Validating Design Knowledge in the Home
A Successful Case Study of Dementia Care

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Background

- Technology now in the home as well as at work
- Implications for
  - Healthcare
  - Technology
  - Cognitive Ergonomics
Trends and Requirements

- Healthcare
  - Less institutional
  - More community-based and so domestic
  - Mental as well as physical

- Requirement
  - Extend care design to the home
  - Develop design of mental care
  - Express quality of life as some kind of performance
Trends and Requirements

- **Technology**
  - Sensors for monitoring
  - Technology includes all domestic artefacts
  - ‘Design for all’ (including dementias)

- **Requirement**
  - Integrate technology and artefacts in (re-)design
  - Design technology for care performance
    - Quality of life
    - Workload (usability)
Trends and Requirements

- Cognitive Ergonomics
  - Greater emphasis on mental than physical tasks
  - Transfer design knowledge from work to home

- Requirement
  - Extend design knowledge
  - Validate design knowledge
Case-study

▪ Aims
  • Re-design technology in the home
  • Improve dementia care and quality of life
  • Validate structured design knowledge - MUSE
Design Method

Application

- Validation of design knowledge (Long, 1996)
  - Conceptualisation
  - Operationalisation
  - Test
  - Generalisation

- Here operationalisation and test
  - 1. Design completeness
  - 2. Design consistency
  - 3. Application of domain knowledge
  - 4. Application of human factors knowledge
  - 5. Integration of desirable existing features
  - 6. Design rationale for 3, 4, and 5
  - 7. All features embodied in MUSE products
Design Method

- **MUSE(C) Containers (Colbert 1997)**
  - **Use**
    - Advanced technology projects
    - Support demonstrators
    - Often no specific user requirements
  - **Features**
    - MUSE design products (containers)
    - Fill/complete as possible
    - No MUSE procedures or notations
    - For use by human factors specialists
Case-study

▪ Design scenario
  • Re-design
  • ‘Advanced development project’
  • Aim: to demonstrate ways of making technologies for dementia care in the home more effective
  • Initial phase, rapid demonstration
  • Participants
    ❖ ‘A’, a caree, suffering from fronto-temporal dementia (poor memory and reasoning)
    ❖ ‘B’, A’s principal carer and husband
    ❖ ‘C’, a human factors trained designer, but with no MUSE application experience
- **Phase 1 Information Elicitation and Analysis**
  - **Products/containers:**
    - task description; rationale; generalised task model for existing and target systems
  - **Example:**
    - task description of existing hifi system use
Task Description

- **Comments**
  - A is supported by B in hifi use (CD, tape, radio, amplifier)
  - B operates CD player well
  - B commits amplifier errors
    - Fails to switch on amplifier
    - Fails to select CD mode

- **Application features**
  1. Design completeness (music selection and hifi preparation, as well as CD use)
  3. Domain knowledge (amplifier hifi relations)
  4. Human factors knowledge (mode errors reflect memory failure)
MUSE(C)

- Phase 2 Design Synthesis
  - Products/containers:
    - statement of user needs; domain of design discourse; domain actions and objects; composite task model; system task model; and user task model
  - Example:
    - composite task model of re-designed CD player use
Composite Task Model

- **Comments**
  - Device-independent description
  - Combines desirable existing and redesign features
  - Distinguishes
    - on-line tasks (technology supported - ‘play music’)
    - from off-line tasks (‘select music’)

- **Application features**
  2. Design consistency
     (between task description, shown earlier, and composite task model)
  5. Integration of desirable existing features
     (‘select music; ‘supply CD player with music’)
MUSE(C)

- Phase 3 Design Specification
  - Products/containers:
    - interaction task model; interface model; pictorial screen lay-out; dialogue and error message table; dialogue and inter-task screen actuation description; and dictionary of screen objects
  - Example:
    - interaction task model of re-designed CD player use

