Product Development Process

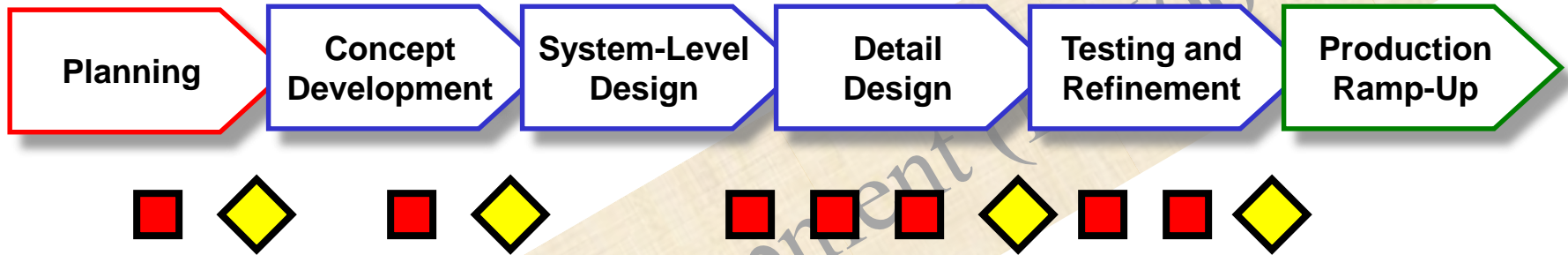| Planning | Concept Development | System-Level Design | Detail Design | Testing and Refinement | Production Ramp-Up |

◆ Go/No-Go Decision Gates

■ Sensitivity and Trade-off Analysis

Product Development Economics Example:
Polaroid Color Photo Printer

Decisions regarding:

- Should the team take more time for development in order to make the product available on multiple computer platforms or would the delay in bringing the product to market be too costly?

- Should the product use standard print media from Polaroid's existing businesses or new & specialized premium-quality print media?

- Should the team increase development spending in order to increase the reliability of the product?

Net Present Value

$$NPV = \sum_{periods} \frac{period\ cash\ flow}{(1 + discount\ rate)^{period}} - Initial\ Investment$$

$$NPV = \sum_{i=1}^{N} \frac{C_i}{(1 + r)^i} - Initial\ Investment$$

+$

Cumulative
Inflow or
Outflow ($)

