Decision Analysis for Project Phasing Using Real Options Tools

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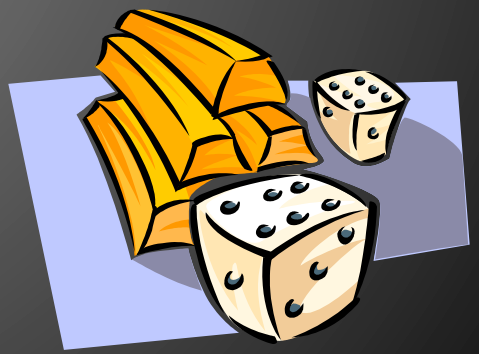
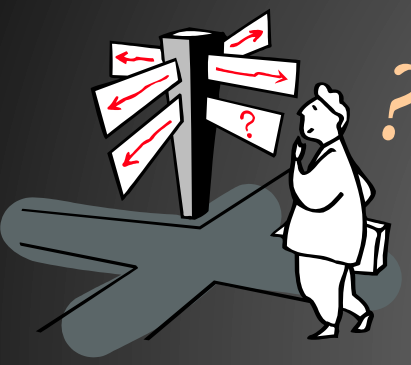


All Choices in Life are Options



- We make choices *based on our beliefs* about which alternative offers the biggest benefit
- Beliefs can be incorrect
- Financial markets account for "incorrectness"

We can adapt financial option pricing strategies to work in 'Real Option' conditions

Today We will learn how to identify and value "Real Options" by:

- Explaining how financial options are priced
- Learning to identify Real Options
- Applying similar strategy to actual program decisions
- Discussing a few Option Examples

Reduce overinvestment

Understand the value of good decisions

Improve stakeholder communications

Adding Real Option strategies to your management and engineering tool kit offers many benefits

An Option is simply:

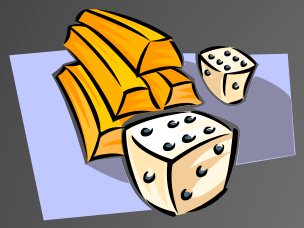
The right, but not the obligation, to do something at some point in the future

"I'm not really unemployed,
I'm just keeping my options open"

Keep your Options Open

The key is the ability to wait to make decisions until we have better information

Everything in the world has an economic value



The future can be difficult to predict, but variability is reasonably stable

The value of money changes over time

Remember the basic facts of finance and option concepts become clear

Example of a Financial Option – Acadia Pharma

ACAD's price is volatile

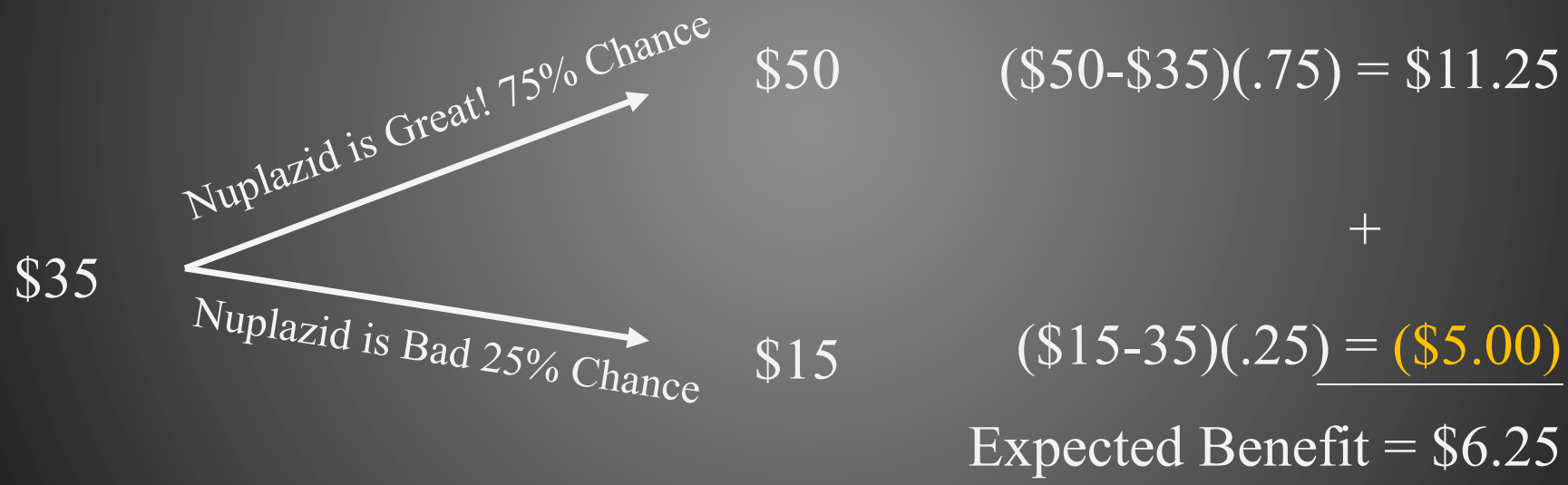
Nuplazid coming to market

May be a winner or may be a flop

An Option can be valuable under these circumstances !

