Spotfire Enables Portfolio Analysis of Investment Opportunities on Efficient Frontiers of Many Measures

Dr. Stephen M. Rasey, Director, WiserWays LLC
Definitions

• Portfolio
  – A collection of investments all owned by the same individual or organization.

• Efficient Portfolio
  – A portfolio that provides the greatest expected return for a given level of risk, or equivalently, the lowest risk for a given expected return. also called optimal portfolio.

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

  – (Source: http://www.investorwords.com)
Portfolio Analysis

– A search for Efficient candidate Portfolios from a collection of potential Investment Opportunities.

– Acceptable Candidate Portfolios must satisfy Investors Requirements:
  • Operational – Physically doable (rig avail, lead time, partners, Working Interest availability)
  • Political – (BU Capex avail, Maximum $ exposure)
  • Resource – Budget, People
  • Performance – Resources found, Production & Earnings Goals, Minimum acceptable results.
Investment Opportunities

• Projects where you have an opportunity to invest capital with estimated, but uncertain, profitable returns in the future.

• Example here: Exploration Projects

The Prize!
NPV >0
Cash Flow >0
Earnings >0

estimated but Uncertain Success

Invest?
G&G
Drill?
Fail

Write Off G&G & DH
Write Off G&G
NPV = 0

Develop
Produce
Tax
Key Parameters of Exploration Investments

• Cost of Entry
• Probability of Entry
• Cost of G&G (Geological and Geophysical) + Overhead
• Cost of Exploratory Wells
• Probability of Success
• Recoverable Resource Size
• Cost and Timing of Development and Production
• Prices
A way to build an inventory of Investment Opportunities

WiserWays Excel to Access upload...

Loading workbook to Database... Please Wait.

P40 Write Flows

(c) 2003 - WiserWays
Types of Projects in this example

Prob Succ = 0.107

Prob Succ = 0.300

Prob Succ = 0.054

Prob Succ = 0.113
Types of Projects in this example

- Cashflow
- Earnings
- Devel

Prob Succ = 0.084

Prob Succ = 0.383

Prob Succ = 0.449

Prob Succ = 0.114
Data Base Schema (Projects)

(Tall and Skinny)

Prod Oil 2005
Prod Oil 2006
Cash Flow 2005
Cash Flow 2006

ProbGeo
ENV
NPV
MMBOE
DevCost
Per BOE
Use the Access Database to prepare Queries for Spotfire

You can do the job many ways...
Do it better with

WiserWays Efficient Frontier Prospect Database
WiserWays Efficient Frontier Prospect Database
Sample Database, Fictitious Prospects - 2003.01.30

A - Home Switchboard

F1D2 - Project Data to Spotfire
B1A2 - Portfolio Data to Spotfire
M1A1 - Copy Queries to Backend Database
Exit - Close Access

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Feb. 20, 2003
F1D2 – Choose Canned Queries to send to Spotfire

Choose a Spotfire Template that is compatible with the query

Choose the Query

Launch the Query

Use an existing instance of Spotfire or create a new one

---

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Typical VBA to send a Query to Spotfire to read data and apply a template.

- 'Get a Spotfire application
  - Set appSF = wwSpotfireDSAny()
  - appSF.Visible = True

- sqlQname = lbxQueries.Column(2)
- strSFTempl = lbxSpotfire.Column(2)

- 'Spotfire OpenODBC Works, but you must use a backend .mdb containing tables and queries.
  - strProv = "Provider=Microsoft.Jet.OLEDB.4.0;"
  - mdbpath = gstrDBNameBack
  - mdbpath = "Data Source=", & mdbpath & ";"
  - strConn1 = strProv & mdbpath

- sql1 = "Select * from " & sqlQname

- strStep = "Close ActiveVisualization"
  - appSF.ActiveVisualization.Close False  'close without saving

- strStep = "Spotfire OpenODBC"
  - appSF.OpenODBC strConn1, 0, sql1

- strStep = "Apply Template: " & strSFTempl
  - appSF.ActiveVisualization.ApplySettings strPathTemplate & "]" & strSFTempl
View the Project Metrics and Flows.

- S1D1 Query: Project Scalers with Flow Data oriented with Line Items in Columns, Years in rows.

