Return on Software

Maximizing the Return on Your Software Investment
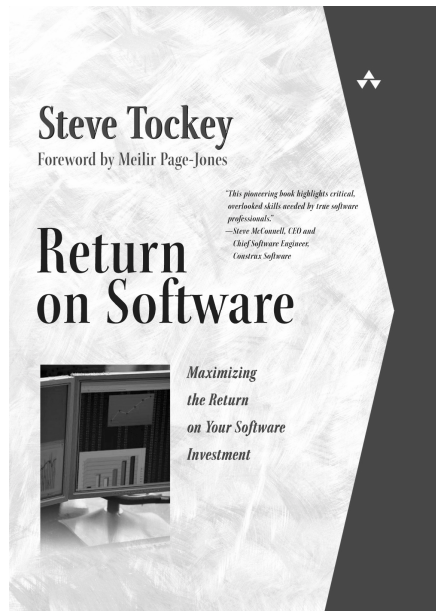
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Delivering Software Project Success

Harsh Realities

❖ **23% of software projects fail to deliver any working software at all**

❖ **Of projects that do deliver, they average**
  ◆ **63% late**
  ◆ **45% over budget**
  ◆ **67% of the features and functions delivered**

❖ **40% of commercial applications of computers are uneconomical**

Reference: [Standish01], [Kidder81]

Harsh Realities (cont)

❖ **Annual software budget in the US is about $275 billion**
  ◆ **$63 billion/year in cancelled projects alone**
  ◆ **As much as $149 billion/year in net money-losing projects**

Reference: [Standish01]

The Cost of Bad Decisions

❖ **Poor project performance can almost always be traced back to bad decisions (whether accidental or intentional), either by the customer, the development staff, or both**
  - **Which projects to do**
  - **Not getting good requirements**
  - **Not giving good requirements**
  - **Using inappropriate technology**
  - **Choosing the wrong design or architecture**
  - **Not giving the project team adequate resources**
  - **Not planning and/or managing the project**
  - **Not paying attention to quality**
  - **…**

Business on Purpose

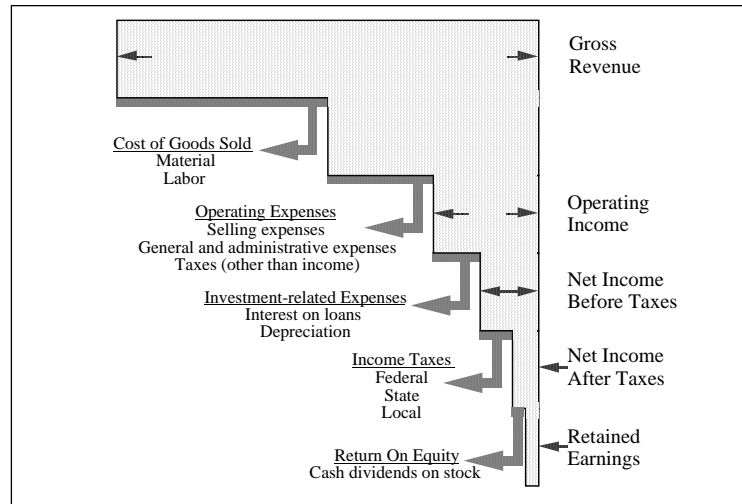**Why are companies in business?**

   Because it's fun? Educational? A way to have a positive impact on society?

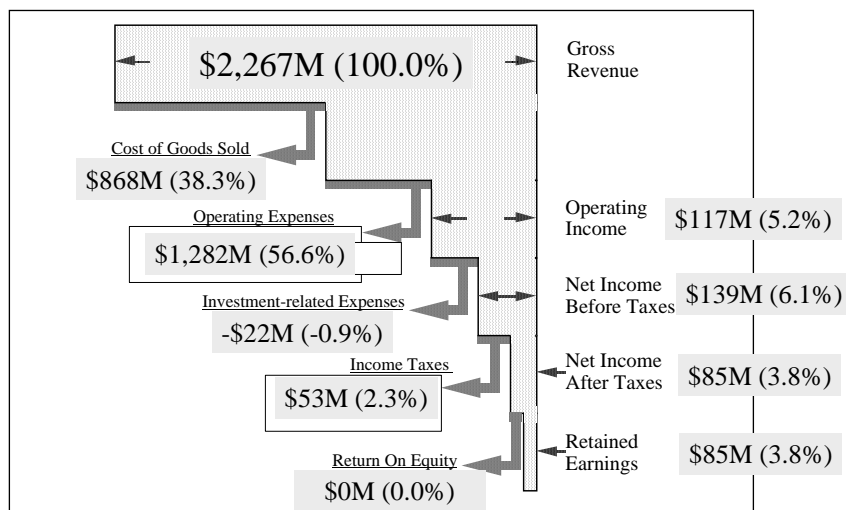   **No: companies are in business to make a profit for the owners**