<table>
<thead>
<tr>
<th>Interaction No.</th>
<th>User Action</th>
<th>Device state</th>
<th>Device Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Press 'receptacle open' button</td>
<td>Receptacle closed</td>
<td>Open receptacle</td>
</tr>
<tr>
<td>2</td>
<td>Ditto</td>
<td>Receptacle open</td>
<td>Display message that receptacle is already open</td>
</tr>
<tr>
<td>3</td>
<td>Introduce media</td>
<td>Receptacle open, no media</td>
<td>Stage 1, do nothing Stage 2, close receptacle, begin playing media</td>
</tr>
<tr>
<td>4</td>
<td>Ditto</td>
<td>Receptacle open, media already present</td>
<td>Stage 1, display feedback Stage 2, display feedback</td>
</tr>
<tr>
<td>5</td>
<td>[Stage 1 shut receptacle]</td>
<td>Receptacle open, media present</td>
<td>Begin playing media, display feedback</td>
</tr>
<tr>
<td>6</td>
<td>Ditto</td>
<td>Receptacle open, media absent</td>
<td>Display a warning</td>
</tr>
<tr>
<td>7</td>
<td>Listens to music</td>
<td>Music finishes</td>
<td>Stage 1, display feedback Stage 2, display feedback, open media receptacle</td>
</tr>
</tbody>
</table>
Interaction Task Model

- **Comments**
  - Device-level description of user behaviours
  - Links to other low level design products (error messages)

- **Application features**
  - 2. Design consistency (via interaction numbers - composite task model - ‘supply CD player with music’)
  - 3. Domain and 4. human factors knowledge (‘switch on amplifier’ and ‘select CD mode’, performed by B)
Case-study

- **Summary**
  - 9 domestic sub-systems re-designed (including: hifi; TV; VCR/playstation; tapestry; piano; etc.)
  - 50 design products
  - 18 different products/containers

- **Conclusions**
  - Re-design generally demonstrated more effective dementia care technologies
  - Re-design suggested further developments
Evaluation

For each re-designed sub-system:
• B rated (1-10) A’s quality of life - TQ(A) and A’s workload - W(A)
• before and after re-design

Results

<table>
<thead>
<tr>
<th></th>
<th>TQ(A)</th>
<th>W(A)</th>
<th>Freq. of Use</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>1</td>
<td>9</td>
<td>O</td>
<td>CD player not easily accessible</td>
</tr>
<tr>
<td>After</td>
<td>3</td>
<td>7</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

Conclusions
• TQ(A) increased (but still low)
• W(A) decreased (but still high)
• frequency of use increased (but still low)
• poor CD player accessibility a possible cause
Validation of MUSE(C)

- **MUSE(C) operationalised and tested**
  - Domestic technologies demonstrated for dementia care
  - Re-design generally more effective
- **MUSE(C) shortcomings**
  - C experienced difficulties in its application (30)
  - Identified design problems
  - Suggested design solutions

<table>
<thead>
<tr>
<th>MUSE Container</th>
<th>Diagnosis</th>
<th>Prescription</th>
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<tbody>
<tr>
<td>CTM(x)</td>
<td>There was difficulty in operationalising this container. The CTM's definition as describing elements of the design is slightly less general terms than a General Task Model is ambiguous and gave little guidance.</td>
<td>Amend description of CTM, gave concrete example of CTM and General Task Models, illustrating the difference in generality between them.</td>
</tr>
<tr>
<td>ITM(y)</td>
<td>It is difficult to distinguish between ITM and Interface Model from their definitions</td>
<td>Expanded definition of ITM, relate it to the 3 levels of interface design: Input/output, Dialogue, and Task levels.</td>
</tr>
<tr>
<td>ITM(y)</td>
<td>Where do changes in auditory display go – the auditory channel is not part of the definition of any MUSE containers?</td>
<td>Expand definition of IM, clarify auditory display changes as belonging to Dialogue and Error Message Table or Interface Model. Define for haptic display / feedback as well.</td>
</tr>
</tbody>
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- **Conclusion**
  - Validation only partial
  - MUSE(C) can now be revised to produce a more effective version
Conclusion

- **Case-study is successful**
  - new domain - dementia care in the home
  - partial validation of MUSE(C)
  - revised MUSE(C) now possible

- **Importance for Cognitive Ergonomics**
  - an example of building on earlier - and others’ - work