Lecture 4, Part 1: the Feasibility Study

What is a feasibility study?
- What to study and conclude?

Types of feasibility
- Technical
- Economic
- Schedule
- Operational

Quantifying benefits and costs
- Payback analysis
- Net Present Value Analysis
- Return on Investment Analysis

Comparing alternatives

Content of a feasibility study

Types to be studied in the feasibility study:
- The present organizational system
- Problems with the present system
- Goals and other requirements for the new system
- Constraints
- Possible alternatives

Comparing alternatives
- "Sticking with the current system" is always an alternative
- Different business processes for solving the problems
- Different levels/types of computerization for the solutions

Advantages and disadvantages of the alternatives

Things to conclude:
- Feasibility of the project
- The preferred alternative.

Why a feasibility study?

Objectives of a feasibility study:
- To find out if an system development project can be done:
- Is it possible?
- Is it justified?
- To suggest possible alternative solutions.
- To provide management with enough information to know:
- Whether the project can be done
- Whether the final product will benefit its intended users
- What the alternatives are (so that a selection can be made in subsequent phases)
- Whether there is a preferred alternative

A feasibility study is a management-oriented activity
- After a feasibility study, management makes a "go/no-go" decision.
- Need to examine the problem in the context of broader business strategy

Exploring Feasibility

The "PIECES" framework
- Useful for identifying operational problems to be solved, and their urgency
- Performance
- Information
- Economy
- Control
- Efficiency
- Services

See the course website for a more specific list of PIECES questions
Four Types of feasibility

- Technical feasibility
  - Is the project possible with current technology?
    - How much technical risk is there?
  - Does the technology exist at all?
    - Is it available locally?
    - Can it be obtained?
    - Will it be compatible with other systems?
  - What kinds of technology will we need?
- Economic feasibility
  - Is the project possible, given resource constraints?
  - What benefits will result from the system?
    - Both tangible and intangible benefits
    - Quantity there?
  - Is the required technology available "in house"?
    - If the technology is available:
      - Does it have the capacity to handle the solution?
    - If the technology is not available:
      - Can it be acquired?
  - Which alternative offers the best return on investment?

Economic Feasibility

- Can the bottom line be quantified yet?
  - Very early in the project:
    - A judgement of whether solving the problem is worthwhile.
  - Once specific requirements and solutions have been identified:
    - ... the costs and benefits of each alternative can be calculated
- Cost-benefit analysis
  - Purpose - answer questions such as:
    - Is the project justified (i.e. will benefits outweigh costs)?
    - Can the project be done, within given cost constraints?
    - What is the minimal cost to attain a certain system?
    - Which alternative offers the best return on investment?
  - Examples of things to consider:
    - Hardware/software selection
    - How to convince management to develop the new system
    - Selection among alternative financing arrangements (rent/lease/purchase)
  - Difficulties
    - Benefits and costs can both be intangible, hidden and/or hard to estimate
    - ranking multi-criteria alternatives

Benefits and Costs

- Tangible benefits
  - Readily quantified as $ values
  - Examples:
    - increased sales
    - decreased cost/reduction
    - increased productivity
    - increased margin on sales
    - more effective use of staff time

- Intangible benefits
  - Difficult to quantify
  - But maybe more important
  - Examples:
    - increased flexibility of operation
    - better customer relations
    - improved staff morale

Development costs (OTO)

- Development and purchasing costs:
  - Personnel costs
    - Cost of development team
    - Consultant fees
    - software licenses and contracts

System Maintenance

- Operations costs (ongoing)
  - Hardware and software maintenance
  - staff salaries
  - training personnel
  - file conversion

Installation and conversion costs:

Examples:

- System Maintenance:
  - hardware and software
  - staff salaries
  - training personnel
  - file conversion

- Operational costs (ongoing):
  - hardware and software maintenance
  - staff salaries
  - training personnel
  - file conversion

- Development costs (OTO):
  - Development and purchasing costs:
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Examples:

- System Maintenance:
  - hardware and software
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    - increased flexibility of operation
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    - improved staff morale
Example: costs for small Client-Server project

