# Managing Risk and Uncertainty for Global Mega Energy Projects

## Dr. Nick Lavingia,. P.E.

**Project Controls**
**EXPO**
Washington, DC - USA

2022

# Dr. Nick Lavingia, P.E.
## Chevron-Retired Project Manager, Consultant, Advisor & Trainer

**Education:** BS & MS in Chemical & Petroleum Refining Engineering and PhD in Mineral Economics from Colorado School of Mines, USA
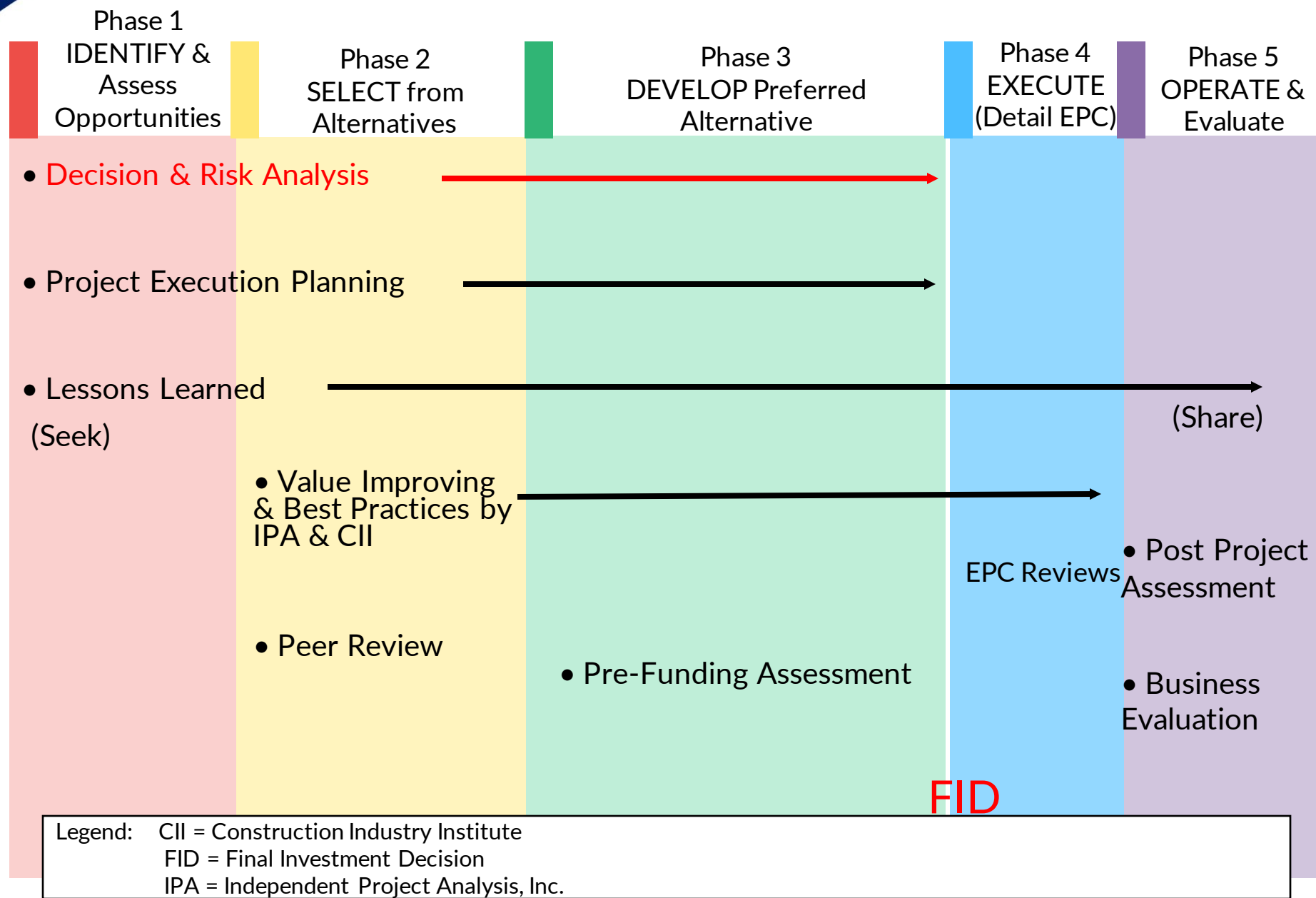
**Experience:** Over 40 years of Project Engineering, Management, Consulting and Training experience in the industry. Supported more than 100 large and small projects globally worth well over $ 100 billion in 20 countries.

**Awards:** Chevron Chairman's award for implementing Value Engineering throughout the corporation, Pathfinder's award for Outstanding Contribution to the Advancement of Project Management Technology and AACE's Educational Service award. Published and presented numerous papers at conferences.

