The purpose of this lecture is to introduce the requirements engineering process, how to structure requirements, and how you should see requirements engineering as part of a much wider creative design process.
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Much of the what I have said in this module depicts requirements engineering as a rather mechanical process. Write requirements in a standard format, structure them in certain ways, and decompose them according to a set of rules. However, while the processes for expressing, structuring and improving requirements are mechanical, the processes of discovering what the requirements are or might be, i.e. what the future system will do, are not. It is essential to see requirements engineering as part of a process of innovation. Just think about the design of a mobile phone, TV system or new car. Most people agree the need for creative design processes to bring in innovation and improvements. However, each of these design processes also has a major requirements phase.

Most stakeholders, on their own, are not inventors. That is your role. Robertson (2002) makes a strong claim that analysts need to be inventors, to bring about the innovative change in a product or business that gives competitive advantage - it is perhaps not something that a stakeholder directly asked for - but it happens at the requirements stage. Not all new ideas are good ones, so the challenge becomes even greater - to innovate good ideas, express them as requirements and link them to other, less innovative requirements coming from stakeholders.

Requirements Engineers Must Invent

Invent ideas to be represented as requirements
– Stakeholders, often lack the technical knowledge to envision and specify all of the requirements
– Consider the following case study of giving stakeholders what they want

Examine the impact of created requirements

Remember - most stakeholders are not inventors or designers. Some of the requirements that stakeholders come up with are real stinkers - just look at the video case study! Nowadays, given the range of new opportunities based on software and computing technology, requirements engineers also need to act as inventors, exploring and recommending ideas that are expressed as requirements. This video demonstrates the point amply. Enjoy it.
Innovation and Invention

Creative design is next major economic trend
- Industrial revolution replaced agriculture, then IT replaced industrial production, and now.....
- Creative design will replace IT as major economic driver

Shift of IT organisations towards creative sector
- IDEO - the world’s leading design organisation (www.ideo.com)
- Innovation in electronic devices such as mobile phones

Writing requirements results from a creative process
- Result of creative step from AS-IS to TO-BE system
- Envision new innovations in the form of requirements
- Where else will the innovation occur?

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If the Nomura Research Institute is correct, we are moving into an exciting new period of product innovation. We have already begun to see this with electronic products such as mobile telephones that combine current features in creative new ways.

We believe that RE is increasingly a creative process in which stakeholders and designers work together to create ideas for new systems, then express these ideas as requirements that envision these new ideas. For example the requirement statement “The system shall use suitable audio cues to inform the controller of a conflict”, taken from requirements for a future air traffic control system, is the result of creative thinking about where and how noise might be usable in system-controller interaction. As RE practitioners and researchers we should admit, and indeed celebrate, the fact that one of the most important characteristics of requirements engineering is creative thinking. Indeed, the importance of creative thinking is expected to increase over the next decade.

Creativity has increasingly been the focus of interest in design. For example IDEO, the innovative design consultancy (www.ideo.com) uses a 4-stage method in which design teams understand the context of a new product, observe real-life situations, visualise the product, then evaluate and refine the product (Kelley 2001). The focus is on team-led multi-disciplinary creativity and innovation. There is no doubt that one of IDEO’s most important activities is to determine customer requirements for new designs. However RE processes, such as brainstorming, simulating and visualising and storyboard-illustrated scenarios, are subservient to IDEO’s tried-and-tested creative design process, environment and team structure.

But Requirements are not Creative!

Davies (1993)
- “the analysis and documentation of both user needs and the external behaviour of the system to be built”

Zave (1994)
- “the branch of systems engineering concerned with the real-world goals for, services provided by, and constraints on software-intensive systems. It is also concerned with the relationship of these factors to precise specifications of system behaviour, and to their evolution over time across families”

Too much focus on elicitation, analysis, management

You read these definitions of requirements engineering earlier in the lecture. Both are accepted definitions in this field. But relate them to what has just been said in the lecture. There is no recognition of the importance of creative acts, let alone a recognition of the importance of them. There is no doubt - writing a requirement statement is the result of a creative act - proposing some change in the world, and the nature of that change is often creative.

Fortunately other researchers and practitioners are beginning to see requirements engineering as a creative process. Our work is at the forefront of this process. The paper attached and included at the end of this lecture notes is a good example. References to other papers on the topic are included here.


Introducing creative techniques into structured requirements processes is easier said than done. That is perhaps one of the reasons that it has received a relatively low profile in requirements engineering research and practice over the years.

