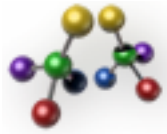
Requirements Engineering Survey Seminar

For the CEC/PIER Demand Response
Enabling Technology Development Project

Presented on October 11, 2006 by
Diane S. Pepetone
Requirements Engineer
L'Monte Information Services



L'MONTE
INFORMATION SERVICES
www.lmonte.com

This workshop is sponsored by the PIER program of the California Energy Commission in conjunction with the California Institute of Energy Efficiency, University of California, Office of the President

Contract No 500-99-013

Seminar Outline

Introductions & Seminar Objectives

Putting Requirements Engineering (RE) in Context: Definitions & History

What RE Can Do & What It Can't Do

RE Process: Comparing It To Policymaking

Break

RE Tools & Techniques: Applying Them To Policymaking

Introductions

- My Background
  - MA in Information Science
  - 22 years experience
    - RE, Information Systems design, User Interface design
  - My company, L'Monte Information Services
    - Future Requirements Engineering (RE) workshop with hands-on exercises using RE tools & techniques presented in this seminar
- Seminar Objectives
  - Provide context, definitions, history of RE
  - Familiarize you with RE tools & techniques
  - Explore how you can (and do) apply RE to your work
  - Be responsive to your objectives
- Who Is Here Today & What Is *Your* Main Objective?

Seminar Outline

- ✓ Introductions & Seminar Objectives

  Any Questions?

- ➢ Putting Requirements Engineering (RE) in Context: Definitions & History

What Does RE Have To Do With Policymaking?

- Basic Premises Of This Seminar:

1. RE tools and techniques can be used in defining any kind of requirements and therefore RE could be applied to policymaking.

2. Policymaking, challenged by growing complexity of the systems it must address, would benefit from using RE tools and techniques.

3. Defining requirements is hard in any field, even for the experts, so any new tools and techniques are welcome.

Fred Brooks, an expert in computer science and systems engineering, had this to say about the most difficult part of developing a system:

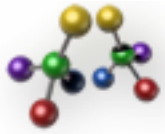
The hardest single part …is deciding precisely what to build.

No other part so cripples the resulting system if done wrong.

No other part is more difficult to rectify later.

(excerpt from "No Silver Bullet", IEEE Computer, 1987)

The Requirements Engineering Challenge



L'MONTE
INFORMATION SERVICES
www.lmonte.com

RE Definitions

- Requirements
  - Functionality, qualities, constraints
    of an object or system that must be satisfied
- Engineering
  - Application of scientific and mathematical principles to *practical ends*
- Requirements Engineering,
  branch of systems engineering
  - Application of information science, social sciences and logic to developing & managing requirements of a system

Requirements Engineer

working with Project Team

applies logic, information science & social sciences to analyzing, modeling, verifying, and managing system requirements

- Closely related titles: business analyst, project manager

- But requirements have been around forever, you say…

My Club Requirements

Length <= length of my arm
and >= .5 length of my arm

Strength:
Can hit a wooly mammoth without breaking

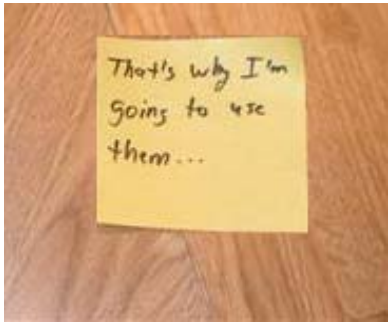
Desires:
Fits my hand comfortably

Constraints:
Limited to local wood and stone

- Why did they need to be formalized into RE?

First, A Closer Look at Systems

- Comparing a Widget to a System:



widget n : a simple device that is very useful for a particular job

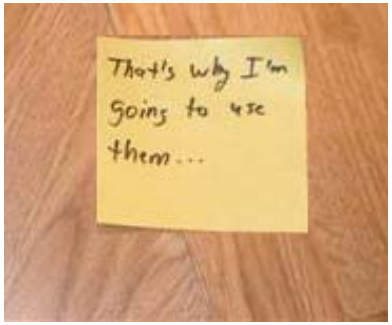
e.g. Post-it

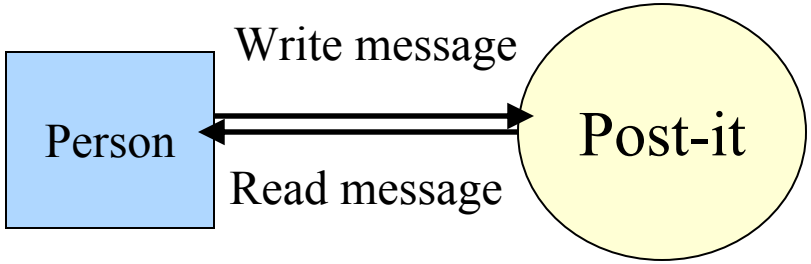
system n. A group of interacting components forming a complex whole

e.g. Cell phone

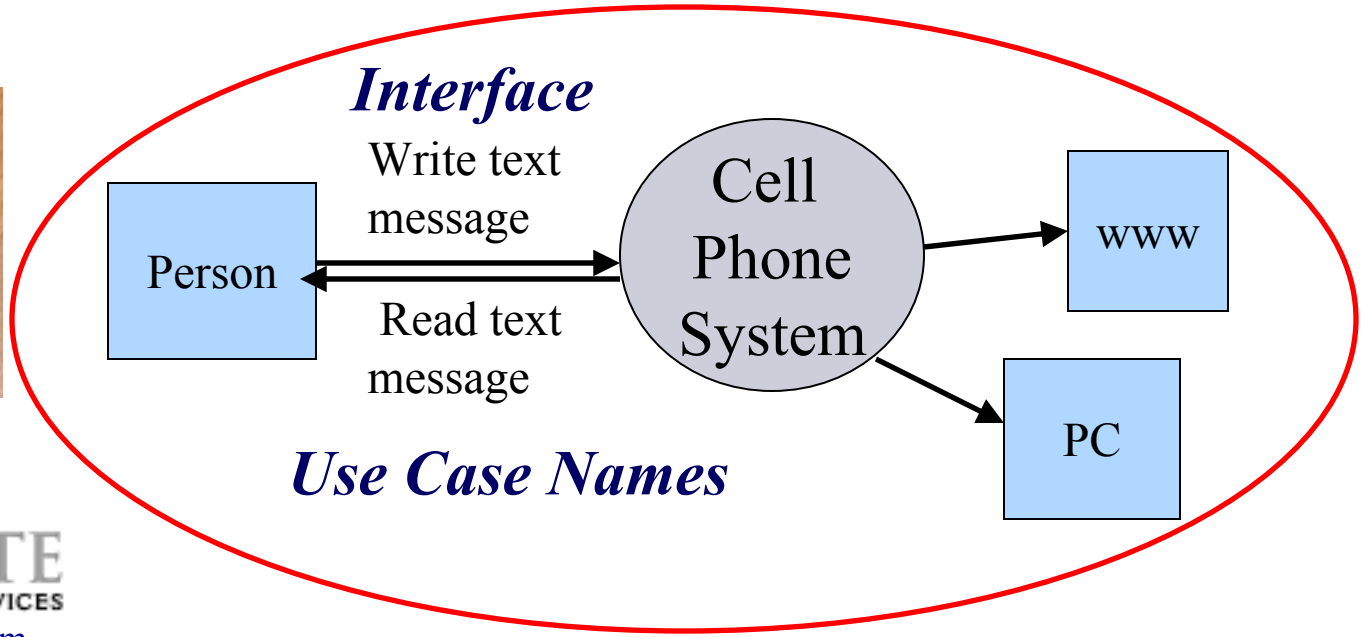
First, A Closer Look at Systems

- Comparing a Widget to a System:



