Developing IS

Advanced Information Systems and Business Analytics for Air Transportation

M.Sc. Air Transport Management

May 16-21, 2016

Slides prepared by Benny Mantin

(Engineering) Design Process

- A problem solving process
  - Incremental/evolutionary problem solving
    - Solution is a natural extension/evolution of existing designs, knowledge & ideas
  - Insight/innovative problem solving
    - “Aha!” , “Eureka!” experience
    - Solution results from conceptual restructuring
      - Reorganize our perception of the problem
      - Combine elements in a new way
    - “Figure – ground” shift of perception
- Reverse engineering
  - Common in software; Military

Examples

- Evolutionary design
  - iOS
    - 1: iPhone is born
    - 2: Apps
    - 3: Features; copy-paste, search, push,…
    - 3.2: iPad – larger screen
    - 4: Multitasking
    - 5: Siri and more
    - 6: no more Google maps
    - 7: control, touch ID
    - 8: Health, fitness apps
- Insight/Innovative design
- Reverse engineering
    - Boeing B-29 => Tupolev Tu-4

Stages in (Engineering) Design Process

- Needs assessment
  - Requirements
  - Constraints
  - What is the basic design problem? – Problem statement
- Synthesis
- Design Analysis
- Implementation of the idea
  - Model, prototype, simulation
- Testing & validation
- Recommendations
- Construction/Manufacturing

Stages in (Engineering) Design Process

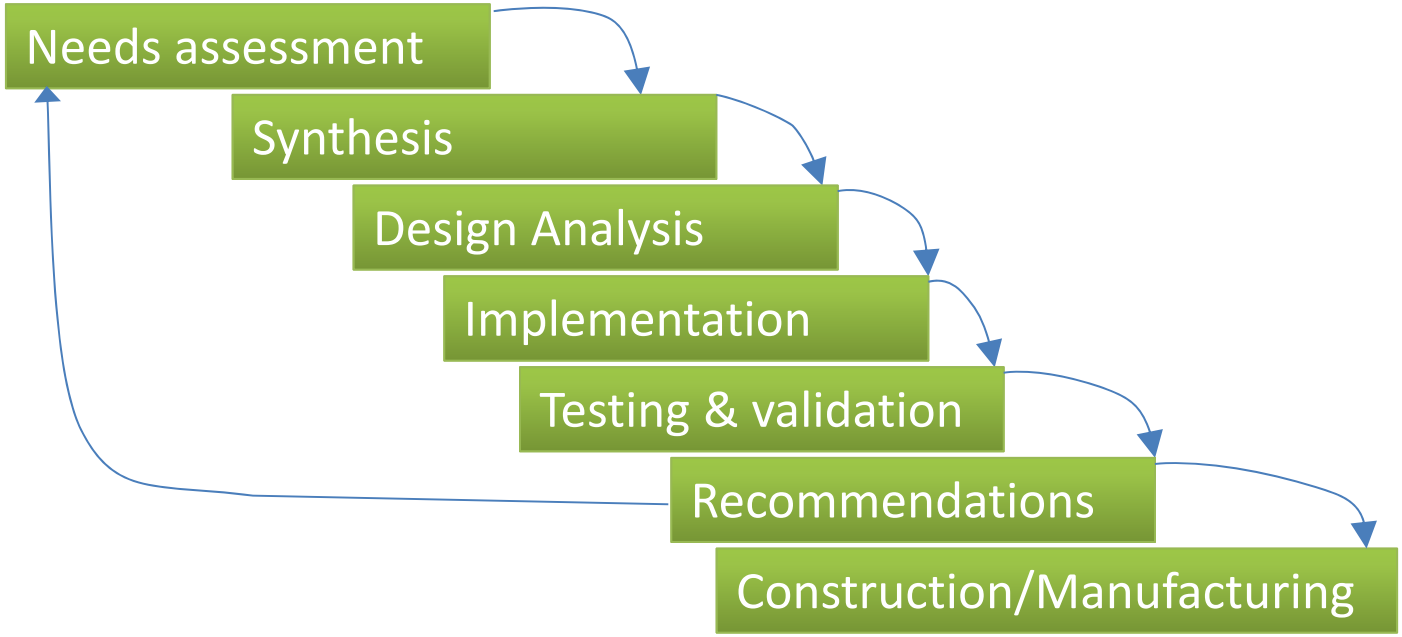
1. Needs Analysis:	Problem Statement:	Identify the underlying need fully and abstractly (without implying a solution).
	Order of Magnitude Calcs:	Make calculations based on estimates, to further understand the problem and its feasibility.
	Requirements:	Identify properties the design solution must have.
	Constraints:	Identify properties the design solution must have a minimum or maximum level of.
	Ranking Criteria:	Identify the criteria on which potential design solutions will be ranked.
2. Conceptual Design:	Brainstorm Concepts:	Think up ideas for design solutions ("*concepts*"), even silly ones. Consider many viewpoints.
	Rank Concepts:	Grade each *concept* by each criterion. Compute weighted average grades for each *concept*.
	Select Concept(s):	Select from amongst the highest graded *concepts*.
	Revisit Needs	Revisit Needs Analysis (*and other phases*) based on new information about Requirements, etc.
3. Preliminary Design:	Select Components:	Identify the combination of components (configuration) needed for the design.
	Simplified Sizing:	Estimate component sizes.
	Simplified Analysis:	Estimate forces and examine responses to verify suitability. Specify potential materials.
	Revisit Needs	Revisit Needs Analysis (*and other phases*) based on new information about Requirements, etc.
4. Detailed Design:	Materials & Assembly:	Specify materials and how components will be assembled.
	Detailed Sizing:	Specify (and optimize) precise sizing of components and their interfaces (within the Constraints).
	Detailed Analyses:	Simulate forces acting on detailed model of system and examine responses. Adjust sizing.
	Solution Statement:	State the design solution completely and concisely so that someone could implement it.
	Revisit Needs	Revisit Needs Analysis (*and other phases*) based on new information about Requirements, etc.
5. Implementation:	Manufacturing & Distribution:	Specify considerations for the manufacture and distribution of the product.
6. Operation:	Actual Use & Maintenance:	Specify considerations for the actual use and maintenance of the product.
7. Retirement:	Deactivation & Disposal:	Specify considerations for the deactivation of the product and its disposal.

