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





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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



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



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?



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



Comparing a Widget to a System:



Comparing a Widget to a System:









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.



Specification tools for buildings or widgets



Small scale models



didn't work to model

- System processes
- System interfaces



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

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 sei
 - 7 million people
 - Staff of 2,700
 - Project: computerize the dispatch
 - Driving force of project



AMBULANCE CHIEF QUITS AFTER PATIENTS DIE IN COMPUTER CRASH

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

-Poor compliance with National Health Service regulations



- 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)
- <u>Mythical Man Month</u> 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



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✓ 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 <u>Requirements by Collaboration</u>, 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:

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- Hubris
- Hidden agendas
- Poor coordination
- No follow through



But there are RE techniques that can help

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✓ 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 The goal

At The End Of Each Stage...

Review the big picture & the ground you have covered

The goal

- 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 <u>Requirements-Led Project Management</u>

RE Process: Getting Valid Requirements



Requirements Engineering Deliverables

Comparing RE Process With The Policymaking Process

Requi	rements Engineeri	ing Process		
Define Scope Commitm & the Plan	Gather Elicit ent Requirement	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
Define the problem	Assemble some evidence	Construct I alternatives Select Criteria	Project outcomes Confront tradeoffs	Decide! Tell your story
Policy	making Process			
from A Pr	actical Guide for Polic	v Analysis by Euge	ene Bardach	

RE Cross-Functional Process Map



Policymaking Cross-Functional Process Map



RE Cross-Functional Process Map



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✓ 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



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





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



LAS CAD Project: <u>Stakeholder classes</u> Decision makers:

Senior Management, The Board

RE Team

LA Direct users:

- Ambulance crews
- **CS** Central Ambulance Control (CAC) Staff
 - **Communication System**

Indirect users:

The public calling for an ambulance

Advisors:

1

1

2

3

Regulatory – National Health Service CAD experts - other ambulance services with CAD systems

The Right RE Techniques For Stage 2





Interviewing <u>Techniques</u> 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.

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

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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



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

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

StepActorSystem1. CAD sends MDTincident report LASCOM receives report & returns receipt2. CAD updates reUse Case Names for CAD-LASCOM Interface3.UC1. Send incident info to MDT4.UC1.1 Send incident info to printer5.UC1.2 Send special case incident to station dispatcher6. CAD updates reUC2. Receive crew shift start/stopUC2.1 Receive crew break start/stop

Stage 1 St	age 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							
Alternate Flow: 1. CAD sends MDT incident 2. CAD updates report status 3. 4a.	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						
4b. CAD records shift start LASCOW receives receipt from WD I							
1a CAD sends incident report LASCOM does not receive report 1b. CAD resends incident report EASCOM does not receive report Rules							

Stage 1	Stage 2	Stage	3 Stag	e 4 Stag	ge 5
Define Scope Get Commitme Make a Plan	Gather nt Elicit Requirer	r Exar Clar ment Orga	nine Re ify Re anize Pr	efine ecord rioritize	Test Verify Deliver
Critical Success	Factor (CS	F) Sieve			
From London Ambo Service CAD Projec	ulance ct Charter	Requirement 1 Management Reports	Requirement 2 Meet ORCON standards	Requirement 3 Staff training	Requirement 4 Use latest Windows
CSF1 Improve com ORCON standards Critical Success Factor Sieve is great for: Prioritizing requirements based on their support					
CSF2 Be as reliable manual dispatch sy Protecting projects from feature creep					
CSF3 Ambulance of 100% supportive of	Making pri	oritizing a	more object	tive activity	
		3?	3√	3√	0

?

Yes

Yes

No

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
	Define Scope Get Commitm Make a Plan	Gather Ient Elicit Requireme	Examine Clarify Organize	Refine Record Prioritize	Test Verify Deliver
Α	cceptance C	Criteria			
Exa	ample: London	Ambulance Servi	ce Computer-Aid	led Dispatch	
Imp	orove ORCON	Compliance Acce	ptance Criteria		
1. F	rom receipt of	[;] call to incident re	port with locatio	n & closest stati	on .5 minute
2. F	rom end of #1	to receipt of incid	ent report at LAS	SCOM	.1 minute
3. F	From end of	cceptance C	riteria are e	essential for	age .3 minute
4. F	From end of th	e requirement		menting	.5 minute
5. F	From end of	rotecting again	st misinterpr	atations	.1 minute
6. F	rom end of				
	C	atching missed	I rules and re	quirements	



The Right RE Technique For Stage 5







'Sign-on Part, as great for:
For deli the Providing positive final approval
Celebrating everyone's efforts
Invi Closure of Part 1 &

whe Kick-off to Part 2

Anc conflicts during the process

A Few Important Resources

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