Where does the money come from?

Where Does the Money Go?

	Gross Revenue
Cost of Goods Sold Material Labor	
Operating Expenses Selling expenses General and administrative expenses Taxes (other than income)	Operating Income
Investment-related Expenses Interest on loans Depreciation	Net Income Before Taxes
Income Taxes Federal State Local	Net Income After Taxes
Return On Equity Cash dividends on stock	Retained Earnings

PeopleSoft, 2003

|	
$2,267M (100.0%)	Gross Revenue
Cost of Goods Sold $868M (38.3%)	
Operating Expenses $1,282M (56.6%)	Operating Income $117M (5.2%)
Investment-related Expenses -$22M (-0.9%)	Net Income Before Taxes $139M (6.1%)
Income Taxes $53M (2.3%)	Net Income After Taxes $85M (3.8%)
Return On Equity $0M (0.0%)	Retained Earnings $85M (3.8%)

Economics, the Science of Choice

"… software economics has often been misconceived as the means of estimating the cost of programming projects. But economics is primarily a science of choice, and software economics should provide methods and models for analyzing the choices that software projects must make"

Reference: [Levy87]

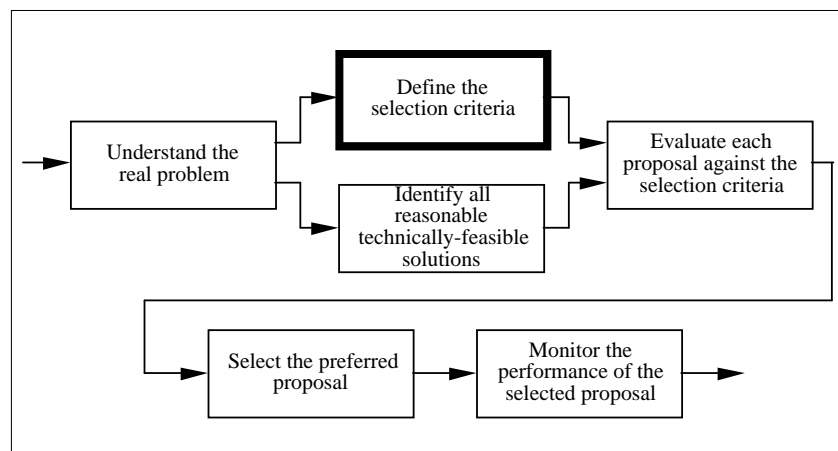## The Business Decision Making Process
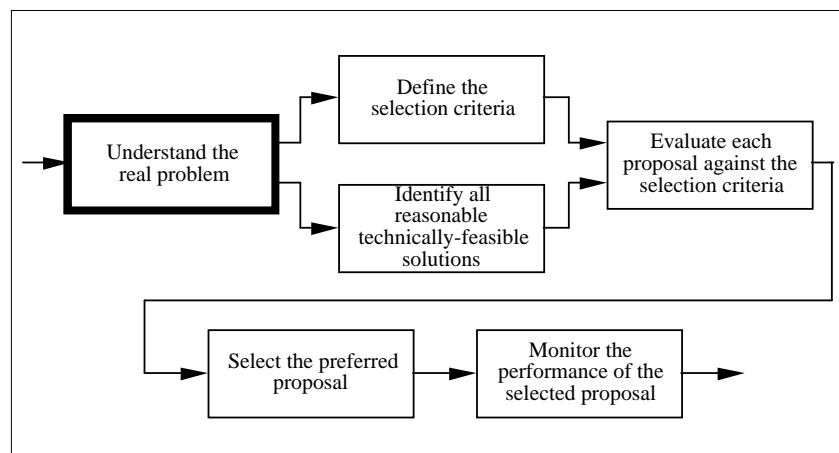
Understand the Real Problem