Personnel:

- 2 System Analysts (400 hours/ea $35.00/hr) $28,000
- 4 Programmer/Analysts (250 hours/ea $25.00/hr) $25,000
- 1 GUI Designer (200 hours/ea $35.00/hr) $7,000
- 1 Telecommunications Specialist (50 hours/ea $45.00/hr) $2,250
- 1 System Architect (100 hours/ea $45.00/hr) $4,500
- 1 Database Specialist (15 hours/ea $40.00/hr) $600
- 1 System Librarian (250 hours/ea $10.00/hr) $2,500

Expenses:

- 4 Smalltalk training registration ($3500.00/student) $14,000

New Hardware & Software:

- 1 Development Server (Pentium Pro class) $18,700
- 1 Server Software (operating system, misc.) $1,500
- 1 DBMS server software $7,500
- 7 DBMS Client software ($950.00 per client) $6,650

Total Development Costs: $118,200

PROJECTED ANNUAL OPERATING COSTS

Personnel:

- 2 Programmer/Analysts (125 hours/ea $25.00/hr) $6,250
- 1 System Librarian (20 hours/ea $10.00/hr) $200

Expenses:

- 1 Maintenance Agreement for Pentium Pro Server $995
- 1 Maintenance Agreement for Server DBMS software $525
- Preprinted forms (15,000/year @ .22/form) $3,300

Total Projected Annual Costs: $11,270

Analyzing Costs vs. Benefits

- Identify costs and benefits
  - Tangible and intangible, one-time and recurring
  - Assign values to costs and benefits
- Determine Cash Flow
  - Project costs and benefits over time, e.g. 3-5 years
  - Calculate Net Present Value for all future costs/benefits
    - determines future costs/benefits of the project in terms of today's dollar values
    - A dollar earned today is worth more than a potential dollar earned next year
- Do cost/benefit analysis
  - Calculate Return on Investment
    - Allows comparison of lifetime profitability of alternative solutions
    \[ \text{ROI} = \frac{\text{Net \textbf{benefits}}} {\text{Net \textbf{costs}}} \]
  - Calculate Break-Even point
    - how long will it take (in years) to pay-back the accrued costs:
      \[ \text{Accrued Cost} (\text{initial} + \text{incremental}) = \text{Accrued Benefit} \]

Calculating Present Value

- A dollar today is worth more than a dollar tomorrow...
  - Your analysis should be normalized to "current year" dollar values.
- The discount rate
  - measures opportunity cost:
    - Money invested in this project means money not available for other things
    - Benefits expected in future years are more prone to risk
      - This number is company- and industry-specific.
      - "what is the average annual return for investments in this industry?"
- Present Value:
  - The "current year" dollar value for costs/benefits n years into the future
    - for a given discount rate i:
      \[ \text{Present Value(n)} = \frac{1}{(1 + i)^n} \]
      - E.g. if the discount rate is 12%, then
        \[ \text{Present Value(1)} = \frac{1}{(1 + 0.12)^1} = 0.893 \]
        \[ \text{Present Value(2)} = \frac{1}{(1 + 0.12)^2} = 0.797 \]

Net Present Value

- Measures the total value of the investment
  - with all figures adjusted to present dollar values
  \[ \text{NPV} = \text{Cumulative PV of all benefits} - \text{Cumulative PV of all costs} \]

