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Designing and evaluating cognitive prosthetics for persons with mild dementia

Lessons Learnt

Professor Chris Nugent

School of Computing and Mathematics
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MATCH

European Commission

alzheimer's association

r&d office

Invest Northern Ireland
Building Locally Competing Globally

EPSRC
Engineering and Physical Sciences Research Council

University of Ulster

- The University has approximately 1500 staff.
- It has six Faculties: Arts, Art, Design and the Built Environment, Computing and Engineering, Life and Health Sciences, Social Sciences, Ulster Business School.

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My Background

- Studied BEng Electronic Systems
- PhD Biomedical Engineering (ECG Analysis)
- Currently Professor Biomedical Engineering, Faculty of Computing and Engineering, University of Ulster.

- Research interests in area of pervasive and wearable computing in smart environments to support AAL.

- Main application domain of research is in the area of assistive technologies for people with mild dementia.

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Dementia related Research Projects

Assistive Technologies (2006-2014)

COGKNOW

dem@care

Information Society Technologies

Everyday Technologies (2006-2015)

CPVS

TAUT

EPSRC

r&d office

alzheimer's association

Self-Management (2013-2016)

SELF-MAN

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Support for Carers (2010-2013)

STAR Skills Training and Re-Skilling for Carers of People with Dementia

Education and Culture DG
Lifelong Learning Programme

Ambient Assisted Living (2008-2014)

AAL AMBIENT ASSISTED LIVING

ROSETTA

PIA

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Presentation Outline

- Summary overview of Cognitive Prosthetics for persons with mild dementia
- The design process for cognitive prosthetics
- Creating an evaluation framework
- Considering Technology Adoption
- Lessons Learnt

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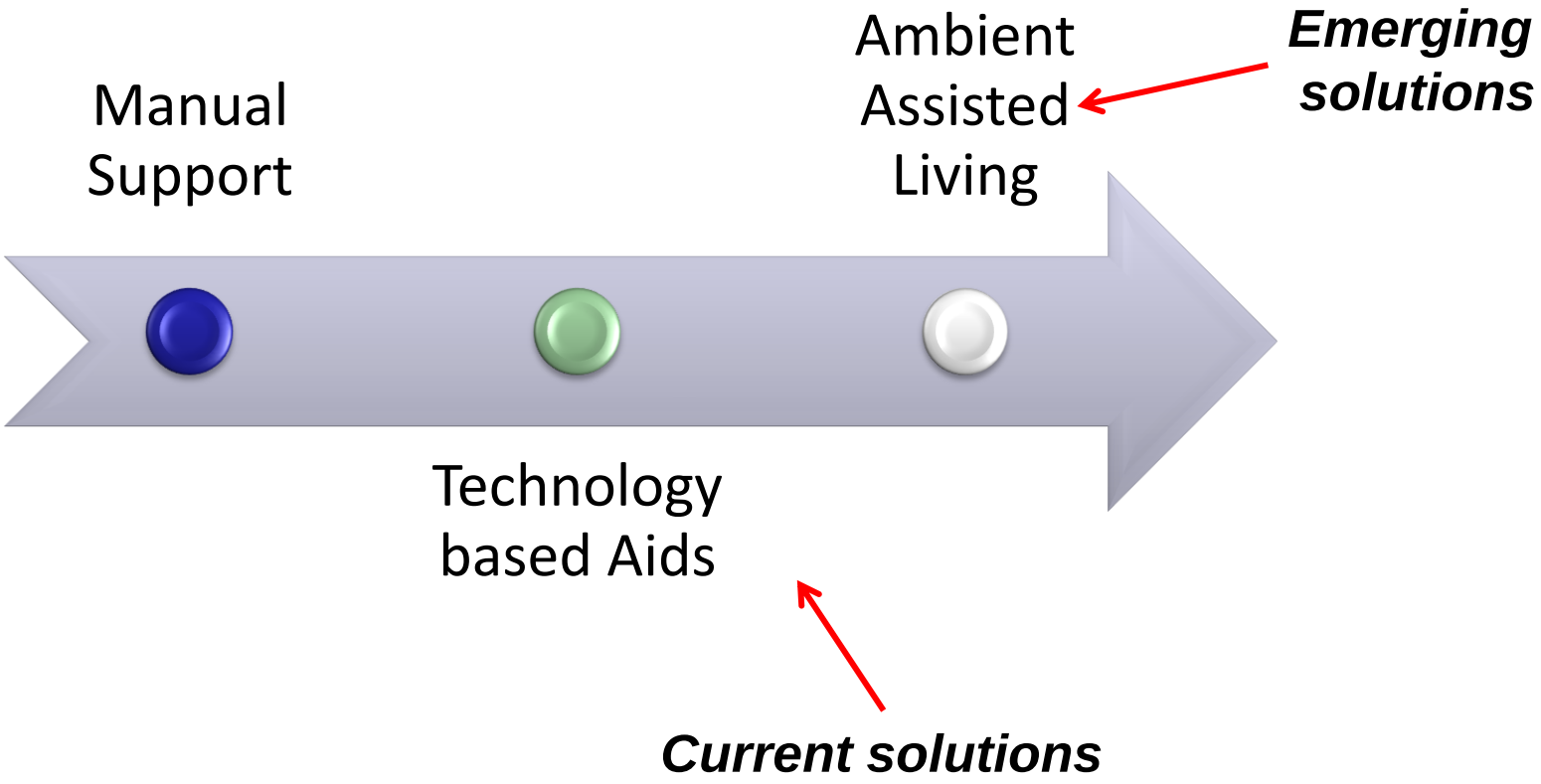
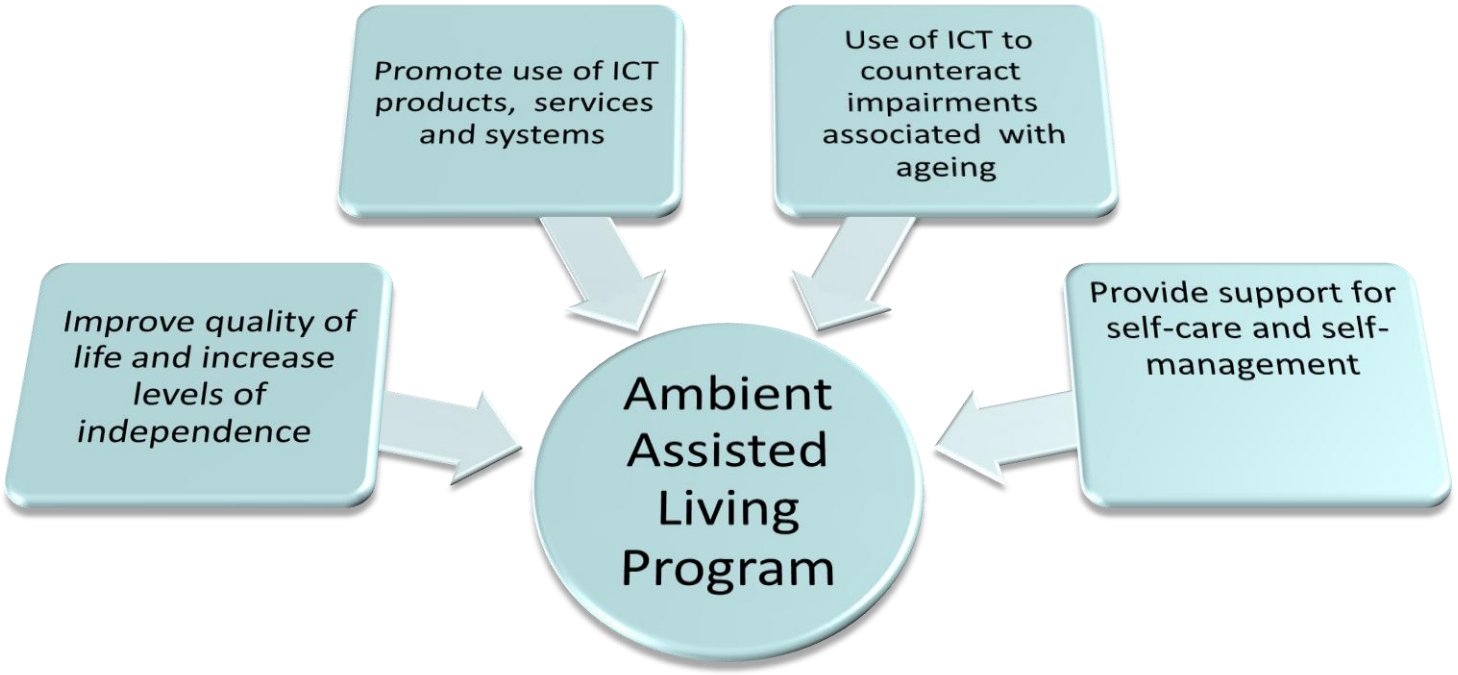
Cognitive Prosthetics