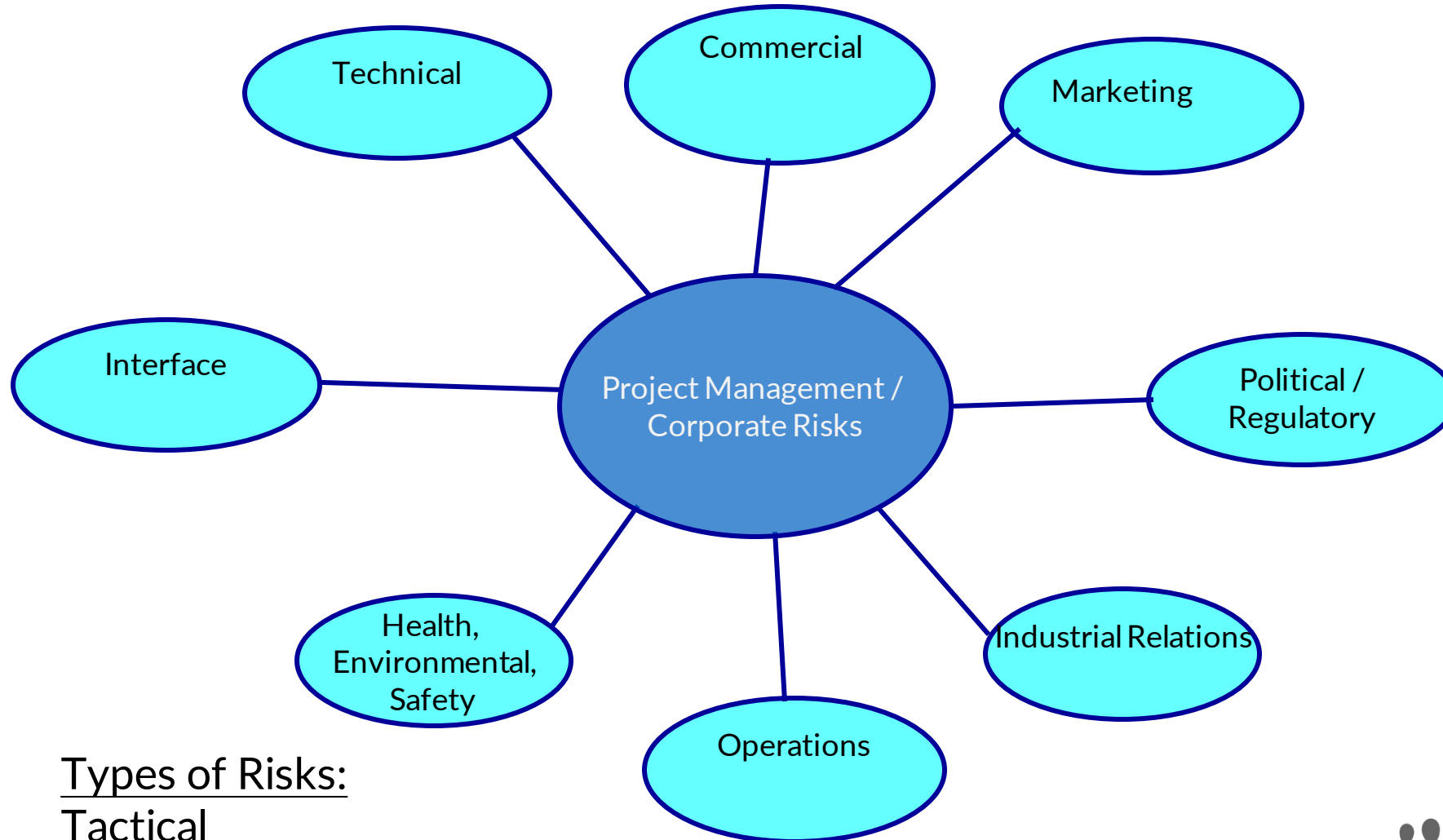Project Controls
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# Agenda

- Project Management Best Practices

- Risk Areas

- Risk Quantification

- Decision Hierarchy

- Strategy Table

- Influential Diagram

- Tornado Diagram

- Decision Tree

- Probability S-Curve

# Project Management Best Practices
# (Optimize Safety, Cost, Schedule and Operability of a project)

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Phase 1
IDENTIFY &
Assess
Opportunities

Phase 2
SELECT from
Alternatives

Phase 3
DEVELOP Preferred
Alternative

Phase 4
EXECUTE
(Detail EPC)

Phase 5
OPERATE &
Evaluate

- Decision & Risk Analysis

- Project Execution Planning

- Lessons Learned

(Seek)

(Share)

- Value Improving
& Best Practices by
IPA & CII

- Peer Review

- Pre-Funding Assessment

EPC Reviews

- Post Project
Assessment

- Business
Evaluation

FID

Legend:   CII = Construction Industry Institute
          FID = Final Investment Decision
          IPA = Independent Project Analysis, Inc.

# Risk Areas



Project Management / Corporate Risks

- Technical
- Commercial
- Marketing
- Interface
- Political / Regulatory
- Health, Environmental, Safety
- Operations
- Industrial Relations