<table>
<thead>
<tr>
<th>Projects</th>
<th>Project Metrics (NPV, ENV, Reserves)</th>
<th>Flow Line Item: Prod, Capex, CF, NIAT:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Repeated</td>
<td>Year</td>
</tr>
<tr>
<td></td>
<td>Project Metrics (NPV, ENV, Reserves)</td>
<td>Flow Data CrossTab:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>By Type and Year</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

400 Projects $\rightarrow$ 8000 records, $\sim$ 50 columns.
ENV vs MMBOE, Color NPV, Size ProbGeo
ENV vs DevCapex/BOE vs MMBOE Produced Full Life -
ROR vs NPV color:Env Size:Prob

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Remove all Projects with ENV < -5 from the database
Select the Projects with ENV > 400. See what other attributes they have in other views.
Op Cost / BOE vs Dev Cost / BOE
ROR vs NPV color:Env Size:Prob
This chart would be more meaningful if I plotted RISKED Development Cost.

Summing by selected projects gives a real-time Portfolio Sum

This is a Summation Bar chart using Year as the X dimension as a variable and the Devel Capex Metric (in a column) for the sum.
Gas vs Oil

We have a big mix of Oil and Gas projects.
The High ENV projects have higher than average NPV/BOE.
This is a Scatter Plot using lines to connect Portfolios ordered by year.

It is tough to make out the selected projects with all the lines, but the lines are necessary.
If Success Cash Flow After Tax by year

A Line Chart is a much better way to show the Flow data.

All columns use individual scales.

Markers are connected by ID Project, and ordered by Year.
MMBOE vs ProbGeo

The High ENV Projects are, not surprisingly, at high Probabilities of Success.

Note that the color scale is not particularly useful because most of the ENV’s are very low.

Size is by Exploration Capex.

Color by ENV
-4.38737... 924.5493...

Size by ExpCap
0.54628... 806.221...

The labels show IDProject
ROCE by Year

If Success Return On Capital Employed.

See how they trend up toward the end of the project life?
Capital employed

It's because the Capital Employed is dropping fast..
Scatter – ROCE vs. Capital Employed

Cross plot ROCE vs Capital Employed.
## Building a Candidate Portfolio

<table>
<thead>
<tr>
<th>ProjectID</th>
<th>Acquire</th>
<th>Prob Acquire</th>
<th>Prob Success</th>
<th>100% MMBOE</th>
<th>100% NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P10L</td>
<td>P50</td>
</tr>
<tr>
<td>359</td>
<td>1</td>
<td>0.102</td>
<td></td>
<td>97</td>
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<td>361</td>
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<td>75</td>
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<tr>
<td>365</td>
<td>1</td>
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<tr>
<td>366</td>
<td>1</td>
<td>0.056</td>
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<td>1</td>
<td>0.200</td>
<td></td>
<td>227</td>
<td>295</td>
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</tbody>
</table>
Confidence of At Least X Reserves

A 1 well Portfolio

This is 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

<table>
<thead>
<tr>
<th>ProjectID</th>
<th>Success</th>
<th>Prob</th>
<th>100% MMBOE P10L</th>
<th>P50</th>
<th>P90H</th>
<th>100% NPV P10L</th>
<th>P50</th>
<th>P90H</th>
<th>Fail</th>
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<tr>
<td>373</td>
<td>0.102</td>
<td>97</td>
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<td>371</td>
<td>0.449</td>
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<td>140</td>
<td></td>
<td>198</td>
<td>230</td>
<td>268</td>
<td>-13</td>
</tr>
</tbody>
</table>

A 2 well Portfolio

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Confidence of At Least X Reserves

<table>
<thead>
<tr>
<th>ProjectID</th>
<th>Prob Success</th>
<th>100% MMBOE P10L</th>
<th>P50</th>
<th>P90H</th>
<th>100% NPV P10L</th>
<th>P50</th>
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<td>373</td>
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<td>156</td>
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<td>437</td>
<td>655</td>
<td>398</td>
<td>543</td>
<td>762</td>
<td>-10</td>
</tr>
</tbody>
</table>

A 3 well Portfolio

Note big high side at low probability

Risked Mean
Confidence of At Least X Reserves

<table>
<thead>
<tr>
<th>ProjectID</th>
<th>Prob</th>
<th>100% MMBOE</th>
<th></th>
<th>100% NPV</th>
<th></th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td>P10L</td>
<td>P50</td>
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<td>369</td>
<td>0.457</td>
<td>107</td>
<td>128</td>
<td>154</td>
<td>42</td>
</tr>
</tbody>
</table>

Expected

A 4 well Portfolio
An 8 well Portfolio, but notice: we also have each portfolio leading to this one – 8 portfolios at different funding levels.
A common measure of Portfolio Risk is to Integrate the Area between the Confidence Curve and the Mean Value.

