Modelling Rich Interaction

- status–event analysis
- rich environments in task analysis
- sensor-based systems

status–event analysis
- events – things that happen
  - e.g. alarm bell, beeps, keystrokes
- status – things that are
  - e.g. screen display, watch face, mouse position
- unifying framework – system (formal analysis)
  - user (psychology & heuristics)
- time behaviour – detect delays, select feedback
- transferable phenomena
  - e.g. polling – active agent discovers status change

rich set of phenomena

<table>
<thead>
<tr>
<th>events</th>
<th>status</th>
</tr>
</thead>
<tbody>
<tr>
<td>input</td>
<td>keypress</td>
</tr>
<tr>
<td>output</td>
<td>mouse position</td>
</tr>
<tr>
<td>internal</td>
<td>interrupt</td>
</tr>
<tr>
<td>external</td>
<td>display</td>
</tr>
<tr>
<td>time</td>
<td>document state</td>
</tr>
<tr>
<td>temperature</td>
<td></td>
</tr>
</tbody>
</table>

Most notations only deal with subset of these
e.g. STNs: event-in/event-out
- may need awkward work-arounds

Properties of events

- status change event
  - the passing of a time
- actual and perceived events
  - usually some gap
- polling
  - glance at watch face
  - status change becomes perceived event
- granularity
  - birthday – days
  - appointment – minutes

rich set of behaviour

- actions:
  - state change at (user initiated) event
- status change events:
  - e.g. stock drops below re-order level
- interstitial behaviour:
  - between actions – e.g. dragging an icon

standard notations:
- usually, typically, occasionally, never!
Design implications

- actual/perceived lag matches application timescale?
- too slow
  - response to event too late
    - e.g., power plant emergency
- too fast
  - interrupt more immediate task
    - e.g., stock level low

Naïve psychology

- Predict where the user is looking
  - mouse – when positioning
  - insertion point – intermittently when typing
  - screen – if you’re lucky
- Immediate events
  - audible bell – when in room (and hearing)
  - peripheral vision – movement or large change
- Closure
  - lose attention (inc. mouse)
  - concurrent activity

email delivery

- mail arrives
  - mail tool agent event
  - mailtool status
  - mail status
  - agent
  - screen
  - user

email delivery (ctd)

- mail has arrived!
  - timeline at each level
  - Perceived event in minutes – not guaranteed
  - alternative timescale
    - explicit examination – hours/days
    - audible bell – seconds
    - but want minutes – guaranteed

screen button widget

- screen button often missed, ...
  - but, error not noticed
  - a common widget, a common error: Why?
  - Closure
    - mistake likely – concurrent action
      - not noticed – semantic feedback missed
  - Solution
    - widget feedback for application event
      - a perceived event for the user
  - N.B. an expert slip – testing doesn’t help

Screen-button - HIT
Screen button – MISS

HIT or a MISS?

the problem

rich contexts

ConcurTaskTrees (CTT)
Paterno et al. CNUCE, Pisa

collaboration

- already in several notations
  - e.g. CTT, GTA
- add artefacts too?
Groupware Task Analysis

GTA
- conceptual framework, tools, elicitation techniques
- rich model of task world
- rich ontology
  - human roles for collaboration
  - physical and electronic objects

control
- open loop control
  - no feedback
  - fragile

adding information

adding information (ctd)

control
- open loop control
  - no feedback
  - fragile
- closed loop control
  - uses feedback
  - robust

information
- pre-planned cognitive model
  - goal → action
- situated action
  - environment → action

information required when
- subtask involves input (or output)
- same kind of choice (how to know what to do)
- subtask repeated (real iterations unspecified)
sources of information
i. part of existing task (e.g. phone number entered)
ii. user remembers it (e.g. recall number after directory enquiry)
iii. on device display (e.g. PDA address book, then dial)
iv. in the environment
  - pre-existing (e.g. phone directory)
  - created in task (e.g. write number down on paper)

GUI easy (lots of space) mobile/PDA need to think
triggers
process – what happens and order

get post from pigeon hole → bring post to desk → open post

common triggers
- immediate
  - straight after previous task
- temporal
  - at a particular time
- sporadic
  - when someone thinks of it!
- external event
  - when something happens, e.g. phone call
- environmental cue
  - something prompts action … artefacts

artefacts
- ethnographic studies
- as shared representation
- as focus of activity
- act as triggers, information sources, etc.

placeholders
- knowing where you are in a process
  - like a program counter
- coding:
  - memory
  - explicit (e.g. to do list)
  - in artefacts

where are you?