ACAD Simple Option Model Using the Binomial Method

Option to Buy to ACAD (very soon in the future)



The Option Value = Expected Benefit + Value of Paying Exercise Price at a Future Date

$6.25 + fn(TVM and volatility) = $6.25 +

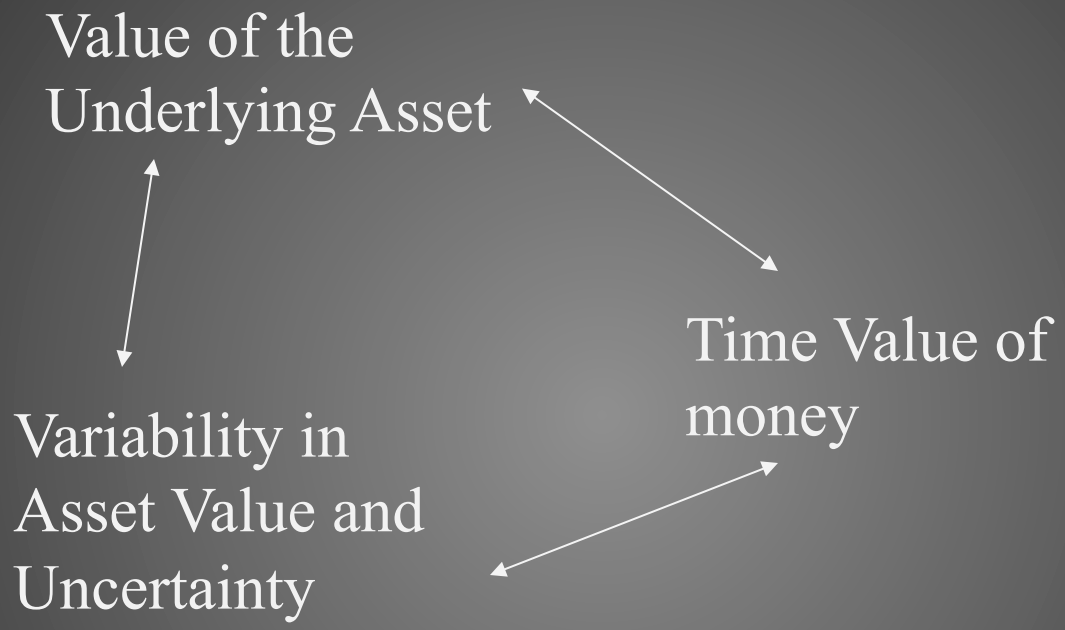
Lots of things can happen to affect the outcome of a stock price. As time passes, we get a better picture of likely outcomes.

Options are most valuable when uncertainty is

High

The Option Allows You to Defer a Decision Pending Better Information

Option value is derived from



Expensive decisions have larger option values

Valuing an Option

- Binomial/Probability Tree (Operations Manager Method)
- Monte Carlo Analysis (Consultant's Method)
- Continuous Time Approach (Black-Scholes – Business School Method)
- Shoehorn Approach (Wall St. Method)

Choose the method most appropriate to the given situation

It is Paramount That:

- The important variables are identified
- Probable values are estimated
- Variability in Outcomes can be modeled

