Requirement Engineering for Designing Efficient User Interfaces

By,
Antony Albert Raj Irudayaraj

User interfaces: What and why do you need user interfaces

- User interfaces are necessary to interact with a system
- UI’s act as the bridge towards to interact with the system
- Without interfaces, the system becomes useless ,even if the system is designed to meet the all functional requirement specifications
- User interfaces are present in almost everything - Web, smartphones, wearables, laptops, control system, health monitoring system …

User interfaces (contd..)

- Usability play a key factor in the success of the system- Need good interfaces
- Bad UI based system leads to poor user satisfaction and product failure
- User interfaces are hardy and tricky to get it right.

Motivation for designing good UI's

One of the engines was malfunctioning but wasn't sure which one.

Pilots assumed that the right engine was malfunctioning because the smoke was coming from the cabin-older version of the boeing 737 had the bleed air taken from the right engine.

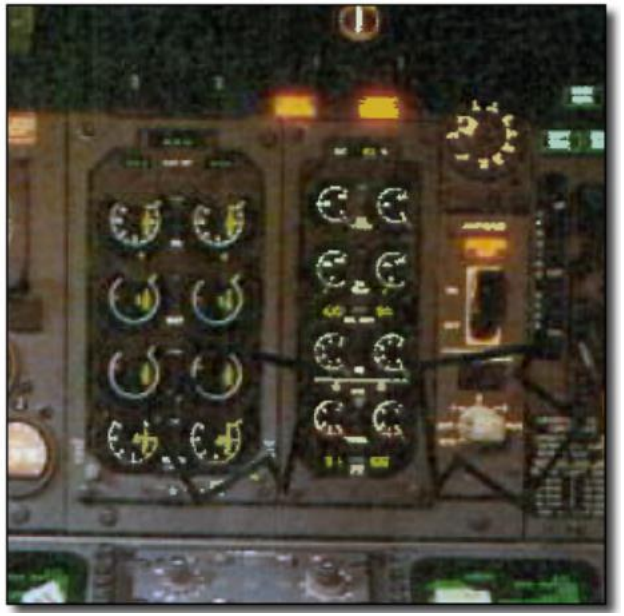
Unfortunately, the newer version of boeing 737 bleeds air from both the engines and the pilots weren't aware about this update.

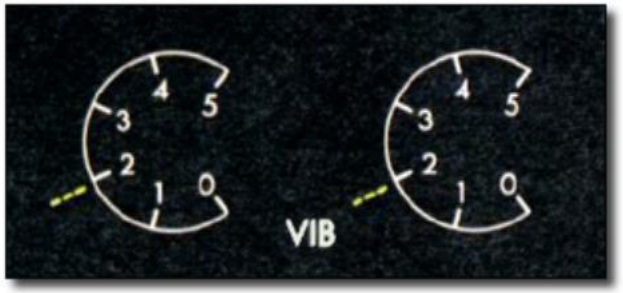
Older Boeing 737 had two vibrations gauges separately for each engine to indicate vibration/malfunctions.

Older versions of boeing 737 had big mechanical dials which had gauges that are hard to miss and ignore.

Motivation for designing good UI's

- New Boeing737 equipped with a digital dial to make it sleek and cool.
- They concentrated more on the sleek looks and comprised on the readability factor.





Sleek UI in the newer boeing 737

*https://www.cracked.com/article_19776_6-disasters-caused-by-poorly-designed-user-interfaces.html

Possible reasons for the flight crash

- Pilots will not be able to see such small display is a human constraint requirements.
- Usability testing wasn’t done properly to test the efficiency of the cockpit UI.
- If the user interface requirement specification was verified, accident could have been avoided
- Bad UI’s could be fatal especially for critical system like health instruments, flight control station