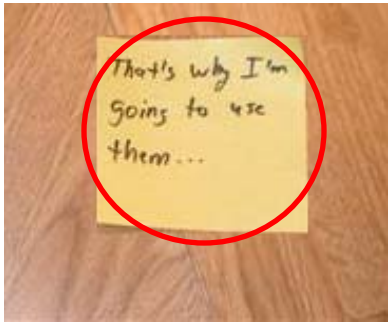


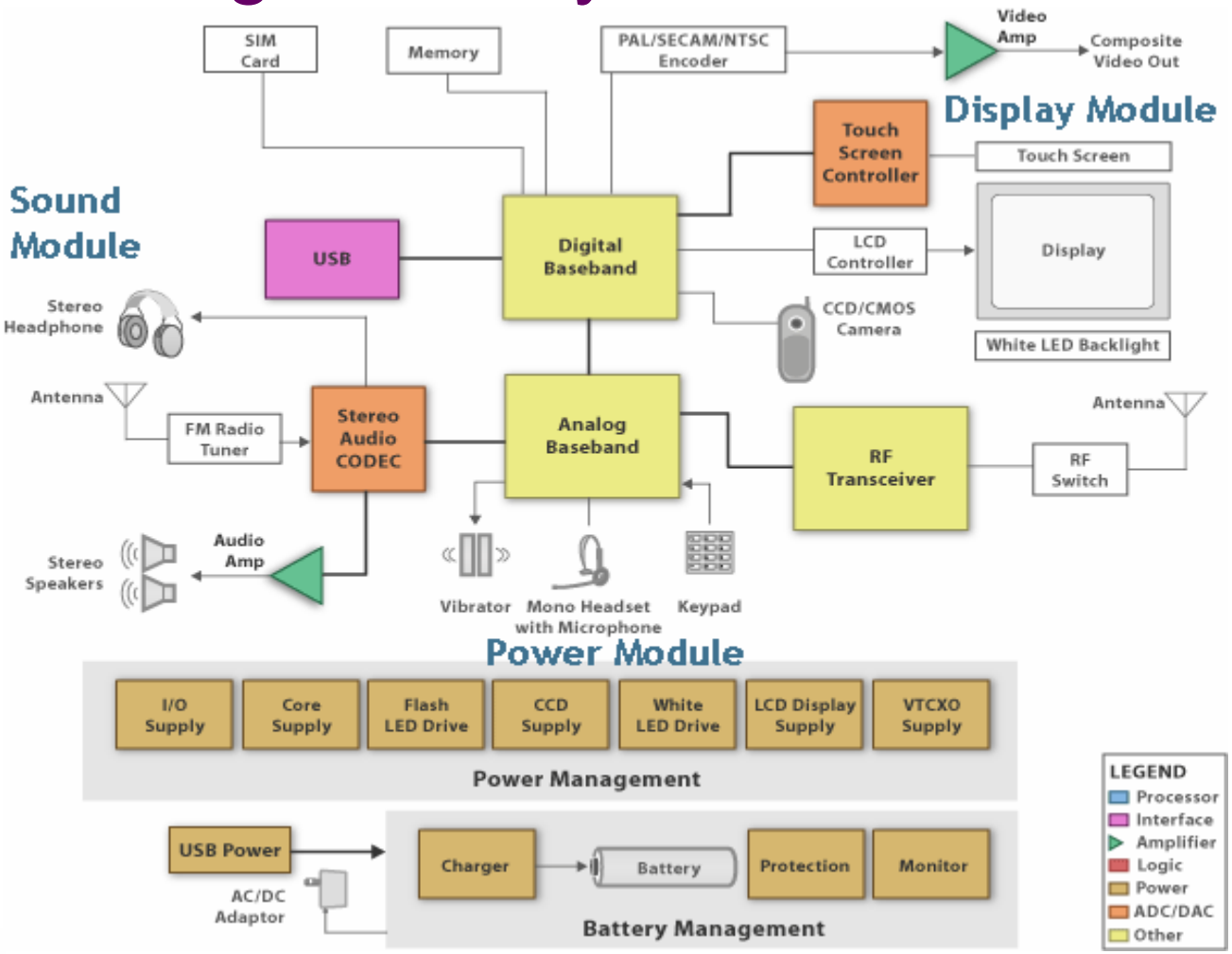
Context Diagram



First, A Closer Look at Systems

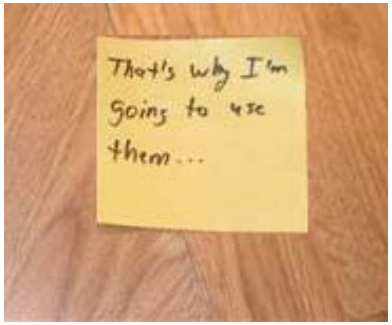
- Comparing a Widget to a System:

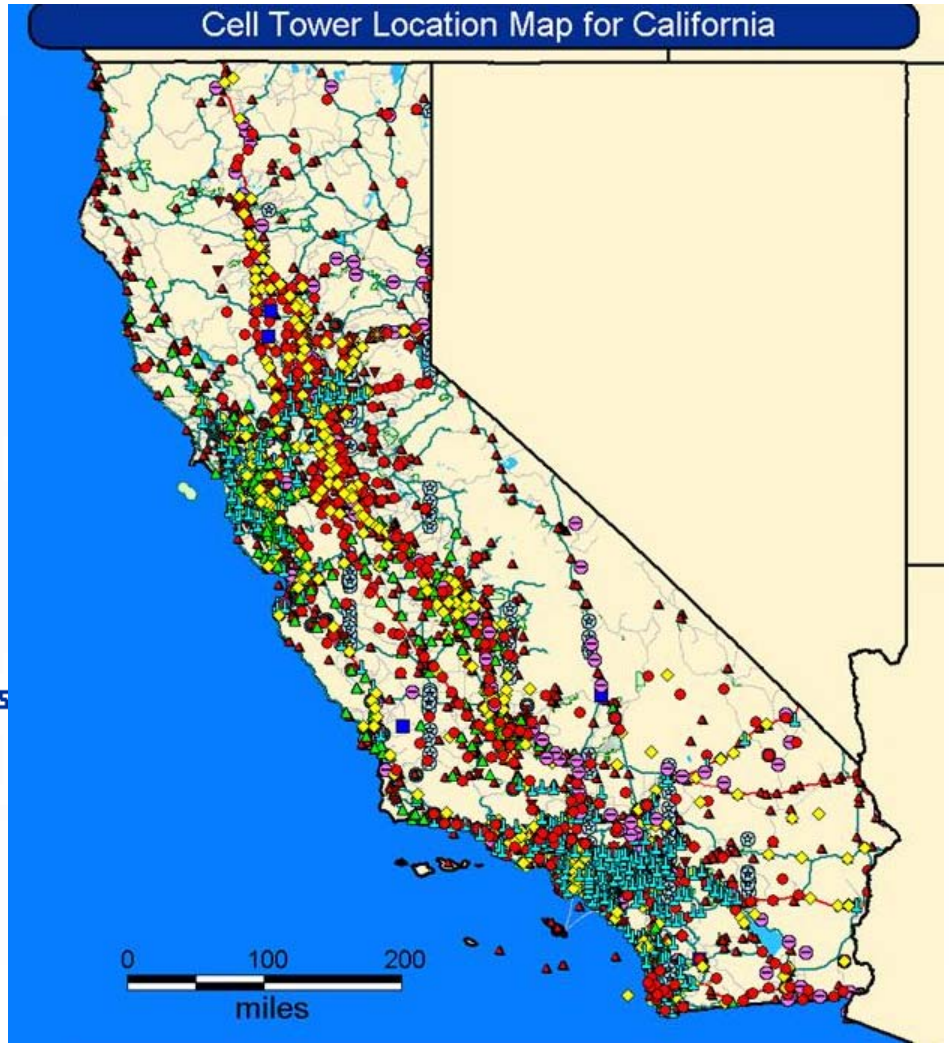




First, A Closer Look at Systems

- Comparing a Widget to a System:





Why Did RE Become Formalized?

- Because Of The Development Of Systems

"Life was simple before WWII.

After that we had systems."

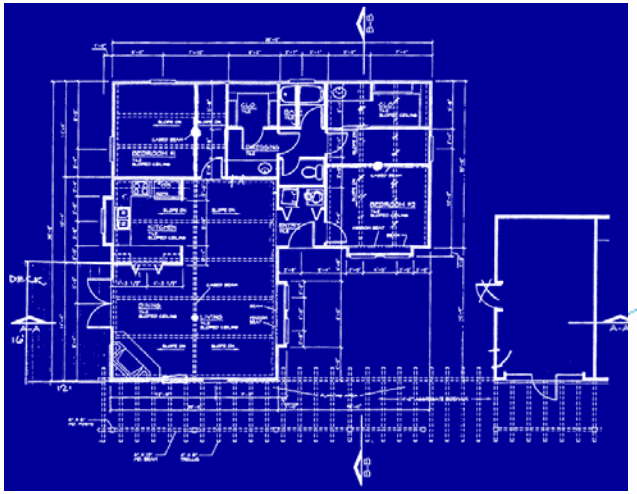
Grace Hopper, a pioneer in computer science with 1st hand experience.

