Creative Requirements Processes: Inventing Your Requirements

Professor Neil Maiden
What’s in the Talk

1. Creative requirements processes
   – Existing views on requirements elicitation

2. Creativity workshops
   – Applied to the **DMAN** Departure Manager
   – Applied to the **MSP** Multi-Sector Planning System

3. Creativity support tools for requirements
   – Developed and evaluated

4. Future work
Creative Requirements Processes

Requirements focus on elicitation
- Ask stakeholders what they want
- Limited by perceptions of what is possible

Separation of requirements from design
- Discourages thinking about possible solutions when eliciting requirements

Requirements encapsulate creative thought
- Requirements are desired properties of a future system
- Results of creative work often expressed as requirements
The Customer is a Rear-View Mirror, not a Guide to the Future

George Colony - Forrester Research

- Companies go out of business providing everything that their customers ask for
- Improvements come mainly from invention based on creative requirements
Inventions

Many useful products are things that nobody asked for. For example, the mobile phone, the World Wide Web, MP3 music, digital photography, CD, DVD, PDF, etc. etc. Once they were invented we wonder how we got along without them. We want what we see.

“Our job is to give the client, on time and on cost, not what he wants, but what he never dreamed he wanted; and when he gets it, he recognizes it as something he wanted all the time.” - Denys Lasdon, architect
So What is Creativity to You?

What do you think creativity is?

Some previous thoughts

- A different approach; new idea from something old; an original and elegant idea; improving something; using your imagination; no limits; building on something; producing a better and less expensive solution; doing something quirky or whacky; aiming to do something similar but bigger; doing something new; synthesis; viewing something from an unusual point of view; new combinations of things; smashing ideas together
Creativity definition

Sternberg and Lubart (1999) define creativity as

- “the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful, adaptive concerning task constraints)”

Draw on theories of creativity

- Psychology and artificial intelligence

Original CPS model (Osborn 1953)

- Six stages: mess finding, data finding, problem finding, idea finding, solution finding and acceptance finding
Frame Requirements Engineering as Creative Problem Solving [DIS’2004]

CPS Method (Osborn & Parnes 1953)
Drill down into the minutae, then come back up - it bounces
RESCUE Creativity Workshops

A space for creating and inventing ideas

- Understanding of current situation
- Overview of future system
- Possible technical solutions
- Outline use case model
- Storyboards for key use cases

Invent ideas with which to write specifications
Creativity Workshops

- Pin boards structured by use case
- System models available to all
- Facilitated guidance at all times
- Colour-coded snow cards for ideas
- U-shaped table for talks and report backs
- Games to encourage playfulness
Creativity Workshop Structure
Design informed by existing creativity models

- **Poincare 1982**
  - Encourage exploratory, combinatorial or transformational creativity

- **Daupert 2002**
  - Workshop period

- **Boden 1990**
  - Encourage exploratory, combinatorial or transformational creativity

- **Revised Model**
  - Shared input/output models

Integrate with structured RE methods
Running the Workshops

Investigated creativity-in-the-large
  – Investing new concepts of operation for air traffic management systems

Adopted action research approach
  – Ran and reflected on creativity workshops within large air traffic management projects

Two projects are reported
  1. DMAN - Departure manager system for Heathrow and Charles de Gaulle
  2. MSP - Multi-sector planning system for European air space
Eurocontrol’s DMAN System [DIS’2004]

Departure manager for major European airports
- Sponsored by Eurocontrol
- Applied RESCUE over 12-month period
- Joint project involving UK and French national bodies
- Applications including Heathrow & Charles de Gaulle
Facilitated Analogical Reasoning

Important technique for creative thinking
- Transfer knowledge from railway scheduling
- Expert presentation followed by 4 working groups

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
Other Creative Activities

Expert presentation of visualization solutions
- Working groups generate DMAN visualizations

Combinatorial creativity
- Expert presentation of fusion cooking
- Rules for idea combining
- Storyboards combine ideas into coherent scenarios
Workshop Results [DIS’2004]

All 4 half-day periods took place
- Three expert presentations followed by working groups of four
- Final storyboarding in groups of four

Ran to time, produced outcomes without conflicts

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>System-wide</th>
<th>Use-case-specific</th>
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<tr>
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First session ideas
- Tended to be given non-functional requirements
Analogical Reasoning Ideas

Ideas were system-wide

- Schedules are built on well-established knowledge including distances, speeds, airways, taxi routes and turnaround times (from established knowledge of railway track layout)

- DMAN can swap flights with the Central Flow Management Unit (CFMU) slots regulated for the same sector, or departure times of aircraft belonging to the same company (from privatised structure of UK railways)
Information Visualization

Visualization encapsulates new ideas
– Visualizations developed per use case

Finally, we do two more breakdowns according to survival (green = survived) and Adult/Child Female Survived Survived Died

The Titanic Disaster

When a DLMN at another airport in the TMA plans a departure time, this may place a constraint on departures because of flow limits over downstream lanes. In some cases DLMN at another airport will request a change to the departure sequence so it can manage its own traffic more efficiently.

