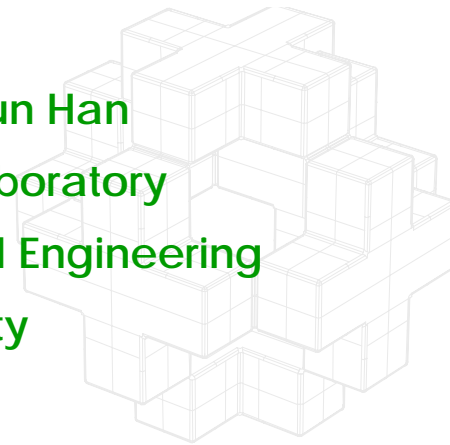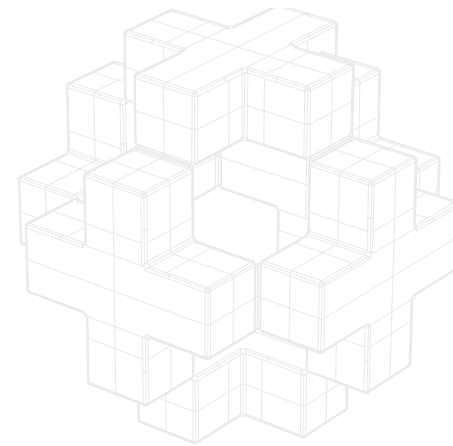# Chemical Product Design

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PART XIII. Product Development Economics

- Product Development Economics

Product Development Process

Planning | Concept Development | System-Level Design | Detail Design | Testing and Refinement | Production Ramp-up