Technology as an enabler?

The Spectrum of Support

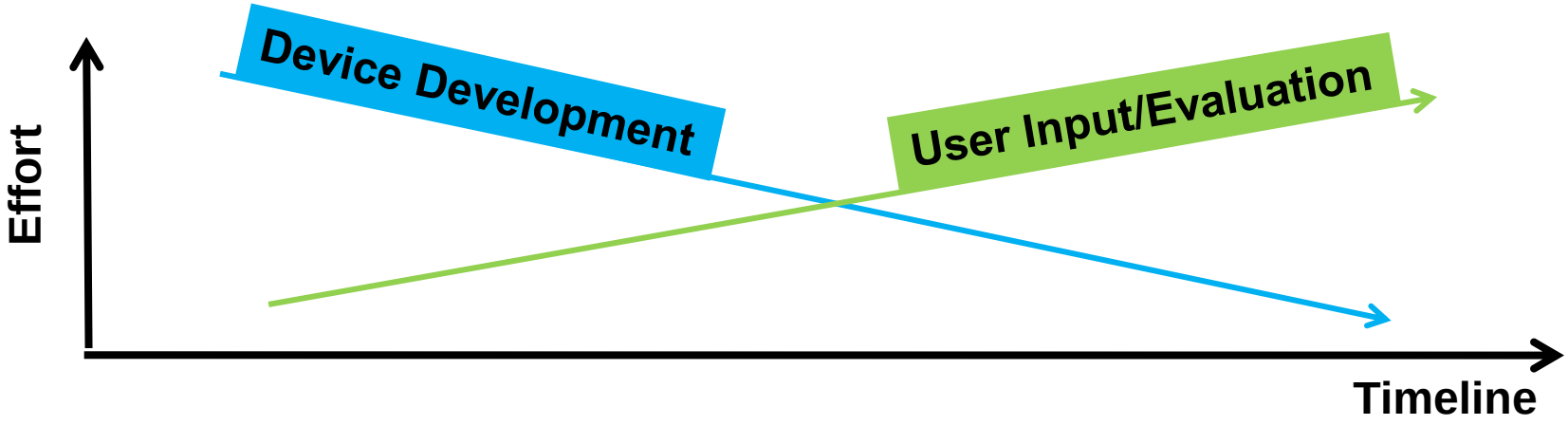


Ambient Assisted Living



The Ambient Assisted Living (AAL) Joint Programme (http://www.aal-europe.eu/)
Ambient Assisted Living, COM(2007) 329 Final, pp. 1-35, 2007.