Source: http://design.uwaterloo.ca

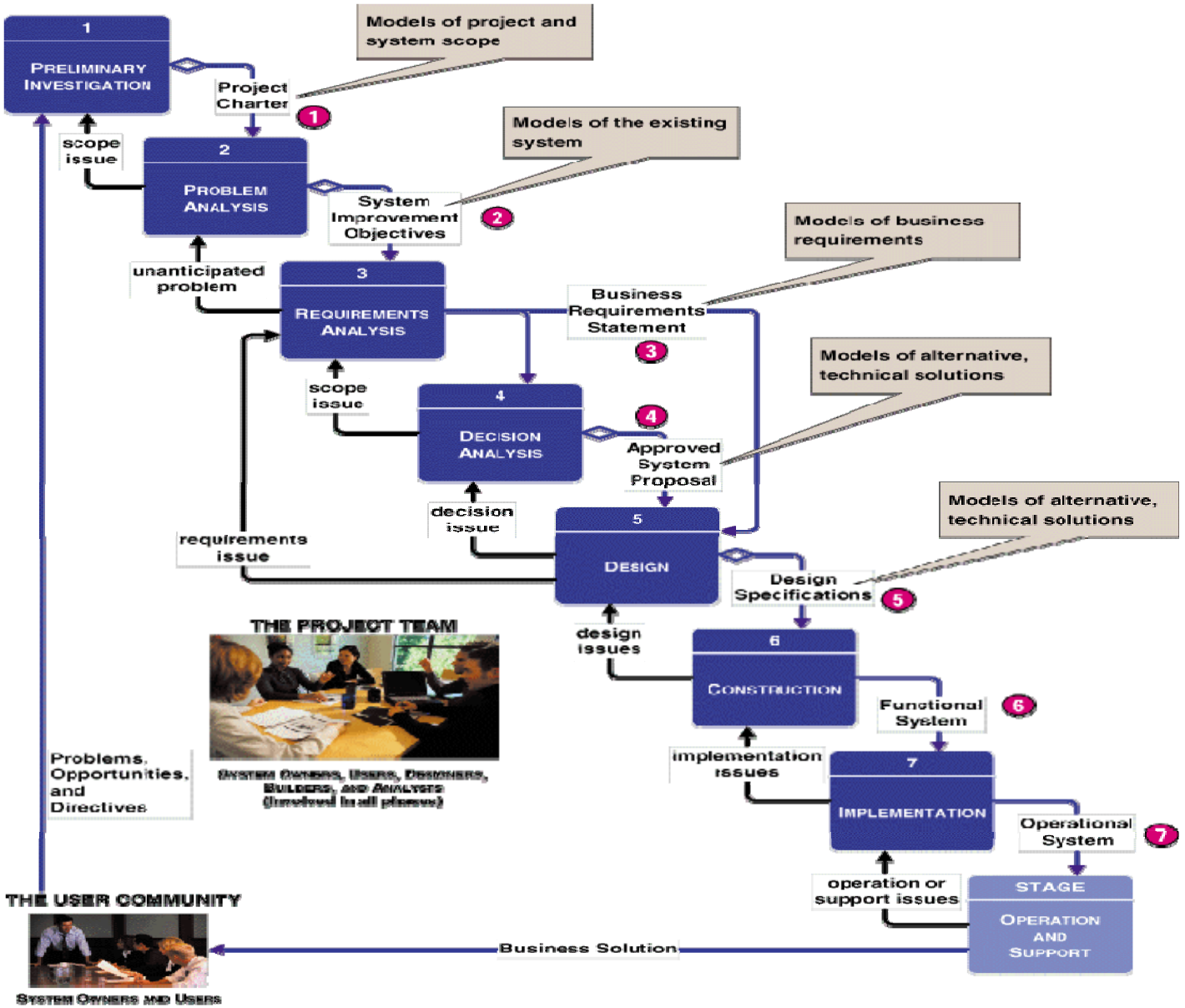
- Organizing the design process
  - Paradox
    - Organized processes are needed for efficient communication & coordination within design team
    - Organizing the process too much leads to bureaucracy
      - Rather than a means to an end, following the process becomes an end in itself
      - Limits creativity & innovation
      - Reduces likelihood that insightful solutions will be accepted
- Two main approaches:
  - Waterfall
  - Spiral

Waterfall approach

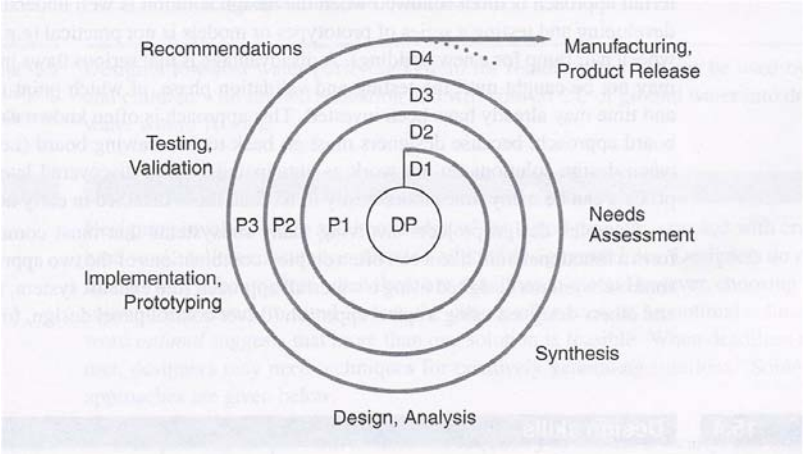
- Sequential “throw it over the wall” approach