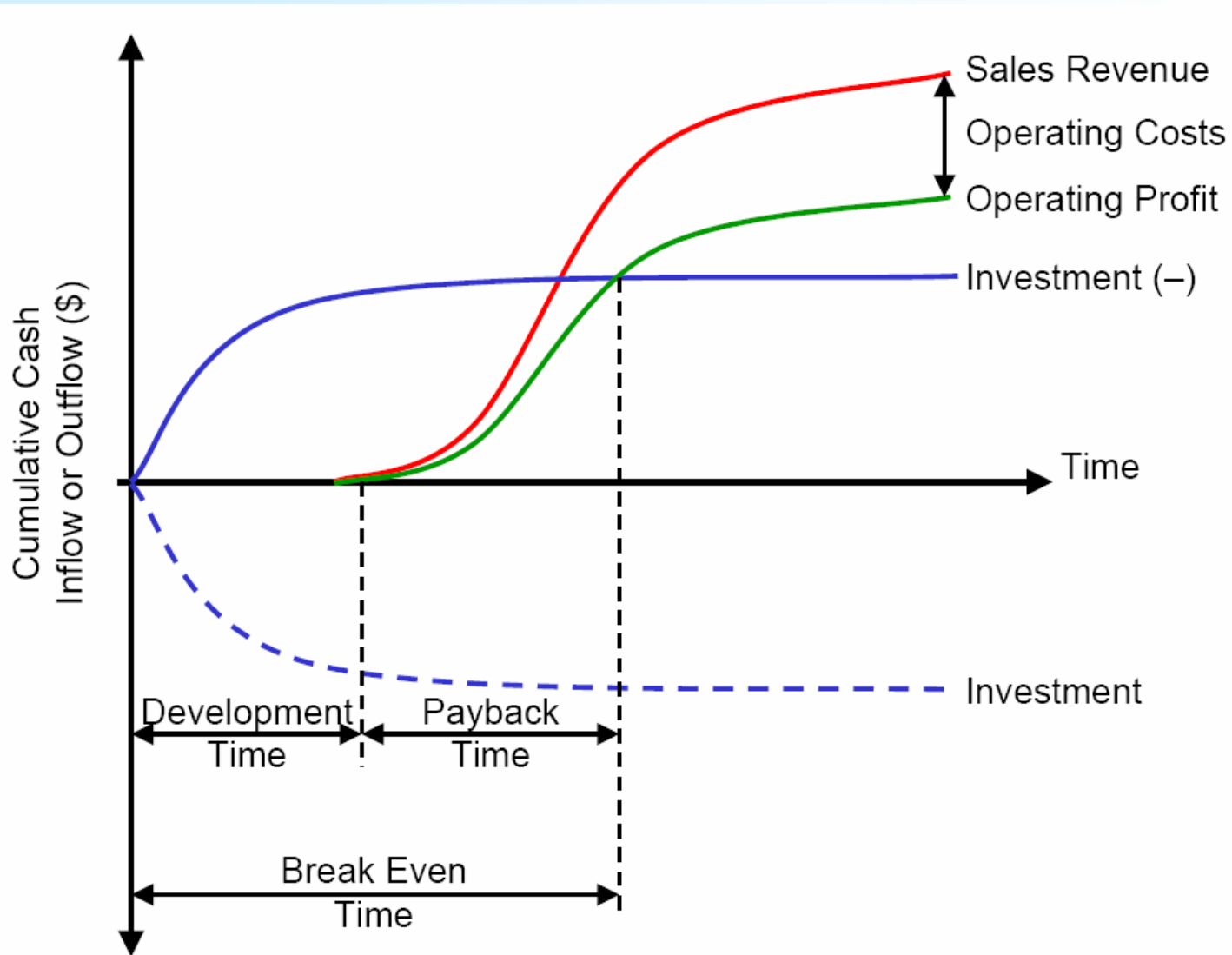Four Phases of Product Development
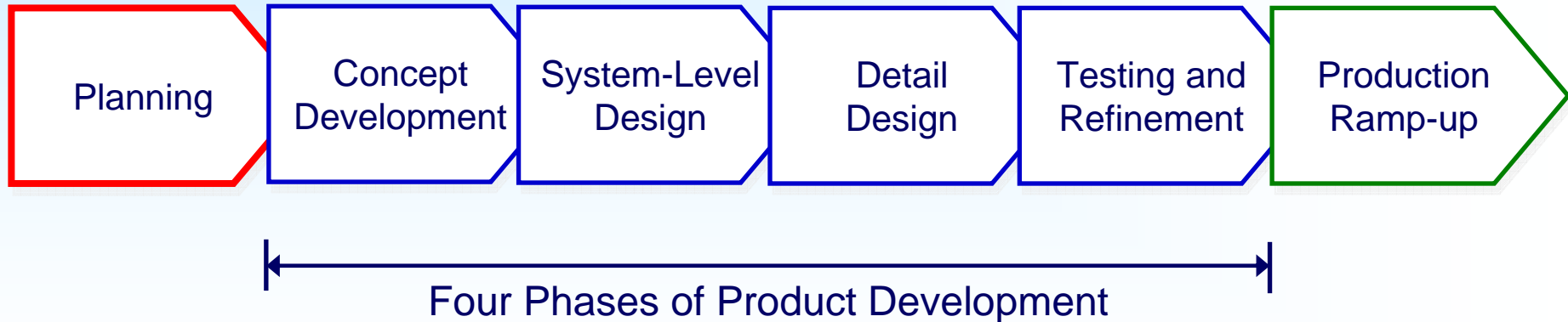
■ Go/No-Go Decision Gates

◆ Sensitivity and Trade-off Analysis

Cash Flow

What is the ultimate objective ?

❖ *To maximize shareholder return*

    - at any cost ?

    - *When ?*

    - *How ?*

        (1) Stock appreciation ?

        (2) IPO

        (3) Dividends ?

    - *What about providing **Customer Satisfaction** ?*

    - *Satisfying **"stakeholders"***

        Customers + employees + community (local, state, and national) + shareholders + …

❖ *How about ?*

    - To maximize shareholder return subject to good practice constraints

Profit

◆ **The purpose of product design is to produce a good or service that a customer will pay a sufficient price for to assure a profit.**

◆ **Gross Profit = Price – Direct Cost**

◆ **Net Profit = Gross profit – allocated expenses**

◆ **To assure a profit, companies act to produce products that can command the highest prices and cost the least to make**

◆ **Any exceptions ?**

What Other Product Issues Drive Companies Besides Profit

Valuation

◆ **Future Earnings**

- Products in the pipeline

◆ **Acquisition Potential**

- Strategic fit of products with another

    company

◆ **Break-up Potential**

- Value of a conglomerate as the sum of its parts

◆ **Tax Consequences**

◆ **Etc.**

Cash Flow

◆ **Require for Business Continuity**

- To pay expenses

- To pay interest on dept

- To pay dividends to stockholders

◆ **To Grow Business**

- To invest in new programs, technologies

- Equipment

- Inventory and Receivables

- Acquisitions etc.