Timeline of Research Activities



Research Themes

Decision support systems
Home based prototypes

Assistive Technologies
Context Aware

Long term evaluations
Data sharing
Practical Challenges

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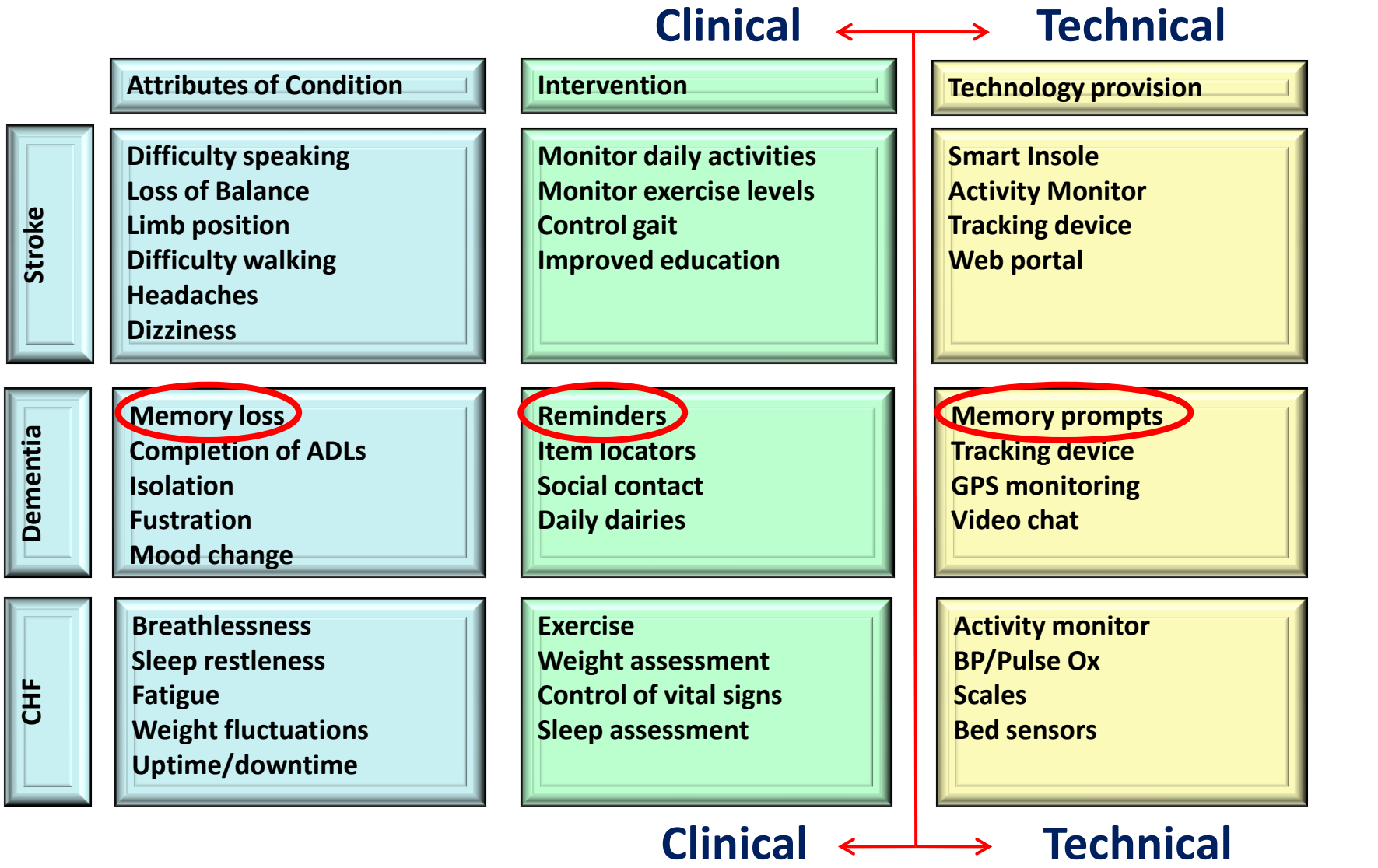
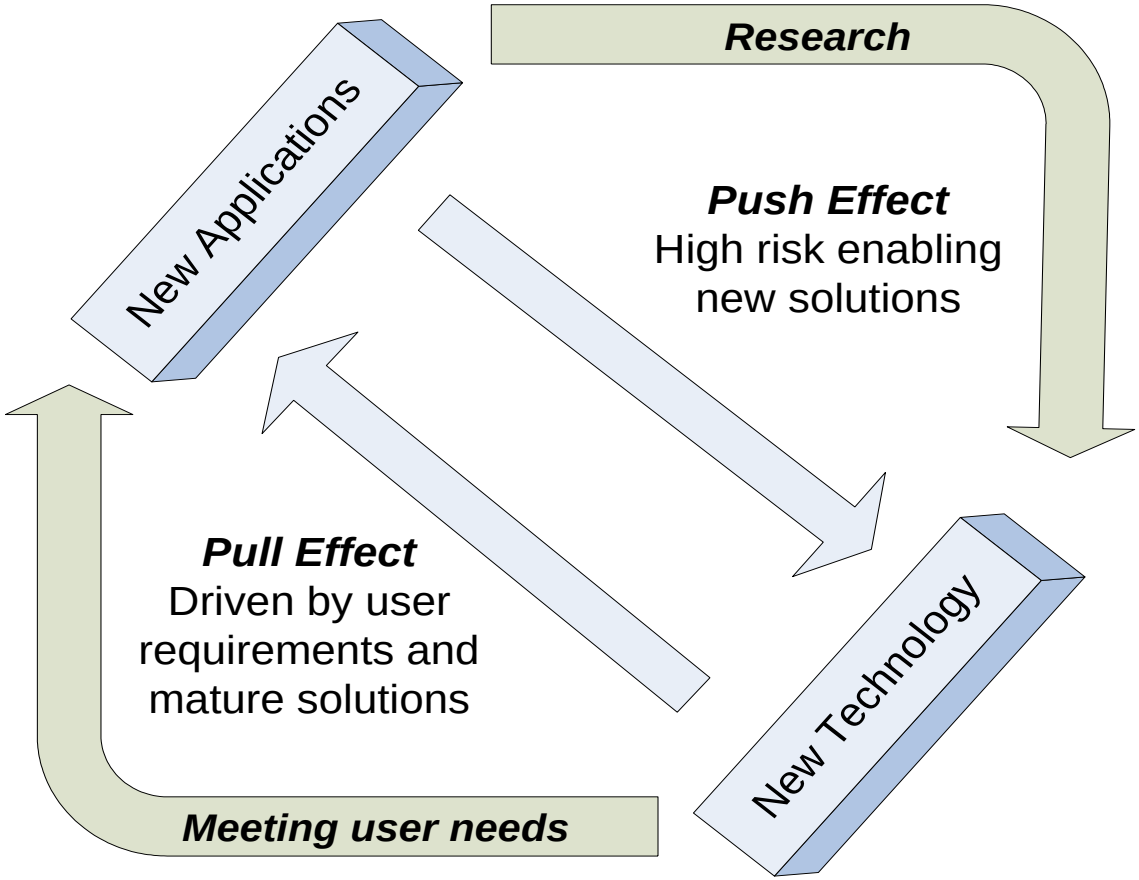
Designing Cognitive Prosthetics

Clinical/Technical Partnership



Adapted from: N Armstrong, CD Nugent, G Moore, D Finlay, Using smartphones to address the needs of persons with Alzheimer's disease, *Annals of Telecommunications*, vol. 65, pp. 485-495, 2010.

Technology as an enabler?



CD Nugent, ICT in the elderly and dementia, *Aging and Mental Health*, vol. 11, no. 5, pp. 473-476, 2007.

