, the stronger the project.
The Higher up in the list, the better the project helps meet your goals....

Portfolios (by Trace Number and Capex)

Ordered by NPV decending left to right

- The Projects are sorted first by the Number of Traces that Fund the project.
- Next by the average Capex level that funded the project.

These 4 projects were funded in all four Traces.

These 9 Projects were funded in 3 of 4 traces.
The Higher up in the list, the better the project helps meet your goals….

Portfolios (by Trace Number and Capex)

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A Grey number means that the project was funded in a Trace higher than the Capex for that selected portfolio.

It is useful when comparing portfolios of different capex levels.
Spotfire Sheds Light on a Complicated Problem

• Woolsey’s 1st Law
  – “A Manager would rather live with a problem he cannot solve than accept a solution he does not understand.”

• Woolsey’s 2nd Law
  – “A Manager does not want, and will not pay for, an OPTIMUM solution. He wants to be better off now, as quickly and as cheaply as possible.

*Dr. R. E. D. Woolsey, Professor of OR/MS, Colorado School of Mines
Spotfire Communicates Portfolio Decisions.
How and where the Portfolios are built matters not.

BlitzPort MultiField

Prospect and Portfolio Database

Management Created Portfolios

Integer/Linear Programing Portfolio Optimizer

NPV vs Capex - CumCapex

Once the Portfolios are stored in the database, Spotfire can compare them all.
WiserWays-Spotfire Portfolio Analysis Process

- Define the population of potential Projects to fund
- Define a set of Strategies for funding candidate portfolios.
- Use an automated process to generate thousands of candidate portfolios according to the different strategies.
- Load the candidate Portfolios into Spotfire
- Apply/change constraints by sliding Spotfire query devices.
- Select many good portfolios that are close to the Efficient Frontiers of many different measures.
- Find the projects most often funded in these good portfolios.
  If happy with plan, Fund these projects, Execute Plan
- Change and Negotiate Goals.
- Refine Strategies.
Goals for Improving the Portfolio Management process

- To know which portfolios are superior to other in the Performance measures that matter.

To “trade-off” one goal with another.

![Chart showing Efficient Frontier at any Capex Level and Efficient Frontier with Capex <= 515 MM]
Goals for Improving the Portfolio Management process

• To Understand, Predict, and communicate the range of possible outcomes of any funded Portfolio

This Portfolio has a
5% Probability for > 2000 MMBOE
65% Probability for > 1000 MMBOE
90% Probability for > 750 MMBOE

A different Portfolio has a
10% Probability for > 2000 MMBOE
45% Probability for > 1000 MMBOE
65% Probability for > 750 MMBOE
How the proposed project meets these goals

- The MultiField Portfolio Confidence Curve Calculator can quickly generate the range of results for candidate portfolios quickly.
Goals for Improving the Portfolio Management process

- To Reduce the time to assemble, calculate and analyze the candidate portfolios
- To increase the number of candidate portfolios that can be considered within a given amount of time, thereby exploring more options.
BlitzPort and Spotfire

• By making **VISIBLE** the potential funding opportunities, DECISION MAKERS can see available alternatives and the degree of difference (or equivalence) between them.

• You can **change your constraints in the conference room** for real-time turnaround.

• Understandable. **Quick. Easy. Inexpensive.**
Thanks to

• Spotfire
  – For the opportunity to speak here and for the work we have done together since 2001.

• Adán Oviedo Pérez, Subdirector, Exploración Vicepresident, Pemex

• Brett Edwards, President, Custer Resources
And Thank You for your attention.

- This presentation will be available for download at http://wiserways.com

You can do the job many ways….

Do it better with WiserWays

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713-353-0139