Types of Risks:
Tactical
Strategic

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# Risk Quantification

| Severity | | People | Assets | Environment | Economic NPV, Cum CPEX, or Capex Cost Impact ($) | Technical Schedule delay (months) from that planned at AFE | Technical Lost production first year as a % of plan | Reputation Reputation | INCREASING PROBABILITY 1 Insignificant Occurs in 1 in 100 Projects | 2 Low Occurs in 1 in 20 Projects | 3 Medium Occurs in every other Project | 4 High Occurs more often than not 2 out of 3 Projects | 5 Very High Occurs more or less in every Project |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HSE | | | | | | | | | | | |
| 5 | Very High | Multiple fatality | Extensive damage | Massive effect | >150 million | >6 | >30% | International impact | 5 | 10 | 15 | 20 | 25 |
| 4 | High | Single fatality | Major damage | Major effect | 100 to 150 million | 6 | 15 to 30% | National impact | 4 | 8 | 12 | 16 | 20 |
| 3 | Medium | Major injury | Localised damage | Localised effect | 50 to 100 million | 3 | 5 to 15% | Considerable impact | 3 | 6 | 9 | 12 | 15 |
| 2 | Low | Minor injury | Minor damage | Minor effect | 10 to 50 million | 2 | 1 to 5% | Limited impact | 2 | 4 | 6 | 8 | 10 |
| 1 | Insignificant | Slight injury | Slight damage | Slight effect | <10 million | <1 | <1% | Slight impact | 1 | 2 | 3 | 4 | 5 |

CONSEQUENCES
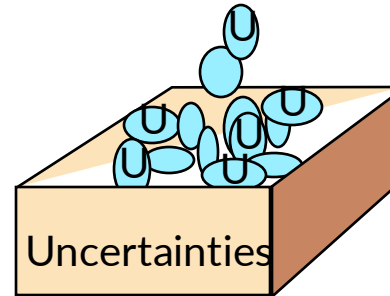
# Brainstormed Issus Sorted

Decisions are the available choices, or actions that can be controlled, by the decision-maker. "what we can do"
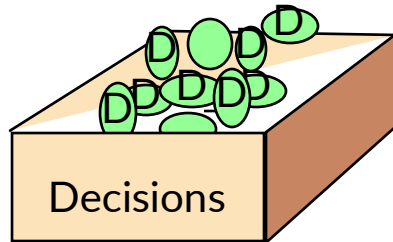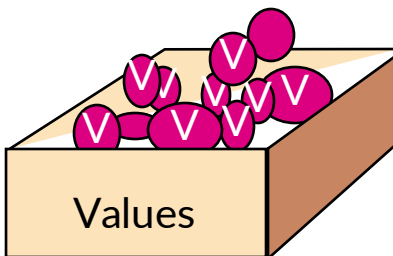
Examples:
• Build Plant
• Acquire competitor
• Sell field

Uncertainties are factors that cannot be controlled. "What we know and don't know"

Examples:
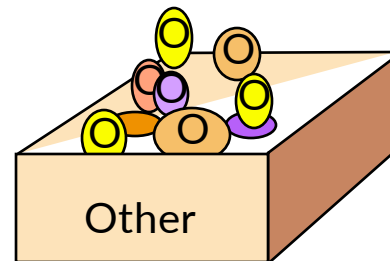• Oil Prices
• Margins
• Capital

Values are metrics used to compare and rank alternatives. "What we want or don't want"

Examples:
• NPV, ROR
• Earnings
• Zero Incidents
• Customer Satisfaction
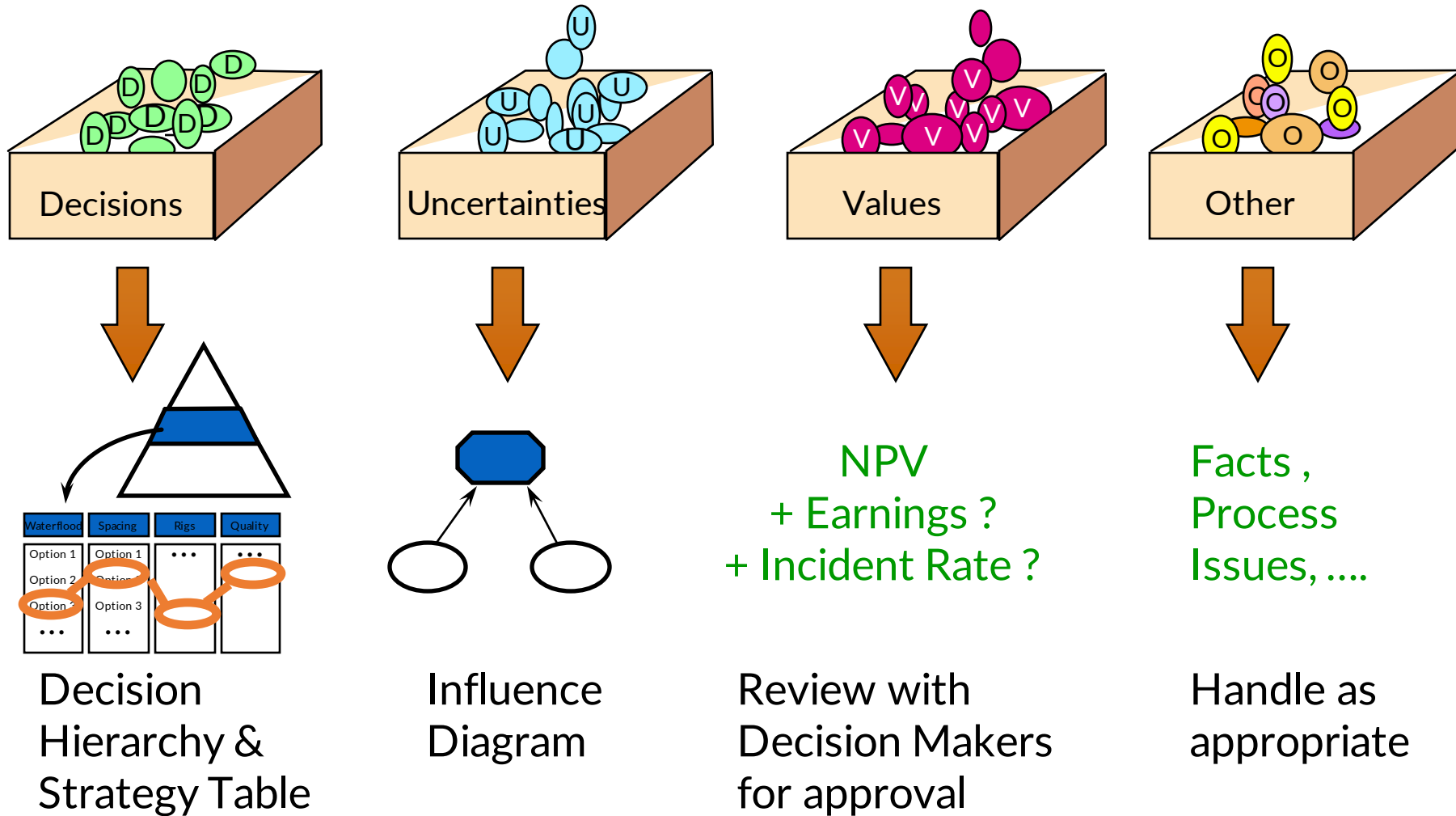
Other are facts or process issues