❖ **In software, this is usually the "requirements"**

  ◆ **Issues in contemporary requirements**

    ⬦ **Ambiguity**

    ⬦ **Incompleteness**

    ⬦ **Mistaking a solution for the problem**

❖ **Example**

  ◆ **Find the best way to invest MegaCorp's development resources over the next 6 months**

The Business Decision Making Process

Define the Selection Criteria

❖ **Selection criteria need to be**
  ◆ **Unique**
  ◆ **Sufficient**
  ◆ **Meaningful**
  ◆ **Discriminating**

❖ **At MegaCorp**
  ◆ **Profitability**
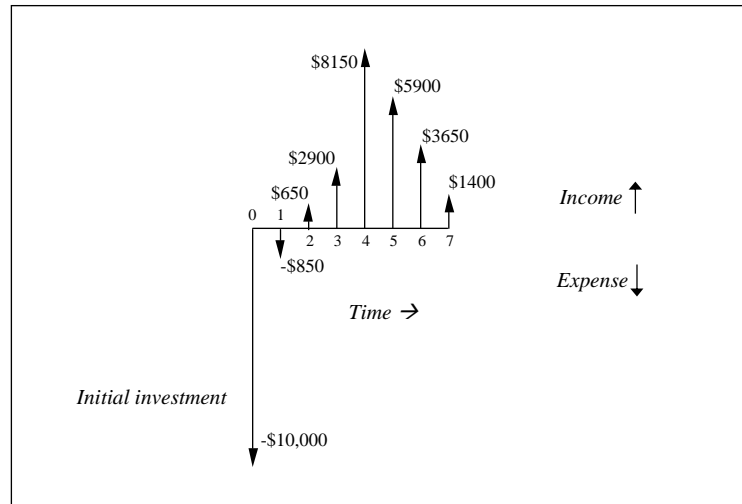 ◆ **Risk**
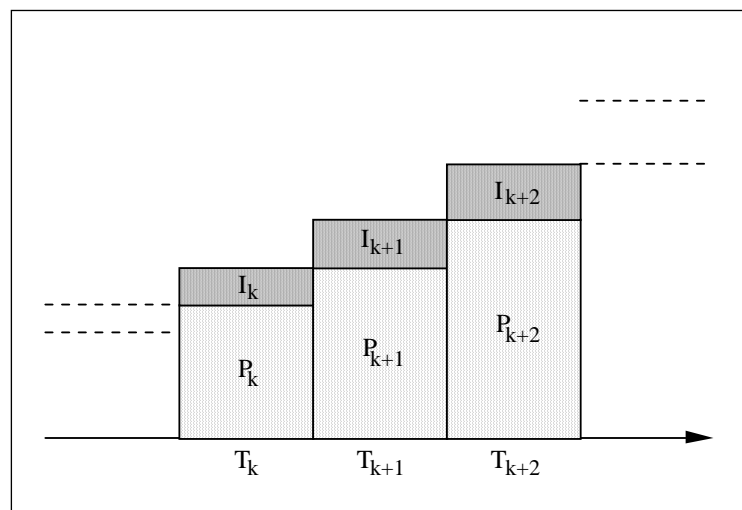 ◆ **Staff morale**

Typical Selection Criteria

❖ **Financial**
  ◆ **Initial investment**
  ◆ **Present worth (Net present value)**
  ◆ **Internal rate of return**
  ◆ **Discounted payback period**
  ◆ **…**
❖ **Technical**
  ◆ **Performance**
  ◆ **Reliability**
  ◆ **Maintainability**
  ◆ **…**
❖ **Non-technical**
  ◆ **Reputable provider**
  ◆ **Creature comfort**
  ◆ **…**