UIR EXAMPLES

User Interface Element	Expressed User Need	User Interface Requirement
Control Panel Buttons	"Buttons should be large enough so that you do not hit the wrong one accidentally."	Control panel buttons should be at least 1.5 cm tall and wide. Control panel buttons should be spaced at least 2 cm apart (measured center-to-center).
Display	"I would like the most important parameters to stand out so I can read them from a distance."	Primary treatment parameter shall be legible from a distance of 6 m (i.e. across the room).
Handle	"I would like the surgical instrument's handle to fit my small hand."	The handle shall accommodate users with various size hands (ranging from the first-percentile female to the ninety-ninth-percentile male in terms of hand length and breadth).
Menu Options	"It would be good if the currently selected menu item was highlighted in some way or another to be distinct."	Highlight the currently selected option in a list of options.
On-screen Information	"I want to be able to tell the difference right away between information that I am just supposed to read versus do something with."	Differentiate read-only displays from those that allow users to edit data.
On-screen Information	"I would like to look at the screen and see how much more time is left in the treatment."	The treatment time remaining shall be displayed continuously on the main monitoring screen (the resting screen that appears while the equipment is running independently).

Source: IEC 62366-2, Annex I

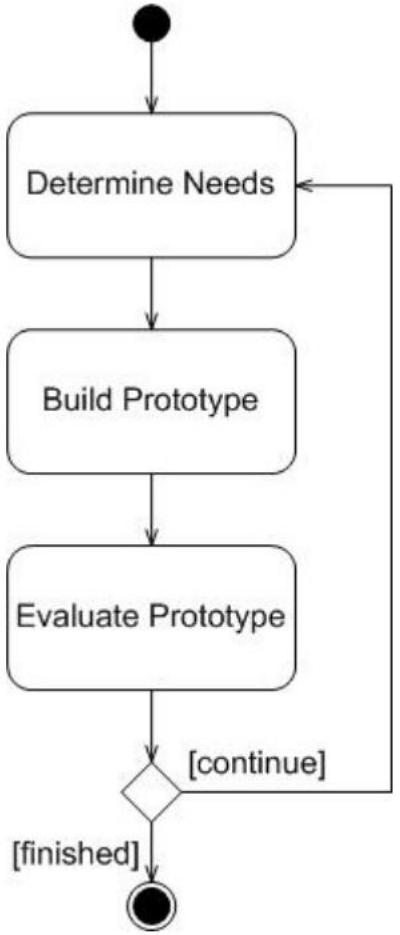
https://www.massmedic.com/wp-content/uploads/2017/05/User-Requirements-Presentation-5_31.pdf

Designing efficient user interfaces

- Design user interfaces by taking into account human constraints , rather than expecting the users to get used to the interface
- User interface design: user driven,not technology driven
- Usability testing and iterative design critical to UI success
- Specify interface requirements that could be verified even before usability testing

Iterative design for UI's

- Iterative model is suitable for UI's.
- Move from a high level implementation to a specific UI suited to user needs
- Cheaper to build a lot of prototypes rather than needing to change requirements at the final stage
- Stop the process when idea generation is stalled



https://www.agilemodeling.com/artifacts/uiPrototype.htm

Requirement engineering in UI design

Techniques for requirement elicitations

- Scenarios
- Brainstorming
- Interviews
- Prototyping

Requirement specification in different formats

- Textual descriptions
- Low fidelity prototypes
- High fidelity prototypes

https://ieeexplore.ieee.org/document/6861056

Prototyping techniques for user interfaces

- Prototypes are primarily used for generating requirements in UI design
- Easy and cheap to build, less time consuming
- They can be thrown away at any stage if found useless
- They help to get feedback from stakeholder about further requirements.
- Start from Low fidelity(cheap) to high fidelity(costly) prototypes