<table>
<thead>
<tr>
<th>Cash Flow</th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dev. Costs</td>
<td>($100,000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Op. Costs</td>
<td>($4,000)</td>
<td>($4,500)</td>
<td>($5,000)</td>
<td>($5,500)</td>
<td></td>
</tr>
<tr>
<td>Present Value</td>
<td>1</td>
<td>0.893</td>
<td>0.797</td>
<td>0.712</td>
<td>0.636</td>
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<tr>
<td>Net Dev Costs</td>
<td>($100,000)</td>
<td>($95,972)</td>
<td>($89,357)</td>
<td>($81,960)</td>
<td>($75,286)</td>
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<tr>
<td>Cumulative Costs</td>
<td>($100,000)</td>
<td>($104,072)</td>
<td>($112,429)</td>
<td>($118,399)</td>
<td>($124,645)</td>
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<tr>
<td>Benefits</td>
<td>0</td>
<td>$25,000</td>
<td>$30,000</td>
<td>$35,000</td>
<td>$50,000</td>
</tr>
<tr>
<td>TD-Adj Benefits</td>
<td>0</td>
<td>$22,225</td>
<td>$25,291</td>
<td>$29,126</td>
<td>$31,300</td>
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<tr>
<td>Cumulative benefits</td>
<td>0</td>
<td>$22,225</td>
<td>$47,516</td>
<td>$71,642</td>
<td>$102,955</td>
</tr>
<tr>
<td>Net Costs-Benefits</td>
<td>($100,000)</td>
<td>($78,743)</td>
<td>($47,516)</td>
<td>($12,692)</td>
<td>($11,580)</td>
</tr>
</tbody>
</table>

- Assuming subsequent years are like year 4:
  - the net present value of this investment in the project will be:
    - after 5 years, $13,652
    - after 6 years, $36,168
Computing the payback period

- Can compute the break-even point:
  - When does lifetime benefits overtake lifetime costs?
  - Determine the fraction of a year when payback actually occurs:
    \[
    \frac{\text{endYear amount}}{\text{beginningYear amount}}
    \]
    - For our last example, \(\frac{51,611}{70,501} = 0.42\)
    - Therefore, the payback period is 3.42 years

Schedule Feasibility

- How long will it take to get the technical expertise?
  - We may have the technology, but that doesn't mean we have the skills required to properly apply that technology.
  - May need to hire new people
  - Or re-train existing systems staff
  - Whether hiring or training, it will impact the schedule.

- Assess the schedule risk:
  - Given our technical expertise, are the project deadlines reasonable?
  - If there are specific deadlines, are they mandatory or desirable?
    - If the deadlines are not mandatory, the analyst can propose several alternative schedules.

- What are the real constraints on project deadlines?
  - If the project overruns, what are the consequences?
    - Deliver a properly functioning information system two months late...
    - Deliver an error-prone, useless information system on time?
    - Missed schedules are bad, but inadequate systems are worse!
### Operational Feasibility

- How do end-users and managers feel about...
  - the problem you identified?
  - the alternative solutions you are exploring?

- You must evaluate:
  - Not just whether a system can work...
  - but also whether a system will work.

- Any solution might meet with resistance:
  - Does management support the project?
  - How do the end users feel about their role in the new system?
  - Which users or managers may resist (or not use) the system?

People tend to resist change. Can this problem be overcome? If so, how?

How will the working environment of the end users change?

Can or will end users and management adapt to the change?

### Comparing Alternatives

- How do we compare alternatives?
  - When there are multiple selection criteria?
  - When none of the alternatives is superior across the board?

- Use a Feasibility Analysis Matrix!
  - The columns correspond to the candidate solutions;
  - The rows correspond to the feasibility criteria;
  - The cells contain the feasibility assessment notes for each candidate;
  - Each row can be assigned a rank or score for each criterion
    - e.g., for operational feasibility, candidates can be ranked 1, 2, 3, etc.
  - A final ranking or score is recorded in the last row.

- Other evaluation criteria to include in the matrix
  - quality of output
  - ease of use
  - vendor support
  - cost of maintenance
  - load on system

### Feasibility Study Contents

1. Purpose & scope of the study
   - Objectives (of the study)
   - who commissioned it & who did it,
   - process used for the study,
   - how long did it take...
2. Description of present situation
   - organizational setting, current system(s),
   - Related factors and constraints.
3. Problems and requirements
   - What's wrong with the present situation?
   - What changes are needed?
4. Objectives of the new system
   - Goals and relationships between them
5. Possible alternatives
   - Including 'do nothing'.
6. Criteria for comparison
   - definition of the criteria
7. Analysis of alternatives
   - description of each alternative
   - evaluation with respect to criteria
   - cost/benefit analysis and special implications.
8. Recommendations
   - what is recommended and implications
   - what to do next;
     - e.g., may recommend an interim solution and a permanent solution.
9. Appendices
   - to include any supporting material.