Our solution has been to introduce creativity workshops into our RESCUE requirements process. A creativity workshop, which usually lasts 2 days, is a space for stakeholders and engineering to create and invent requirements and other ideas in a facilitated environment. One project will typically have one or more creativity workshops. These workshops take place once the initial scope of the new system or product has been determined, but before detailed requirements and system behaviour are specified. Typical inputs to a workshop are context and use case diagrams that you will encounter later in the module. The main output from a workshop is a set of use case specifications that describe how a system will behave. Again you will learn how to write use case specifications later in the module. What is important to learn here is that the use case specification includes many of the requirements and ideas that result from creative thinking in the workshop. In fact, we consider that it is nearly impossible to write complete use case specifications without doing some creative thinking first.
Workshops tend to be held in large meeting rooms. At the beginning of a workshop each context and use case diagram and précis was posted on separate 1m² pin boards placed around the work-shop room that became the physical and logical space for ideas and requirements that were associated with that model and use case during the workshop.

The room is divided into 2 areas – a presentation area with a LCD projector in front of a large table around which all the participants could sit – and a breakout area with comfortable chairs placed around small tables to enable group work for 4 groups containing 4 or 5 people each.

Workshops are facilitated to encourage a fun atmosphere so that the participants are relaxed and prepared to generate and voice ideas without fear of criticism. For example, begin with a balloon animal making competition, with a prize for the participant who created the best animal. During creativity periods, standard RAD/JAD facilitation techniques and rules such as avoiding criticism of other people’s ideas and time-boxing each topic under discussion were applied.

Participants are supplied with A6 RESCUE colour-coded idea cards, post-it notes, A3 paper, felt pens and blu-tack with which to capture the results from the workshop. Everything captured on the posters is subsequently documented electronically.
CREATIVITY WORKSHOP STRUCTURE

Design informed by existing creativity models

Daupert 2002

Workshop period

Poincare 1982

Boden 1990

Two-day workshops

Integrate with structured RE methods

RESCEU incorporates creativity workshops to encourage creative thinking about requirements. Workshop activities were designed based on 3 reported models of creativity from cognitive and social psychology. Firstly, we design each workshop to support the divergence and convergence of ideas described in the CPS model (Daupert 2002). As such each workshop period, which typically lasts half a day, starts from an agreed current system model, diverges, then converges towards a revised agreed model that incorporates new ideas at the end of the session. Secondly, we design each workshop period to encourage one of 3 basic types of creativity identified by Boden (1990) – exploratory, combinatorial and transformational creativity. Thirdly, we design each period to encourage 4 essential creative processes reported in Poincare (1982): preparation, incubation, illumination and verification. The incubation and illumination activities are determined by the type of creativity that we seek to encourage. The slide shows how these models are used in a creativity workshop.

Applied Creativity Theories

Important creative activities (Poincare 1982)
- Incubation
  - Relaxing period during which people combine ideas with a freedom that denies linear and rational thought
- Illumination
  - Shorter period in which creative or innovative idea suddenly emerges, often at the most unlikely time - the EUREKA effect

Three creativity types (Boden 1990)
- Exploratory: opening up the space of ideas
- Combinatorial: combining ideas to generate new ones
- Transformational: Changing the problem space so that something that was impossible is now possible

We design each workshop to support 4 essential processes (preparation, incubation, illumination and verification) in creative thinking (Poincare 1982). To prepare stakeholders we maintained regular dialogue with stakeholders via e-mail between workshops to encourage them to discuss creative processes and ideas from earlier workshops. In each workshop we encouraged ideas to incubate using techniques including presentations from experts in non-air traffic control domains (see below), games to remove people’s inhibitions, listening to music and discussing paintings, and playing with props such as making aeroplanes from balloons! Each incubation period is followed by shorter, more intensive periods to illuminate ideas. People work together in dynamically-designed groups to generate new ideas from the baseline of the previous creative process cycle. In the later workshops we also encouraged verification of ideas by asking stakeholders to assess, rank and categorise the new ideas in different ways. We repeat this process several times in each workshop. To guide the participants during these processes, we used Occh’s (1986) simple explorer, artist, judge, warrior roles to focus them on specific activities.

Facilitated Analogical Reasoning

Important technique for exploratory creative thinking
- Transfer knowledge from analogical domain
- Expert presentation followed by 4 working groups

Analogy: Train - Plane

What features of a train type might be applied to an aircraft type in DMAN?