In 1944 she worked on the Mark I, the 1st large scale automatic digital computing system, with roughly 765,000 components.

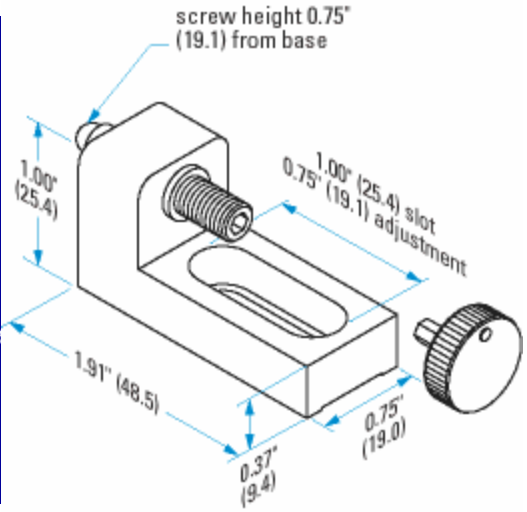
Systems Engineers Needed RE Because

- Specification tools for buildings or widgets

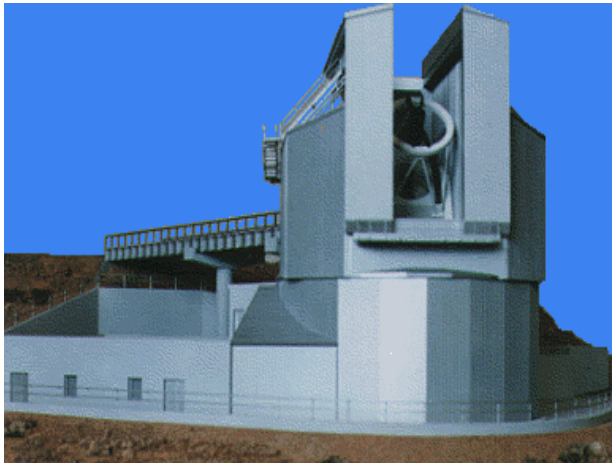
Blueprints



Drawings



Small scale models



didn't work to model

- System processes
- System interfaces

Systems Engineers Needed RE Because

- *Invisible* logic errors were causing serious damage

Mariner 1 had to be shot down at launch due to a systems integration failure

Headine: SOVIET MISTAKE LED TO 'SUICIDE' FOR MARS PROBE" Phobos 1 was given a fatal command

SAC/NORAD scrambled unknowingly on simulated data, almost starting a war

- They needed tools that could track the relationship between components and provide

Visibility - like the laws of physics

L'MONTE INFORMATION SERVICES
www.lmonte.com

Systems Engineers Needed RE Because

- New Systems Changed People's Jobs
  - And when stakeholders were ignored, sometimes -
    - Lives were lost
      - **London Ambulance Service (LAS) disaster of 1992**
- Background
  - One of the largest ambulance se
    - **7 million people**
    - **Staff of 2,700**
  - Project: computerize the dispatch
  - Driving force of project
    - **Poor compliance with National Health Service regulations**


The Daily W

Thurs 29 Oct 1992

AMBULANCE CHIEF QUITS AFTER PATIENTS DIE IN COMPUTER CRASH

The Chief executive of the London Ambulance Service resigned yesterday over allegations that up to 20 people may have died because of the collapse of a new computer system controlling emergency calls. ...

Systems Engineers Needed RE Because

- New Systems Changed People's Jobs And…
  - Caused resistance when stakeholders weren't consulted
    - **IRS 1986 Tax Modernization project -**
      - **An $8 billion failure**

"It is not quite accurate to say that requirements are in the minds of clients.

It would be more accurate to say that they are in the social system of the client organization...

The difficulties are mainly social, political, and cultural, and not technical."

Joseph Goguen, Professor, UCSD

Development of RE Tools & Techniques

- 1970's & 1980's
  - **Joint Application Development (JAD) Workshops** (IBM)
  - **Mythical Man Month** published (Fred Brooks, IBM)
  - **Quality Function Development** (Japanese industry & W.Edward Demming's Quality Circles)
  - **Use Cases** are born (Ivar Jacobson)

- 1990's To 2006
  - **UML**, United Modeling Language ('The 3 Amigos": Jacobson et al)
  - **RE Standards**: IEEE & ISO/IEC
    - e.g. ISO/IEC 19501:2005 defined standards for UML
  - **RE Books and classes**:
    - Barry Boehm, Alistair Cockburn, Ellen Gottesdiener, Suzanne & James Robertson, Karl Wiegers, among others
  - **RE conferences:** IEEE 1st international RE conference, 2000

Seminar Outline

- ✓ Introductions & Seminar Objectives
- ✓ Putting Requirements Engineering in Context: Definitions & History

  Any questions?

- ➢ What RE Can Do & What It Can't Do

What RE Can Do

- Capture What A System Needs To Do
  - Functional requirements
  - Example: London Ambulance Service (LAS) Computer-Aided Dispatch functional requirements:
    - **Receive incident information & locate it on a map**
    - **Contact closest ambulance with incident information**
    - **Track incident status until it is closed**
- Define Within What Parameters It Must Function
  - Non-functional requirements: qualities & constraints
    - **Look & Feel**: Monitor display in ambulances must be easy to use
    - **Constraints on the proposed system**:
      - **NHS regulations**
      - **ORCON Standards**
      - **Labor Unions & labor law**
    - **Integration**: It must work with existing communication system
    - **Stability**: It must be very stable for this life critical service

What RE Can Do

- Protect Projects From Costly Requirements Errors*
  - If a requirement is missed in initial project definition,
    - **When RE is applied, time to correct is:**
      10 minutes during requirements gathering process
    - **But - if RE is poorly practiced or not at all, it takes:**

1200 minutes if found after it's released

» And time is money – cost to correct these errors:
between 30-40% of the total development costs

***Based on four different studies referenced in Requirements by Collaboration, E. Gottesdiener, p264**

RE Can't Protect Projects From:

- Last Minute Changes
  - Cutting edge technology, new regulations
- Inadequate Budget or Schedule
  - But good RE up front can help to
    - **Cut schedule and budget by as much as 40%**
- Human Follies:
  - Hubris
  - Hidden agendas
  - Poor coordination
  - No follow through

But there are RE techniques that can help

Seminar Outline

- ✓ Introductions & Seminar Objectives
- ✓ Putting RE in Context: Definitions & History
- ✓ What RE Can Do & What It Can't Do

  Any questions?