1. controller
   choose new flight level

2. controller
   tell pilot new flight level

3. pilot
   confirm new flight level

4. pilot
   ascend to new level

5. new flight level achieved
step 1. choose new flight level

1. controller
2. controller
3. pilot
4. pilot
5. new flight level achieved

step 3. flight level confirmed

1. controller
2. controller
3. pilot
4. pilot
5. new flight level achieved

tracing placeholders

a form of information, may be ...
- in people's heads
  - remembering what to do next
- explicitly in the environment
  - to-do lists, planning charts, flight strips, workflow
- implicitly in the environment
  - location and disposition of artefacts

electronic environments ...
- fewer affordances for artefacts
- danger for careless design!

low intention and sensor-based interaction

car courtesy lights

- turn on
  - when doors unlocked/open
- turned off
  - after time period
  - when engine turned on

driver's purpose is to get into the car

incidentally the lights come on
Pepys

- Xerox Cambridge (RIP)
- active badges
- automatic diaries

Allan’s purpose to visit Paul’s office
  incidentally diary entry created

MediaCup

- cup has sensors
  - heat, movement, pressure
- broadcasts state (IR)
- used for awareness
  - user is moving, drinking, ...

Han’s purpose to drink coffee
  incidentally colleagues are aware

shopping cart

- goods in shopping cart analysed
  - e.g. Amazon books
- used to build knowledge about books
  - people who like X also like Y
- used to give you suggestions
  - "you might like to look at…", "special offer …"

my purpose to buy a book
  incidentally shown related titles

onCue

- ‘intelligent’ toolbar
  - appropriate intelligence
  - make it good when it works
  - don’t make it hard if it doesn’t
- analyses clipboard contents
- suggests things to do with it

user’s purpose to copy text elsewhere
  incidentally alternative things to do

the intentional spectrum

intentional
  press light switch

expected
  walk into room expecting lights to switch on

incidental
  walk into room … unknow to you … air conditioning increases

fluidity

intentional
  co-option
  users explicitly use behaviour
  e.g. open door for lights

expected
  comprehension
  users notice, form model
  then rely on behaviour

incidental
interaction models

- intentional cycle
  - Norman execution/evaluation loop
- some exceptions
  - multiple goals, displays, opportunistic
- guidelines
  - feedback, transparency

system
goal
evaluation
intention
execution

cognition

- physical things (inanimate)
  - directness of effect
  - locality of effect
  - visibility of state
- computational things (also animate)
  - complex effects
  - non-locality of effect
  - distance – networks; time – delays, memory
  - large hidden state

• need richer representations
  - of the world, of devices, of artefacts
  - wider ecological concerns
• two tasks
  - purposeful task – for interpretation
  - supported task – for actions

issues and process

- no accepted methods but … general pattern
- uncertainty
  - traditional system due to errors
  - sensor-based intrinsic to design
  - uncertain readings, uncertain inference
  - usually control non-critical aspects of environment
- process … identify
  - input – what is going to be sensed
  - output – what is going to be controlled
  - scenarios – desired output and available input

designing incidental interaction

• understanding
  - innate intelligences
    - physical, natural/animal, social, physiological
    - rational thought
    - imagination
  - interfaces
    - GUI, VR, AR, tangible
    - recruit physical/tangible intelligence
    - ubicomp, ambient, incidental
    - ?? ?
      - homunculi, haunted houses

• need richer representations
  - of the world, of devices, of artefacts
  - wider ecological concerns

• two tasks
  - purposeful task – for interpretation
  - supported task – for actions

designing a car courtesy light

1. deactivate alarm
2. walk up to car
3. key in door
4. open door & take key
5. get in
6. close door
7. adjust seat
8. find road map
9. look up route
10. find right key
11. key in ignition
12. start car
13. seat belt light flashes
14. fasten seat belt
15. drive off

- illegal to drive with
  - interior light on
- safe? light
  - advertises presence

Available input
- door open, car engine
- desired output
  - light
- identify scenario
label steps
  0. don't care
  +, ++, … want light
  -, ––, … don't want #
- legal requirements
  - light off whilst driving
- safety
  - approaching car??
implementation

- sensors not used for original purpose
  - open architectures, self-discovering, self-configuring
- privacy
  - internet-enables kettle broadcasts to the world!
- context
  - inferring activity from sensor readings – status not event
- data filtering and fusion
  - using several sensors to build context
- inference
  - hand-coded or machine-learning
- must be used
  - control something (lights) or modify user actions (TV on)

architectures for sensor-based systems?