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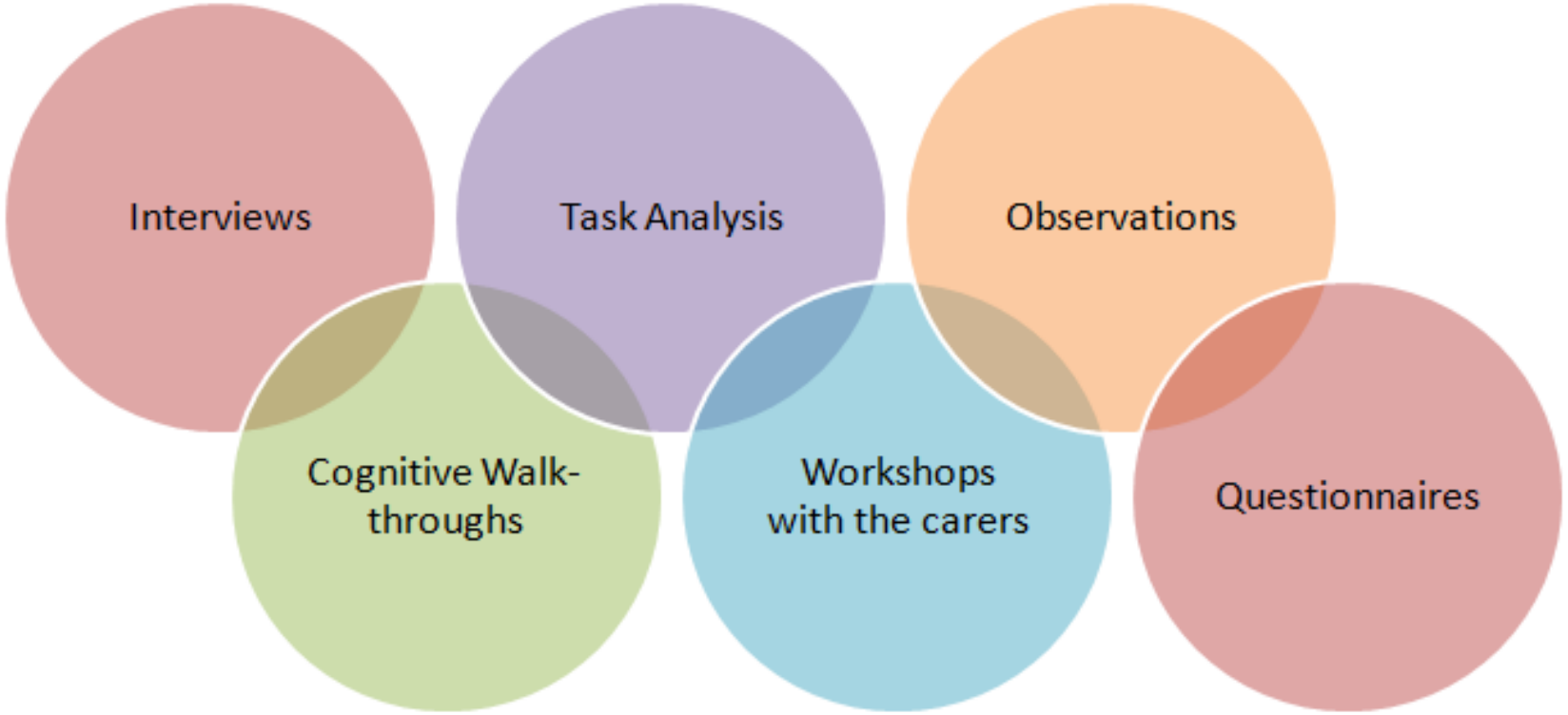
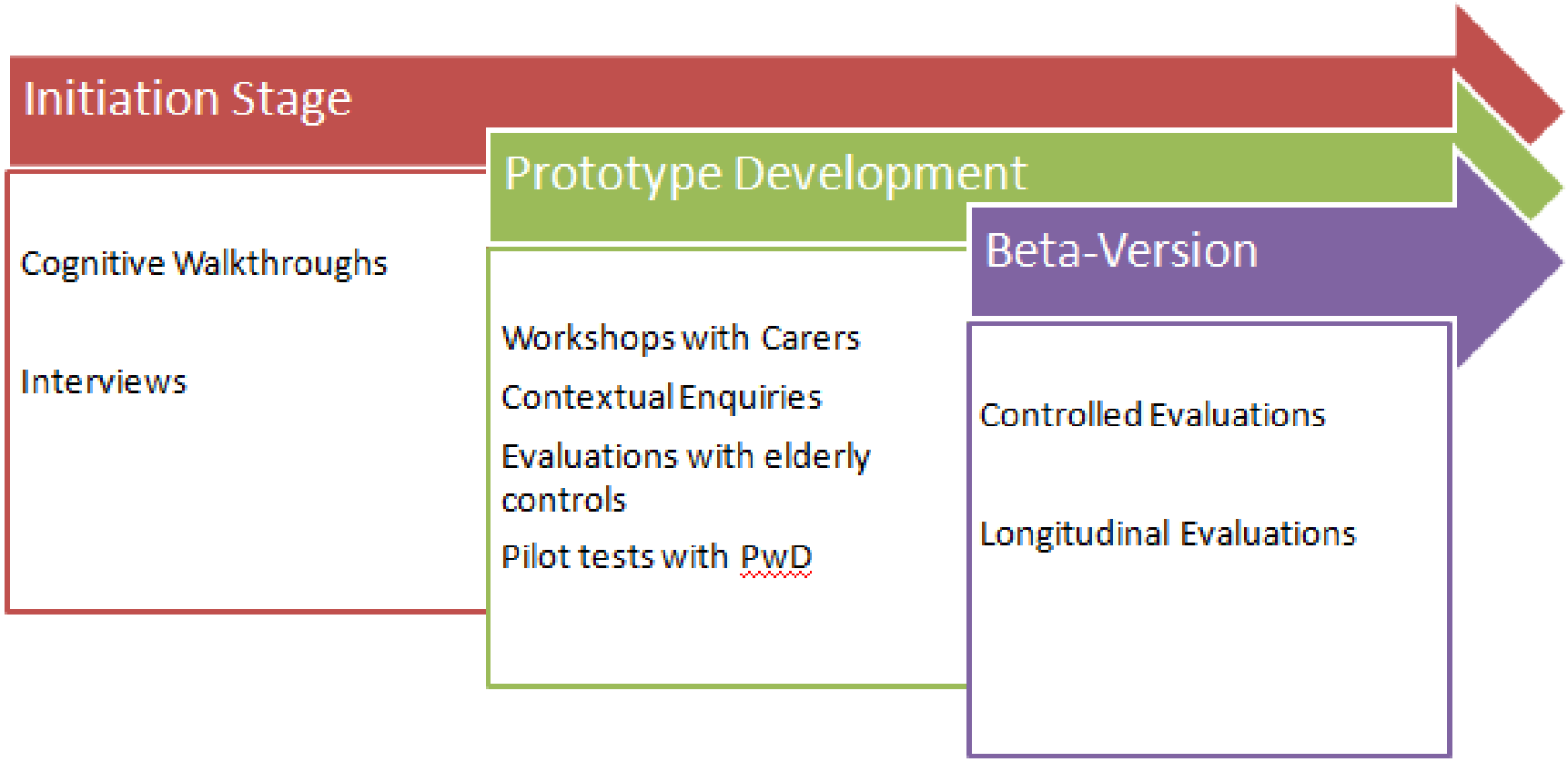
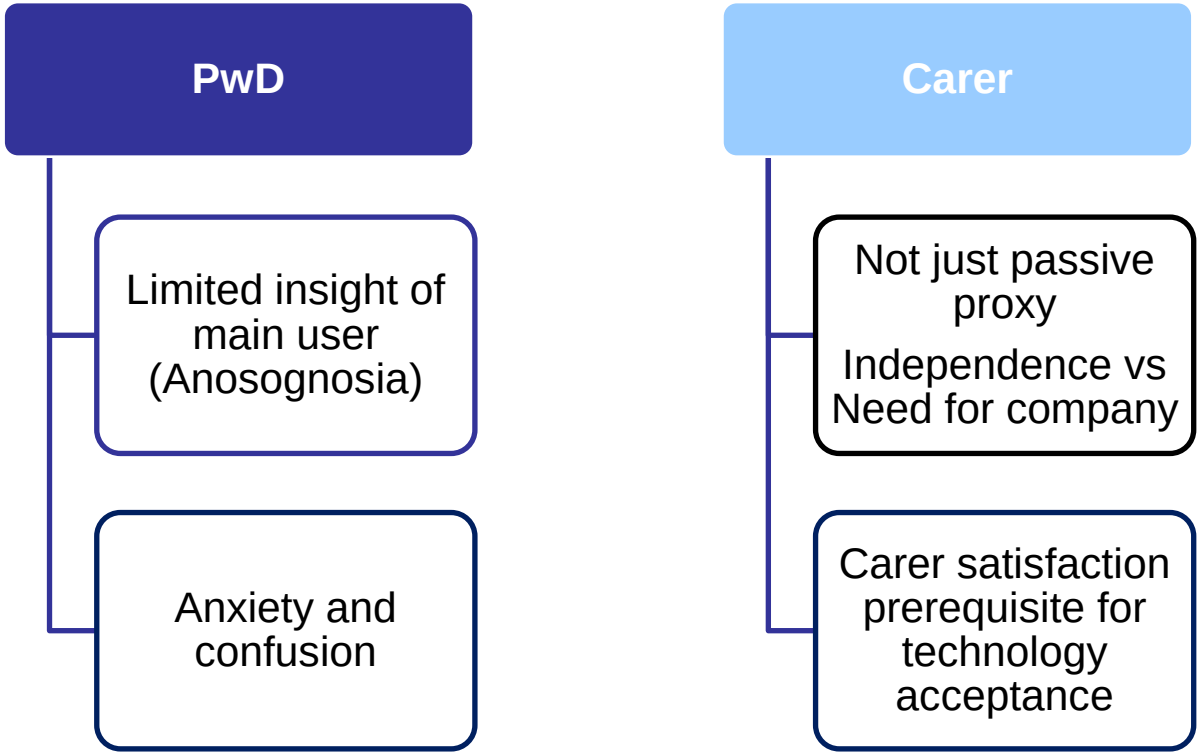
Interaction with users