- ➢ RE Process: Comparing It To Policymaking

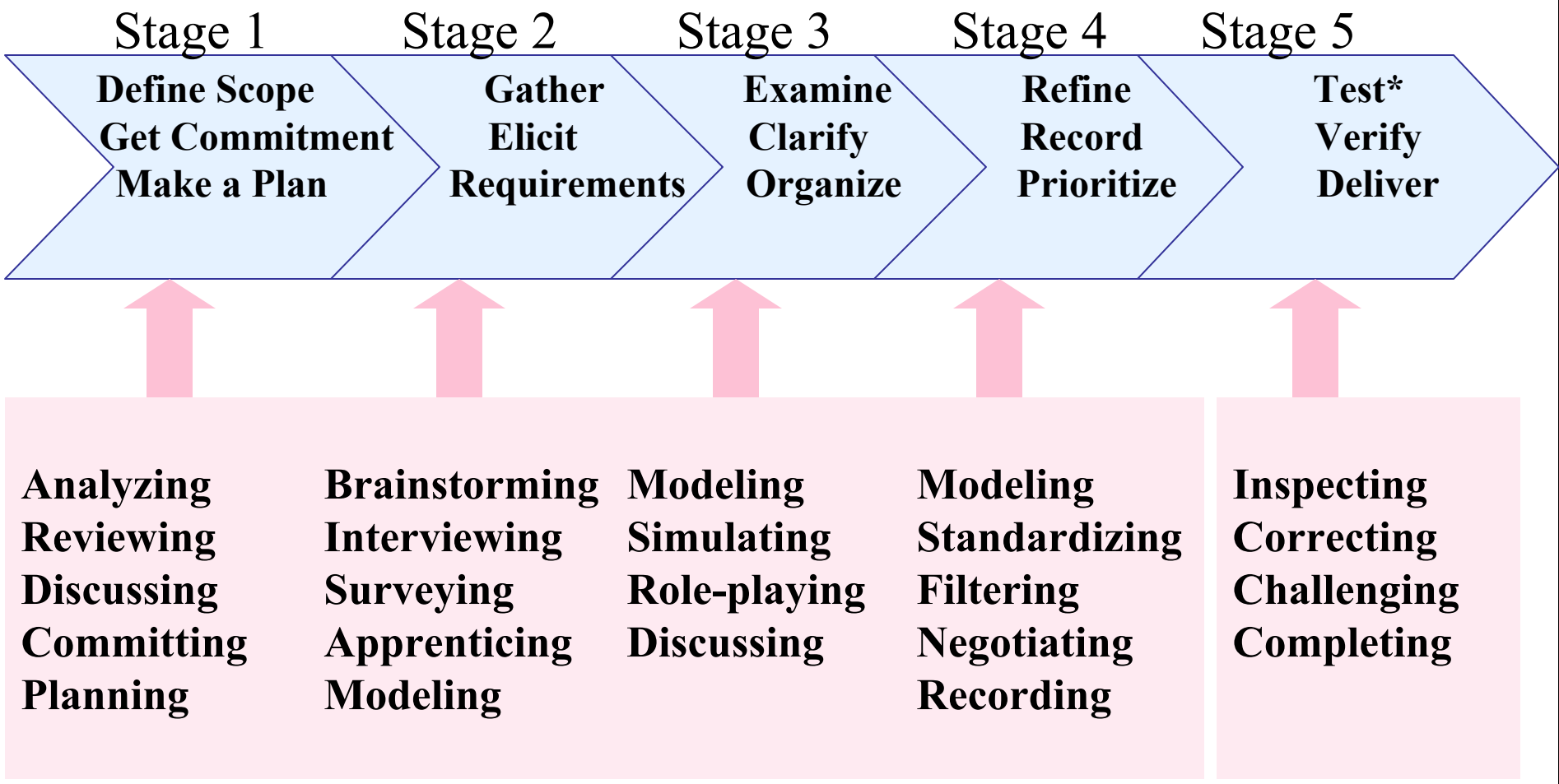
The RE Process

- Lay out the big picture of where you are going
- Define a rough plan: stages, decision points
- Equip yourself for the trip: tools, skills, advisors
- Begin: cover ground, gather information, chart the next stage

At The End Of Each Stage…

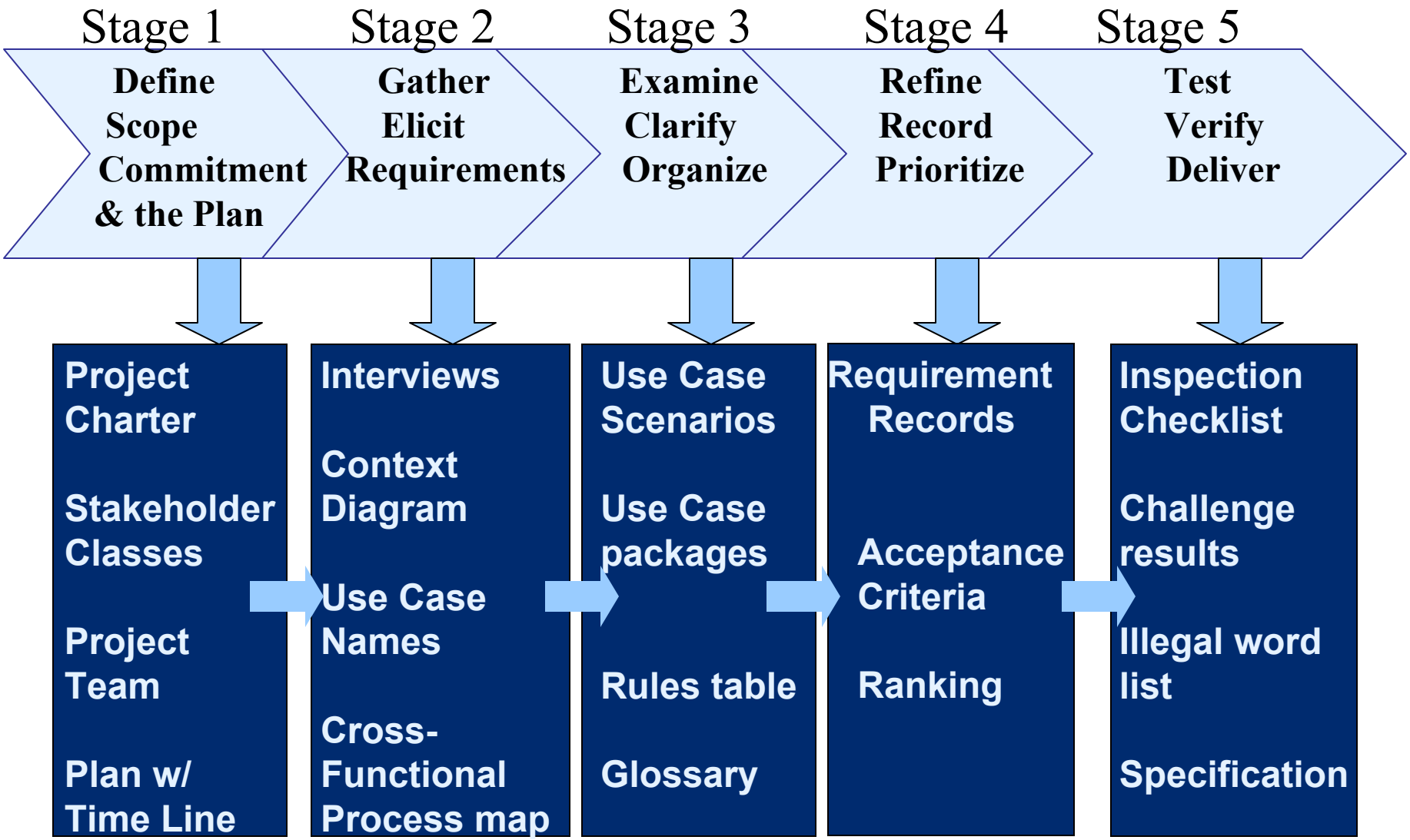
- Review the big picture & the ground you have covered
- Look at what's up ahead – the next stage
- Refine your plan, retool & regroup if needed

RE Process: Getting Valid Requirements



* "**Any requirement that cannot be tested is not a requirement**"
from S&J Robertson's Requirements-Led Project Management