Call this "Downside Risk";
Plot (Downside Risk, Mean) as an (X,Y) Pair.

(111,352)
I call this cumulative Portfolio Build a Portfolio Trace. Each point is a Portfolio Trace Sequence. Each Trace Sequence has a Confidence Curve on each Measure (MMBOE, NPV) studied.
Confidence of At Least X Reserves

<table>
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<th>100% NPV</th>
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<td>0.056</td>
<td>335</td>
<td>586</td>
</tr>
<tr>
<td>364</td>
<td>0.125</td>
<td>249</td>
<td>374</td>
</tr>
</tbody>
</table>

To do Portfolio Analysis, we must change which projects are funded and their working interests.

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

<table>
<thead>
<tr>
<th>ProjectID</th>
<th>Prob</th>
<th>Success</th>
<th>100% MMBOE</th>
<th>100% NPV</th>
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<tr>
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<td>P10L P50 P90H</td>
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<td>0.497</td>
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<td>34 41 50</td>
<td>58 67 78</td>
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<td>0.053</td>
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<td>49 85 149</td>
<td>115 152 217</td>
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<td>384</td>
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<td>5 9 15</td>
<td>7 10 17</td>
</tr>
</tbody>
</table>

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WiserWays MultiField Confidence Curve Calculator

• The version used here can handle
  – a 200 Project inventory,
  – Up to 50 funded at any one portfolio
  – Up to 3 discrete working interest per project
  – Customized weighted project selection based upon good heuristics.

• Each trace calculates has up to 50 Portfolio points.

• Each Portfolio point has two confidence curves at isotiles (every 5%) for MMBOE and NPV written to the database.

• Process time: 4 seconds per trace including writing to the Database. -- 10 Portfolios per second.
Data Base Schema (Projects)

Trace ID
TraceSeq ID
Cumul Capex to this point
ProjectID last added at WI.

At each TraceSeq
for each Measure
record the
Downside Risk
Mean
and 21 Isotiles of the
confidence curve
View the Portfolio Confidence Curves and Project Funding.

- T1D5 Query: Confidence Curves (MMBOE, NPV) and Funding level Each Project (Wk.Int.) by Trace Sequence Number

- 200 Projects in columns
- TraceSeq, CumulCapex, Conf Curves (MMBOE, NPV)
- Wk Int of each project in each TraceSeq (Portfolio Point)

- 1 to 4 Sets, 100-400 Traces per Set, 20-50 Portfolio per Trace. 2000-80000 records, 256 columns. (Max)
- 16000 records in about 20 seconds (PIV 2.4 GH) Access 2002
MMBOE & NPV vs Cum Capex  Trace 602

All columns use the same scale.

- C.BOE.Mean
- C.NPV.Mean

Markers are connected by C.IDTrace, and ordered by CumCapex.
Pale blue grey points are “Shown deselected” points of all portfolios in all traces run.

Showing only the portfolios along Trace 602.

The red Portfolio points are those where Project 422 were funded at 33% working interest.

These portfolios are not particularly close to the Efficient Frontier.
NPV Risk Reward (Scatter Plot), Trace 602

Same type of Risk / Reward plot, but this is for the NPV metric.

Also showing just the portfolios along Trace number 602 against a background of all portfolio points (Shown deselected).
NPV Prob by Cumul Capex  Trace 602

This is a Line Chart, X-Axis as Cumulative Capex.

Here we display Each confidence Level as more and more project are funded.

This Metric is Portfolio NPV

C10 = “P10High”
C50 = “P50”
C90 = “P90Low”

All columns use the same scale.

Markers are connected by C.IDTrace, and ordered by CumCapex.
MMBOE Prob by Cumul Capex

This is a Line Chart, X-Axis as Cumulative Capex.

Here we display Each confidence Level as more and more project are funded.

This Metric is Portfolio MMBOE

Pick a funding level, see the range of results
Spotfire requires we use a Line Chart on the 21 columns of confidence levels. Therefore the plot is rotated from

All columns use the same scale.

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NPV Confidence Curves

All columns use the same scale.
ISeq (sequence number within a Trace)
DS NPV - Color by WI of 1 Project -

Color by 422
- 0.33333343267441
- 0.5
- 1
- (Empty)

Markers are connected by C.:IDTrace, and ordered by C.:IDTraceSeq.
NPV Risk Reward, Trace 602, with Details of Project WI

Trace 602 Shown
MMBOE Confidence (Profile Chart) Trace 602

All columns use the same scale.
NPV Confidence (Profile Chart) Trace 602

All columns use the same scale.
DS BOE  Trace 616

Some of the Portfolios in Trace 616 are close to the efficient frontier. These points are selected.
Also pretty close to the NPV efficient Frontier
Those selected points seen with their confidence curves. BOE.
Profile Chart Trace 616

And the selected points seen in their confidence curves of NPV.