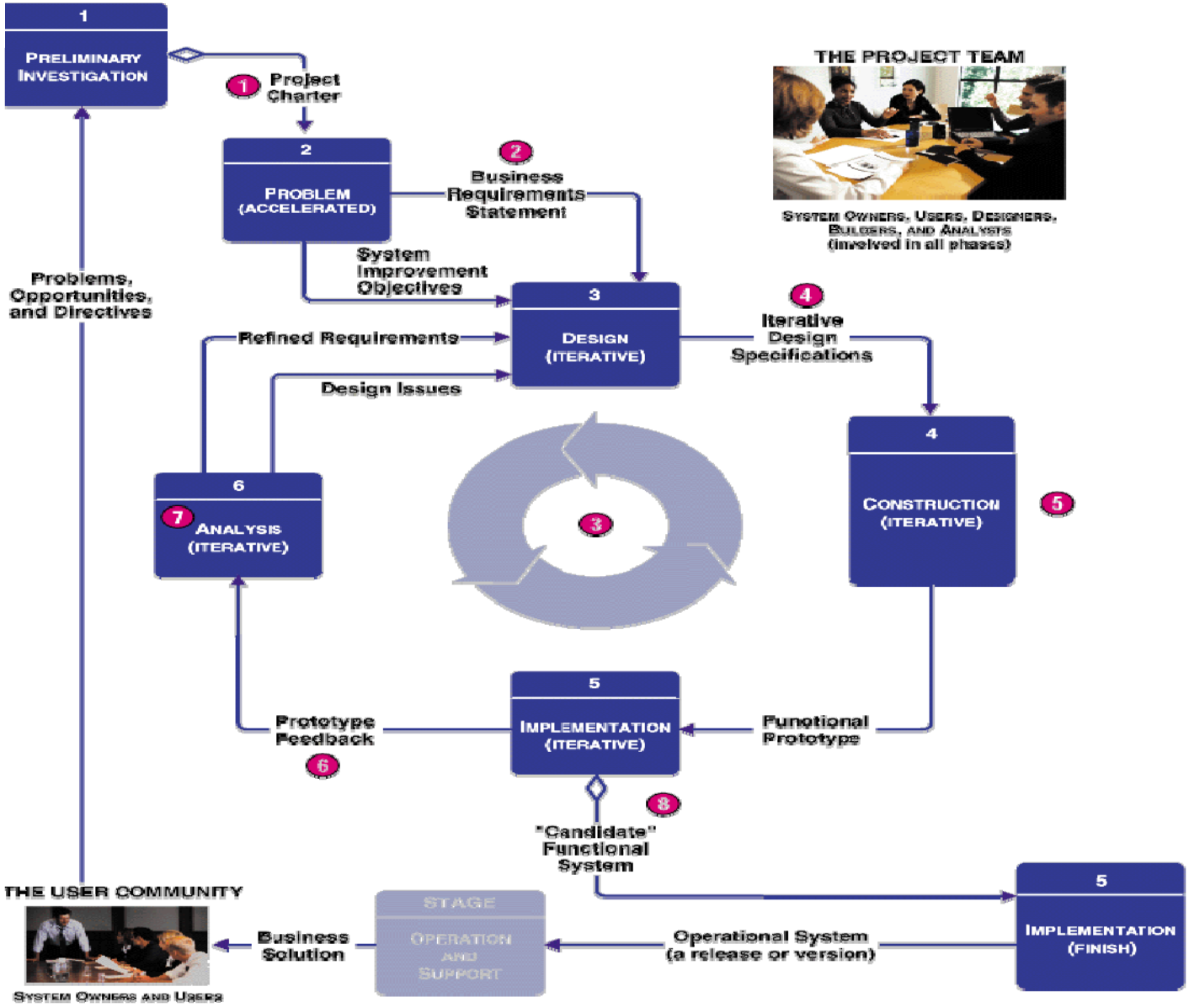
- Flaws
  - Assumes perfect information & perfect specification of the design problem at the beginning
  - Slow/late feedback cycle if initial information wasn’t perfect (it never is!)
  - Need to go back to drawing board


1
PRELIMINARY INVESTIGATION
Project Charter
1
Models of project and system scope
scope issue
2
PROBLEM ANALYSIS
System Improvement Objectives
2
Models of the existing system
unanticipated problem
3
REQUIREMENTS ANALYSIS
Business Requirements Statement
3
Models of business requirements
scope issue
4
DECISION ANALYSIS
4
Approved System Proposal
Models of alternative, technical solutions
decision issue
requirements issue
5
DESIGN
Design Specifications
5
Models of alternative, technical solutions
design issues
6
CONSTRUCTION
Functional System
6
implementation issues
7
IMPLEMENTATION
Operational System
7
operation or support issues
STAGE
OPERATION AND SUPPORT
THE PROJECT TEAM
SYSTEM OWNERS, USERS, DESIGNERS, BUILDERS, AND ANALYSTS (Involved in all phases)
Problems, Opportunities, and Directives
THE USER COMMUNITY
SYSTEM OWNERS AND USERS
Business Solution

Iterative /spiral approach



- Concurrent involvement of all relevant actors/perspectives
  - Users
  - Task requirements
  - Implementation environment
  - Manufacturing constraints
- Continually refine the design problem and adapt the design until all perspectives are accommodated
  - Progression of prototypes/models
- Advantages
  - Recognizes that information & design problem specification are imperfect at beginning
  - Never get too far from the “drawing board” before recognizing necessary adjustments
  - Faster in long run (though may be slower initially as design problem is getting defined)
  - End result is usually a better design


1
PRELIMINARY INVESTIGATION
1 Project Charter
2
PROBLEM (ACCELERATED)
2 Business Requirements Statement
THE PROJECT TEAM
SYSTEM OWNERS, USERS, DESIGNERS, BUILDERS, AND ANALYSTS (involved in all phases)
Problems, Opportunities, and Directives
System Improvement Objectives
3
DESIGN (ITERATIVE)
4 Iterative Design Specifications
Refined Requirements
Design Issues
6
7 ANALYSIS (ITERATIVE)
3
4
CONSTRUCTION (ITERATIVE)
5
5
IMPLEMENTATION (ITERATIVE)
Prototype Peedback
6
Functional Prototype
8
"Candidate" Functional System
THE USER COMMUNITY
SYSTEM OWNERS AND USERS
Business Solution
STAGE
OPERATION AND SUPPORT
Operational System (a release or version)
5
IMPLEMENTATION (FINISH)

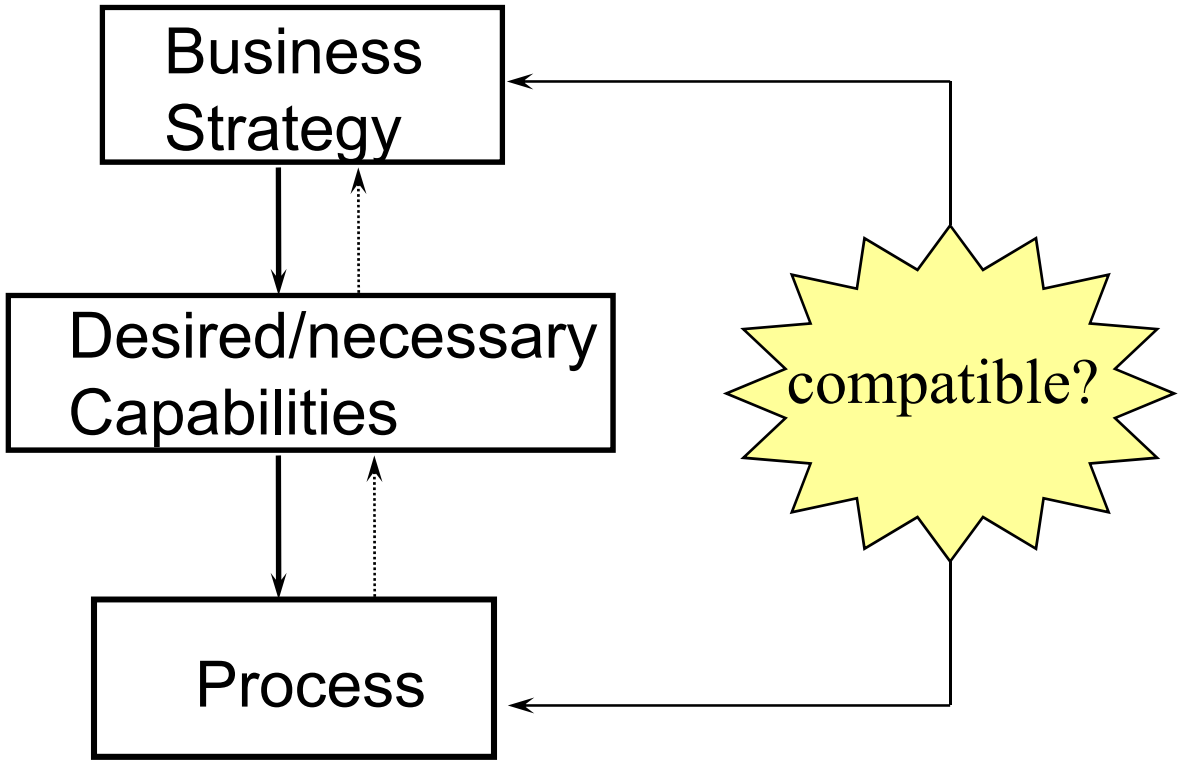
- Design takes place within complex social networks of actors
  - Conflicting goals of different actors
    - "Obvious" design goals
      - e.g., solving some technical problem
    - Manufacturing/construction constraints
      - Designing for efficient manufacturability/construction
      - Quality vs. low production costs
    - Other "political" objectives (often hidden)
      - e.g., Airlines-GDS-OTAs and IATA's NDC
  - Users
    - Safety
    - Ease of use – "User-centred design"
    - Evolution of design based on how users interpret & interact with objects
      - E.g., in 1964 personal computers were advertised for storing recipes!
      - Could today's uses of the Internet have been predicted 10 years ago?
      - Can we predict Internet uses 10 years from now?