User Involvement



Specific Challenges to consider



Questions

- Consider two questions:

1. *Do you like the colour blue?*

2. *What colour do you like?*

Evolution of solutions based on Stakeholder Needs Analysis

S O'Neill, S Mason, G Parente, M Donnelly, CD Nugent et al., Video reminders as cognitive prosthetics for people with dementia, *Ageing International*, vol. 36, no. 2, pp. 267-282, 2011.

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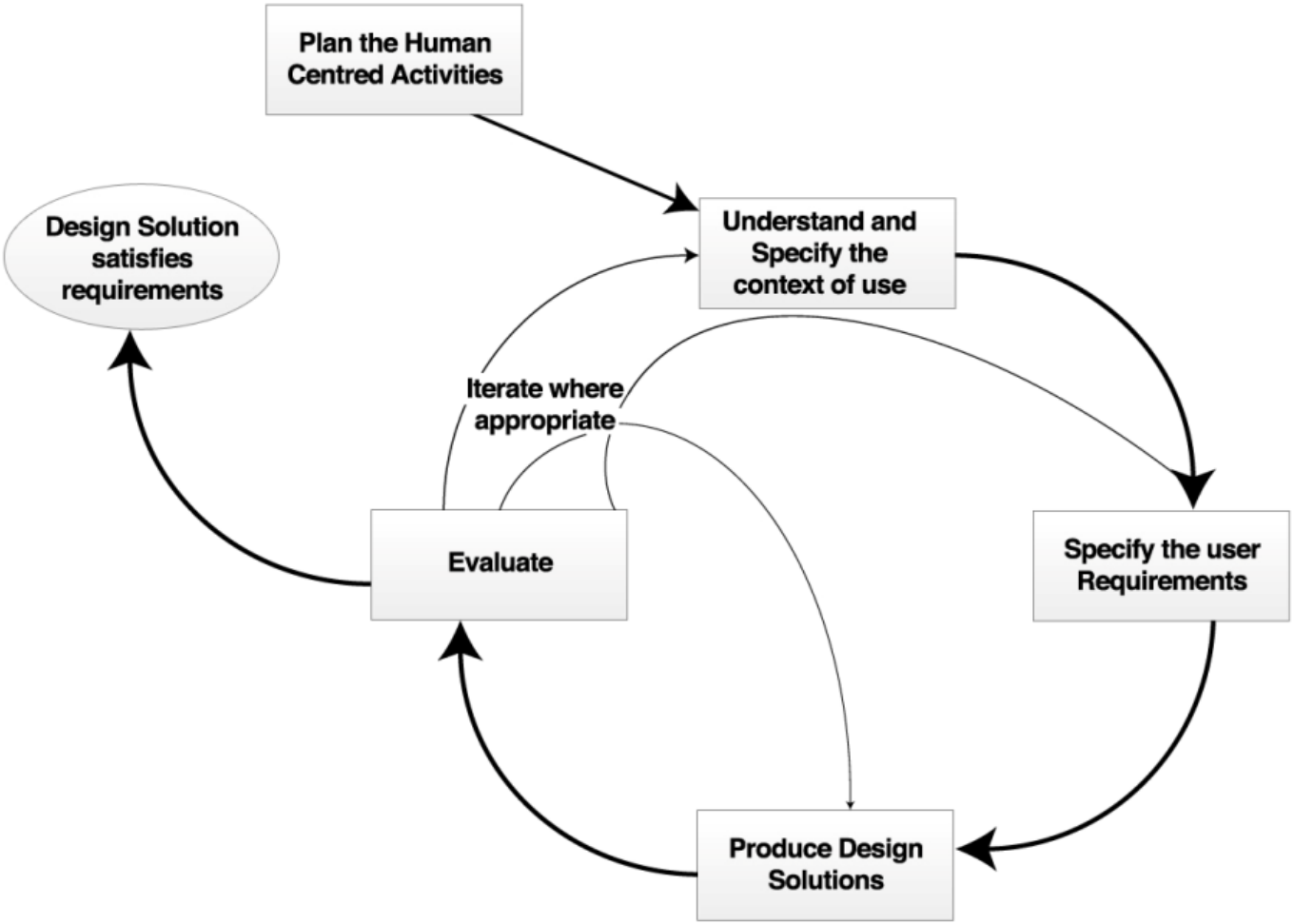
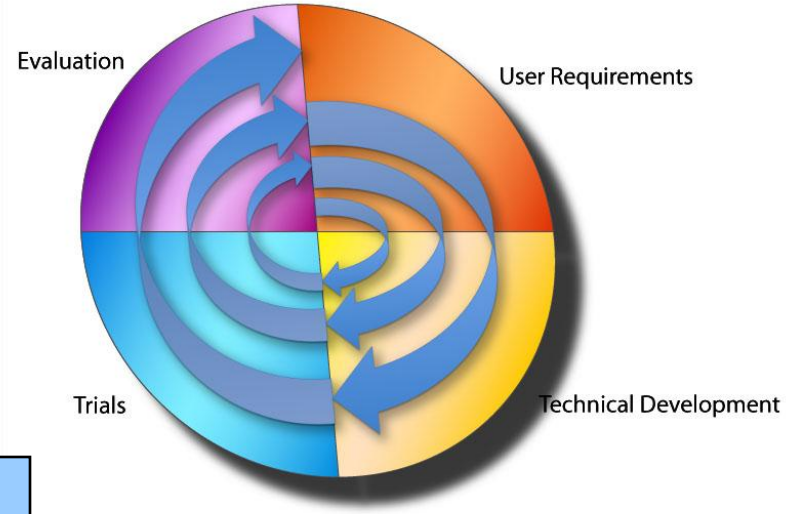
Human-centred product design as outlined by ISO/DIS 9241-210:2010.



