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?

Net Income
Before Taxes
Gross Revenue

Investment-related Expenses
Interest on loans
Depreciation

Income Taxes
Federal
State
Local

Return On Equity
Cash dividends on stock

Operating Income
Net Income Before Taxes

Cost of Goods Sold
Material
Labor
Operating Expenses
Selling expenses
General and administrative expenses
Taxes (other than income)

Investment-related Expenses
Interest on loans
Depreciation

Return On Equity
Cash dividends on stock

Operating Income
Net Income After Taxes

Net Income After Taxes
Retained Earnings

PeopleSoft, 2003

$2,267M (100.0%)

$868M (38.3%)
Cost of Goods Sold

$1,282M (56.6%)
Operating Income

$117M (5.2%)
Net Income Before Taxes

$139M (6.1%)
Net Income After Taxes

$85M (3.8%)
Retained Earnings

$53M (2.3%)
Income Taxes

$0M (0.0%)
Return On Equity

$85M (3.8%)
Retained Earnings
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

1. Understand the real problem
2. Define the selection criteria
3. Identify all reasonable technically-feasible solutions
4. Evaluate each proposal against the selection criteria
5. Select the preferred proposal
6. Monitor the performance of the selected proposal
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

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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

Interest: Time is Money
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)

<table>
<thead>
<tr>
<th>End of year</th>
<th>Net cash flow</th>
<th>(P/F, 14%, n)</th>
<th>Discounted cash flow</th>
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</thead>
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<tr>
<td>0</td>
<td>-$450,000</td>
<td>1.0000</td>
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<td>184,680</td>
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<tr>
<td>3</td>
<td>240,000</td>
<td>0.6750</td>
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<tr>
<td>4</td>
<td>180,000</td>
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<tr>
<td>Total</td>
<td>$510,000</td>
<td></td>
<td>$266,418</td>
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</table>

<table>
<thead>
<tr>
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<tr>
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<td>Total</td>
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<td>$264,462</td>
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</table>

The Business Decision Making Process

- Understand the real problem
- Define the selection criteria
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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
- Identify all reasonable technically-feasible solutions
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Evaluate Each Proposal Against the Selection Criteria

<table>
<thead>
<tr>
<th>Proposals</th>
<th>Financial</th>
<th>Risk</th>
<th>Morale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extend</td>
<td>$66,021</td>
<td>0.40</td>
<td>1.00</td>
</tr>
<tr>
<td>Fix defects</td>
<td>$58,056</td>
<td>0.20</td>
<td>0.50</td>
</tr>
<tr>
<td>Client-server</td>
<td>$76,605</td>
<td>0.50</td>
<td>0.80</td>
</tr>
</tbody>
</table>
The Business Decision Making Process

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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)

<table>
<thead>
<tr>
<th>Proposals</th>
<th>Financial (0.60)</th>
<th>Risk (0.25)</th>
<th>Morale (0.15)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extend</td>
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<td>1.00 (100.0)</td>
<td>49.0</td>
</tr>
<tr>
<td>Fix defects</td>
<td>$58,056 (0.0)</td>
<td>0.20 (100.0)</td>
<td>0.50 (0.0)</td>
<td>25.0</td>
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<tr>
<td>Client-server</td>
<td>$76,605 (100.0)</td>
<td>0.50 (0.0)</td>
<td>0.80 (60.0)</td>
<td>69.0</td>
</tr>
</tbody>
</table>
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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

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