Why do firms Initiate Development Projects?

- Problems with existing systems
- Exploitation of new opportunities
- Competition
- Better use of information
- Organizational growth
- M&A
- Change in market

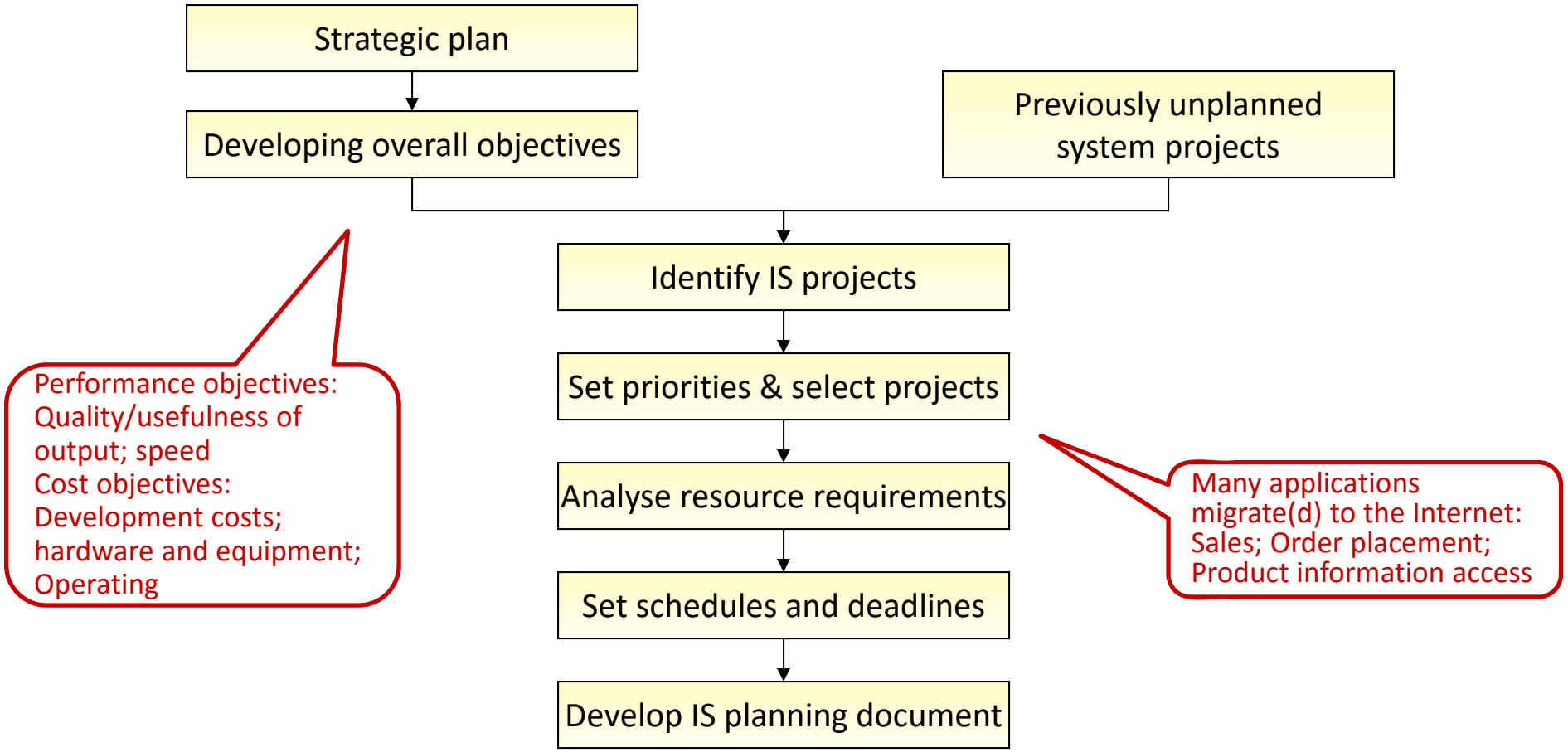
Perceived benefits can initiate a change and trigger development process

Recall: What is a good process?



The IS can critically support the process

Steps in IS Planning



Preliminary Investigation

- A brief study of the problem; determine whether the project should be pursued in light of the goals of the company
- Set investigation team
  - Managers and stakeholders
  - IS personnel
- Outcomes
  - Feasibility analysis
  - Feasibility Assessment report

Technical feasibility
Operational feasibility
Schedule feasibility
Economic feasibility
Net present value

Summarizes the investigation:

1.Introduction

2.Existing System: strengths and weaknesses

3.Benefits of new system

4.Feasibility of new system

5.Recommendations

Analysis

- Studying an existing system to determine how it works and how it meets user's needs.
- Stage may be bundled with preliminary investigation
- Data gathering and analysis
- Outcomes
  - System development goals
  - System development methodology
  - System Investigation report

Summarizes the investigation and recommends a course of action:

1. Executive summary
2. Review of goals and objectives
3. Existing System: strengths and weaknesses
4. System requirements
5. Project feasibility
6. Project costs
7. Projects benefits
8. Recommendations

Data gathering

Internal Sources

- Users, stakeholders, managers
- Organization charts
- Forms and documents
- Procedure manuals and policies
- Financial reports
- IS manuals
- Other measures of business processes