Developmental design

Three iterative cycles



Workshops with PwDs & carers (15 dyads) Technical Development Field test #1 and Evaluation

Results from Field test #1 are input for 2nd stage of Technical development

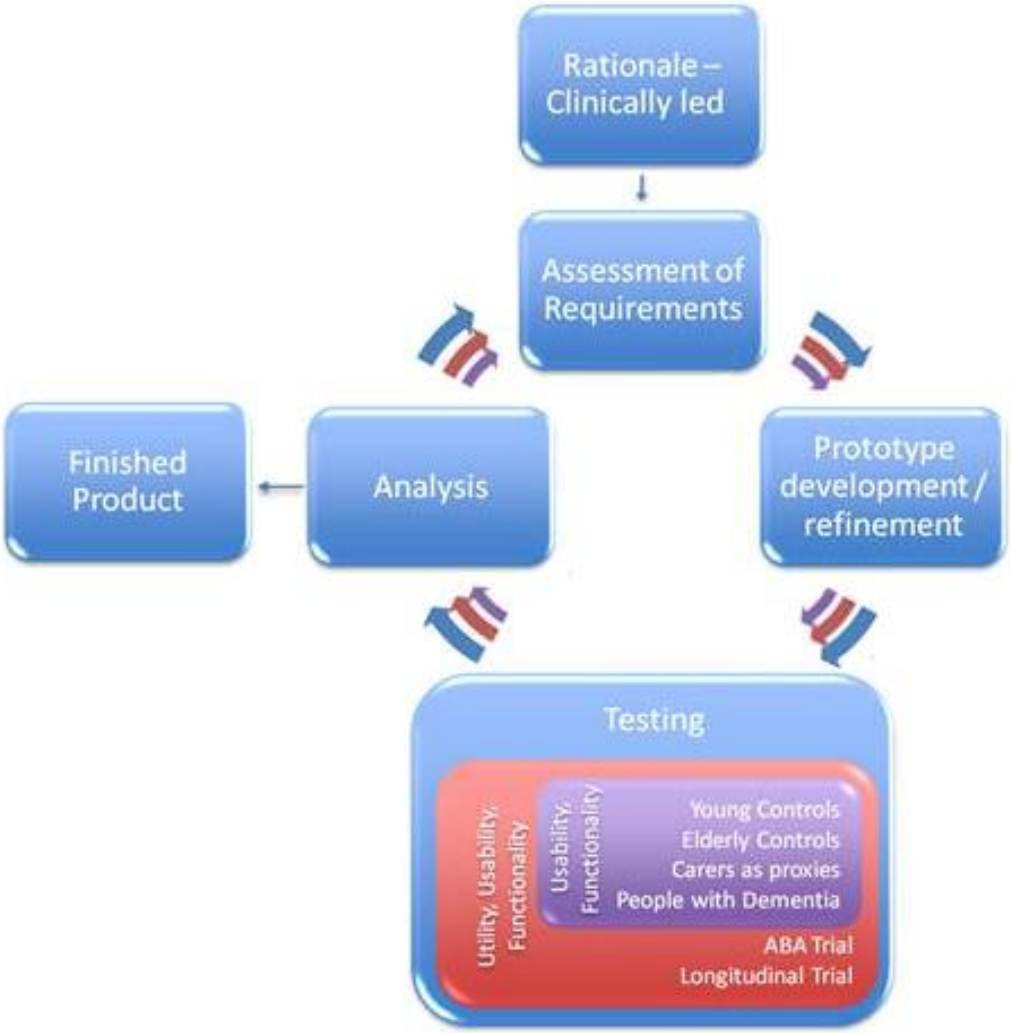
Workshops with PwDs & carers (15 dyads) Refining Technical Development Field test #2 and Evaluation

Results from Field test #2 are input for 3rd stage of Technical development

Workshops with PwDs & carers (15 dyads) Final Technical Development Field test #3 and Evaluation