1. Turnaround time
2. Speed and time to move
3. Length and platform fits
4. Typical routes followed

1. Turnaround and cleaning time
2. Taxi speeds
3. Aircraft size and gates
4. Terminals and flight routes

Analogy reasoning is an important technique for exploratory creativity, i.e. discovering new ideas in the problem space. Studies have showed that people can exploit such analogies to reuse requirements if they are given support to recognise, understand and transfer the analogies. In the creative workshops we provide this support but encouraged the participants to go one step further and use the transferred knowledge from another domain for which a solution exists to provoke creative thinking about requirements and ideas in the target domain.

Previous studies of analogical problem solving have suggested that similarity-based reasoning is difficult, and that people often needs syntactic similarities between the domains to recognize the analogy. Therefore, in contrast to our previous use of analogies with few syntactic similarities (e.g. Indian 17th century textile design to aircraft conflict resolution), we have explored analogies between domains that have shared more surface similarities.

Participants work in small groups to illuminate the analogical ideas. To aid them, the facilitators presented a simple example of analogical creativity between the two rental domains – from a video rental store to improve services offered by an academic library. The example identified how to detect and record analogical mappings between do-mains, then how to use each mapping in turn to transfer knowledge from the source domain to generate new ideas in the target domain.
During transformational creativity people change the solution space in a way that things that were considered impossible are now possible (Boden 1990), for example by challenging pre-conceived constraints and exploring new solutions to existing problems. In creativity workshops we encourage transformational creativity by introducing knowledge about possible solutions, for example candidate visualizations for presenting information to air traffic controllers. The knowledge is usually delivered to the workshop participants via an expert presentation on information visualization. Participants then work in small groups with information about possible solutions, and sometimes changing the possible solution space along the way. Ideas resulting from the illumination activity are then verified when each group reported back ideas to other workshop participants.

Combinational creativity is the creation of new ideas from combination and synthesis of existing ideas. Combinatorial creativity is characterised by the improbability of the combination, or in other words, the surprise encountered when such an unusual combination is presented. Association is an important mechanism for combinatorial creativity. It is the recognition of similar patterns in different domains, sometimes in the presence of noise or uncertainty. Combinatorial creativity by association is applied during workshops to create new ideas based on the ideas generated in earlier periods.
Yummy yummy. What you are looking at here is a classic example of fusion cooking that demonstrates the combinatorial creativity that we were trying to encourage from the workshop participants. The dish that you are looking at is Fois Gras (ducks liver) with a Mango salsa. Fois gras is a traditional French dish, often drunk with a sweet, almost syrupy wine such as a Sauterne. The clever, fusion-part of this dish, is to replace the Sauterne wine with the Mango salsa. The taste and texture of the mango is sweet and almost syrupy, and it works a treat. This example demonstrates one principle behind good fusion cooking, that there are simple ‘replacement’ rules behind the design of the dish. During combinatorial creativity we need to ensure that stakeholders understand the benefits from combining items together, and to use simple rules to guide and constrain the ideas that can be combined.
Storyboarding is another technique that is often used to elaborate and combine creative ideas without constraining the creative process. Participants again work in small groups. Each group is asked to produce a story-board that described the possible combination of requirements and ideas associated with one use case according to the relevant 1m2 board. The storyboard elaborates the use case description by combining ideas together in the story-board. To structure the storyboarding process, each group is given A1-size pieces of paper that were annotated with 16 boxes to contain a graphical depiction of each scene of the storyboard and lines upon which to describe that scene. An example storyboard for the DMAN Departure Management system is shown in the slide above.
Think of the product that your company sells to its customers. Is it unique? If not, providing a better service may well be the way to differentiate your organization and product from your competitors.

For example, how many banks are there with a branch close to you? They all offer much the same in the way of products. Most of us leave a bank if another bank offers a noticeably better level of service. Your customers are looking at your organization the same way you look at your retail bank.

If your service is worthwhile, it must provide value for your customers’ work. Federal Express reasoned people would pay for a reliable delivery service. So FedEx started asking people to pay $21 for a service that had formerly cost about 21 cents. Today this service delivers 3.3 million packages each business day.

Any service you provide must of course relate to what your customers will value if you give it to them. Hertz offers Le Swap to UK customers who want to take a car to continental Europe.

Maybe you feel you cannot invent a way to improve on the service you already provide. In which case, can you invent some extra service? Wells Fargo bank understood its customers were wealthy enough to have a bank account and thus probably traveled. Wells Fargo began offering travel services to its customers, and picked up a lot of business that would otherwise have gone to travel agents. This is simply an invention based on the idea of providing an extra service.