Time

Sales Revenues

Development Cost
Ramp-up Costs

Marketing and
Support Costs

Production Cost

−$
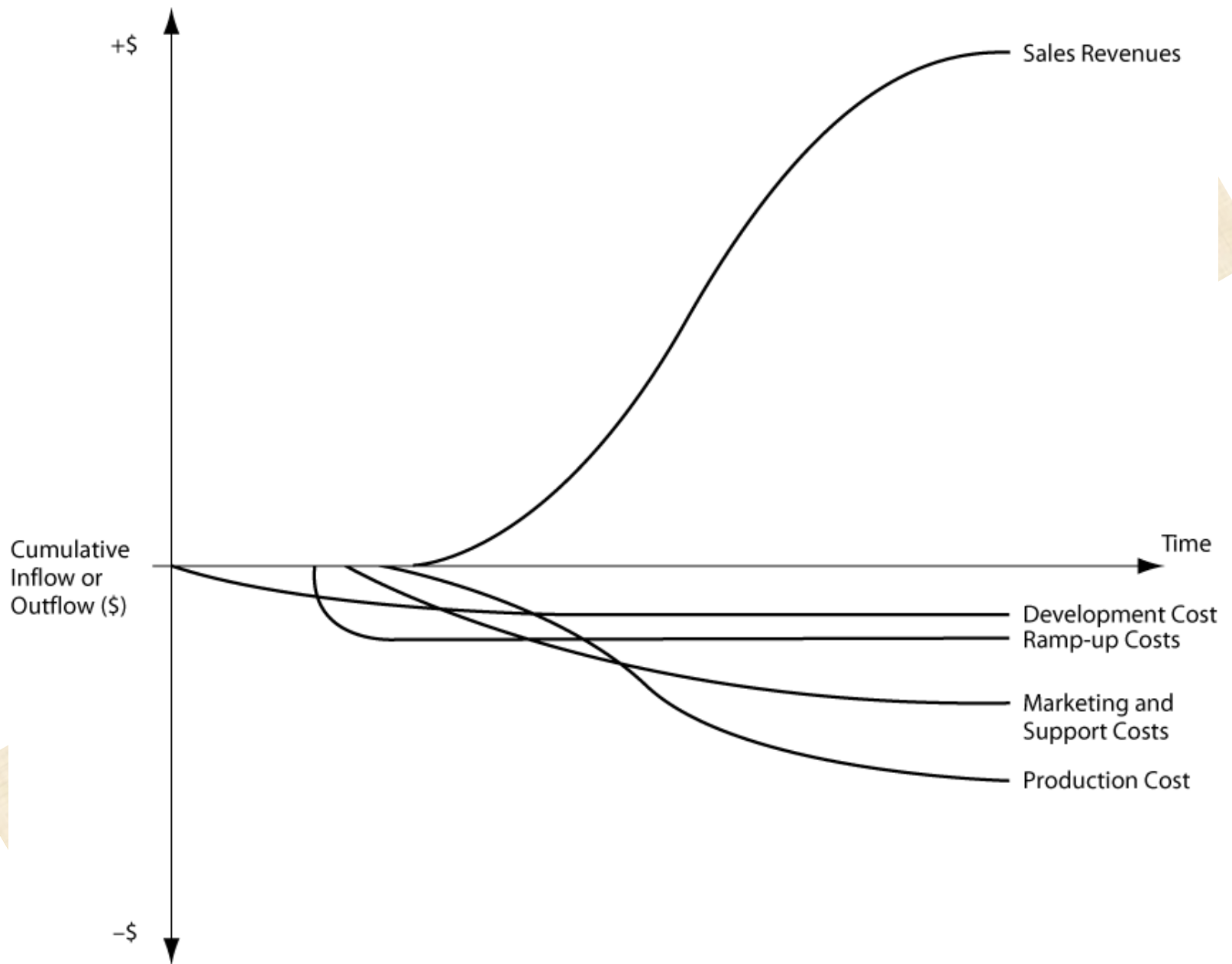
Product Development Cash Flow
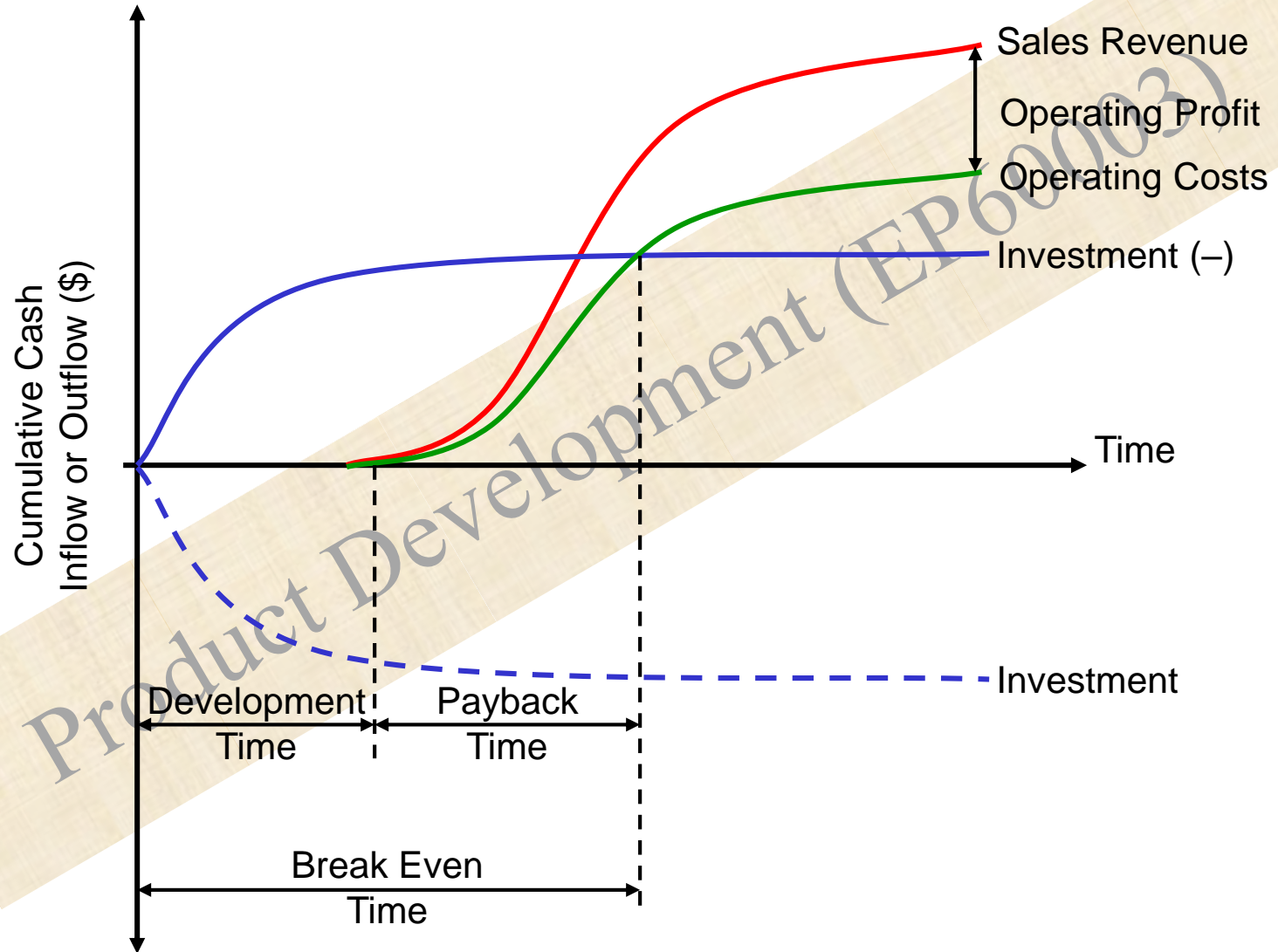
When should Economic Analysis be performed?