◆ **Best Measure of Financial Perform.**

- Used by Wall Street

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Understanding Cash Flow……

Activities which bring cash into the business

Business Activity

Personal Activity

❖ **Operating**

(+)

❖ **Financing**

❖ **Receiving payments from customers**
❖ **Borrowing money**
❖ **Selling shares of the company**

❖ **Cashing out paychecks**
❖ **Receiving a car loan / home mortgage**

(-)

Activities which remove cash from the business

❖ **Operating**

❖ **Financing**

❖ **Paying our expenses for**
 - **Salaries**
 - **Materials**
 - **Equipment**
❖ **Paying interest on debt**
❖ **Paying dividends to shareholders**
 = Cash Flow of Business

❖ **Paying monthly expenses**
 - **Food**
 - **Utilities**
 - **Insurance**
❖ **Paying monthly car payment / mortgage** = Cash in the Bank

Investment Alternatives

◆ **The object is to take capital earned, borrowed or from investors and allocate it in a fashion that earns the highest return for the shareholders of the company**

◆ **There needs to be an appropriate balance of long and short term returns**

◆ **More complex and as simple as a matter of dollars and cents**
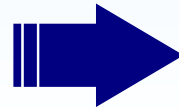
Question:

What are some investment alternatives for a company ?

Investment Alternatives

What are typical investment alternatives ?

❖ **Invest in**

- *Product line **a** or product line **b***

- *Advertising*

- *Information systems*

- *A new factory*

- *Buy-bank companies stock*

- *Acquisition*

- *Employee bonus or salary raise*

- *Hire more HR personnel*

- *Etc.*

Principal of Equivalence:

The state of being equal in value

- Amount

- Discount assumptions

- Time transactions occur

→ **All investments must be normalized to give equivalence !!!**

The Criteria is:

Which investment(s) gives the highest return ?

Net Present Value

Net Present Value of an Investment

◆ **Holds for all investments**

◆ **Takes into account inflation, cost of capital, corporate expectations**

   of return

◆ **Reduces all times to a common point**

Calculation of Net Profit Value   Calculation of Payback Period

$$NPV = \sum_{t=0}^{n} \frac{A_t}{(1+k)^t}$$

$$\sum_{t=o}^{n} \left[\frac{A_t}{(1+r)^t} \right] = 0$$

where k is the expected rate of return A sub t is the cash flow in the period t

where r is rate and A_t is the cash flow in period t

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Preparing an Economic Feasibility Study

Compare Product Returns on Investment

Dollars

Time (Years)