### Example matrix

<table>
<thead>
<tr>
<th>Description</th>
<th>Candidate 1 Name</th>
<th>Candidate 2 Name</th>
<th>Candidate 3 Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Feasibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Feasibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schedule Feasibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic Feasibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ranking</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Feasibility Criteria

<table>
<thead>
<tr>
<th></th>
<th>Candidate 1</th>
<th>Candidate 2</th>
<th>Candidate 3</th>
<th>Candidate 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational Feasibility</strong></td>
<td>30% Score: 80</td>
<td>100% Score: 100</td>
<td>100% Score: 100</td>
<td>100% Score: 100</td>
</tr>
<tr>
<td><strong>Technical Feasibility</strong></td>
<td>30% Score: 80</td>
<td>95% Score: 95</td>
<td>100% Score: 100</td>
<td>100% Score: 100</td>
</tr>
<tr>
<td><strong>Economic Feasibility</strong></td>
<td>30%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cost to develop:</strong></td>
<td>Approximately $350,000</td>
<td>Approximately $400,000</td>
<td>Approximately $410,000</td>
<td>Approximately $400,000</td>
</tr>
<tr>
<td><strong>Payback period (discounted):</strong></td>
<td>5 years</td>
<td>3 years</td>
<td>3 years</td>
<td>3 years</td>
</tr>
<tr>
<td><strong>Net present value:</strong></td>
<td>Approximately $210,000</td>
<td>Approximately $306,748</td>
<td>Approximately $350,000</td>
<td>Approximately $325,500</td>
</tr>
<tr>
<td><strong>Detailed calculations:</strong></td>
<td>See Attachment A</td>
<td>See Attachment A</td>
<td>See Attachment A</td>
<td>See Attachment A</td>
</tr>
<tr>
<td><strong>Schedule Feasibility:</strong></td>
<td>10%</td>
<td>9-12 months</td>
<td>9 months</td>
<td>30 days</td>
</tr>
<tr>
<td><strong>An assessment of how long the solution will take to design and implement:</strong></td>
<td>Score: 95</td>
<td>Score: 80</td>
<td>Score: 85</td>
<td>Score: 95</td>
</tr>
</tbody>
</table>

### Scenarios
- **Identify the problem**
  - **what is the objective of the project?**
    - e.g., “Meeting scheduling is too costly right now”
  - **What does the problem owner want?**
    - e.g., “Build a system that schedules meetings”
  - **What is the “vision” of those who are pushing for it?**
    - e.g., “Build a system that maintains people’s calendars”
  - **What is the goal of the project?**
    - e.g., “Anyone can submit a meeting request, participants are informed and a negotiation settles meeting details”
  - **Identifying the problem owners**
  - **Identifying the problem owners’ goals**
  - **Identifying the success criteria**
  - **Using concrete examples to understand the problem**

### Lecture 4, Part 2: Stakeholder Goals
- **Boundaries**
- **Stakeholders**
- **Goals**
- **Scenarios**

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**Where do we start?**

- **Identify the problem**
  - **What is the objective of the project?**
    - e.g., “Meeting scheduling is too costly right now”
  - **What does the problem owner want?**
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- **Identifying the problem owners’ goals**
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**Operational Feasibility**

- **Development life cycle:**
  - waterfall
  - spiral
  - prototype
  - scrum

**Technical Feasibility**

- **Technology:**
  - MS Visual Basic
  - C++
  - PowerBuilder

**Economic Feasibility**

- **Cost to develop:**
  - Approximately $350,000
  - Approximately $400,000
  - Approximately $410,000
  - Approximately $400,000

- **Payback period (discounted):**
  - 5 years
  - 3 years
  - 3 years
  - 3 years

- **Net present value:**
  - Approximately $210,000
  - Approximately $306,748
  - Approximately $350,000
  - Approximately $325,500

- **Detailed calculations:**
  - See Attachment A

- **Schedule Feasibility:**
  - 10% Less than 3 months
  - 9-12 months

- **An assessment of how long the solution will take to design and implement:**
  - Score: 95

- **Ranking:**
  - 100%
  - 85%
  - 72%
  - 85%
Requirements Elicitation

Starting point
- Some notion that there is a "problem" that needs solving
  - e.g. dissatisfaction with the current state of affairs
  - e.g. a new business opportunity
  - e.g. a potential saving of cost, time, resource usage, etc.