- Go/no-go milestones
- Operational design & development decisions

Product Development (EP60003)

Project Financial Analysis
(also Business Case Analysis or Product Economics)

- Build a Base-case financial model which computes nominal NPV.

- Perform a Sensitivity analysis to understand the relationships between financial success & the key assumptions & variables of the model.

- Use the sensitivity analysis to understand the project trade-offs.

- Consider the influence of Qualitative factors on project success.

Inputs for NPV Base Case

- Development cost and timing
- Testing cost and timing
- Tooling investment and timing
- Ramp-up cost and timing
- Marketing and support cost and timing
- Sales volume and lifetime
- Unit production cost
- Unit revenue
- Discount rate

CI700 Project Budgets

Items	Numbers
Development Cost	$5 million
Ramp-up cost	$2 million
Marketing & Support cost	$1 million/year
Unit production cost	$400/unit
Sales & Production volume	20,000 units/year
Unit price	$800/unit

	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development	▓	▓	▓	▓												
Ramp-up				▓	▓											
Marketing and support					▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓
Production and sales window						▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓

($ values in thousands)	Year 1 Q1	Q2	Q3	Q4	Year 2 Q1	Q2	Q3	Q4	Year 3 Q1	Q2	Q3	Q4	Year 4 Q1	Q2	Q3	Q4
Development cost	−1,250	−1,250	−1,250	−1,250												
Ramp-up cost				−1,000	−1,000											
Marketing & support cost					−250	−250	−250	−250	−250	−250	−250	−250	−250	−250	−250	−250
Production cost						−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000
Production volume						5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Unit production cost						−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4
Sales Revenue						4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Sales volume						5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Unit price						0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

($ values in thousands)	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development cost	−1,250	−1,250	−1,250	−1,250												
Ramp-up cost				−1,000	−1,000											
Marketing & support cost					−250	−250	−250	−250	−250	−250	−250	−250	−250	−250	−250	−250
Production cost						−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000
Production volume						5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Unit production cost						−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4
Sales Revenue						4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Sales volume						5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Unit price						0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Period Cash Flow	−1,250	−1,250	−1,250	−2,250	−1,250	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750
PV Year 1, r = 10%	−1,250	−1,220	−1,190	−2,089	−1,132	1,547	1,509	1,472	1,436	1,401	1,367	1,334	1,301	1,269	1,239	1,208
Project NPV	8,203															