Example: Sample business plan pro forma
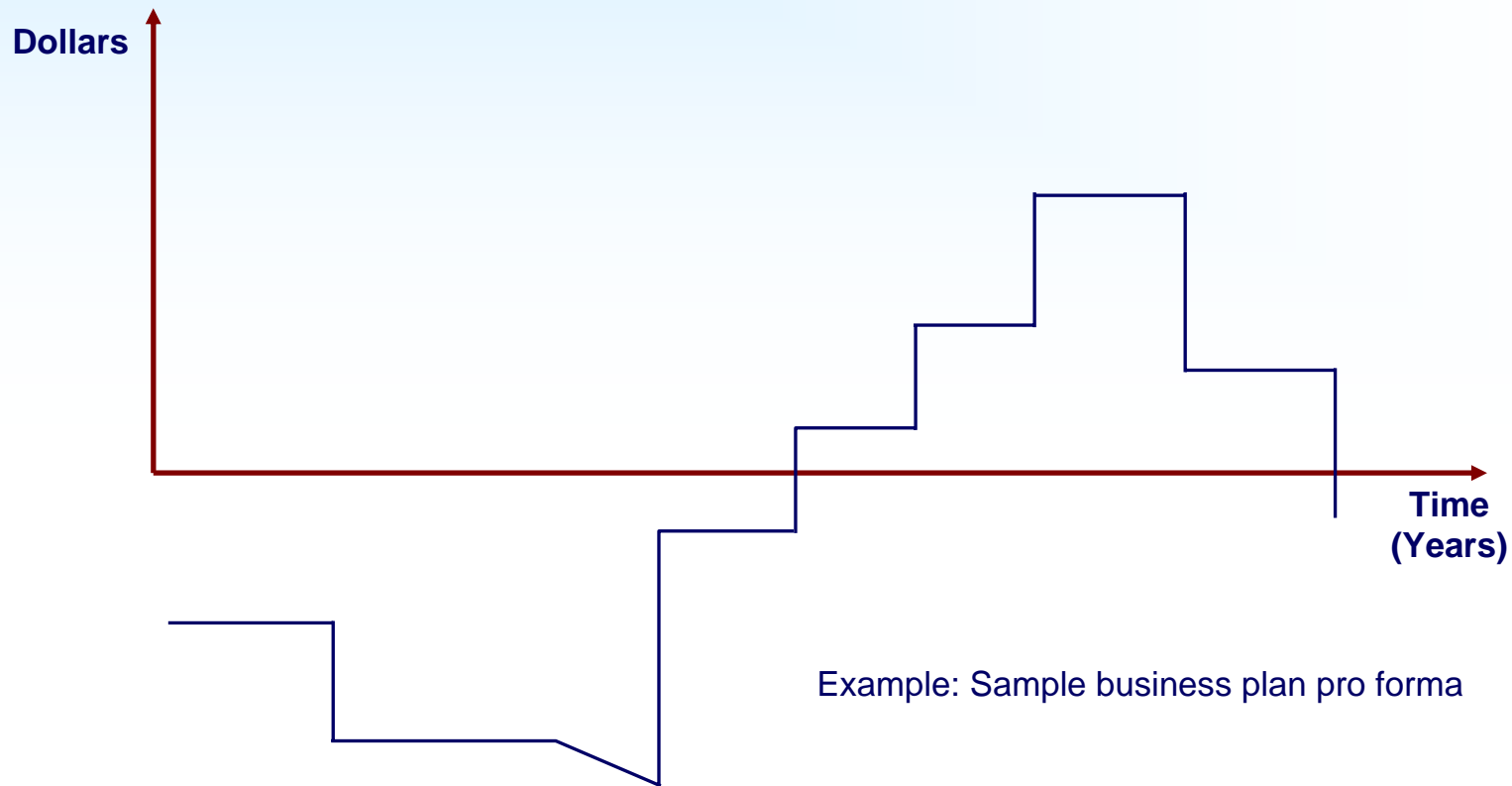
To Calculate NPV, First Assume a Cash Flow
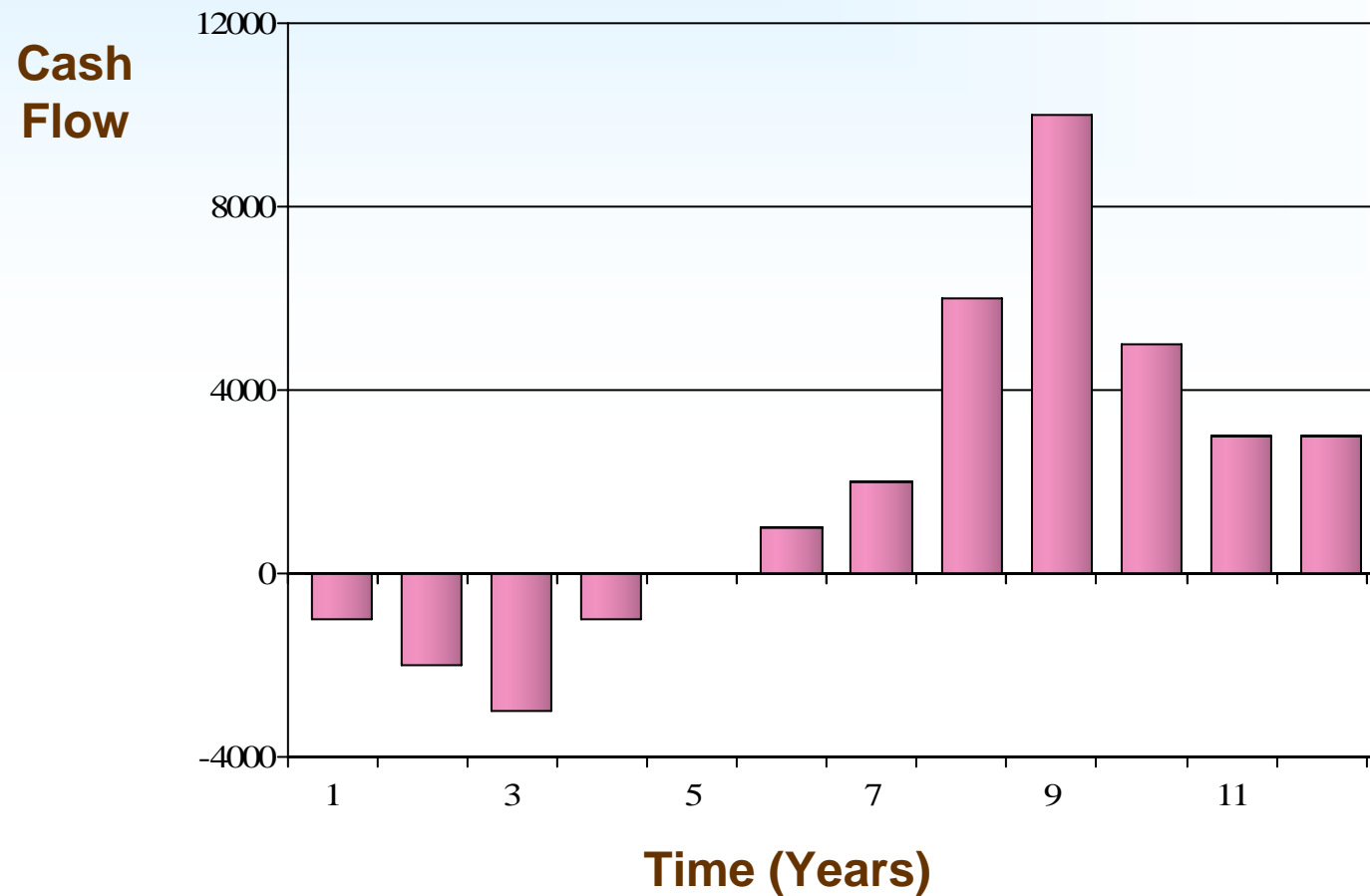
Calculation of NPV and Payback Period of an Investment