Examples:
• Historical spending
• Organizational Challenges

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# Sort Decisions, Uncertainties and Values

# Simple Build vs. Buy Decision

John owns a 3 bedroom, 2 bath home that he bought 4 years ago.  His family is growing, and he needs to add at least one more bedroom to his house.  He is considering:

- Building on to his existing home, adding the one bedroom that he needs.
- Doing a more extensive building program and adding 2 bedrooms and a bath that will meet his needs over the longer term.
- Taking this opportunity to sell his current home and buy a bigger house in a better neighborhood with a better school for his children.

John wants to make a decision that will meet his changing family needs as well as trying to increase his net worth or value over the long term.

D  Should we build just the minimum we need?

U  How much will be the building cost?

D  Who should we get to build it for us?

D  I think that we should build 2 rooms and a bath.

D  How about moving to a new house instead.

V  We could move to a better school district.

V  But all of our friends live near us now.

U  How much does a new house cost relative to our current house?

U  What will our house be worth after we build the addition?

Sort the issues into Decisions (D), Uncertainties (U), Values (V), and other

# Decision Hierarchy

Example: John's Build vs Buy Decision Hierarchy

Policy Decisions or Givens -
Assumed to be made, but must be
confirmed, before we can proceed
with the focus decisions.

GIVENS

• Continue in current job
and live in same area

• Savings is adequate for the alternatives,
but will finance a significant portion

Strategic Decisions -
Focus on in this
analysis.

FOCUS

Build addition - # rooms & # baths
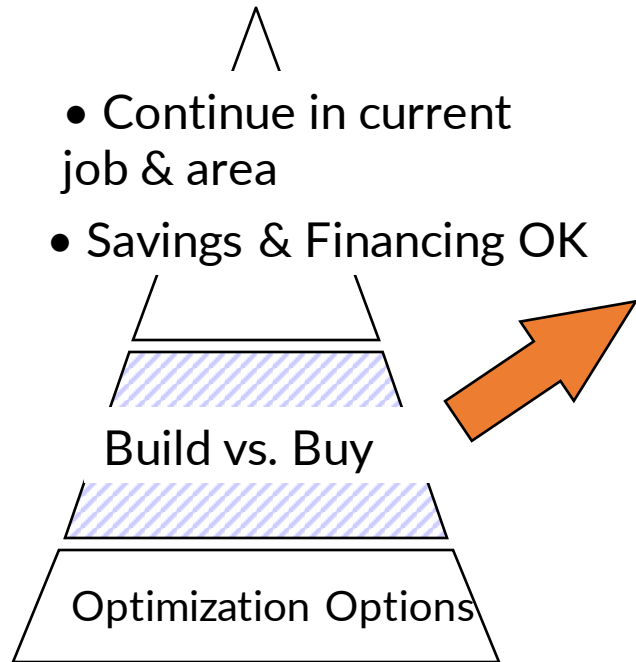
Buy a bigger house, Sell current house

Tactical Decisions -
can be made later

Contractor Selection ,    % to Finance,
Fixed Rate loan or ARM

DETAIL

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# Strategy Table

## Decision Hierarchy



- Continue in current job & area
- Savings & Financing OK

Build vs. Buy

Optimization Options

Listing the choices for each decision in the table helps brainstorm the range of options.