UC17: Departure Planned from another airport in TMA

Male Adult First Second Third Crew

Child Died

Parallel Coordinate Plots

An example for a collection of over 100 cars. The user has selected a particular year to highlight the characteristics of all cars manufactured during that year. By sliding the year range up and down one can immediately see the effect of the oil crisis.
Combinatorial Creativity

One group was very productive
  – Integrated ideas and components to produce **coherent DMAN architecture**

  – **75-minute** report-back session, to elicit feedback and identify potential disagreements
Storyboarding

Six storyboards

– Integrate all ideas related to 6 use cases, using structured storyboard templates

More new ideas
## Revised Use Cases

### UC4: DMAN gives Start Up Clearance to Aircraft

<table>
<thead>
<tr>
<th>Name</th>
<th>UC4: DMAN gives Start Up Clearance to Aircraft</th>
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</table>
| Précis | If PDCS exists automatic start-up clearance given  
If no PDCS is available then Clearance Delivery CONTROLLER checks planned start-up time from DMAN (DMAN only shows list of aircraft that can start) and delivers clearance if appropriate. |
| Actor who initiates | Clearance Delivery CONTROLLER |
| Pre-conditions | Flight is in DMAN plan |
| Post-conditions | Start-up clearances are delivered according to DMAN schedule |
| Actor who benefits | Clearance Delivery CONTROLLER, Ground CONTROLLER, Runway CONTROLLER, Pilot (reduced fuel burn) |

### Idea Cards

- **W28:** Different visualisations for different position / role in tower
- **W30:** Provide airport schedule to en-route controller over each exit point. Rate can be set
- **W31:** Information from boarding card system - i.e. last passenger boarding aircraft, sent to DMAN. Airline knows time until ready for that point. Incentives for airline - if give accurate ready information will meet slot / schedule
- **W32:** Use of Mode-S to pass delivery via datalink to cockpit
- **Y7:** Potential negative effects of key performance indicators
- **Y8:** Punctuality: Scheduled flights, For passengers
And After the Workshop...

Generated 46-page report
  – Important component of final specification delivered

Effective integration with structured methods
  – Sold as enhancements to RUP
  – Direct contributions to RUP/UML artifacts
Lessons Learned from DMAN

1. Physical ideas spaces define ideas context
   - Challenges stakeholders to determine context(s)

2. More creative work happens later on
   - Incubation and trust-building are essential

3. Structured analogical activities work
   - Facilitation to scope analogical reasoning is key
Eurocontrol’s MSP System [RE’05]

Multi-Sector Planning (MSP)
- Gate-to-gate scheduling of aircraft across European national boundaries
- Manage controller complexity levels
- Redesign controller work
- Co-ordinate existing systems

Operational Concept of Use
Workshops Results

All 3 workshops took place and were successful
– Ideas and requirements were generated
– Models produced
– Storyboards done
– Conflicts arose

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<td>6 sboards</td>
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<tr>
<td>W3 storyboards</td>
<td>1 sboard</td>
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</table>
The Two Analogies

1. Intelligent highway systems
   - Successful analogical mappings that exploited some syntactical similarities between domains
   - Eleven ideas from 3 groups - e.g. delegation of aircraft separation assurance to pilots (based on close-following car systems), disseminate information to pilots to make route decisions (based on electronic signposting)

2. Contract negotiation processes
   - Seven ideas from 3 groups
   - However, changed assumptions from W1 - air traffic controllers would NOT negotiate directly
   - Workshop preparation difficult when concepts unstable
Combining Ideas Directly

Second workshop

– Direct combination of ideas using rules inspired by fusion cooking presentation

Timeline structured the idea combination
Rich Storyboards

Combinatorial process
- Complete system view
- UML inadequate
- Film screenplay techniques
- Constructed 2 large storyboards for whole system over 4 hours period
- Participants invented semantics of storyboard
- Tactile and flexible
- Ownership important
Lessons Learned from MSP

1. **Brainstorming** generated more than analogies
   - No discernible qualitative differences
   - Failure to externalize all analogical mappings

2. **Storyboarding** more effective for combining
   - Storyboards are frameworks for managing cognitive effort and communicating

3. **Constraint removal**
   - Effective, more difficult to envision consequences of constraints being removed
Creativity Support Tools

Workshops not always cost-effective
  – Little creativity support for individual work and outside of workshops

Creativity support tools
  1. Extending scenario walkthroughs with creativity support
  2. Analogical creative thinking based on service descriptions
  3. Creative collaboration space on-line for requirements brainstorming
  4. Creative stickies on multi-user devices such as Microsoft Surface
  5. Shared physical and digital spaces for creative collaboration
Scenarios with Creativity Support

Extended ART-SCENE with cF and CRIS

- Systematically walk through scenarios to discover requirements
- Extend scenario events with creativity support
- Discover associated text and images from internet
- Compile text and images in graphical storyboards to generate requirements

Initial evaluation

- More creative requirements
Requirements from Analogical Services [RE08]

Requirements for Service Systems

- Discover requirements from services
- Retrieve analogical service descriptions
- Led to more innovative requirements in FIAT requirements workshop

“The driver shall be able to book car park spaces of different sizes”
Collaborative Requirements Brainstorming

Stakeholders are scarce

- Rarely in the same time and place
- Web-based brainstorming
- Asynchronous collaboration between distributed stakeholders
Collaborative Creative Stickies

Multi-user touch technologies

- Digital tabletops and interactive walls
- Stickies application developed for Microsoft Surface
- Write, draw, share and sort digital stickies
- Enhance with other documents such as images, videos and plans
Shared Digital and Physical Spaces

Analysts and stakeholders still want physical artifacts
- Combined electronic and non-electronic spaces
- Combined walls and tabletops
- Combined physical and digital pens
- Cards for user stories in agile development
- Snow cards for requirements description
Making Your Requirements Creative

Opportunities for collaboration

– Redesign your current requirements processes
– Facilitate your creativity workshops
– Train you to use more creativity techniques
– Guide you to use our technologies for creative requirements work

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