Year	Cash	Discounted		Cash Flow		Discount rate
1	-1000	$	(909)	$	(909)	**10%**
2	-2000	$	(1,653)	$	(2,562)	
3	-3000	$	(2,254)	$	(4,816)	
4	-1000	$	(683)	$	(5,499)	
5	0	$	-	$	(5,499)	
6	1000	$	564	$	(4,934)	
7	2000	$	1,026	$	(3,908)	
8	6000	$	2,799	$	(1,109)	
9	10000	$	4,241	$	3,132	
10	5000	$	1,928	$	5,060	
11	2000	$	701	$	5,761	
12	2000	$	637	$	6,398	

Net Present Value= $ 6,398

Payback   9 years

Assume all cash is spent at end of perid

$ -

Calculation of NPV and Payback Period of an Investment

1	-1000	$	(769)	$	(833)	**30%**	
2	-2000	$	(1,183)	$	(2,016)		
3	-3000	$	(1,365)	$	(3,382)		
4	-1000	$	(350)	$	(3,732)		
5	0	$	-	$	(3,732)		
6	1000	$	207	$	(3,525)		
7	2000	$	319	$	(3,206)		
8	6000	$	736	$	(2,471)		
9	10000	$	943	$	(1,528)		
10	5000	$	363	$	(1,165)		
11	2000	$	112	$	(1,053)		
12	2000	$	86	$	(967)		

Net Present Value= $ (904)