Understanding the Variables is Critical to Successful Valuation

Typical “Real” Option Types

Proceed

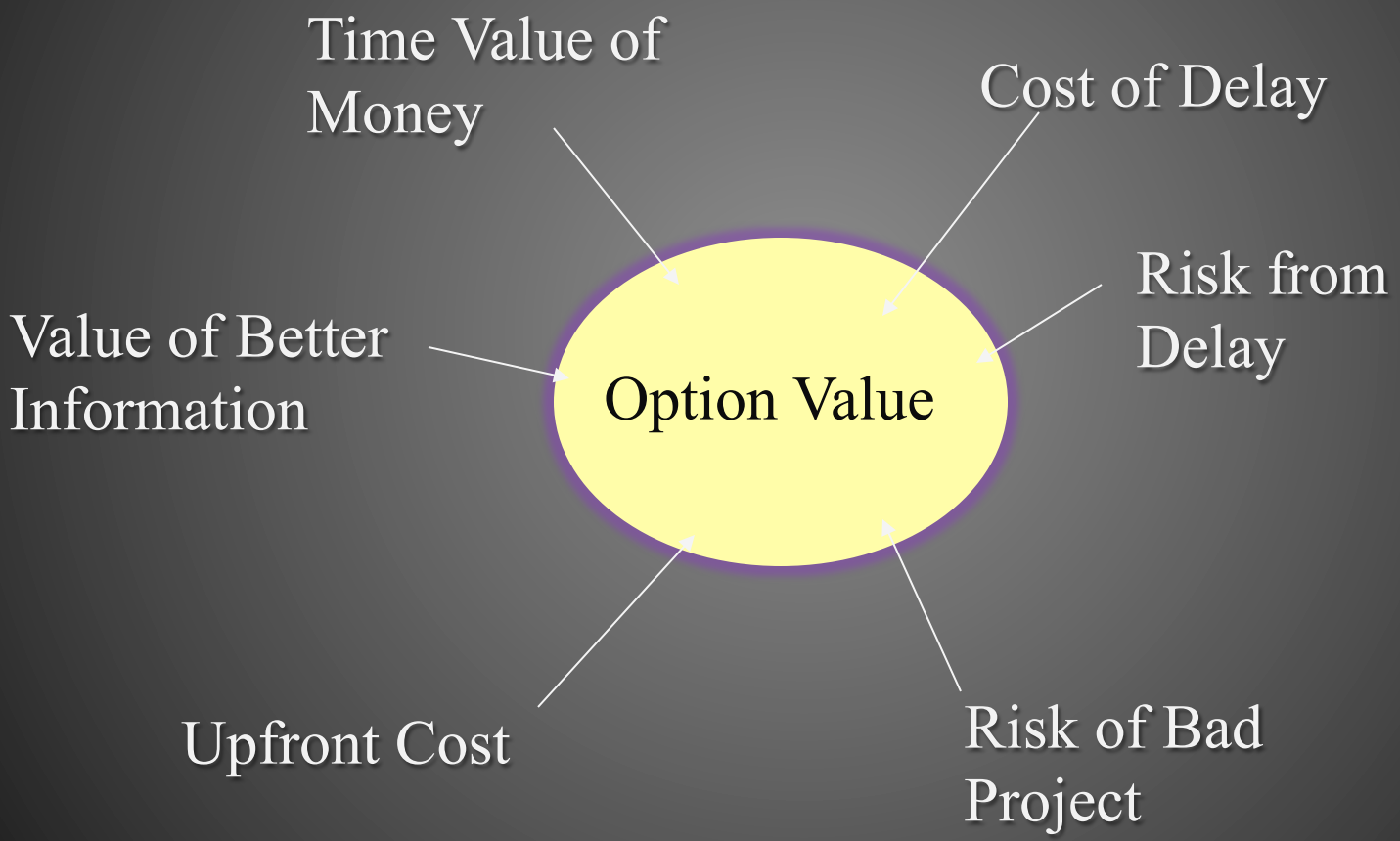
Delay

Expand

Abandon

Can you identify some examples?

How a Real Option Works



Option Value = fn(delay risks) + known costs – fn(reduced project risk)

Black-Scholes Valuation

$$C = SNd_1 - Ke^{(-rt)}Nd_2$$

C = Option Value
S = Present Value of the Underlying Asset
K = Exercise Price (the price at which you can buy/sell the underlying asset)
Nd_1 = Cumulative probability density
Nd_2 = Same as Nd_1 but with one standard deviation*time removed

This model can include multiple variables and explicitly accounts for time value of money

Black-Scholes Valuation

Broken into its parts, we see an ordered solution

$$C = SNd_1 - Ke^{(-rt)}Nd_2$$

SNd_1 = Expected benefit of buying an asset outright

(Nd_1 can also be expressed as $\frac{\text{Spread of possible option prices}}{\text{Spread of possible future values}}$)

$Ke^{(-rt)}Nd_2$ = Present value of paying the exercise price on the expiration date (r = interest rate, t = time)

Let's suppose you are building a new screen chamber for a large water intake…

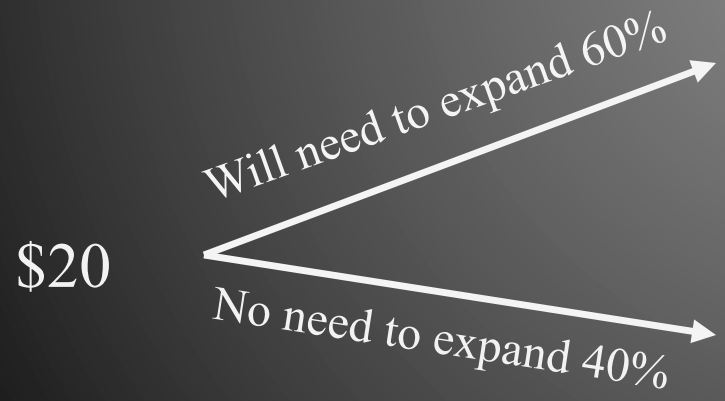
But the flowrate is still not clear

Current demand is 100 MGD
Potential peak is 500 MGD
Bypassing may be OK at peak

What are our options??