- **Service** - what extra service can you provide? *Request a statement, top up a phone, pay bills, foreign currency, stamps, tickets,*
Information and Choices

Your customers already have lots of information, and expect more.

Give customers access to your company’s information.

What do your customers want to know?

What information would they find useful?

Today’s consumers are far better informed than they were a generation ago when people were accustomed to being kept in the dark. If any organization refuses to provide information it can look forward to a departing customer.

Your customers already have lots of information, and they expect more of it. Your systems must give customers access to your company’s information. The customer is king and expects to be treated royally when it comes to information. As an example of good information, the website of Progressive Insurance provides car insurance rates for all known insurers. They perform this service regardless of whether or not a competitor’s rates are higher. Consider how the consumer shopping for insurance reacts to the openness of this kind of information.

Visit Charles Schwab’s site or any other online brokerage site. Look at the amount of information you can get, and a lot of it is free. Today investors can get information that was until a few years ago considered arcane and privileged to stockbrokers only. Schwab online is a huge hit. He took his brokerage business online and gave customers what they wanted—lots of information—and he lets them get on with it.

Federal Express has launched its InSight service. This allows anybody to get proactive delivery and delay information. The reasoning is if people can get information on incoming FedEx shipments, regardless of whether they know who sent them or when, then consignees will ask their suppliers use Federal Express as their carrier. So here we have a service being sold on the back of information.

How much information does your customer get? What is it your organization knows, or could know, that your customers would also like to know? You need to open the corporate information kimono by inventing some way of getting more information to the outside world.
Participation

People want to do more of the work themselves
- FedEx, DHL and UPS tracking
- Amazon encourage site visitors to write their own book reviews
- Software support sites
- Self-booking of flights
- Self-scanning at supermarkets

How do your customers participate in your business?

"Changes in business processes will emphasize self-service...Your costs will go down and the perceived level of service goes up because customers are conducting it themselves." - Raymond Lane, president Oracle.

Federal Express, DHL, and UPS spent millions on systems to facilitate self-service. Visit any of these company’s websites and look at the options for self-service they provide. You can do an amazing amount of the shipping work yourself. While the shipper probably won’t give you a discount because you have done the work, giving your customers this ability encourages loyalty. And if customers are doing the work themselves, they are far less likely to complain about the service.

We are seeing the rise of cut-rate airlines. Self-service makes a major contribution to their cheaper fares. One of the more notable players in Europe is easyJet. This airline is coming close to a complete self-service airline. If you want to fly easyJet you must go online and book the flight yourself. No seat assignments, you find your own seat. No tickets, just bring yourself. Most easyJet passengers bring food and drink on board, as cabin service is not included in the fare. easyJet still handles your luggage and flies the plane, but as much as possible, or acceptable, is done by the passengers themselves. And the airline is very popular with the growing number of passengers who fly with it.

• Participation - how can you involve the customer? Have the interface reflect the customers. For example, have photos of relevant actors tell the customer what is happening “I’m counting your money, please wait.”
Connections

We love to be connected
You will keep your customers
if you connect them to your business
  – For example, loyalty cards, frequent flyer plans, newsletters, branded credit cards, automatic software updates are connections
The information umbilical cord
How can you connect to your customers?

We love to be connected so much so that we are willing to walk around looking like total dorks with things glued to our ears. Why? Because we do not want to miss that VERY IMPORTANT CALL.

• Connectivity - what new connections can you make?
  News, suggestions for budgeting, for example, suggest moving a DDR to another more convenient date.

• People have crashed their cars so that they can answer their phones

• Suki wakes at 3am to answer her phone

• A test study showed Italians becoming ill when deprived of their phones

• What is going on here?
Trust

Your customers must trust you

- eBay, eopinions.com and others have self-policing trust systems

Invent a better way to let your customers know they can trust you, or your system
Convenience

Your customers want the perception of convenience
Why are we willing to pay more for mobile phone calls?
Why do we shop online?
What can you do for your customers to make their lives more convenient?
Remove one step
Do something instead of making your customer do it

•Convenience - what can you make more convenient? “Same amount this time Mr. Robertson?”
So Remember, Requirements Engineers!

You are inventors in a wider design process

- Requirements engineering should be **systematic**
- Innovation should be **creative**
- Requirements capture the future high-level innovation

What you have to practice in this module

- marry creative design with rigorous system requirements engineering to produce testable requirements that envision high-level design ideas

It involves thinking!!!

The slide and the exercises say it all. Free up your thinking and be prepared to be creative. We'll be practising this throughout the module.