## Strategy Table

| Theme | Current House | New House |
|-------|---------------|-----------|
| | Build 1 bedrm | Don't Buy |
| | Add 1 bedrm + 1 bath | 4 bedroom / 2 bath |
| | Add 2 rooms + 1 bath | 5 bedroom/ 3 bath |
| | Sell | |
| | Rent | |

# Strategy Themes

| Strategy Theme | Current House | New House |
|---|---|---|
| Minimum Investment | Build 1 bedroom | Don't Buy |
| | Add 1 bedroom + 1 bath | 4 bedroom / 2 bath |
| Room to Grow | Add 2 rooms + 1 bath | |
| Moving Up | Sell | 5 bedroom/ 3 bath |
| | Rent | |

*Choose theme names that are memorable but neutral to avoid biasing decision makers.*
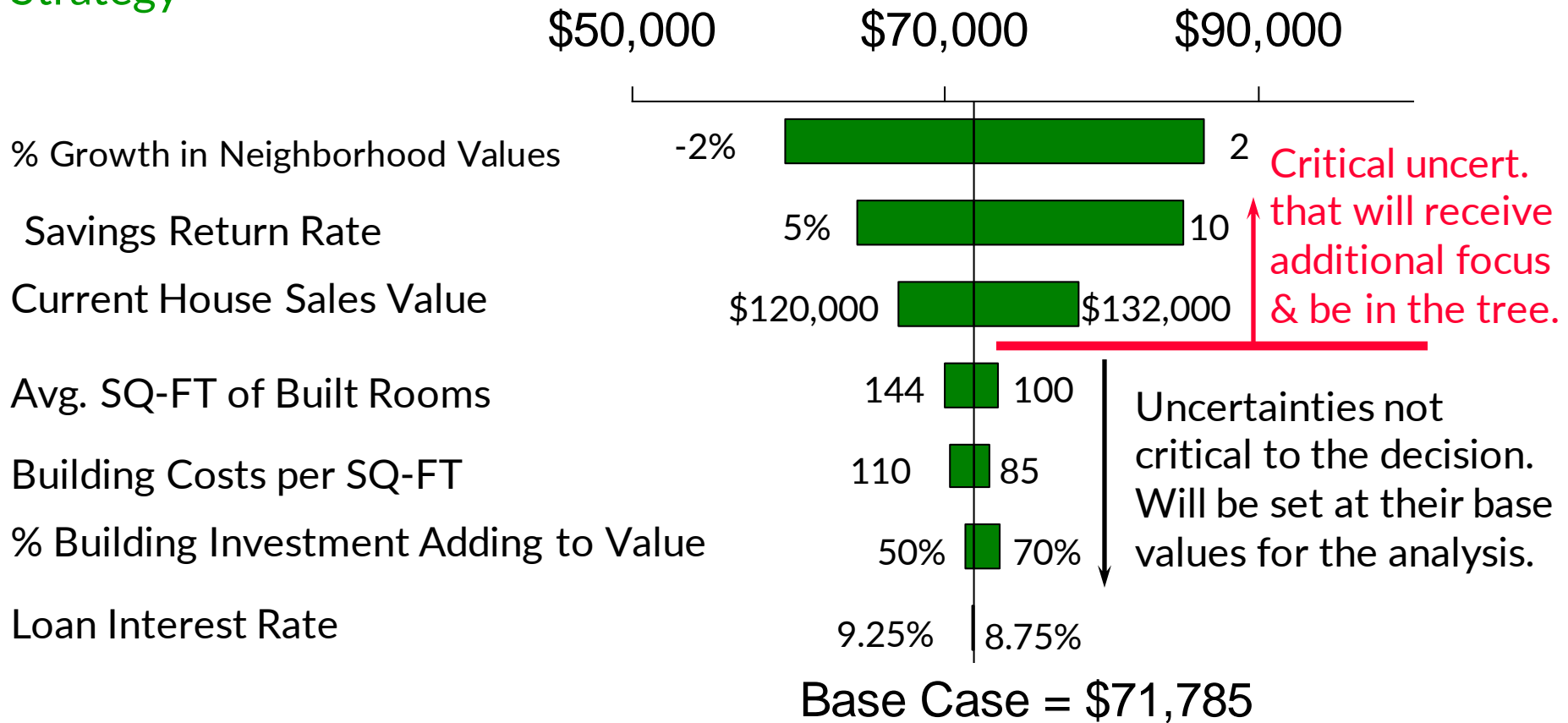Analyzing too many themes reduces the insights from the analysis.

# Influence Diagrams



Buy vs Build → NPV

Costs → NPV

House Value → NPV

Savings → NPV

Costs ← One Time Costs

One Time Costs ← Mortgage & Building Loans

One Time Costs ← Realtor's Commission

One Time Costs ← Building / Purchase Cost

Savings ← Savings Interest Rate

Savings ← Points & Closing Costs

House Value ← Current Market Value

House Value ← % Avg. Annual Value Growth of Neighborhood

House Value ← % Investment adding to value

Mortgage & Building Loans ← Loan Rate

Mortgage & Building Loans ← Building / Purchase Cost

Building / Purchase Cost ← Cost per SQ. FT. to build or buy

Building / Purchase Cost ← # Square Feet Added per room

Building / Purchase Cost ← # rooms # baths

Be sure to have all the key experts involved in developing the diagram.