External Sources

- Customers
- Suppliers
- Stockholders
- Government agencies
- Competitors
- Outside groups
- Journals, etc.
- Consultants

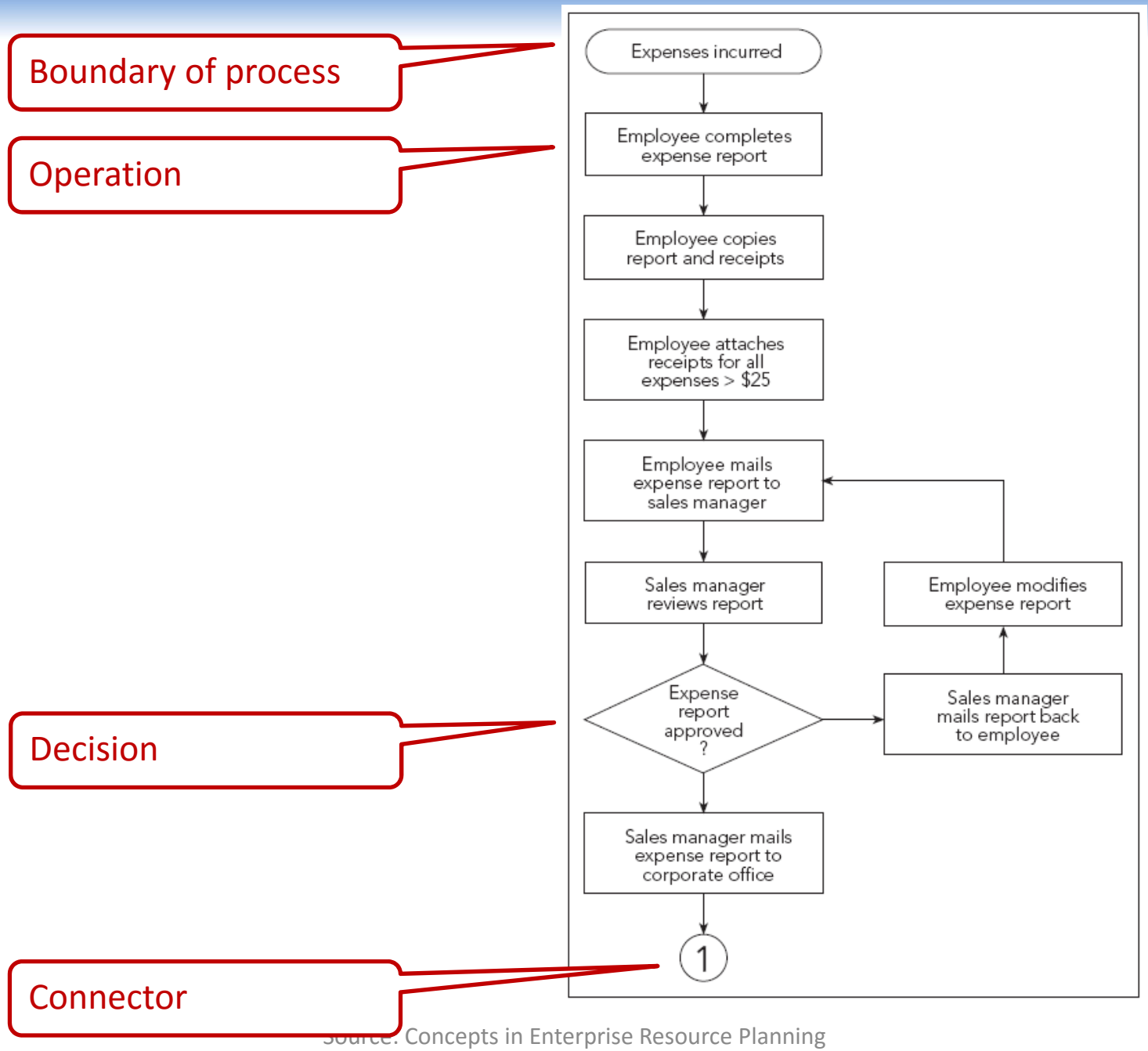
- Structured interview
- Unstructured interview
- Direct observation
- Questionnaires
- Statistical sampling

Data Analysis

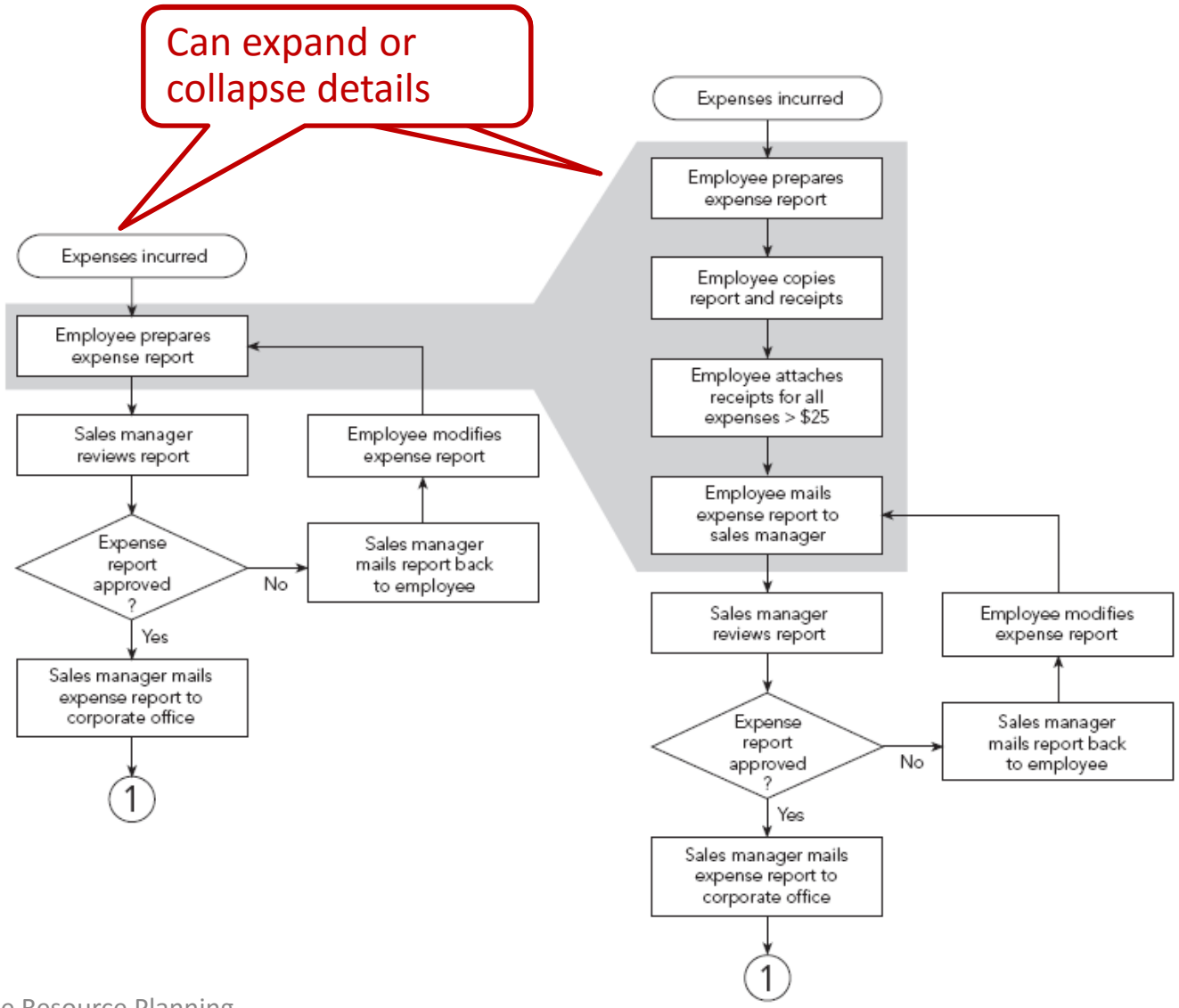
- Data analysis
  - Manipulating collected data so that it is usable for the development team members participating in systems analysis
- Data modeling
  - A commonly accepted approach to modeling organizational objects and associations that employ both text and graphics
  - E.g, ER (entity relationship) diagrams
- Activity modeling
  - A method to describe related objects, associations, and activities
- Data flow diagram
  - A diagram that models objects, associations, and activities by describing how data can flow between and around them