COGKNOW

User-centred designs

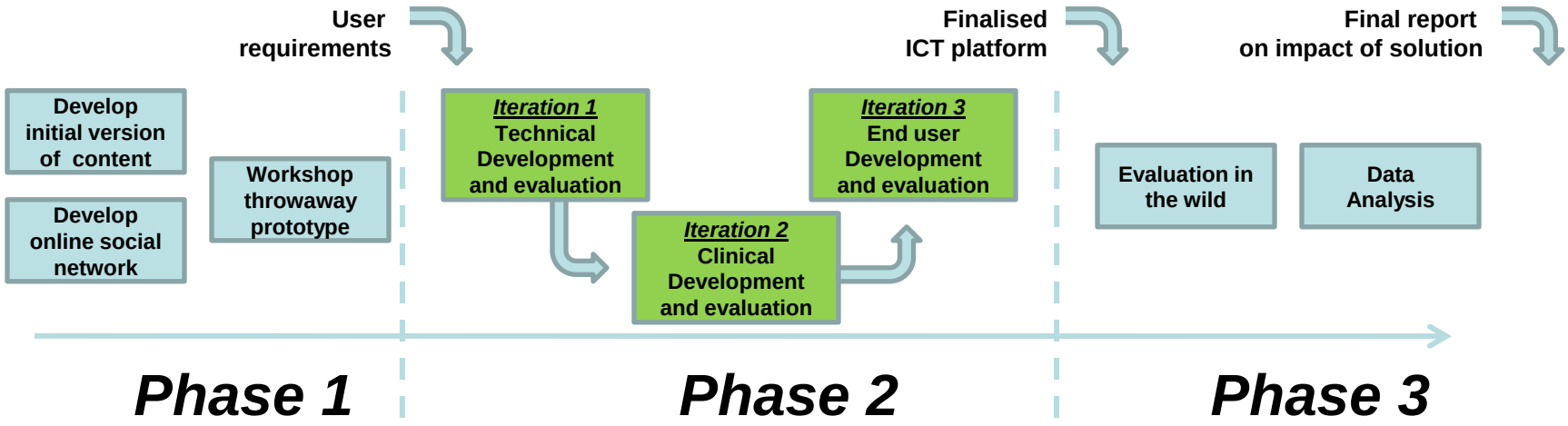


User-centred designs

Start with idea from experience, literature and clinical guidance

Consider iterative evaluations from different perspectives

Perform longitudinal evaluation in the wild



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Evaluating Cognitive Prosthetics

Design of the evaluation framework

- Consider very carefully what is it that you wish to evaluate.

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Assessment of Evaluations of Cognitive Prosthetics

	Year	Name of System	What is it?	Target User	Tested User	Tested Time Period	Total Day Count
Tran [11]	2007	Cook's collage	ingredients and instructions to cook	forgetful people	3 young adults	5 cooking sessions, 2 wk	15
Mihailidis [12]	2008	Coach	Handwashing Support	People with dementia	6 pwd (moderate to severe)	8 wk, 40 trials each	Over 330 days
Liu [14]	2008	Indoor wayfinding	PDA, Indoor wayfinding, directions and prompts	cognitive impairment	cognitive impaired, 2TBI, 2 mental retard., 2 PDD, 1 cerebral palsy, age 26-46	1 time trial	7
Szymkowiak [4]	2004	Memojog	PDA, server, carer interface, text based action prompts	memory impaired user	memory impaired users, 12 user, 2 phases 4 drop outs	12 weeks	96
Davies [7]	2009	Cogknow	Home based cognitive prosthetic embedded in smart environments	People with dementia	mild dementia	3 phases, each N=15, P_1=1d, P_2= 1wk, P_3=4wk	540
Wilson [3]	1997	NeuroPage	Pager with prompts	people with brain injury	ABA, 15 samples with organic memory problems (mostly through head injury)	A phase 2-6wk, B phase 12wk, A phase 3wk	180
Wilson [13]	2003	NeuroPage - now commercial	Pager with prompts	people with brain injury	40, traumatic brain injury (13), stroke (7) and others	27 ongoing: μ=12.7mon, max=24mon, N=13 quit after μ=9 mon	around 13,000

CD Nugent *et al.*, Evaluation of video reminding technology for persons with dementia, *Proceedings of the 9th International Conference on Smart homes and health Telematics,* ICOST2011.

Evaluation strategy

- **Human factors perspective**

  Insight into needs; evaluate the user-friendliness, usability, usefulness and the impact on autonomy and quality of life.

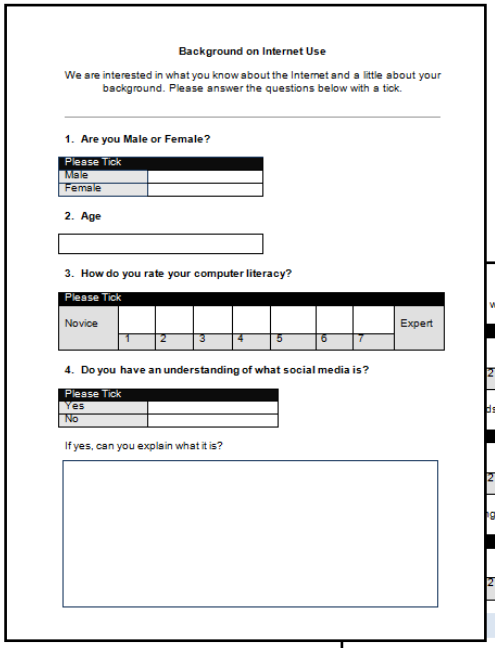
- **Technical factors perspective**

  Advance the state-of-the-art in e.g.: use of multi-modal services, predicting context, integration of systems, speed and efficiency.

- **Business factors perspective**

  Check the viability of business opportunities, and to identify critical business success factors.

Questionnaire Design



Background on Internet Use

We are interested in what you know about the Internet and a little about your background. Please answer the questions below with a tick.

1. **Are you Male or Female?**

Please Tick	
Male	
Female	

2. **Age**

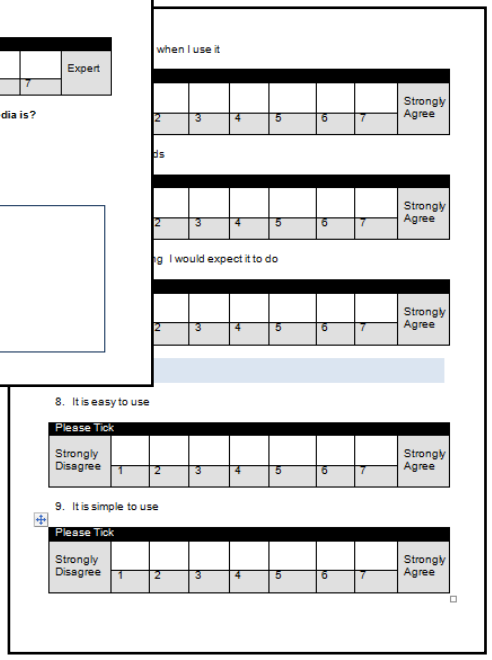
3. **How do you rate your computer literacy?**