Collect enough information to:
- identify the "problem"/"opportunity"
  - Which problem needs to be solved? (identify problem Boundaries)
  - Where is the problem? (understand the Context/Problem Domain)
  - Whose problem is it? (identify Stakeholders)
  - Why does it need solving? (identify the stakeholders' Goals)
  - How does the problem manifest itself? (collect some Scenarios)
  - What might prevent us solving it? (identify Feasibility and Risk)

- become an expert in the problem domain
  - Learn how to find your way round a new problem area quickly
  - Use your (initial) ignorance as an excuse to ask questions
  - Recognise the domain expertise of the people you talk to

Stakeholders

Stakeholder analysis:
- Identify all the people who must be consulted during information acquisition

Example stakeholders
- Users
  - concerned with the features and functionality of the new system
- Designers
  - want to build a perfect system, or reuse existing code
- Systems analysts
  - want to "get the requirements right"
- Training and user support staff
  - want to make sure the new system is usable and manageable
- Business analysts
  - want to make sure "we are doing better than the competition"
- Technical authors
  - will prepare user manuals and other documentation for the new system
- The project manager
  - wants to complete the project on time, within budget, with all objectives met.
- "The customer"
  - Wants to get best value for money invested

Identifying the Problem

Vague problem stated by the customer:
- E.g. university textbook store:
  - Manager wants to computerize the book order forms filled out by instructors;
- E.g. A large insurance company:
  - Claims manager wants to cut down the average time it takes to process an insurance claim from 2 months to 2 weeks
- E.g. A telecommunications company:
  - CEO wants to integrate the billing system with customer record systems of several affiliates, so there is only one billing system...
- E.g. Large Government Aerospace Agency:
  - The president wants to send a manned mission to Mars by the year 2020

Often you only see symptoms rather than causes:
- E.g. "Ontario patients needing X-ray scans have to wait for months"
  - The long wait is the symptom, not the problem. The problem may be:
    - Shortage of X-ray machines;
    - Shortage of trained staff;
    - Shortage of doctors to process the data
    - Inefficient scheduling procedures
Finding Stakeholders: Levels of authority

- **Top management**
  - Establishes goals
  - Sets long-range planning
  - Determines new market & product developments
  - Decides on mergers & acquisitions.

- **Middle management**
  - Establishes strategic plans
  - Allocates & controls resources
  - Does planning
  - Measures performance

- **Lower management**
  - Supervises day-to-day operations
  - Takes corrective action when necessary.

- **Operational level**
  - Performs day-to-day operations

Identifying Stakeholders’ Goals

- **Approach**
  - Focus on why systems are constructed
  - Express the why as a set of stakeholder goals
  - Use goal refinement to arrive at specific requirements
  - Goal analysis
    - Document, organize, and classify goals
    - Refine, elaborate, and operationalize goals
  - Goal hierarchies show refinements and alternatives

- **Advantages**
  - Reasonably intuitive
  - Explicit declaration of goals provides sound basis for conflict resolution

- **Disadvantages**
  - Captures a static picture - what if goals change over time?
  - Can regress forever up (or down) the goal hierarchy

Goal Modeling

- **(Hard) Goals:**
  - Describe functions that must be carried out. E.g.: Satisfactory goals
  - Information goals

- **Softgoals:**
  - Cannot really be fully satisfied. E.g.: Accuracy, Performance, Security
  - ... of

- **Also classified temporally:**
  - Achieve/cease & maintain/avoid goals
  - Maintain some properties invariant
  - Optimize & a criterion for selecting behaviour