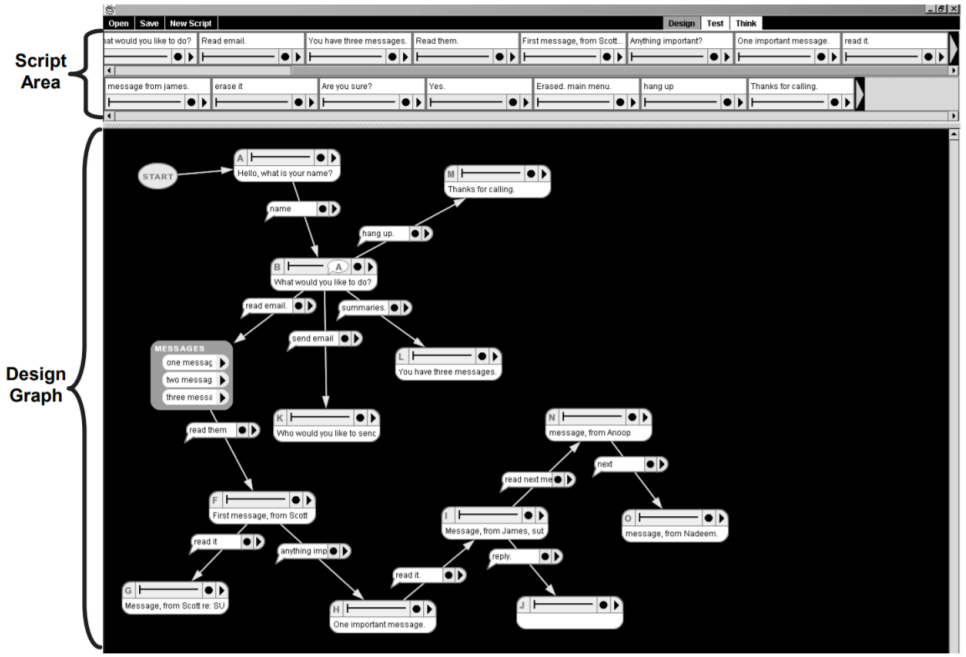
Examples of Low fi Prototypes

- Storyboarding
- Paper prototypes
- Wizard of oz

https://cs.uwaterloo.ca/~dberry/reqs.prototype.html

Storyboarding

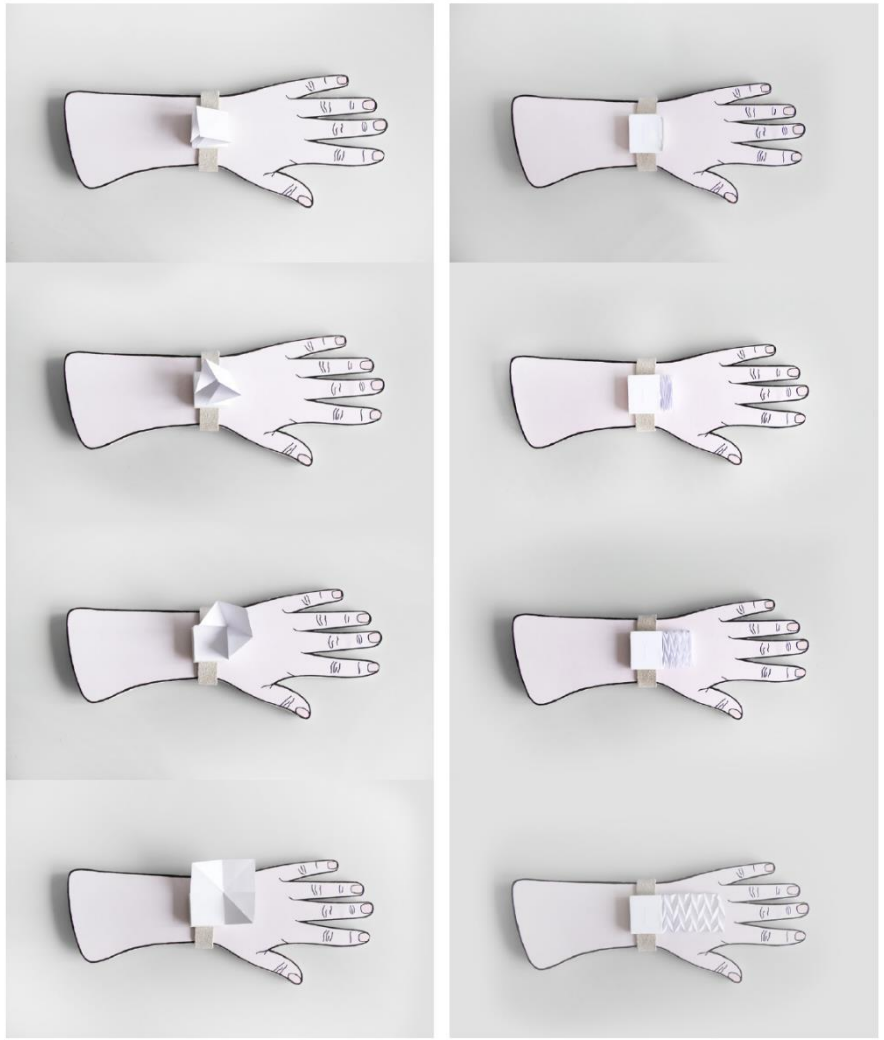
- Storyboarding involves a graphical representation of different pages of the UI and the interaction flow between the different pages.
- Can be used to generate scenarios- used for requirement elicitation
- Includes both input and output interactions.