Expense report example

- Osman, a salesperson,
  - Completes a paper expense report after travel
  - Makes a copy for her records
  - Attaches receipts for any expenses over $25
  - Mails it to his zone manager at the branch office
- Ela, zone manager
  - Reviews expense report
  - Approves report or mails it back to Osman asking for explanation, verification, or modification
  - After approval, mails it to corporate office
- Process at corporate office
  - Accounts payable (A/P) clerk

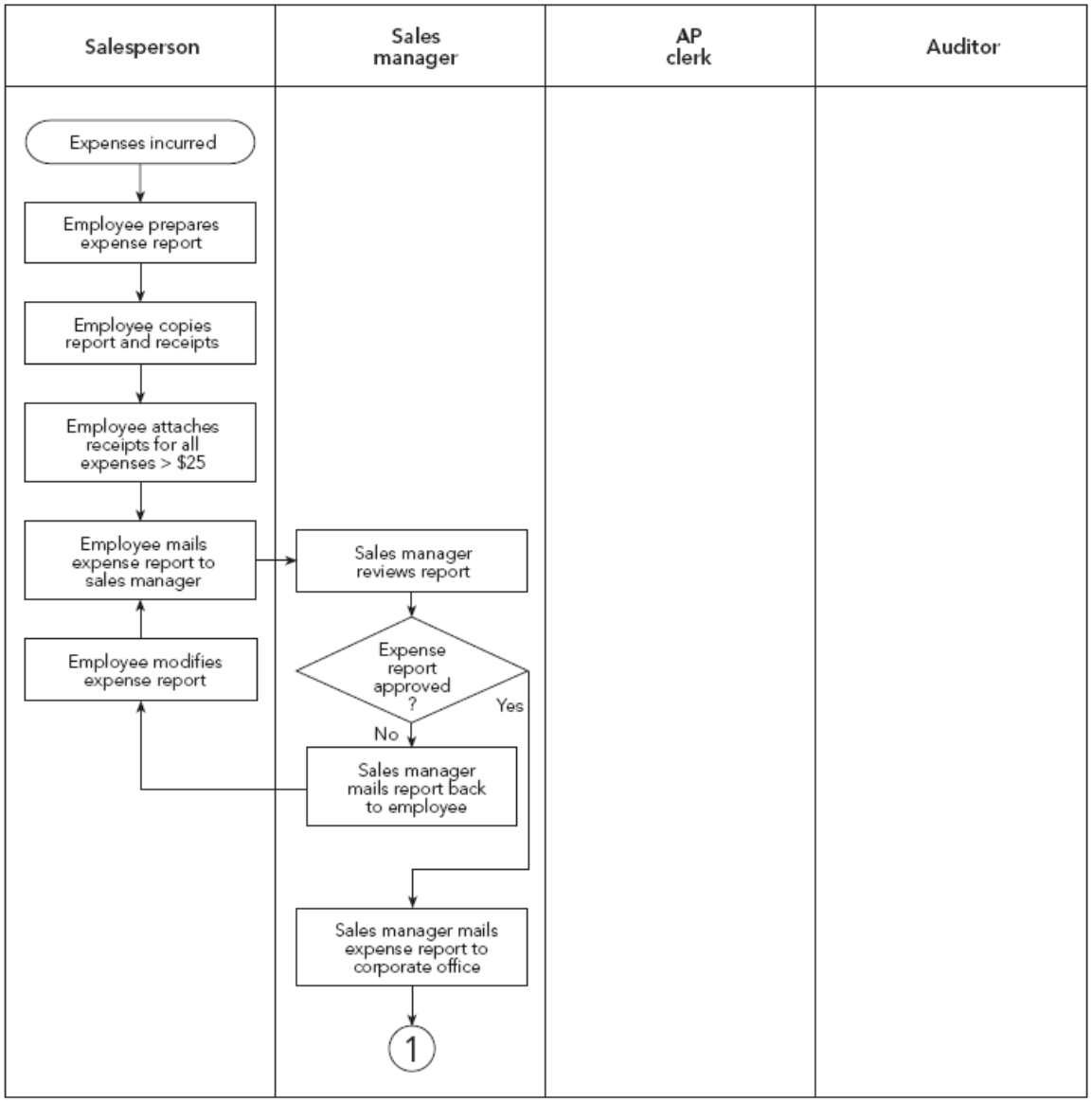

Boundary of process
Operation
Decision
Connector
Expenses incurred
Employee completes expense report
Employee copies report and receipts
Employee attaches receipts for all expenses > $25
Employee mails expense report to sales manager
Sales manager reviews report
Expense report approved ?
Sales manager mails expense report to corporate office
1
Employee modifies expense report
Sales manager mails report back to employee