Payback never breaks even

Assume all cash is spent at end of period

Calculation of Internal Rate of Return (IRR) for a Project

◆ **Calculate a discount rate (k) that reduces the NPV of a project to zero**

$$NPV = 0 = \sum_{t=0}^{n} \frac{A_t}{(1+k)^t}$$

IRR=24.3%

NPV($) Vs Discount Rate (%)
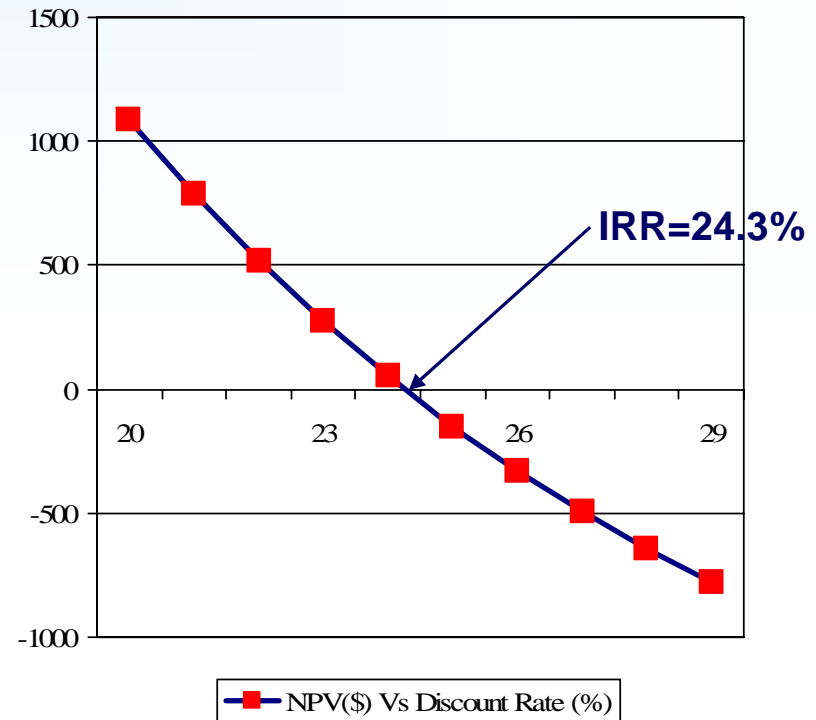
Preparing an Economic Feasibility Study

What's wrong with this picture ?

❖ **Predictions are very difficult – especially when they involve the future.**

- **Extrinsic**

  (a) Marketing Change

  (b) Competitor's Change

  (c) Macro-economic conditions change

- **Intrinsic**

  The analyses are based on flawed assumptions

  - Program delays

  - Manufacturing snafus

  - Technologies not ready

  - Externalities (out of your control)

  - Many other reasons

  Then why does everybody do it ???

Sensitivity Analysis

◆ **Reduce (Increase) Price**

◆ **Change Product Development Time**

◆ **Consider competitive response**

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Sensitivity Analysis

Some Thoughts on How to Increase Profits

P=SP-C
1. Increase Selling Price

◆ **Increase Customer Value**

- Put extra features in product which require little marginal cost

- Provide extra service

- Target less competitive segment of the market

- Get to market before competition

- Price at the maximum the customer is willing to pay

Price models should reflect customer value – not cost (except in government contracts if you wish to avoid jail)

Note in English gardening magazine: Even though seed sales are at an all time high, the price is not expected to come down

Sensitivity Analysis

Some Thoughts on How to Increase Profits

P=SP-C
2. Decrease Selling Price

Why ?

Sensitivity Analysis

Some Thoughts on How to Increase Profits

$$P=SP-C$$

3. Decrease Product Development (NRE) and Manufacturing (RE) Costs

◆ **Do it right the first time**

◆ **Don't commit to detailed design until you have customers specifications firm then don't change**

◆ **Build a manufacturable product. Bring manufacturing in early**

◆ **Don't overload with features that the customer doesn't want that are costly to develop**