Cash Flow Diagrams

$8150

$5900

$2900

$650

$3650

$1400

Income ↑

Expense ↓

0   1   2   3   4   5   6   7

-$850

Time →

Initial investment

-$10,000

Interest: Time *is* Money

I_k

I_{k+1}

I_{k+2}

P_k

P_{k+1}

P_{k+2}

T_k T_{k+1} T_{k+2}
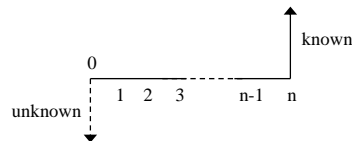
Some Interest Formulas

❖ **Single-payment Present-worth (P/F)**

$$P = F\left[\frac{1}{(1+i)^n}\right]$$

❖ **Present Worth, PW(i)**

$$PW(i) = \sum_{t=0}^{n} F_t(1+i)^{-t}$$

Minimum Attractive Rate of Return (MARR)

❖ **A statement that the organization is confident it can achieve at least that rate of return through its typical operations**
  ◆ **aka "Opportunity cost"**

Present Worth (Net Present Value)

Inventory Control Project			
End of year	Net cash flow	(P/F,14%,n)	Discounted cash flow
0	-$450,000	1.0000	-$450,000
1	300,000	0.8772	263,160
2	240,000	0.7695	184,680
3	240,000	0.6750	162,000
4	180,000	0.5921	106,578
Total	$510,000		$266,418

CRM Project			
End of year	Net cash flow	(P/F,14%,n)	Discounted cash flow
0	-$450,000	1.0000	-$450,000
1	90,000	0.8772	78,948
2	210,000	0.7695	161,595
3	360,000	0.6750	243,000
4	390,000	0.5921	230,919
Total	$600,000		$264,462

The Business Decision Making Process
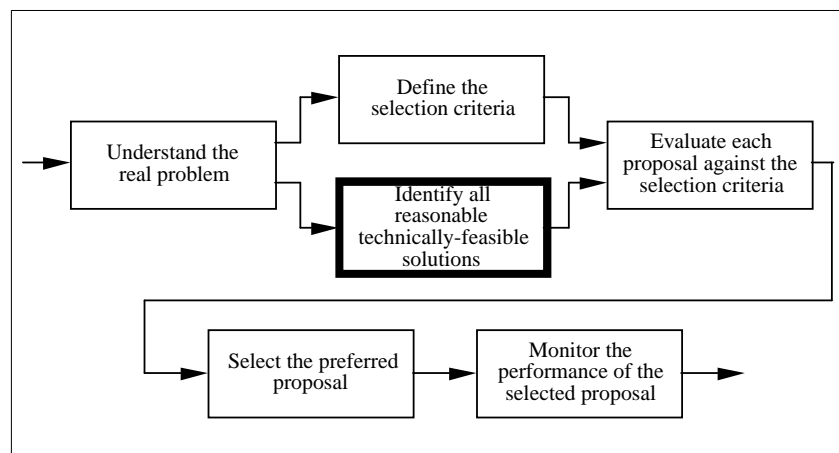
Identify Reasonable Technically-feasible Solutions

❖ **We're usually pretty good at this…**
  ◆ **Creative/lateral thinking helps (see [DeBono92] or [vonOech98])**
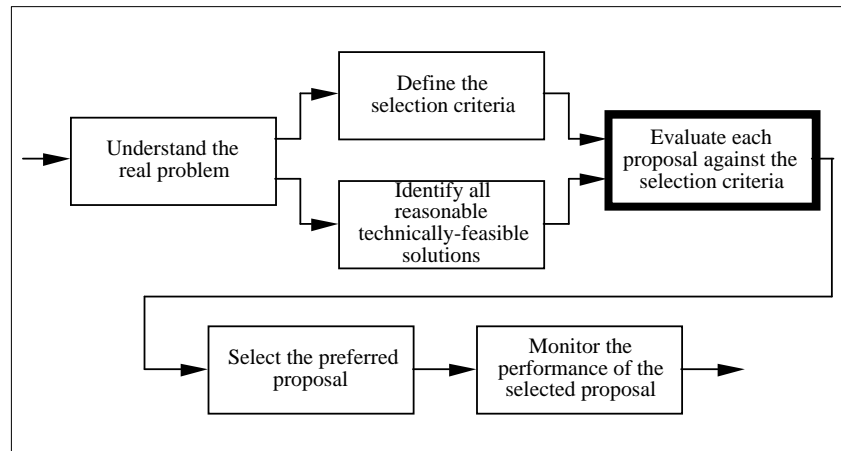