Internal Factors

- Development
  Expense
  Investigation cost
  Development cost
- Development Speed
  Investigation time
  Development time
- Production Cost
- Product Performance

PRODUCT DEVELOPMENT PROJECT

External Factors

- Product Price
- Sales Volume
- Competitive Environment

Net Present Value

($ values in thousands)	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development cost	−1,000	−1,000	−1,000	−1,000												
Ramp-up cost				−1,000	−1,000											
Marketing & support cost					−250	−250	−250	−250	−250	−250	−250	−250	−250	−250	−250	−250
Production cost						−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000
Production volume						5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Unit production cost						−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4
Sales Revenue						4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Sales volume						5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Unit price						0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Period Cash Flow	−1,000	−1,000	−1,000	−2,000	−1,250	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750
PV Year 1, r = 10%	−1,000	−976	−952	−1,857	−1,132	1,547	1,509	1,472	1,436	1,401	1,367	1,334	1,301	1,269	1,239	1,208
Project NPV	9,167															

($ values in thousands)	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Development cost	−1,000	−1,000	−1,000	−1,000	−1,000											
Ramp-up cost					−1,000	−1,000										
Marketing & support cost						−250	−250	−250	−250	−250	−250	−250	−250	−250	−250	−250
Production cost							−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000	−2,000
Production volume							5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Unit production cost							−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4	−0.4
Sales Revenue							4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Sales volume							5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Unit price							0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Period Cash Flow	−1,000	−1,000	−1,000	−1,000	−2,000	−1,250	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750
PV Year 1, r = 10%	−1,000	−976	−952	−929	−1,812	−1,105	1,509	1,472	1,436	1,401	1,367	1,334	1,301	1,269	1,239	1,208
Project NPV	6,764															

Development Cost Sensitivities

Change in Development cost, %	Development cost, $ Thousands	Change in Development cost, $ Thousands	Change in NPV, %	NPV, $ Thousands	Change in NPV, $ Thousands
50	7,500	2,500	-29.4	5,791	-2,412
20	6,000	1,000	-11.8	7,238	-964
10	5,500	500	-5.9	7,721	-482
base	5,000	Base	0.0	8,203	0
-10	4,500	-500	5.9	8,685	482
-20	4,000	-1,000	11.8	9,167	964
-50	2,500	-2,500	29.4	10,615	2,412

Development Time Sensitivities

Change in Development time, %	Development time, Quarters	Change in Development time, Quarters	Change in NPV, %	NPV, $ Thousands	Change in NPV, $ Thousands
50	6	2	-34.6	5,363	-2,840
25	5	1	-17.5	6,764	-1,439
base	4	base	-0.0	8,203	0
-25	3	-1	18.0	9,678	1,475
-50	2	-2	36.4	11,190	2,987