◆ **Manage tightly to schedule with appropriate risk and risk reduction plan**

◆ **Use rigid phase exit criteria**

All of these consistent with Fast C/T

Sensitivity Analysis

Some Thoughts on How to Increase Profits

P=SP-C

4. Decrease Cycle Time for Product Development

◆ **Effect on product price in bring first to market ?**

◆ **Effect on total revenue of turning out products faster ?**

◆ **Effect on Cost ?**

Sensitivity Analysis

Assume the decision is made to invest in developing new products

◆ **How do you make the decision on which new product to invest**
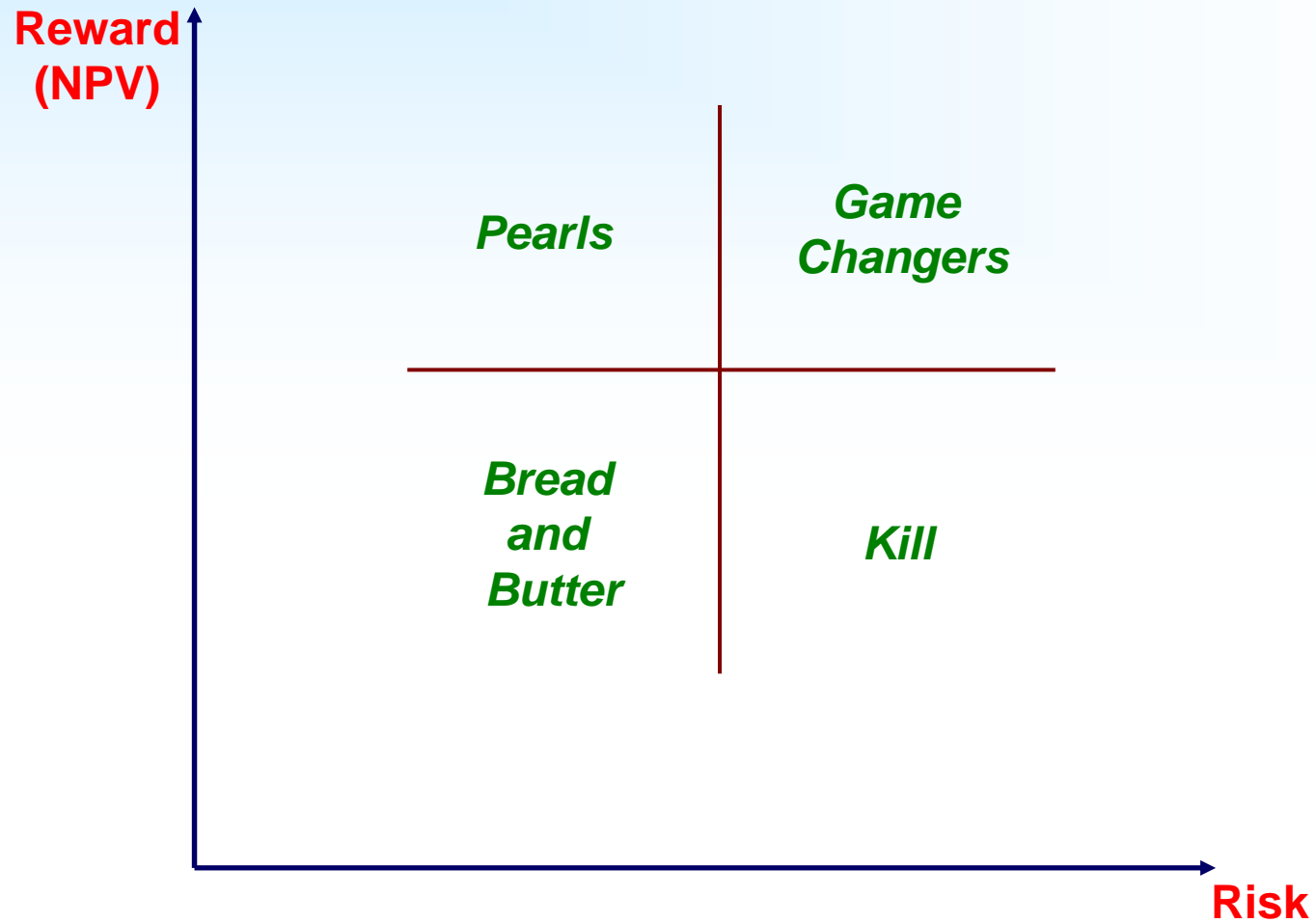
in ?