Identify Reasonable Technically-feasible Solutions (cont)

❖ **Option 1**
  ◆ **Extend product with new functionality**
❖ **Option 2**
  ◆ **Fix outstanding defects**
❖ **Option 3**
  ◆ **Make it a client-server application**

The Business Decision Making Process

```
                    ┌─────────────────┐
                    │   Define the    │
                    │ selection criteria │────┐
                    └─────────────────┘    │   ┌───────────────────┐
┌──────────────┐  ─┤                        ├──▶│   Evaluate each    │
│ Understand the │──┤                        │   │ proposal against the │
│  real problem  │  └┐ ┌─────────────────┐  │   │  selection criteria │
└──────────────┘    └▶│   Identify all   │──┘   └───────────────────┘
                       │    reasonable    │
                       │ technically-feasible │
                       │    solutions    │
                       └─────────────────┘

      ┌─────────────────┐      ┌───────────────────┐
      │ Select the preferred │      │    Monitor the     │
      │      proposal      │─────▶│ performance of the  │───▶
      └─────────────────┘      │  selected proposal  │
                                └───────────────────┘
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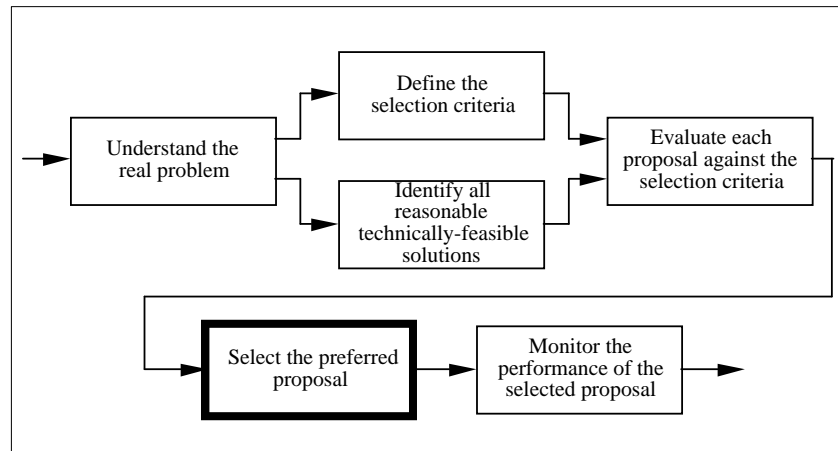
Evaluate Each Proposal Against the Selection Criteria

Proposals	Financial	Risk	Morale
Extend	$66,021	0.40	1.00
Fix defects	$58,056	0.20	0.50
Client-server	$76,605	0.50	0.80

The Business Decision Making Process

Select the Preferred Proposal

❖ **Non-compensatory techniques**
  ◆ **Dominance**
  ◆ **Satisficing**
  ◆ **Lexicography**
❖ **Compensatory techniques**
  ◆ **Nondimensional scaling**
  ◆ **Additive weighting**
  ◆ **Analytic hierarchy process**

Additive Weighting

1. **Define the criteria weights**
   1. Assign points to each criterion by importance
   2. Divide by total points across all criteria
2. **Scale the values on the proposals**
   1. Worst value within a criterion assigned 0.0
   2. Best assigned some arbitrary value, say 100.0
   3. Intermediate values are scaled proportionally
3. **Calculate total scores for each proposal**
   1. Add up (scaled value * criterion weight)
4. **Identify best score**
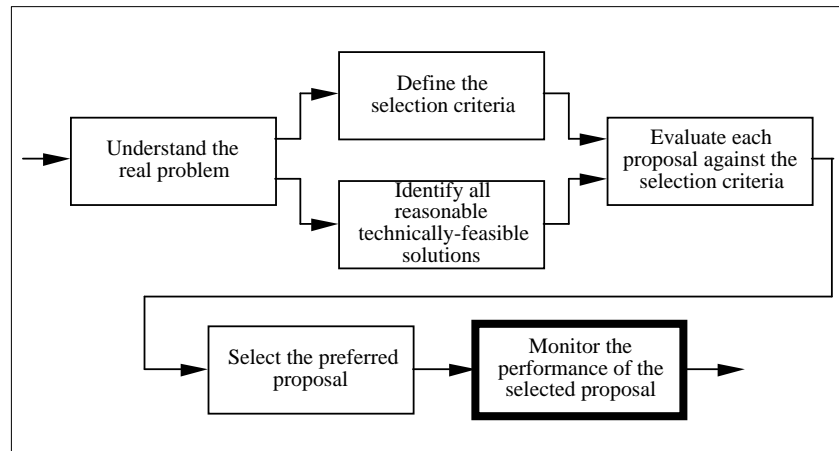

Select the Preferred Proposal
(cont)

Proposals	Financial (0.60)	Risk (0.25)	Morale (0.15)	Total
Extend	$66,021 (42.9)	0.40 (33.3)	1.00 (100.0)	49.0
Fix defects	$58,056 (0.0)	0.20 (100.0)	0.50 (0.0)	25.0
Client-server	$76,605 (100.0)	0.50 (0.0)	0.80 (60.0)	69.0

The Business Decision Making Process