# Tornado Diagram

## Minimum Investment Strategy

### NPV (Investment + Savings + House Value)



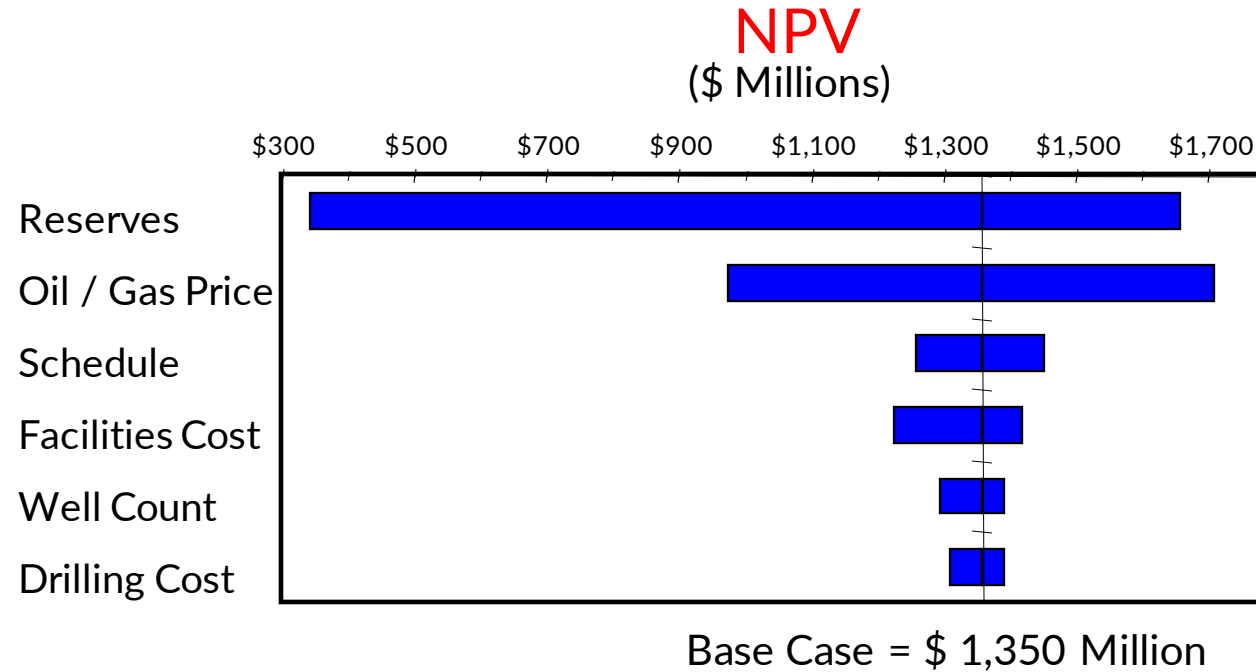$50,000     $70,000     $90,000

% Growth in Neighborhood Values    -2%    2

Savings Return Rate    5%    10

Current House Sales Value    $120,000    $132,000

**Critical uncert. that will receive additional focus & be in the tree.**

Avg. SQ-FT of Built Rooms    144    100

Building Costs per SQ-FT    110    85

% Building Investment Adding to Value    50%    70%

Uncertainties not critical to the decision. Will be set at their base values for the analysis.

Loan Interest Rate    9.25%    8.75%

### Base Case = $71,785

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# Decision Tree



| | | | | % Growth of Neighborhood House Values | Savings Return Rate | Current House Value |
|---|---|---|---|---|---|---|

Minimum Investment

Room to Grow

Moving Up

Purchase Price per SQ-FT: 95, 80, 70

# SQ-FT Purchased: 2100, 2000, 1850

Savings Return Rate: 10%, 7%, 5%

Current House Value: $132,000, $125,000, $120,000

Values are Strategy Dependent

This is a schematic tree drawing. If all the paths were shown, the total number of branches would be 297 (2*3*3*3+(3^5)).