◆ **What are the criteria for this decision making process ?**
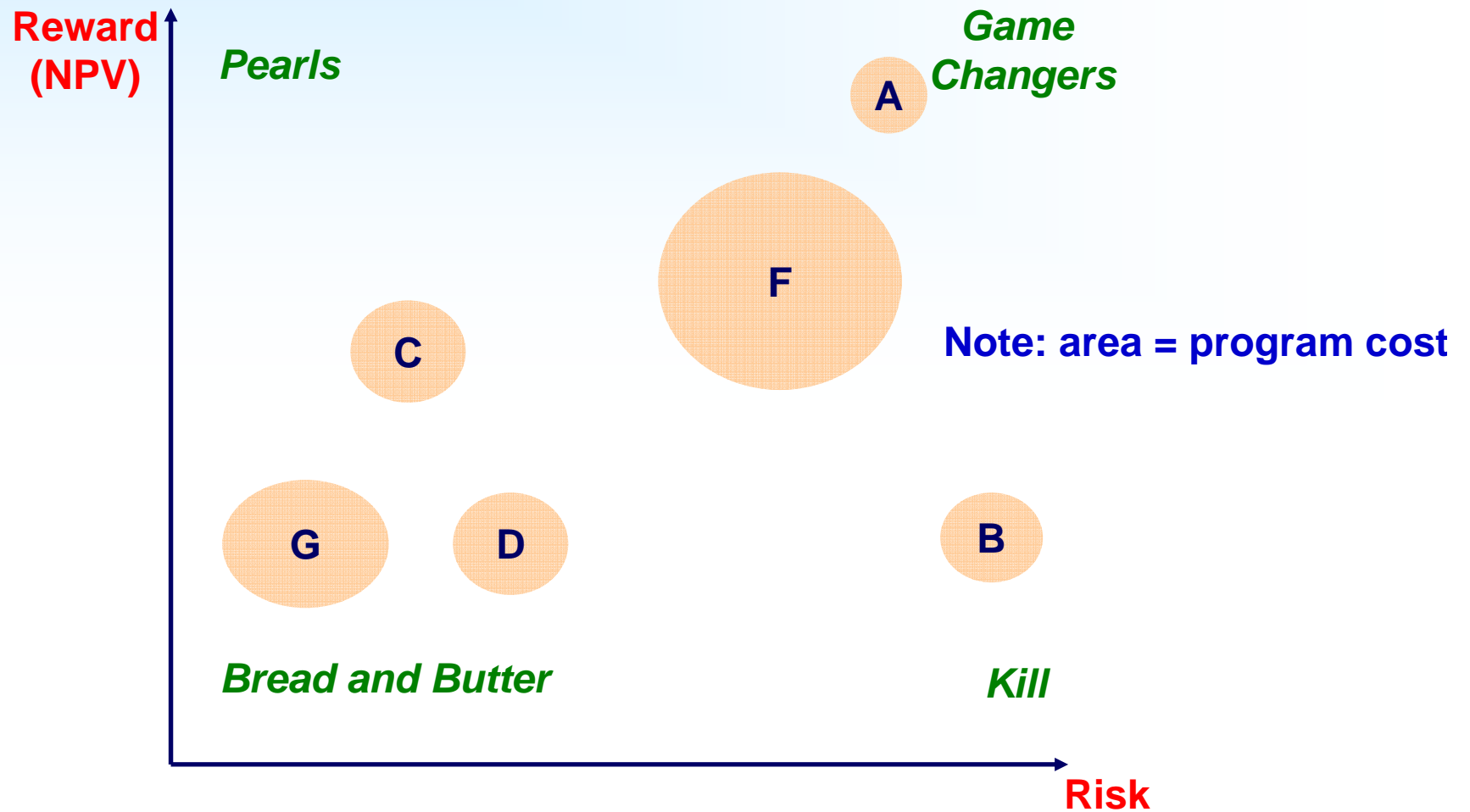
◆ **How do we maximize profit ?**

- in the long range

- in the short range

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Portfolio Analysis

Portfolio Analysis

A Portfolio of 6 Programs

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Portfolio Analysis

How do you allocate ???

Not by NPV and Payback Period alone

But…….

◆ **Portfolio Balance (Long / Short)**

◆ **Strategically Important vs. Tactically Important**

◆ **Product Families and Platforms**

◆ **Future Sales Model**

◆ **Available Resource**

- People and Dollars

◆ **Customer Demands**

Portfolio Analysis

Data for Rank Ordered List

Project Name	IRR	NPV	Strategic Importance	Probability of Technical Success
Alpha	20 %	10.0	5	80 %
Beta	15 %	2.0	2	70 %
Gamma	10 %	5.0	3	90 %
Delta	17 %	12.0	2	65 %
Epsilon	12 %	20.0	4	90 %
Omega	22 %	6.0	1	85 %

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Portfolio Analysis

Rank Ordered by Discounting Returns by Probability of Success

Project Name	IRR	NPV	Strategic Importance	Ranking Score
Alpha	16.0 (2)	8.0 (2)	5 (1)	1.67 (1)
Beta	10.8 (4)	18.0 (1)	2 (2)	2.33 (2)
Gamma	11.0 (3)	7.8 (3)	3 (4)	3.33 (3)
Delta	18.7 (1)	5.1 (4)	2 (6)	3.67 (4)
Epsilon	9.0 (6)	4.5 (5)	4 (3)	4.67 (5)
Omega	10.5 (5)	1.4 (6)	1 (4)	5.0 (6)

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Product Development Economics

Whatever the methodology, the choices you make have an
Opportunity Cost

◆ **Product Development Resource is always finite**

◆ **Most companies with good engineering and marketing resource**

are in a "target rich" environment

◆ **Thus in this environment, allocation is a zero sum game**

◆ **An investment that ties up resource – even a "good investment"**

(High NPV) can crowd out a better (sometimes much better)

investment

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