```
                        ┌──────────────────┐
                        │   Define the     │
                        │ selection criteria│────┐
                        └──────────────────┘    │
    ┌──────────────────┐                         ▼
──▶ │  Understand the  │─┐              ┌──────────────────────┐
    │   real problem   │ │              │   Evaluate each      │
    └──────────────────┘ │              │ proposal against the │──┐
                         │              │  selection criteria  │  │
                         │  ┌──────────────────┐               │  │
                         └─▶│   Identify all   │───────────────┘  │
                            │    reasonable    │                  │
                            │technically-feasible│                │
                            │    solutions     │                  │
                            └──────────────────┘                  │
      ┌───────────────────────────────────────────────────────────┘
      │
      ▼
    ┌──────────────────┐    ┌──────────────────────┐
    │ Select the preferred│ │   Monitor the        │
───▶│    proposal      │──▶│ performance of the   │──▶
    └──────────────────┘    │  selected proposal   │
                            └──────────────────────┘
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Monitor the Performance of the Selected Proposal

❖ **Look at where you've been**
  ◆ **Meeting expectations?**
❖ **Look at where you are**
  ◆ **Earned value**
❖ **Look at where you're going**
  ◆ **Improve future estimates**

Other Important Methods and Tools

❖ **Proposals → Alternatives**
❖ **Planning horizons and economic life**
❖ **Replacement and retirement decisions**
❖ **Inflation and deflation**
❖ **Depreciation**
❖ **General accounting and cost accounting**
❖ **Income taxes and their consequences**
❖ **Not-for-profit decisions**
❖ **Break-even analysis**
❖ **Optimization analysis**
❖ **Estimation, risk, and uncertainty**

Other Important Decisions

❖ **Which software project(s) should we do?**

❖ **Should Technology X be used on this project?**

❖ **Which software development lifecycle should we use?**

❖ **How much software testing is enough?**

❖ **…**

Engineering, Defined

"Finding the balance between what is technically feasible and what is economically acceptable"

"Doing well with one dollar that which any bungler can do with two"

Reference: [DeGarmo93], [Wellington1887]

References

❖ **[DeBono92] Edward DeBono, *Serious Creativity: Using the Power of Lateral Thinking to Create New Ideas*, Harper Collins, 1992**

❖ **[DeGarmo93] E. DeGarmo, W. Sullivan, J. Bontadelli, *Engineering Economy*, 9th Edition, Prentice Hall, 1993**

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❖ **[Levy87] Leon Levy, *Taming the Tiger—Software Engineering and Software Economics*, Springer-Verlag, 1987**

❖ **[Standish01] ___, *Extreme Chaos*, The Standish Group, West Yarmouth, MA, 2001**

❖ **[vonOech98] Roger von Oech, *A Whack on the Side of the Head*, Revised Edition, Warner Business, 1998**

❖ **[Wellington1887] A. Wellington, *The Economic Theory of the Location of Railways*, 2nd Edition, John Wiley & Sons, 1887**

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