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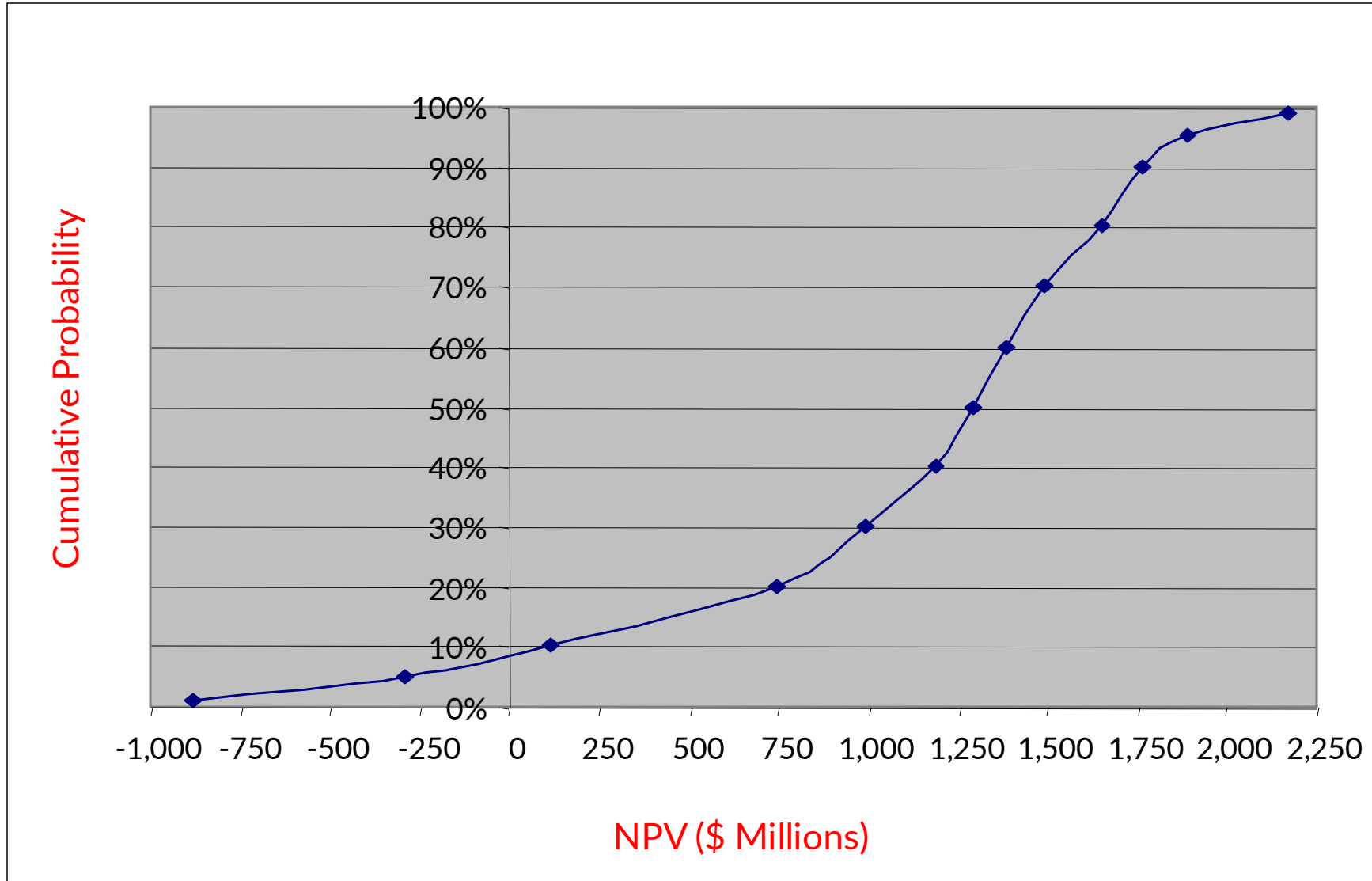Washington, DC - USA