RE Process: Getting Valid Requirements



Requirements Engineering Deliverables

Comparing RE Process With The Policymaking Process

Requirements Engineering Process

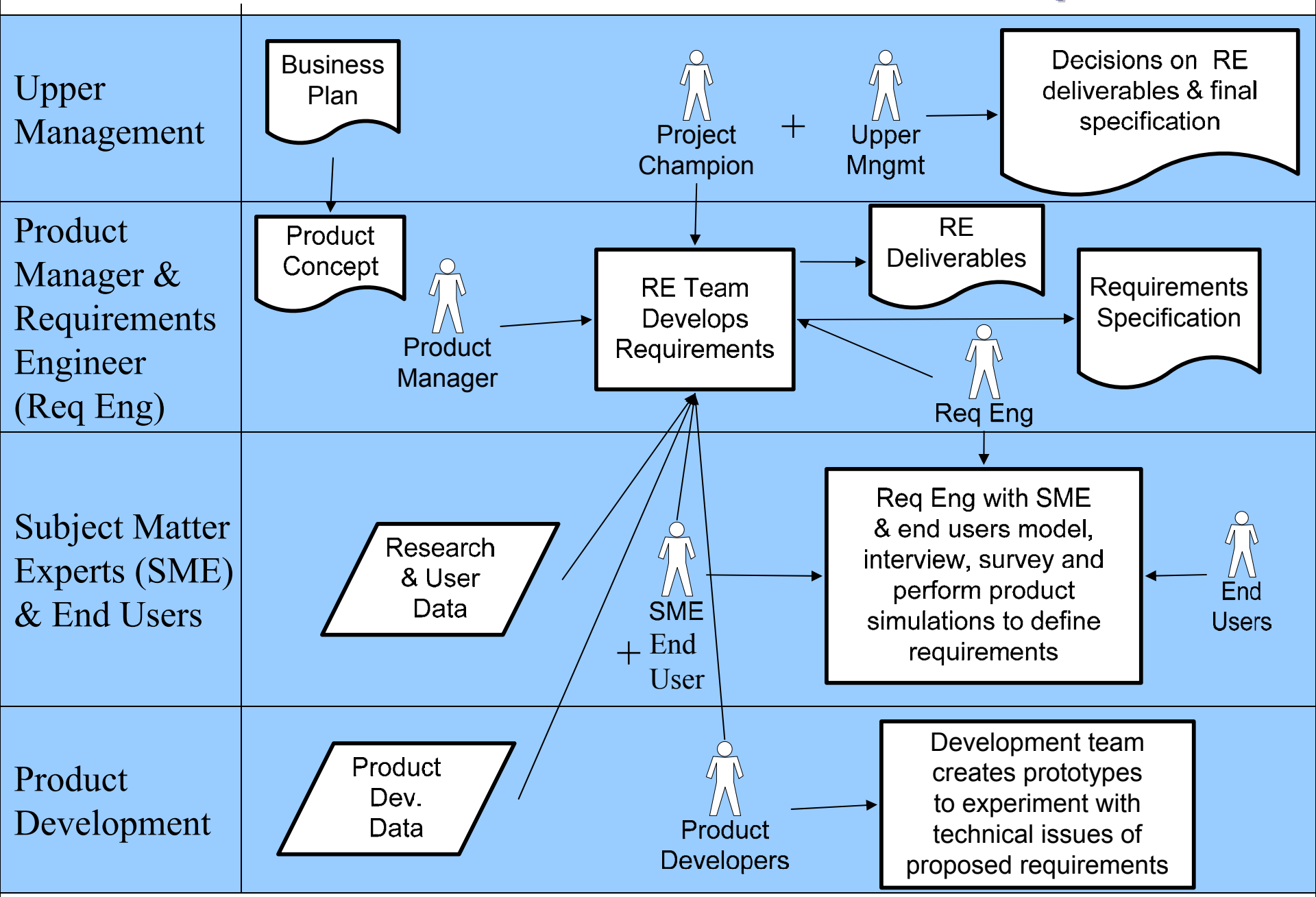
Define Scope Commitment & the Plan	Gather Elicit Requirements	Examine Clarify Organize	Refine Record Prioritize	Test Verify Deliver
Analyzing Reviewing Discussing Committing Planning	Brainstorming Interviewing Surveying Apprenticing Modeling	Modeling Simulating Role-playing Discussing	Modeling Standardizing Filtering Negotiating Recording	Inspecting Correcting Challenging Completing

Policymaking Process

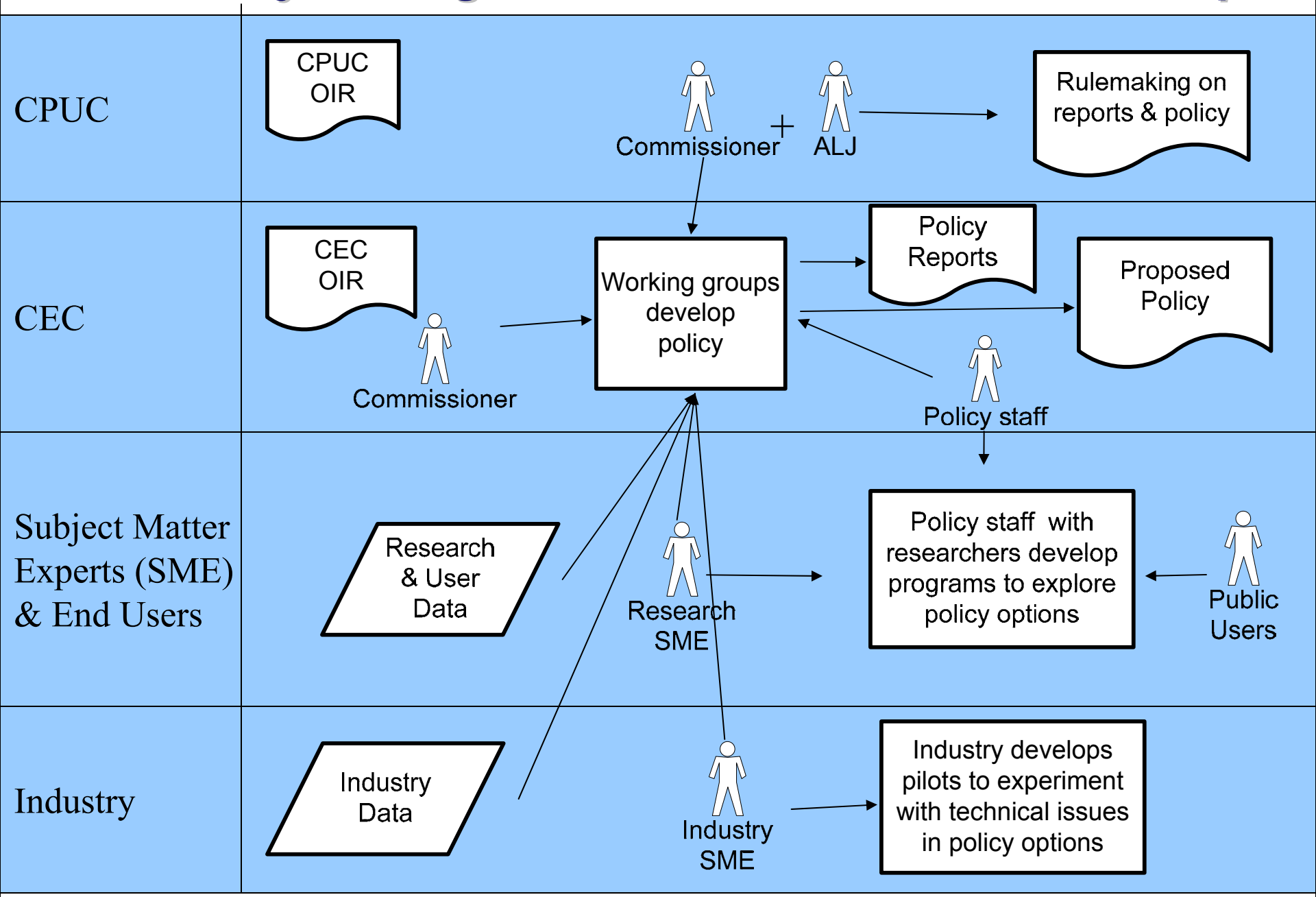
Define the problem	Assemble some evidence	Construct alternatives Select Criteria	Project outcomes Confront tradeoffs	Decide! Tell your story