Example Goal Elaboration

- **Or-decomposition**
  - Crucial planning decision made
  - Change requests accepted
  - Meeting be held
  - Minutes be circulated
  - Attendee list obtained
  - AV & other needs defined
  - Date and location set
  - Attendees know details
  - Participating notified
  - Change requests accepted
  - Meeting be held
  - Minutes be circulated
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  - Participating notified
  - Change requests accepted
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  - Minutes be circulated
  - Attendee list obtained
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  - Date and location set
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  - Participating notified
  - Change requests accepted
  - Meeting be held
  - Minutes be circulated
  - Attendee list obtained
  - AV & other needs defined
  - Date and location set
  - Attendees know details
  - Participating noticed
Goal Analysis

- **Goal Elaboration:**
  - "Why" questions explore higher goals (context)
  - "How" questions explore lower goals (operations)
  - "How else" questions explore alternatives

- **Relationships between goals:**
  - One goal helps achieve another (+)
  - One goal hurts achievement of another (-)
  - One goal makes another (++)
  - One goal breaks another (- -)
  - Achievement of one goal guarantees achievement of another
  - Precedence ordering - must achieve goals in a particular order

- **Obstacle Analysis:**
  - Can this goal be obstructed, if so how?
  - What are the consequences of obstructing it?

Softgoals

- **Some goals can never be fully satisfied**
  - Treat these as softgoals
  - E.g. "system be easy to use", "access be secure"
  - Also known as 'non-functional requirements'; 'quality requirements'
  - Will look for things that contribute to satisficing the softgoals
  - E.g. for a train system:
    - minimize costs
    - serve more passengers
    - improve safety
    - maintain passenger comfort
    - reduce staffing
    - increase train speed
    - more frequent trains
    - automate braking
    - automate collision avoidance
    - hire more operators
    - buy new rolling stock
    - clearer signalling

Scenarios

- **Scenarios**
  - Specific sequence of interaction between actor and system
  - Tend to be short (e.g. between 3 and 7 steps)
  - May be:
    - positive (i.e. required behavior)
    - negative (i.e. an undesirable interaction)
  - May be indicative (describe current system) or optative (how it should be)

- **Advantages**
  - Very natural: stakeholders tend to use them spontaneously
  - E.g. "suppose I'm admitted to hospital - what happens during my admission?"
  - Typical answer: "You, or the person accompanying you would talk to the person at the admissions desk. You have to show your OHIP card and explain who referred you to the hospital. Then you..." [and so on]
  - Short scenarios very good for quickly illustrating specific interactions

- **Disadvantages**
  - Lack of structure
## Example Scenario

**Title:** Successful meeting scheduled using messaging option  
**Participants:** Alice (initiator, not attending); Bob, Carlo, Daphne (attendees)

<table>
<thead>
<tr>
<th>Action</th>
<th>Goals satisfied</th>
<th>Obstacles / Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice requests meeting, specifying participants, timeframe</td>
<td>Meeting requested; Attendee list obtained</td>
<td>What if selected timeframe is infeasible?</td>
</tr>
<tr>
<td>AS sends participant requests to Bob, Carlo and Daphne</td>
<td></td>
<td>Did we miss a goal?</td>
</tr>
<tr>
<td>Bob reads message</td>
<td>Participants informed</td>
<td>Can’t detect when messages are read; what happens if Bob reads the message but doesn’t reply?</td>
</tr>
<tr>
<td>Carlo reads message</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daphne reads message</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bob replies with preferences</td>
<td>Attendees preferences known</td>
<td>What if the preferences are mutually exclusive? Should we allow some to be higher priority?</td>
</tr>
<tr>
<td>Carlo replies with preferences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daphne replies with preferences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AS schedules meeting</td>
<td>Room availability determined; room booked</td>
<td></td>
</tr>
<tr>
<td>AS notifies Alice, Bob, Carlo, Daphne of time and location</td>
<td>Meeting announced; Attendance Confirmed (?)</td>
<td>How do we know if they’ve all read the announcement? What if the schedule is no longer convenient for one of them?</td>
</tr>
</tbody>
</table>