Sales Volume Sensitivities

Change in Sales volume, %	Sales volume, $ Thousands	Change in Sales volume	Change in NPV, %	NPV, $ Thousands	Change in NPV, $ Thousands
30	6,500	1,500	63.0	13,375	5,172
20	6,000	1,000	42.0	11,651	3,448
10	5,500	500	21.0	9,927	1,724
base	5,000	base	0.0	8,203	0
-10	4,500	-500	-21.0	6,479	-1,724
-20	4,000	-1,000	-42.0	4,755	-3,448
-30	3,500	-1,500	-63.0	3,031	-5,172
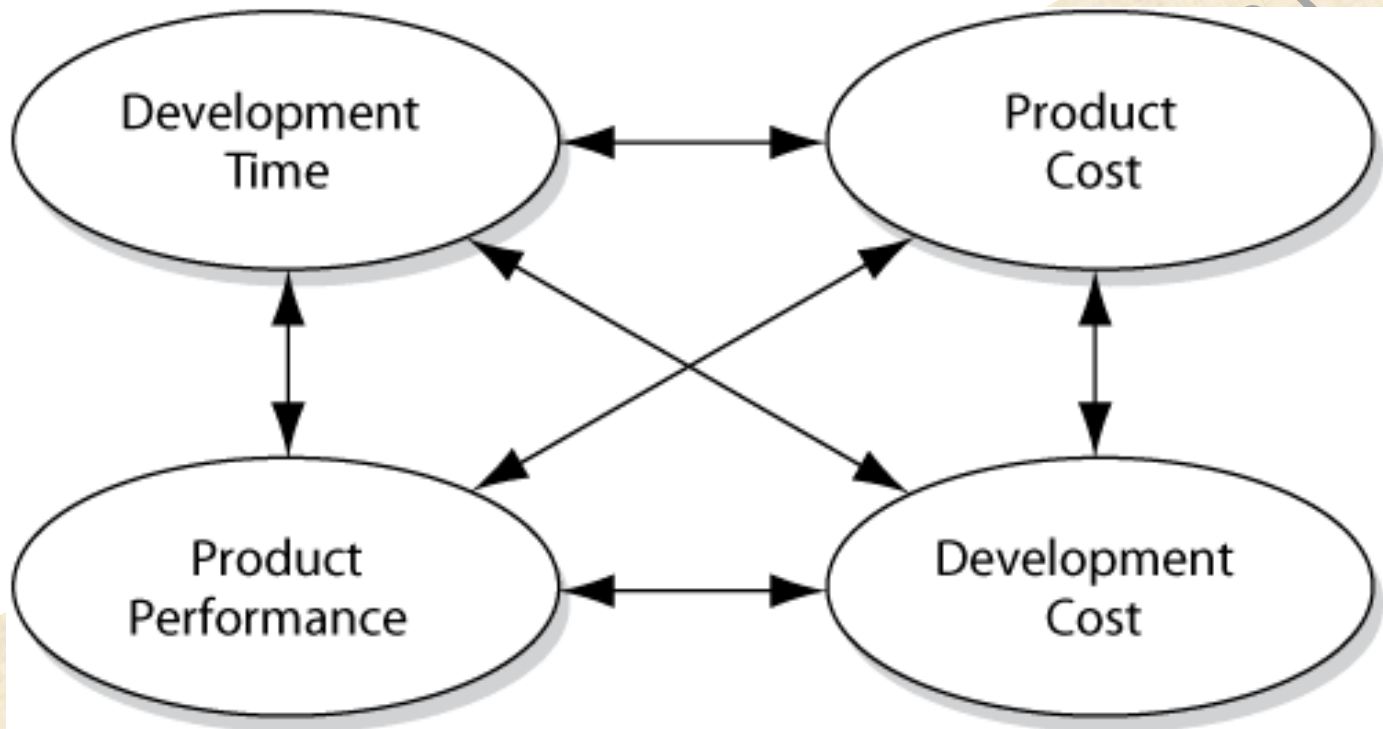
Trade-Off Rules

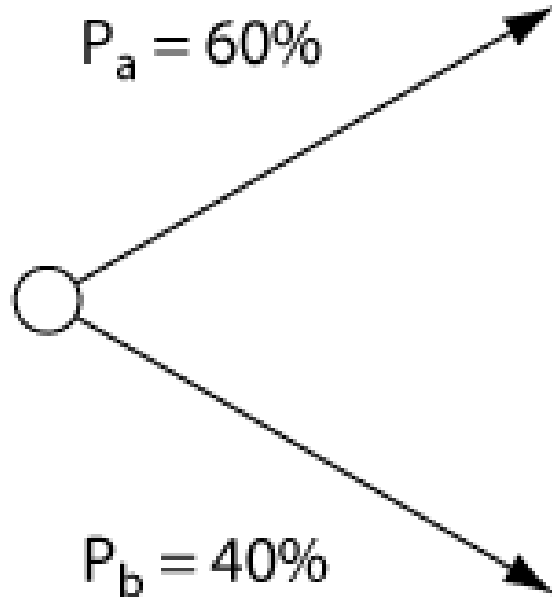| Factor	Trade-Off Rule	Comments
Development time	$480,000 per month change	Assumes a fixed window of opportunity for sales.
Sales volume	$1,724,000 per 10% change	Increasing sales is a powerful way to increase profits; 10% is 500 units per quarter.
Product cost or sales price	$43,000 per $1 change in cost or price	A $1 increase in price or a $1 decrease in cost; each results in a $1 increase in unit profit margins.
Development cost	$482,000 per 10% change	A dollar spent or saved on development is worth the present value of that dollar; 10% is $500,000.