from A Practical Guide for Policy Analysis by Eugene Bardach

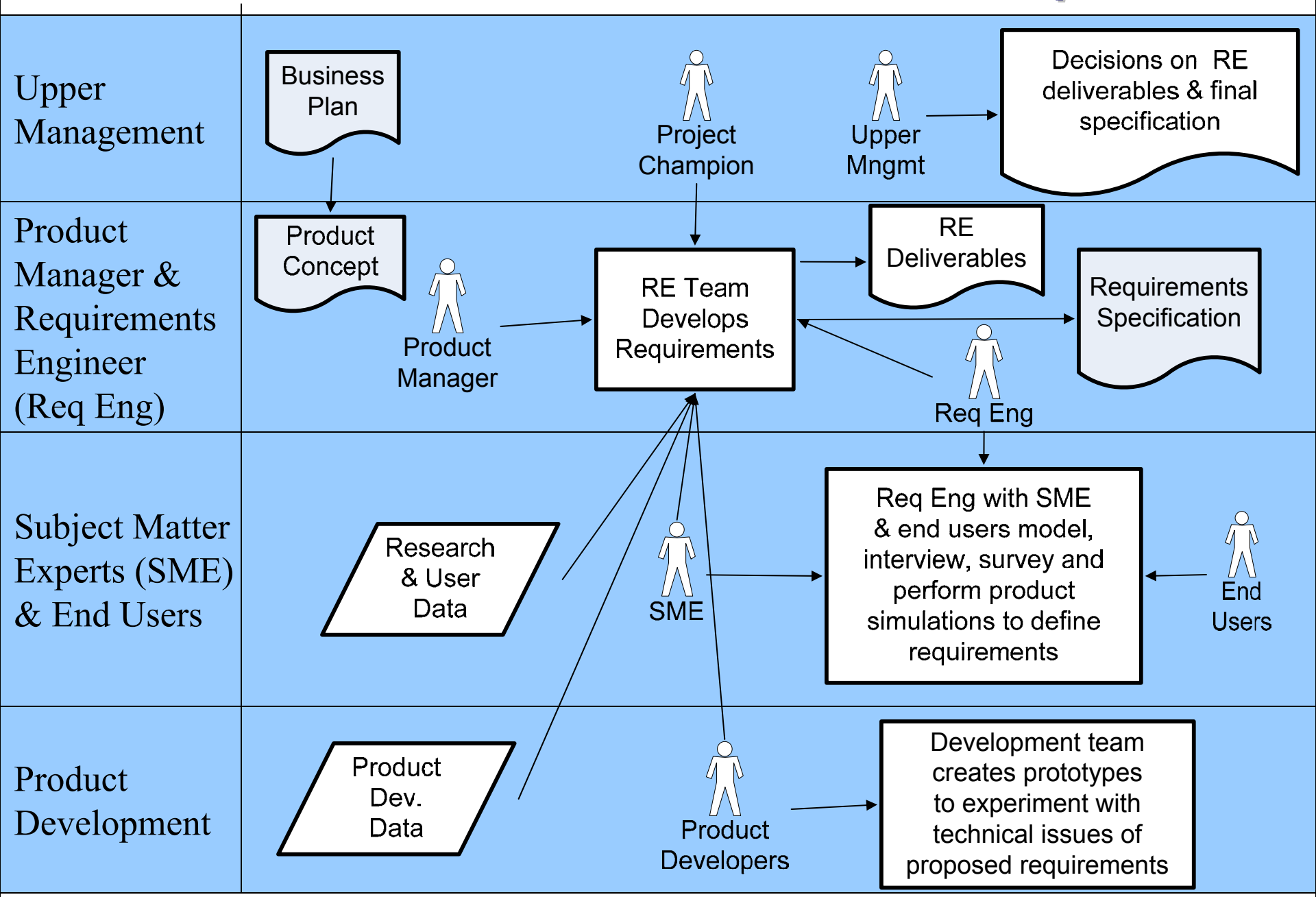
RE Cross-Functional Process Map



Policymaking Cross-Functional Process Map



RE Cross-Functional Process Map



Seminar Outline

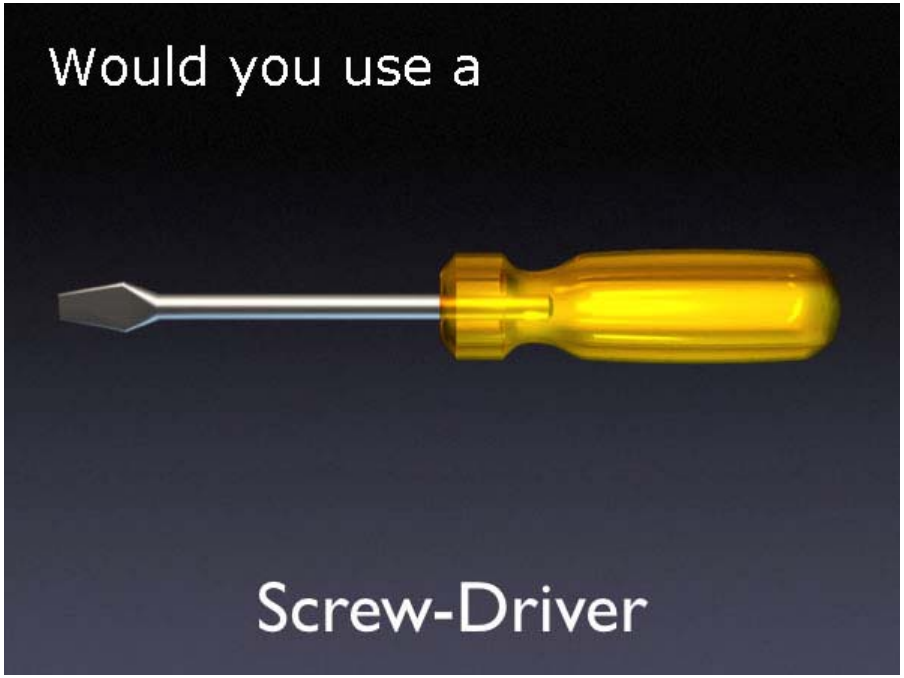
- ✓ Introductions & Seminar Objectives
- ✓ RE Definitions & History
- ✓ What RE Can Do & What It Can't Do
- ✓ RE Process: Comparing It To Policymaking
  - ✓ **Any questions?**

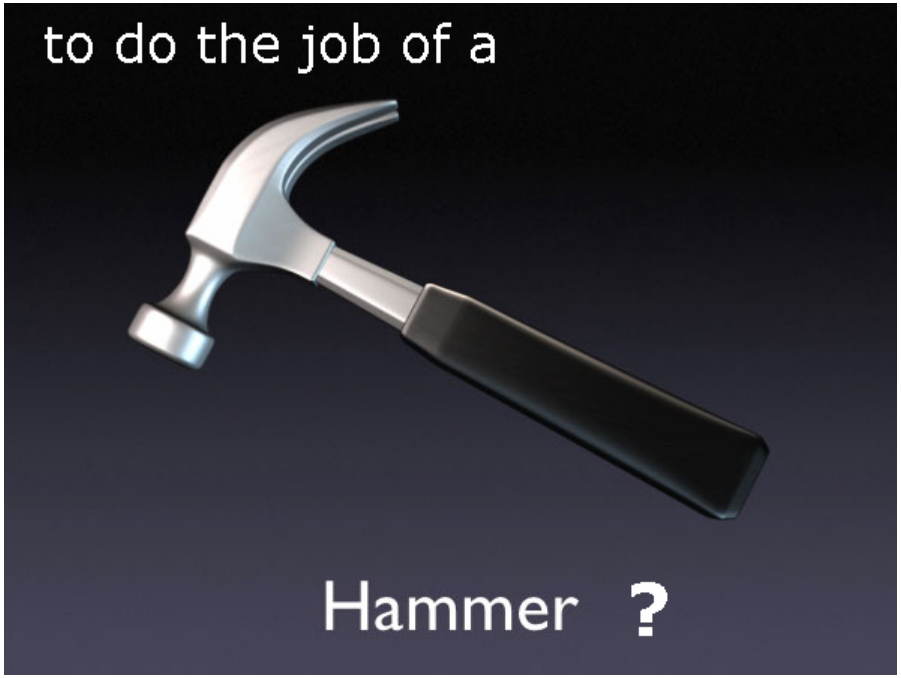
BREAK

- ➢ RE Tools & Techniques:
  Applying Them To Policymaking

RE Tools & Techniques

- The Right RE Tool/Technique For Each Stage
  - To get the “Information Advantage“





The Right RE Technique for All Stages

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Define Scope Get Commitment Make a Plan	Gather Elicit Requirements	Examine Clarify Organize	Refine Record Prioritize	Test* Verify Deliver

JAD Workshop:
- Selected team
- RE Facilitator
- Recorder
- Interactive space
- Planned activities
- Deliverables

JAD Workshops are great for:
- Team building
- Work efficiency
- Intelligence sharing
- Mutual understanding
- Collaborative decision making
- Protection against
  - Hubris of one powerful person
  - Hidden agendas
  - 'Silenced' agendas

What If London Ambulance Service Used JAD-type Workshops in The CAD Project?