Hierarchical Modeling



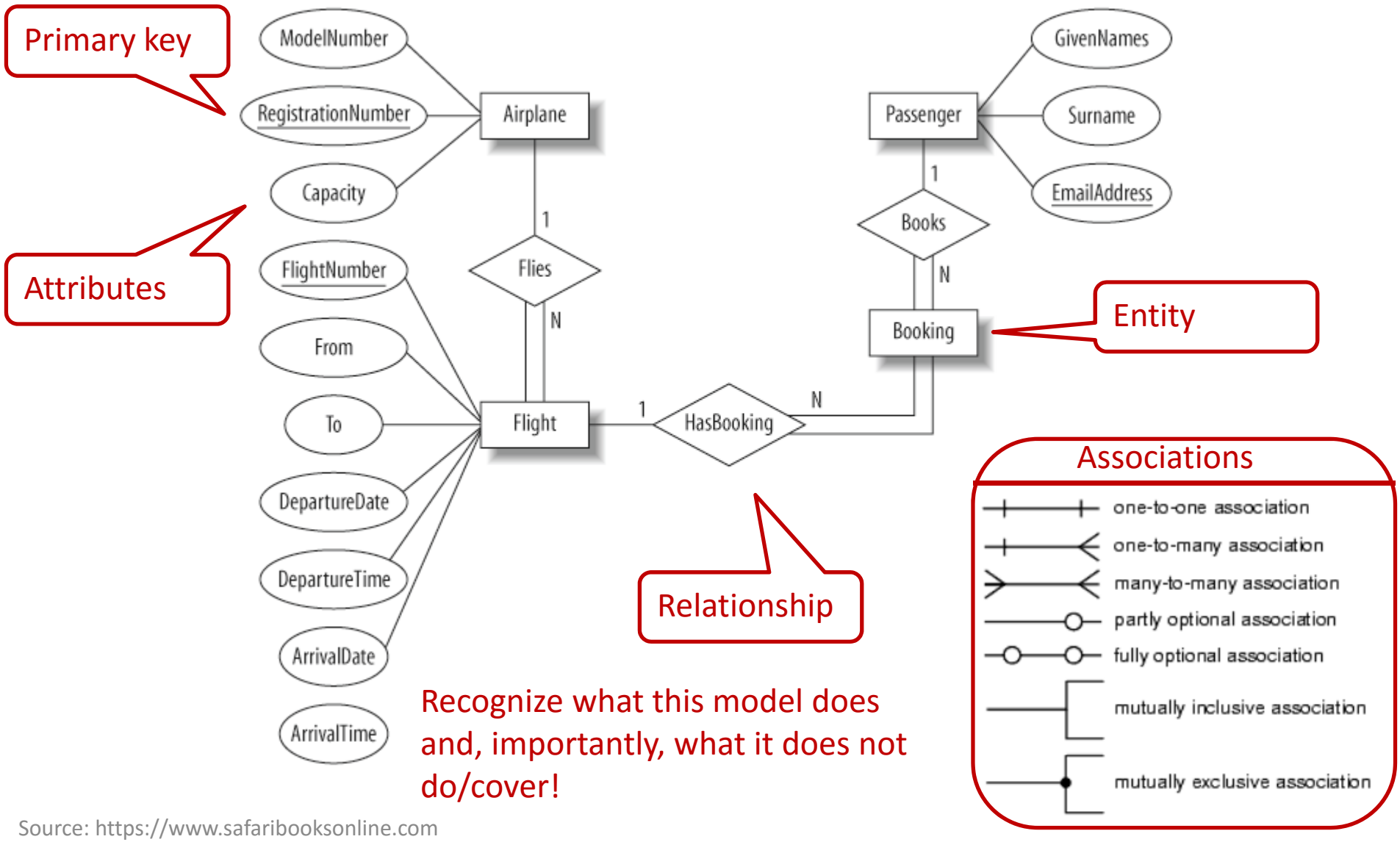
Source: Concepts in Enterprise Resource Planning

Deployment (Swimlane) Flowchart



Source: Concepts in Enterprise Resource Planning

Entity Relationship Example



Recognize what this model does and, importantly, what it does not do/cover!

Source: https://www.safaribooksonline.com

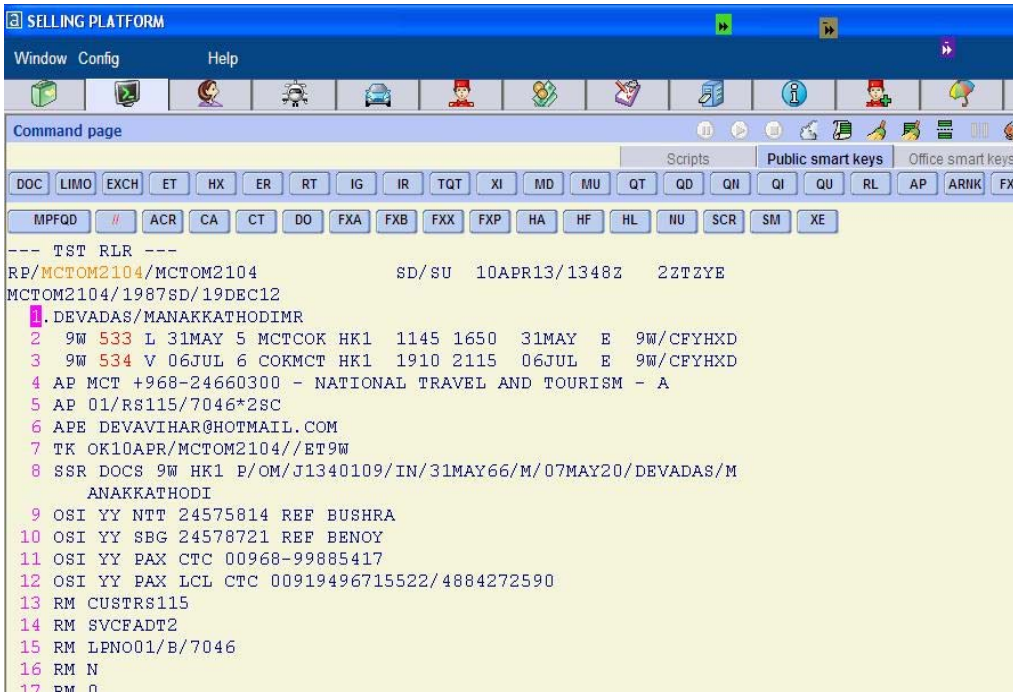
Grid Charts

- A table that shows relationships among the various aspects of a systems development effort

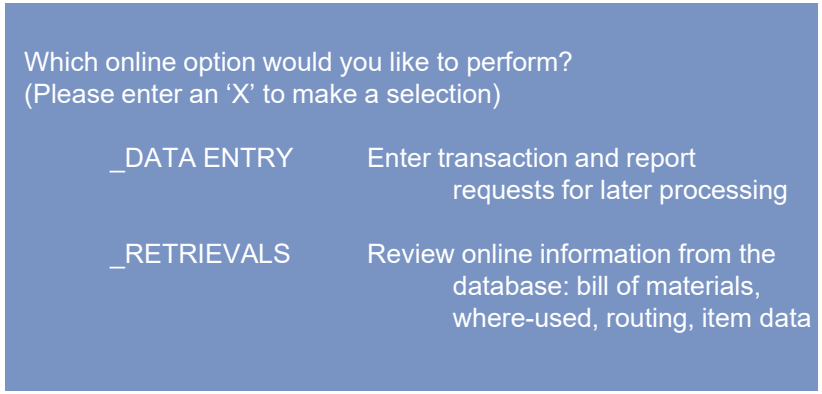
Database Applications	Customer	Inventory	Supplier	Accounts receivable
Order processing	X	X		
Inventory control		X	X	
Marketing analysis	X			
Invoicing	X	X		X