Limitations of Quantitative Analysis:

- It focuses only on measurable quantities

- It depends on the validity of assumptions and data

- Bureaucracy reduces productivity

Project

Firm

Market
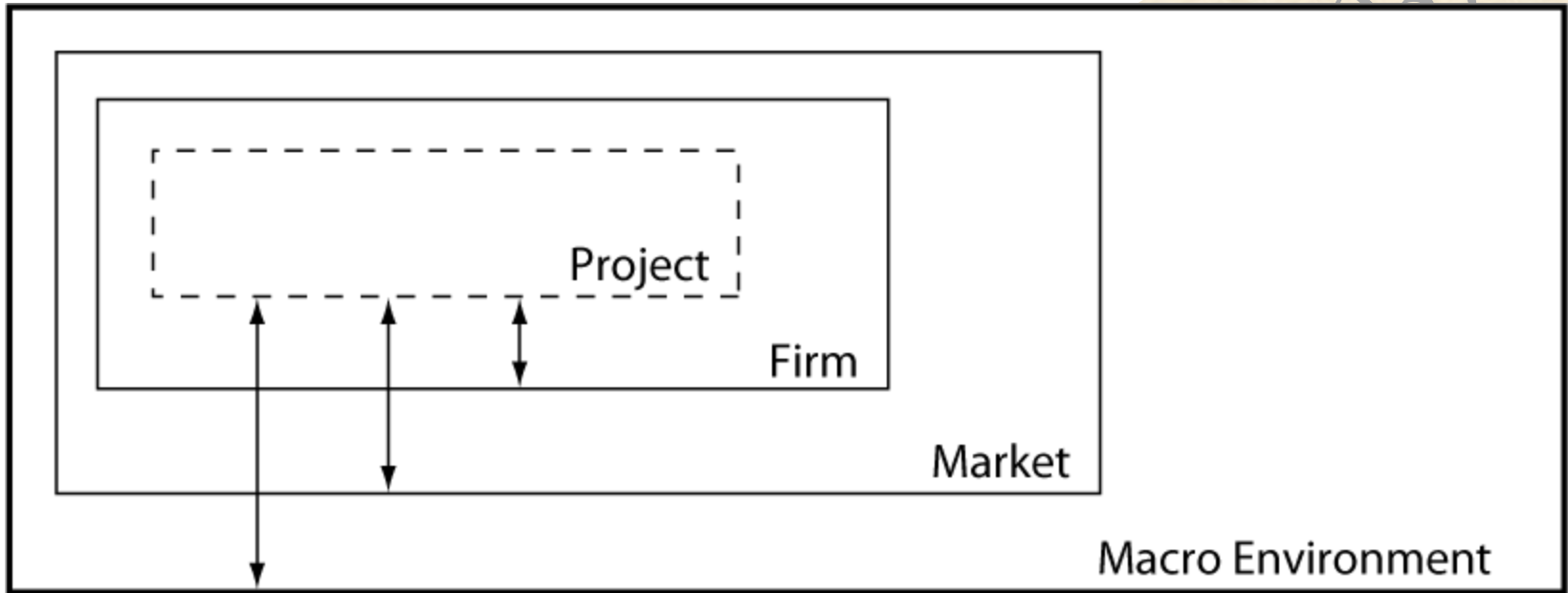
Macro Environment

$P_a = 60\%$ → Patent Allowed
$PV_a = \$6,500,000$

Launch Product

$P_b = 40\%$ → Patent not Allowed
$PV_b = \$1,500,000$

Launch Product
with High Market Risk

○————————————————▶ $PV_i = \$2{,}000{,}000$

Market Testing

○————————————————▶ ○

$PV_i = -\$1{,}000{,}000$

$P_a = 70\%$ ↗ Launch Product with Low Market Risk
$PV_a = \$5{,}000{,}000$

$P_b = 30\%$ ↘ Cancel Project and Salvage Assets
$PV_b = \$500{,}000$