# Probability S-Curve
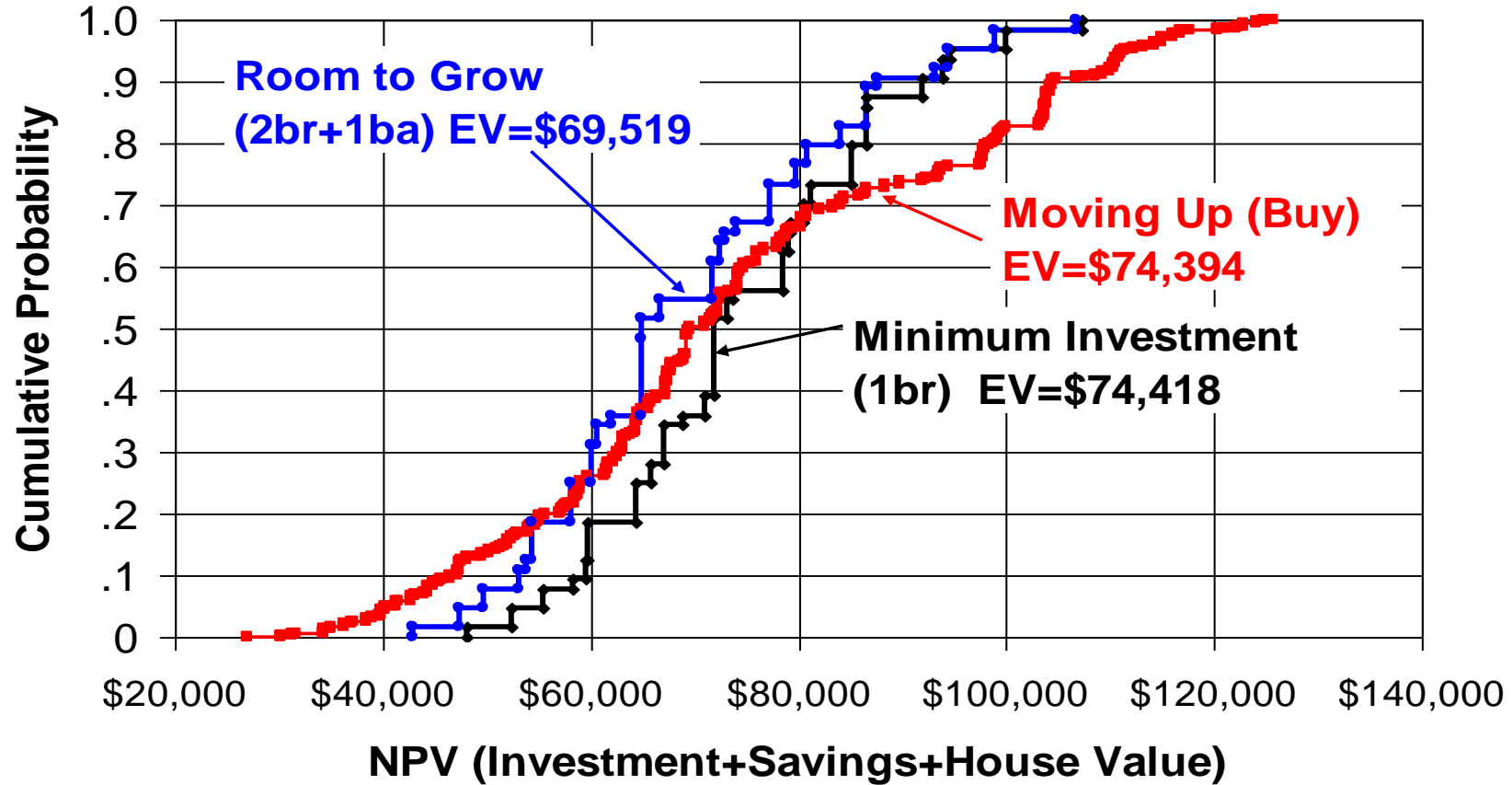
# Tornado Diagram for Oil & Gas Development Project
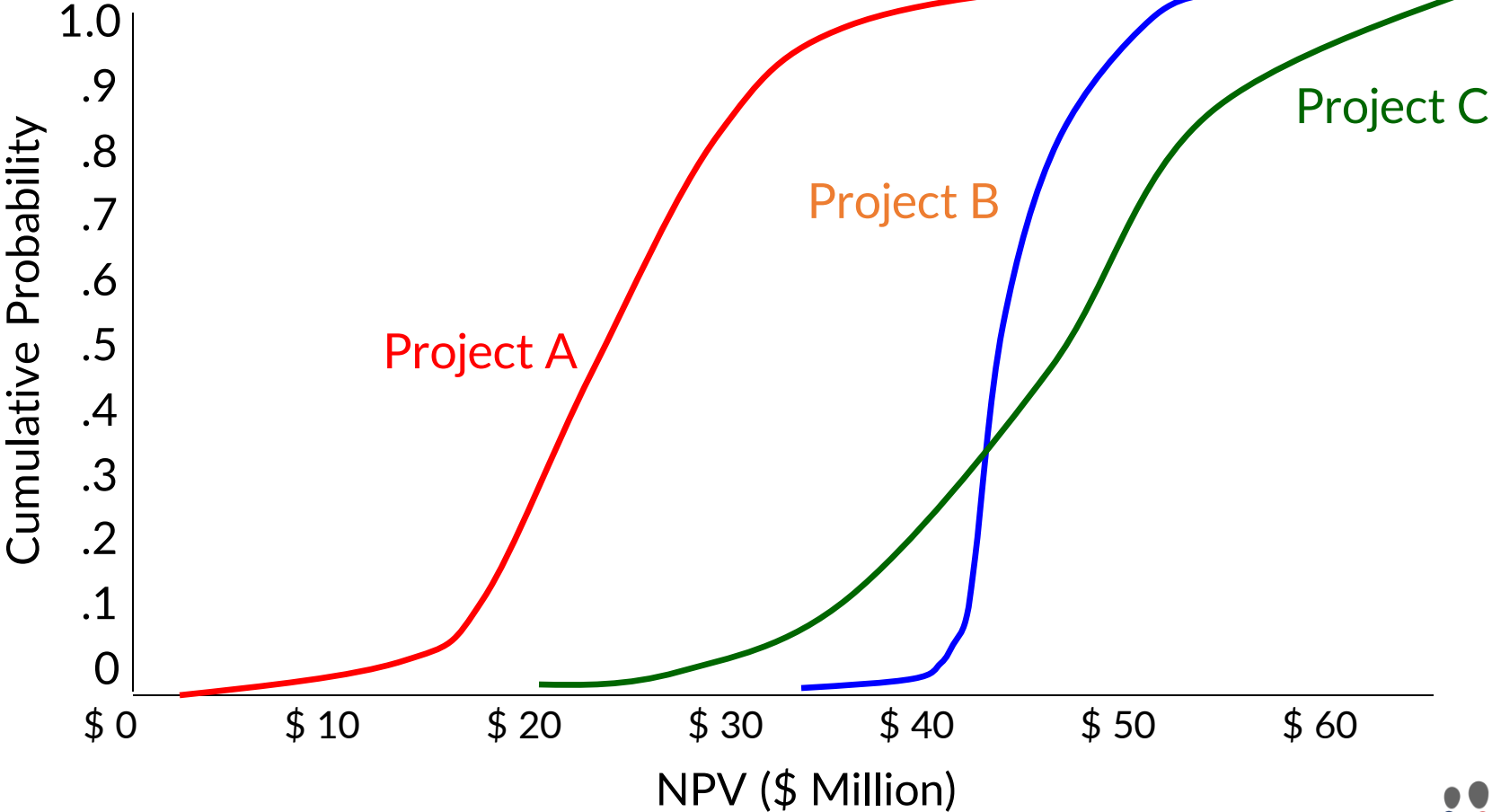
NPV
($ Millions)

Base Case = $ 1,350 Million

P10, P50 and P90 Values of Key Variables

# Probability S-Curve for Oil & Gas Development Project

# Projects with Different Risk Profiles

# THANK YOU

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