Screen Layout Charts

- May be tailored for:
  - Frequent users who require little descriptive information, or



  - Infrequent users who require more descriptive information



THY example

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*TK1588/22APR/FRA-STD:1135*ETD:1205/STA:1545*EA:1615*EB:1625

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*** PLEASE CONTACT WITH HCC AS SOON AS THIS MESSAGE RECEIVED ***
==========
THIS REPORT INDICATES -PREDICTED REMAINING TRANSFER TIMES WHICH ARE CALCULATED ACCORDING TO ETD AND SCHEDULED BLOCK TIME OF THE FLIGHT. ESTIMATED ENROUTE TIME (EET TAKEN FROM FLIGHT PLAN OR THE COCKPIT CREW) SHOULD BE CONSIDERED BY ORIGIN STATION STAFF BEFORE REACCOMMODATING MISCONEX PASSENGERS.

- Automatic message by IT system automatically
- Triggered when connection time for passengers reduces below pre-defined minimum connection time threshold.
- Sent from SOC (Stations Control Center) to the related station (FRA)
- Staff are informed before the airplane actually arrives and are able to take necessary proactive actions in order to prevent any downstream effects.

Phase 3: Design

- The new system is actually planned
- Divided into two sub-phases
  - Preliminary design
    - High-level design
    - Decision: Build or Buy
  - Detailed design specifications
    - Input and Output requirements
    - Design databases
    - Specific network and security needs
    - Develop Disaster Recovery Plans
    - May enter data into a CASE Tool to generate drawings and actual programming code
      - Computer Aided Software Engineering

Make or Buy?

- Develop Software
  - Customized
  - Developed in-house
  - Developed by outside vendor
  - Prototyping
    - Limited function if any; shows what system may look like.
  - Next phase: Development
- Buy Software
  - Prepackaged software
  - Select software vendor
  - Customization may be offered by software vendor for a price
  - Next phase: Testing

Thomas Cook Airlines case study

- 1995: Lufthansa decided to develop an EFB (electronic flight bag) solution: to automate documentation and eliminate paper from pilots
- Condor was leisure arm of Lufthansa
- 1997: implementation
- 2008: LH sells Condor, and soon will lose EFB
- EFB providers offered a solution that was
  - At an earlier point of the development cycle
  - Inflexible
- Decision: build. Emulate LH's system while leveraging the emergence of new technologies (3G)

Prototyping

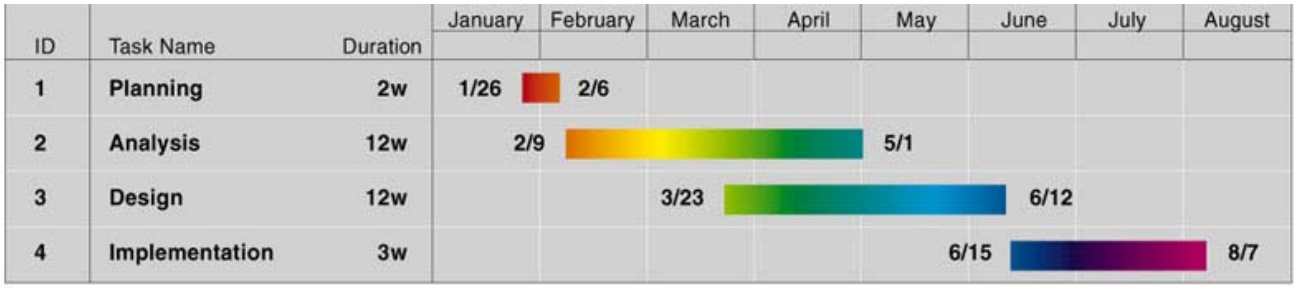
- Operational prototype
  - Accesses real data files, edits input data, makes necessary computations and comparisons, and produces real output
- Non-operational prototype
  - A mockup or model that includes output and input specifications and formats
- Rapid Application Development (RAD)
  - A system of tools, techniques, and methodologies designed to speed application development, automates source code generation, and facilitates user involvement in design and development activities
  - Popular RAD systems are VB and Delphi
  - Many traditional environments now support RAD concepts; line blurred
- Joint Application Development (JAD)
  - Involves group meetings in which users, stakeholders, and IS professionals work together to analyze existing systems, proposed solutions, and define requirements for a new or modified system.

Phase 4: Development

- Scheduling
  - Define tasks and schedule
  - Use project management software to plan resources and dependencies
- Programming
  - Develop actual programs that make up the system
  - Each program is tested by the programmer.
- Testing
  - Use various tests to evaluate entire system:
    - Unit testing – verifies that individual program units work.
    - System testing – determines whether all program units work together as planned.
    - Volume testing – uses real data in large amounts to see if system can handle it.
    - Load testing – used to determine if system can handle large number of concurrent users.

Factors Affecting Systems Development Success

- Managing change
  - Requires the ability to recognize existing or potential problems and deal with them before they become a serious threat to the success of a new or modified system
- Use of project management tools
  - Schedule
  - Milestone; deliverables
  - Deadline
  - Critical path analysis
  - Program Evaluation Review Technique (PERT)
  - Gantt chart



Use of Computer-Aided Software Engineering (CASE) Tools

- CASE tools automate system development tasks
  - Summarizing initial requirements
  - Developing flow diagrams
  - Scheduling development tasks
  - Preparing documentation
  - Controlling software versions
  - Developing program code
- Upper CASE tools
  - Focus on the early stages of system development
- Lower CASE tools
  - Focus on the later implementation stage of system development
- Integrated-CASE (I-CASE) tools
  - Provide links between upper and lower CASE packages, allowing lower CASE packages to generate program code from upper CASE package generated designs

Phase 5: Implementation

- Training – hands-on and user manuals
- Equipment conversion – allow for delivery and installation
- File conversion – manual to electronic, or system's old format to new format
- Auditing - need to be able to track data in system back to the source.
- Evaluation – does system meet original requirements, benefits, and budget?
- Maintenance – Fix bugs, enhancements, and new regulations
- System conversion

System Conversion Options

- Direct conversion – the user simply stops using the old system and starts using the new one
- Parallel conversion – the old and new systems are both used until users are satisfied the new system works
- Phased conversion – the system is implemented one part at a time
- Pilot conversion – the entire system is used by a designated set of users