- **Hubris (quotes from the inquiry report)**
  - "LAS management ignored or chose not to accept advice."
    - JAD Workshop: Team using collaborative decision making
- **Silenced agendas**
  - "Staff saw deadlines set by the top level of management as being rigid, inflexible and, more importantly, not to be challenged."
    - JAD Workshop: Neutral facilitator
- **No follow through**
  - "At project group meetings a number of issues were raised…but there is no evidence that any of them were followed up."
    - JAD Workshop: Recorder & Workshop Deliverables

The Right RE Tool for Stage 1

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Define Scope *Get Commitment* *Make a Plan*	Gather Elicit Requirements	Examine Clarify Organize	Refine Record Prioritize	Test* Verify Deliver

Project Charter:
- Stakeholder classes
- High Level Scope
- Critical Success Factors
- Risks & Issues
- Project team
- Project calendar & plan

The Project Charter is great for:
- Painting the big picture
- Defining what success means
- Identifying challenges
- Getting commitment at the start
- Setting a course of action
- Guiding the RE process

What if LAS Had Started the CAD Project with a Project Charter?

- **Stakeholders were ignored (quotes from inquiry report)**

  "…staff were alienated to the changes rather than brought on board…There is no evidence of the ambulance staff having joint 'ownership' of the system as one of the key stakeholders."

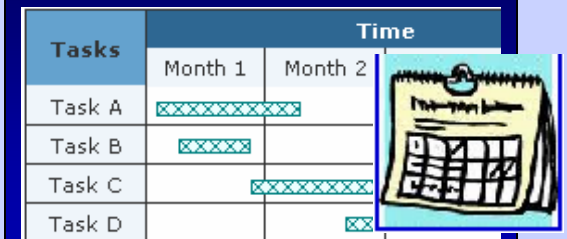
- **Misguided Priorities**

  "LAS management were under constant pressure to improve performance and to meet the ORCON standards. This contributed to the pressure on the project team to achieve the earliest implementation…In particular, it is evident that no proposal made the shortlist if the timetable could not be met."

What LAS CAD Project Charter Might Look Like

Project Charter:
- Stakeholder classes
- High Level Scope
- Critical Success Factors
- Risks & Issues
- RE team
- Project calendar & plan

Gantt Chart



LAS CAD Project: Stakeholder classes

Decision makers:

Senior Management, The Board

RE Team

LA

Direct users:

Ambulance crews

CS

Central Ambulance Control (CAC) Staff

1

Communication System

1

Indirect users:

2

The public calling for an ambulance

3

Advisors:

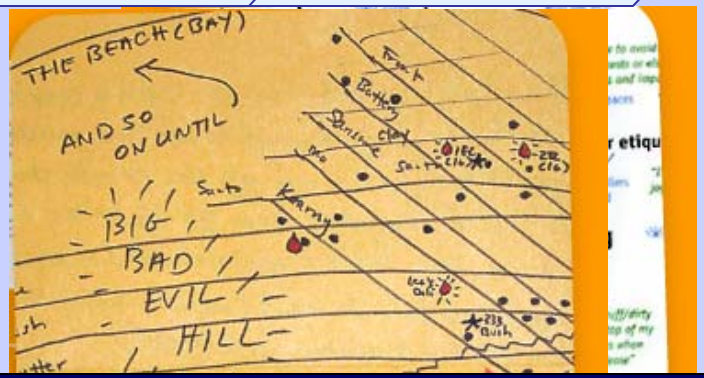
Regulatory – National Health Service

CAD experts - other ambulance services with CAD systems

The Right RE Techniques For Stage 2

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Define Scope Get Commitment Make a Plan	*Gather* *Elicit* *Requirements*	Examine Clarify Organize	Refine Record Prioritize	Test* Verify Deliver

Brainstorming Techniques
- Word Association
- Affinity Diagrams
- Cognitive maps



Interviewing Techniques
- 5 Why's
- Apprenticing
- Extreme user interviews

These techniques are great for:
- Freeing the imagination
- Revealing
  - underlying causes
  - unexpected connections
  - unconscious requirements
- Involving stakeholders in the process

What if LAS Had Used These Requirements Elicitation Techniques With Their Staff?

- **Stakeholders ignored**
  - "The proposed new system would impact quite significantly on the way in which staff carried out their jobs, yet in the case of the ambulance crews. there was little consultation on this new method of working."
    - Apprentice with Ambulance crews
    - 5 Why interviews to get at unconscious but critical requirements
  - "Physical changes to the layout of the control room…meant that CAC staff were working in unfamiliar positions, without paper backup, and were less able to work with colleagues with whom they had jointly solved problems before."
    - Apprentice with CAC staff
    - Cognitive mapping: Have CAC staff map out how they do their job in the control room.

Hypothetical 5 Why interchange while apprenticing with an LAS Ambulance Crew

1.Why did you send Joe's ambulance crew? They aren't the closest.

For starters, Joe will still get to the incident quicker.

2. Why is he able to do that?

Because the closest crew has a substitute driver – our regular guy is out sick today.

3. Why else did you send Joe's crew for this incident?

Because his crew is better trained for this call.

4. Why are they better trained?

It's a poisoning incident & Joe recently took a class in that.

5. Why doesn't the other crew have this training?

Because Joe's got seniority - we don't have the budget to send all crew members to all trainings.

The Right RE Tool For Stage 2

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Define Scope Get Commitment Make a Plan	*Gather* *Elicit* *Requirements*	Examine Clarify Organize	Refine Record Prioritize	Test* Verify Deliver

Modeling

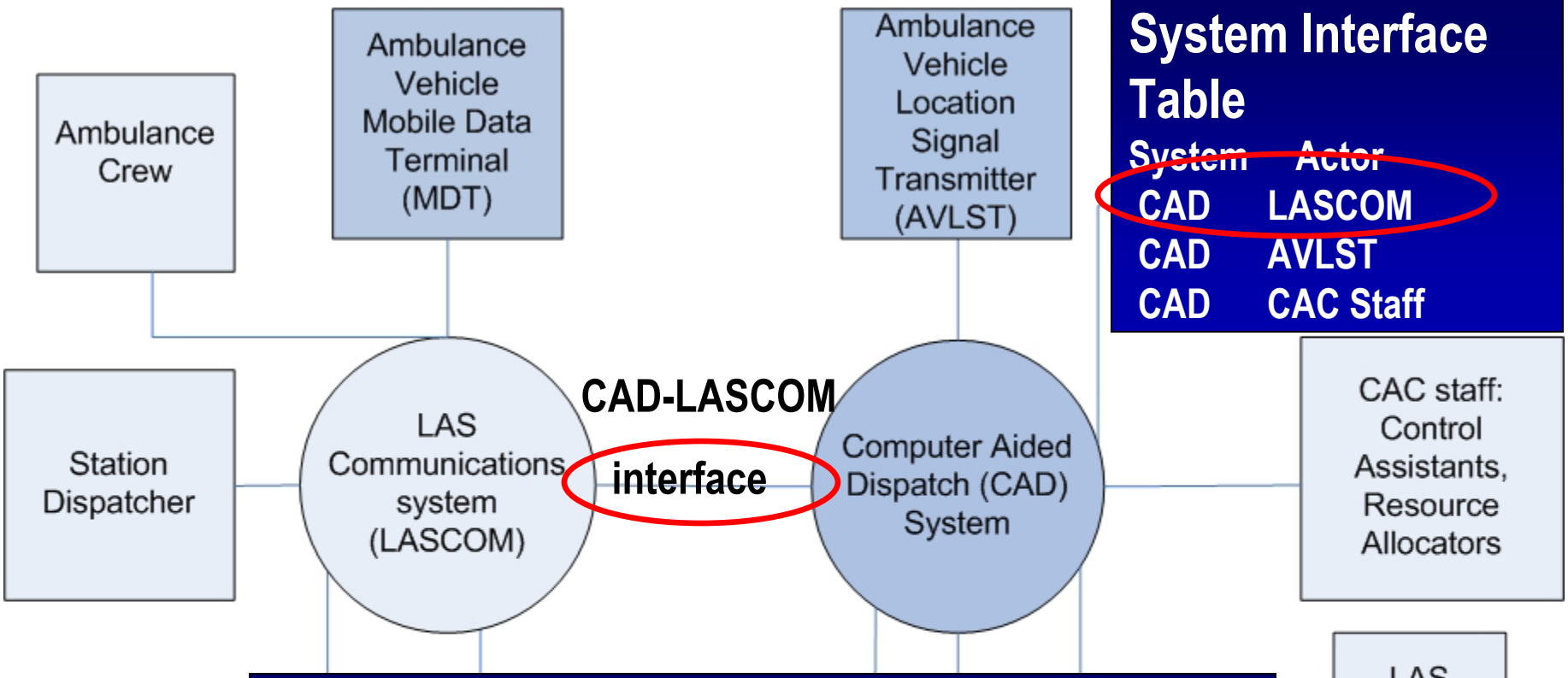
Context Diagram
Model the system being defined by looking at all its connections to stakeholders & other systems

Context Diagram is great for:
- Defining system Interfaces
- Defining system actors
- Deriving use case names
- Establishing functional scope
- Estimating the project size

What if LAS had created a Context Diagram to model the planned CAD System ?