All columns use the same scale.
The Heat map shows which projects are funded at each portfolio.

The projects funded at the selected portfolios

Increasing Capex

Order by CJDTraceSeq

Projects →
Scatter Plot Trace 616

Color by 360
- 0.33333343267441
- 0.5
- 1
- (Empty)

The labels show ID/Project
DS NPV - Color by WI of 1 Project - C.NPV.Mean vs. C.NPV.DSRisk Trace 616

Color by 404
- 0.333333343267441
- 0.5
- 1
- (Empty)

Markers are connected by C.IDTrace, and ordered by C.IDTraceSeq.

The labels show IDProject
Scatter Plot Trace 616

Color by WI
0.133333... 1
Size by CumCapex
0.85889... 1641.41...
Markers are connected by C.IDTrace, and ordered by C.IDTraceSeq.
The labels show IDProject.
NPV Prob by Cumul Capex  Trace 616

All columns use the same scale.

Markers are connected by C.IDTrace, and ordered by CumCapex.

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Some individual Portfolio Build Traces

Highlighted points are approx 500 $500 MM Capex
DS BOE

Highlighted 500 MM Capex.
Some Portfolio build traces (615-623)
DS NPV

Highlighted 500 MM Capex. Some Portfolio build traces (615-623).
Profile Chart

Highlighted 500 MM Capex. Some Portfolio build traces (615-623).

All columns use the same scale.
Profile Chart

Highlighted 500 MM Capex. Some Portfolio build traces (615-623)

All columns use the same scale.
All columns use the same scale.
All columns use the same scale.
NPV vs Capex

This may be a dumb looking chart, but it comes in very handy. It is the only thing to tell you the Capex range selected when you output to PowerPoint.

Note to Spotfire Developers: You should offer the option to output the SQL to PowerPoint as you do with a web page. It is far easier to delete a PPT object than to add notes later.

BTW: Kudos for the PowerPoint writer!!!!
VBA to Summarize Marked Records of a Heat Map.

- Dim appSF As Spotfire.Application
- Dim shmH1 As Spotfire.HeatMap
- Dim svisCur As Spotfire.Visualization
- Dim hmc As HeatMapColumn
- Dim srec As Spotfire.Record

Sub S00_main()
- S10_Get_AppSF
- Dim sum(1 To 1000, 3) As Single 'index2: 1: running sum, 2: count, 3: average
- Dim nHMcols As Integer
- Dim value As Variant
- Dim i As Integer

  Set svisCur = appSF.ActiveVisualization
  Set shmH1 = svisCur.Views("HMProj")
  nHMcols = shmH1.Columns.count

  For Each srec In svisCur.MarkedRecords
    If srec.Marked = True Then
      i = 0
      For Each hmc In shmH1.Columns
        i = i + 1
        value = srec.Field(hmc.Column)
        If IsNull(value) Then
          Else
            sum(i, 1) = sum(i, 1) + value
            sum(i, 2) = sum(i, 2) + 1
        End If
      Next
    End If
  Next

  For i = 1 To nHMcols
    If sum(i, 2) > 0 Then
      sum(i, 3) = sum(i, 1) / sum(i, 2)
    Else
      sum(i, 3) = 0
    End If
    With ActiveWorkbook.ActiveSheet
      .Cells(5 + i, 2).value = sum(i, 1)
      .Cells(5 + i, 3) = sum(i, 2)
      .Cells(5 + i, 4) = sum(i, 3)
    End With
  Next
End Sub
The Projects, and how many times selected in the marked portfolios and at what average working interest.

The Process:
1. Use the T1D5 template to pick a few portfolio points of interest.
2. Open HeatMapReader.xls.
3. Run the VBA macro (from the previous slide).
4. Copy the output cells and paste into a NEW INSTANCE of Spotfire.
The NPV Risk Reward Plot.

In the Properties box, Color by Project Number then, Arrow Down to move quickly from one project to the next looking for project that hug the Efficient Frontier.
Here we see the portfolios highlighted by funding levels of Project 386.

This project is in both efficient and very inefficient portfolios.