https://hci.stanford.edu/publications/2007/MobilePrototyping.pdf

3D Paper Prototypes

- Small screen size in wearable makes interaction difficult – Fat Finger Problem
- Keyboard typing, viewing map for navigation is difficult with smart watches
- Paper prototypes to visualize possible screen extensions
- Focus group, concept videos, questionnaires and to understand the viability of paper prototypes
- Useful for people having no experience with using software



https://dl.acm.org/citation.cfm?id=3240173

Wizard of Oz

- Speech based web access for visually impaired people
- Understand if voice based web access is feasible and beneficial even before building the entire system
- Time and cost for developing the actually speech interface would high
- So, a human experimenter act as the wizards
- Useful for prototyping systems having complicated control logic

Subject: "*I want to buy CDs*"
Wizard: [enter "CDs" in the search box, clicks "Go", and narrate search results one by one] *Verbatim 97458 700 MB 80 Minute ... Disc CD-R by Verbatim link ...*
Subject: "*Search for new age items*"
Wizard: [searches for "new age items", clicks on results]
Screen reader: *Age of Wushu – Free Amazon…. Game Connect link by Snail Games USA…*
Subject: *"stop"*
Wizard: [presses pause shortcut]
Subject: *"new age music CDs"*
Wizard: [searches for "new music CDs" …]
Screen reader: *The ultimate Most Relaxing New Age ….*
Subject: *"new age music CDs by Kitaro"*
Wizard: [Searches for "new music cds by Kitaro", …]
Screen reader: *Most Relaxing New Age Music link by Kitaro, List 8 items, $10.87 link, order in the next 3 hours….Only 13 left in stock…. Tenku link by Kitaro….*
Subject: *"sample recordings"*
Wizard: [follows the current link]
Screen reader: *Page loading*
Wizard: [plays the first sample track]
Subject: "next"
Wizard: [plays the next sample track]
Subject: *"next"*
Wizard: [plays the next sample track]

https://dlnext.acm.org/doi/pdf/10.1145/2596695.2596699?download=true

Usability Testing

Results of the usability testing is used as requirements for building the next iteration of the UI

- Interviews
- Focus groups
- Pre and post experiment surveys
- Design workshops and hackathons
- Think Aloud Techniques

Toolkits to incorporate RE in designing user interface

- **QualiHM** : Consistency between different requirement specification formats and ensure completeness.
- **Blueprint**
- **GUILayout++**
- **Just in Mind Prototyper**
- **Axure RP**

https://ieeexplore.ieee.org/document/6861056

Summary and Future Work

Summary

- Why do we need good user interfaces?
- How to design efficient user interfaces ?
- How does requirement engineering help in gathering user interfaces requirements?

Future Work

- Detailed research on RE toolkits used for efficient management of user interface design

References

1) https://www.theverge.com/2015/1/8/7512765/amazon-redesigns-its-homepage-again
2) https://support.apple.com/en-au/HT204389

Thank you