- **Poor Systems Integration**
  - "The impact of CAD upon the existing communications infrastructure was never properly and systematically considered."
  - "…no formal calculations were ever done to show how the CAD system would impact on the communications system."

What LAS CAD Context Diagram Would Have Looked Like



System Interface Table

System	Actor
CAD	LASCOM
CAD	AVLST
CAD	CAC Staff

Use Case Names for CAD-LASCOM Interface

UC1. Send incident info
UC1.1 Send incident info to MDT
UC1.2 Send incident info to printer
UC1.3 Send special case incident to station dispatcher
UC2. Receive crew shift start/stop
UC2.1 Receive crew break start/stop

The Right RE Tool For Stage 3

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Define Scope Get Commitment Make a Plan	Gather Elicit Requirements	*Examine* *Clarify* *Organize*	Refine Record Prioritize	Test Verify Deliver

Use Case with Scenario: e.g. UC1.1 Send incident info to MDT

Success Scenario:

Step	Actor	System
1.	CAD sends MDT incident report	LASCOM receives report & returns receipt
2.	CAD updates re	
3.		
4.		
5.		
6.	CAD updates re	

Use Case Names for CAD-LASCOM Interface

UC1. Send incident info to MDT
UC1.1 Send incident info to printer
UC1.2 Send special case incident to station dispatcher

UC2. Receive crew shift start/stop
UC2.1 Receive crew break start/stop

The Right RE Tool For Stage 3

Stage 1 Stage 2 ***Stage 3*** Stage 4 Stage 5

Use Case with Scenario: UC1. Send incident info to MDT

Preconditions: CAD received incident (UC3 Success Scenario)

Success Scenario:

Step	Actor	System
1.		

Alternate Flow:

1. CAD sends MDT incident	
2. CAD updates report statu	
3.	
4a.	
4b. CAD records shift start	LASCOM receives receipt from MDT

Error Flow:

1a CAD sends incident report	LASCOM does not receive report
1b. CAD resends incident report	

Rules

Use Case Scenarios are great for:

- Examining and clarifying system interfaces
- Defining sequential steps of a process
- Uncovering error conditions that must be handled
- Defining the rules that govern the system

The Right RE Tool For Stage 4

Stage 1 Stage 2 Stage 3 Stage 4 Stage 5

Define Scope
Get Commitment
Make a Plan

Gather
Elicit
Requirement

Examine
Clarify
Organize

Refine
Record
Prioritize

Test
Verify
Deliver

Critical Success Factor (CSF) Sieve

From London Ambulance Service CAD Project Charter	Requirement 1 Management Reports	Requirement 2 Meet ORCON standards	Requirement 3 Staff training	Requirement 4 Use latest Windows
CSF1 Improve com ORCON standards				
CSF2 Be as reliable manual dispatch sy				
CSF3 Ambulance c 100% supportive of				
	3 ? ?	3✓ Yes	3✓ Yes	0 No

Critical Success Factor Sieve is great for:

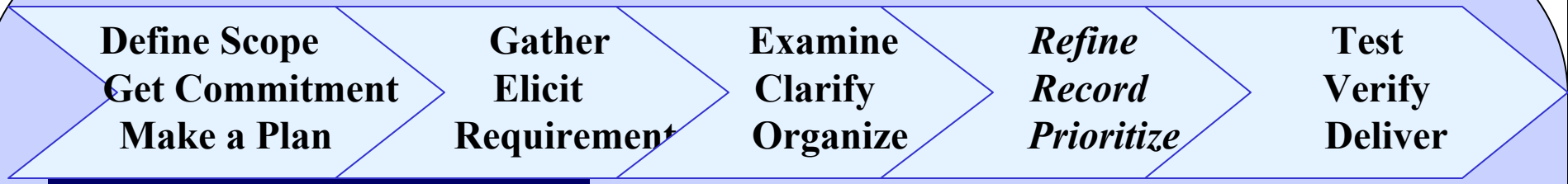
Prioritizing requirements based on their support of project success

Protecting projects from feature creep

Making prioritizing a more objective activity

The Right RE Tool For Stage 4

Stage 1 Stage 2 Stage 3 Stage 4 Stage 5



Acceptance Criteria

Example: London Ambulance Service Computer-Aided Dispatch

Improve ORCON Compliance Acceptance Criteria

1. From receipt of call to incident report with location & closest station	.5 minute
2. From end of #1 to receipt of incident report at LASCOM	.1 minute
3. From end of	age .3 minute
4. From end of	.5 minute
5. From end of	.1 minute
6. From end of	

Acceptance Criteria are essential for:

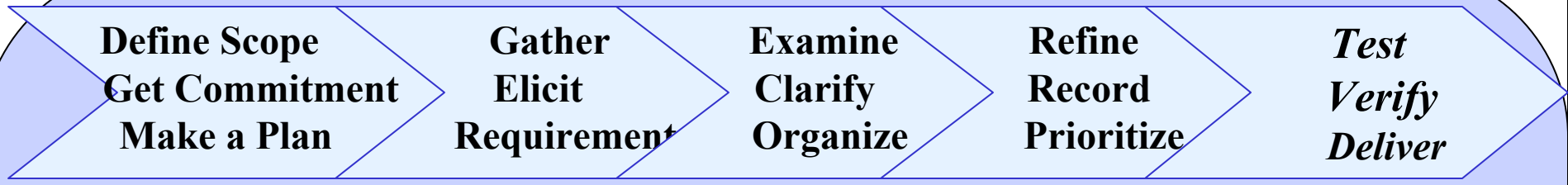
Defining the 'recipe' for implementing the requirement

Protecting against misinterpretations

Catching missed rules and requirements

The Right RE Tool For Stage 5

Stage 1 Stage 2 Stage 3 Stage 4 **Stage 5**



Inspection Checklist

1. Completeness check
2. Illegal word check
3. Misinte
   Reward
   show ho
   be misin
4. Team a

Illegal Word List

Words not allowed in the acceptance criteria of requirements because they are vague and can be misinterpreted

Inspection Checklist is essential for:

Providing a last chance to catch requirements errors

Objective evaluation of requirements

Encouraging team to challenge their own work

Final team approval of the specification

The Right RE Technique For Stage 5

Stage 1	Stage 2	Stage 3	Stage 4	**Stage 5**
Define Scope Get Commitment Make a Plan	Gather Elicit Requirement	Examine Clarify Organize	Refine Record Prioritize	*Test* *Verify* ***Deliver***

'Sig

For
deli
the

Invi
who

And
little

'Sign-on Party' is great for:

- Providing *positive* final approval
- Celebrating everyone's efforts
- Closure of Part 1 & Kick-off to Part 2
- Releasing tensions from any conflicts during the process

L'MONTE INFORMATION SERVICES
www.lmonte.com

A Few Important Resources

- Policymaking
  - A Practical Guide For Policy Analysis by Eugene Barbach
- Requirements Engineering
  - IDEO Method Cards produced by IDEO
    - http://www.ideo.com
  - Requirements by Collaboration by Ellen Gottesdiener
    - http://www.ebgconsulting.com
  - Requirements-Led Project Management by Suzanne and James Robertson
    - http://www.systemsguild.com/ & http://www.volere.co.uk/
  - Writing Effective Use Cases by Alistair Cockburn