In the inefficient portfolio, there are OTHER projects making it inefficient.
Here we see the portfolios highlighted by funding levels of Project 386.

Highlight the good and bad. Create a new column on Marked Records “386Difference”

Select only
386Difference = yes
View the Heat map.
Heat Map

Candidates for Poor performing Projects

Look for differences in the project selections.

The longer the stripe, the earlier the project is picked in the Portfolio Trace

Inefficient Points

Efficient Points without 386 caught up in the selection

Efficient Points

386

Order by 386Difference
View the Portfolio Confidence Curves and Portfolio Flow Data (Production, Devel Capex, CFAT, NIAT, CapEmpl) on a Risked Basis

• T1F6 Query: Confidence Curves (MMBOE, NPV) and Portfolio Flow data (Years 2003 through 2012)

<table>
<thead>
<tr>
<th>Set</th>
<th>Trace</th>
<th>TraceSeq, CumulCapex, Conf Curves (MMBOE, NPV)</th>
<th>Lineltem and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>DevCap03,DevCap04,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>…DevCap12,ProdOil03…. All on one line</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DevCap03,DevCap04,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>…DevCap12,ProdOil03…. All on one line</td>
</tr>
</tbody>
</table>

1 to 4 Sets, 100-400 Traces per Set, 20-50 Portfolio per Trace.
2000-80000 records, 175 columns.

16000 records in about 2:00 minutes (PIV 2.4 GH) Access 2002

The trick is that at each TraceSeq, you must sum the Risked Flows from all funded Projects (times their Working interests) at each Portfolio Point (TraceSeq record)
Cash Flow After Tax Line Chart (T1F6)

We highlight all portfolios that exceed a mean expected $1.4 Billion negative cash flow in any year.

All columns use the same scale.
The projects we selected are, surprise, surprise, the project that have the highest earnings in the production years.
Those projects are highlighted in Yellow on the Risk Reward plot.
DS BOE Risk / Reward

We mark the records selected.
Then turn them off.

The portfolios that remain stay within the $1.4 Billion negative Risk Cash Flow restriction.
DS NPV  Risk / Reward

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WiserWays LLC

Spotfire Regional Energy Users Meeting,
Feb. 20, 2003
Let's look at the remaining portfolios that we fund at

About $500 Capex and

20 to 30 Projects (because there are limits to the number of projects we can manage with our available staff)
The highlighted portfolios in the this BOE Risk / Reward abid by the $500 Capex, 20-30 project limit.
DS NPV Risk/Reward

The same portfolios seen in the NPV Risk Reward plot.
MMBOE Confidence Profile Chart

All columns use the same scale.
NPV Confidence Profile Chart

All columns use the same scale.
CFAT Profile Chart

All columns use the same scale.
NIAT by Year Line Chart

All columns use the same scale.
We Mark those projects and only select them.

We select two portfolio nearest the Efficient Frontiers (yes, the yellow is hard to see --- sorry.)
Fortunately, those projects also appear near the efficient frontier of the NPV Risk Reward plot. (It doesn’t have to be).
Those projects have relatively good performance at high confidence,

But don’t have as great an upside as other points.

(Only the $500 MM Capex, 20-30 project Portfolios are displayed in blue. All other portfolios are hidden.)

All columns use the same scale.
NPV Confidence Curves Profile Chart

Likewise for the NPV Confidence curves

All columns use the same scale.
All columns use the same scale.

- C.BOE.Mean
- C.NPV.Mean

All markers are connected and ordered by CumCapex.
CFAT by year Profile Chart

For the two selected portfolios.

Can we stand it? A management call.

If not, we select additional portfolios to exclude and analyze what is left.

All columns use the same scale.
NIAT by Year Line Chart

All columns use the same scale.
Spotfire Sheds Light on a Complicated Problem

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

• Woolsey’s 2\textsuperscript{nd} 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.

* R. E. D. Woolsey, Professor of OR/MS, Colorado School of Mines
WiserWays Portfolio Calculator and Analyzer

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

• Understandable. Quick. Easy.
Thanks to

• **Spotfire**
  – For the opportunity to speak hear and for the work we have done together.

• **Joe Taylor**
  – For helping me debug the Access-Spotfire interaction.

• **Ian Learch (Prof. U. of S. Carolina)**
  – Who in 1997 catalyzed my development of the Confidence Curve Calculator.
And Thank You for your attention.

- This presentation is available on-line at http://wiserways.com/downloads/030220Spotfire.pdf

You can do the job many ways....
Do it better with WiserWays

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