Look at the option to expand using the binomial method

Price to build at 100 MGD = $20 million
Price to build at 500 MGD = $120 million
Added Cost to build with future expansion in mind = $20 million
Cost of land acquisition for future expansion = $10 million
Time = 5 years at 3% cost of capital



$120 ($120-$20)(.4) = $40

+

$20 ($20-20)(.6) = 0

Expected Benefit = $40

Time value = $30*(1.03)^5 = $35

Investing in a new Biosolids processing plant…

40 tpd available locally
Each unit is good for 40 tpd
Can find another 20-50 tpd

Future user at 200 tpd out of area but interested and need a commitment!

What are our options??

- 80 tpd unit is $20 million
- Can build full 7 units for $100 million (economies of scale) if done today, but goes to a total of $150 million if additional 5 units are done as a future project
- Cash flow on first 80 tpd = $100/ton
- 200 tpd provider is waiting on other disposal bids – Cash flow could range from $100 - $140/ton

Progressive Design-Build might work

Evaluate Delay Option Cost:

- Up front cost small project = $20 million
- Present Value = $130 million - $100 million = -30 million

So the Delayed Project has a negative NPV at the current time. Use option valuation model to predict the value of the delay right

Evaluate potential increase in cash flows:

Cash flow per ton		Avg	Min	Max	SD
$ 144.39		$ 140.04	$ 135.68	$ 144.39	6.16
$ 130.72		$ 116.04	$ 109.85	$ 122.24	8.76
$ 115.76		$ 128.63	$ 124.77	$ 132.49	5.46
$ 106.21		$ 126.04	$ 113.93	$ 138.16	17.13
$ 101.84		$ 106.06	$ 102.12	$ 109.99	5.57
$ 127.54		$ 136.41	$ 125.94	$ 146.89	14.81
$ 134.50		$ 110.05	$ 100.21	$ 119.89	13.91
$ 145.69		$ 137.75	$ 133.27	$ 142.23	6.34
$ 138.90		$ 140.72	$ 140.44	$ 141.01	0.40
$ 149.96		$ 128.17	$ 113.48	$ 142.86	20.78
$ 108.39		$ 132.93	$ 120.71	$ 145.15	17.28
$ 146.99		$ 118.18	$ 100.82	$ 135.55	24.56
$ 124.14		$ 120.63	$ 107.74	$ 133.52	18.23
$ 129.88		$ 126.73	$ 114.45	$ 139.01	17.36
$ 116.22		$ 131.83	$ 114.64	$ 149.02	24.31
$ 112.46		$ 111.90	$ 103.28	$ 120.51	12.18
$ 127.58		$ 139.04	$ 135.80	$ 142.27	4.58
$ 120.43		$ 134.68	$ 121.59	$ 147.76	18.50
$ 128.79		$ 123.70	$ 120.04	$ 127.36	5.18
$ 134.51		$ 121.09	$ 105.05	$ 137.13	22.69
$ 116.49		$ 119.16	$ 100.50	$ 137.83	26.39
$ 120.42					
$ 102.12	Averages	$ 126.18	$ 116.40	$ 135.96	13.84
$ 121.32	SD %				71%

Estimate uncertainty – In this case assumed a monte carlo simulation of 200 tpd cash flows

Results show a standard deviation of 71% from average cash flow of $126/ton

Price to Build now = $100m
Price to Build later = $130m
SD of potential cash flow growth = .71
Years to 'maturity' = 5
Interest rate = 3%
Present value of 200 tpd cash flows = $40m (@126/ton)
Current value of cash flows = $31m (@100/ton)

Calculate d_1 =.06 Calculate d_2 = -1.53

Nd_1 (probability that a variable will be more than .06 SD above the mean) = .53

Nd_2 (probability that a variable will be less than 1.53 SD below the mean) = .06

(.53 x 40mm) – (.06 x 30mm/1.0348) = $19.5 million

The Value of a Delay Option is $16.4 million

The upfront premium is $30 million

This implies that waiting for better information is not worth the cost in this case.

Investigate other options to reduce future construction cost?

Look for options embedded in decisions

Understand the variables and values

Use appropriate valuation techniques

Explain decisions based on option valuations

Reality is Optionality
and optionality is a sustainability tool

For Additional Information

Great Resource for papers and spreadsheets at:
http://pages.stern.nyu.edu/~adamodar

Questions or comments?

Identifying and Acting on Project Options is a Sustainability Tool !

Maintaining a Healthy Financial Bottom Line is Critical to Support the Social and Environmental Bottom Lines