Please Tick								
Novice	1	2	3	4	5	6	7	Expert

4. **Do you have an understanding of what social media is?**

Please Tick	
Yes	
No	

If yes, can you explain what it is?



when I use it

	2	3	4	5	6	7	Strongly Agree

ds

	2	3	4	5	6	7	Strongly Agree

g I would expect it to do

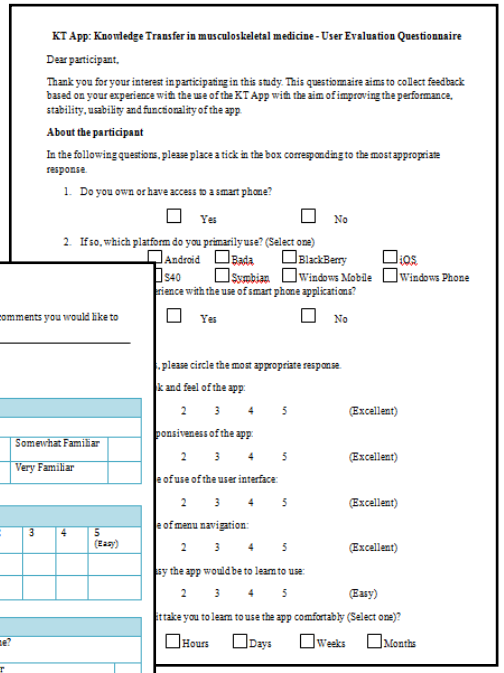
	2	3	4	5	6	7	Strongly Agree

8. It is easy to use

Please Tick								
Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

9. It is simple to use

Please Tick								
Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree



KT App: Knowledge Transfer in musculoskeletal medicine - User Evaluation Questionnaire

Dear participant,

Thank you for your interest in participating in this study. This questionnaire aims to collect feedback based on your experience with the use of the KT App with the aim of improving the performance, stability, usability and functionality of the app.

About the participant

In the following questions, please place a tick in the box corresponding to the most appropriate response.

1. Do you own or have access to a smart phone?

☐ Yes ☐ No

2. If so, which platform do you primarily use? (Select one)

☐ Android ☐ Bada ☐ BlackBerry ☐ iOS
☐ S40 ☐ Symbian ☐ Windows Mobile ☐ Windows Phone

rience with the use of smart phone applications?

☐ Yes ☐ No

, please circle the most appropriate response.

k and feel of the app:

2 3 4 5 (Excellent)

ponsiveness of the app:

2 3 4 5 (Excellent)

e of use of the user interface:

2 3 4 5 (Excellent)

e of menu navigation:

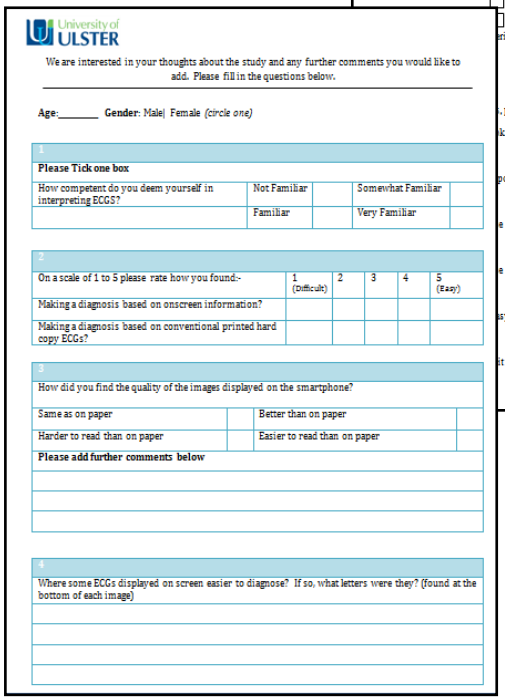
2 3 4 5 (Excellent)

sy the app would be to learn to use:

2 3 4 5 (Easy)

t take you to learn to use the app comfortably (Select one)?

☐ Hours ☐ Days ☐ Weeks ☐ Months



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We are interested in your thoughts about the study and any further comments you would like to add. Please fill in the questions below.

Age:_____ **Gender:** Male| Female *(circle one)*

1				
Please Tick one box				
How competent do you deem yourself in interpreting ECGS?	Not Familiar		Somewhat Familiar	
	Familiar		Very Familiar	

2						
On a scale of 1 to 5 please rate how you found:-	1 (Difficult)	2	3	4	5 (Easy)	
Making a diagnosis based on onscreen information?						
Making a diagnosis based on conventional printed hard copy ECGs?						

3			
How did you find the quality of the images displayed on the smartphone?			
Same as on paper		Better than on paper	
Harder to read than on paper		Easier to read than on paper	
Please add further comments below			

4
Where some ECGs displayed on screen easier to diagnose? If so, what letters were they? (found at the bottom of each image)

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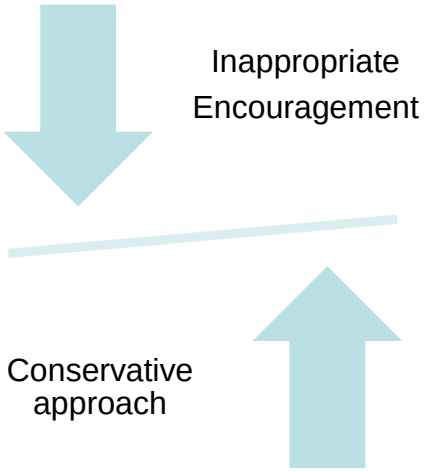
Technology Adoption

Using assistive technologies

- People with dementia may be reluctant to change their routine.
- Usage of technology causes apprehension due to the inability to use it or of making mistakes.

- Inappropriate encouragement to use technology may increase the likelihood of later refusing a technology which may otherwise have been of use.
- A conservative approach can, however, lead to loosing out on the potential benefits.



Adoption modelling

- Technology acceptance is a critical factor in successfully rolling out technology based solutions and should not be taken for granted (Wilkowska, 2010).
- A number of attempts have been made to develop prediction models:

  TAM: Technology acceptance model. Based on the notion that behaviour intention is influenced by *perceived usefulness*.

  PIADs: Physcosocial impact of assistive device scale. This is an extension to TAM including external factors which impinge upon *self-image*.

- These approaches have, however, been questioned due to their heuristic nature and lack of explanatory power (Chuttur, 2009).
- WSD Project in the UK has recently identified the need to model the prediction of early removal of telehealth equipment (Cartwright, 2013)

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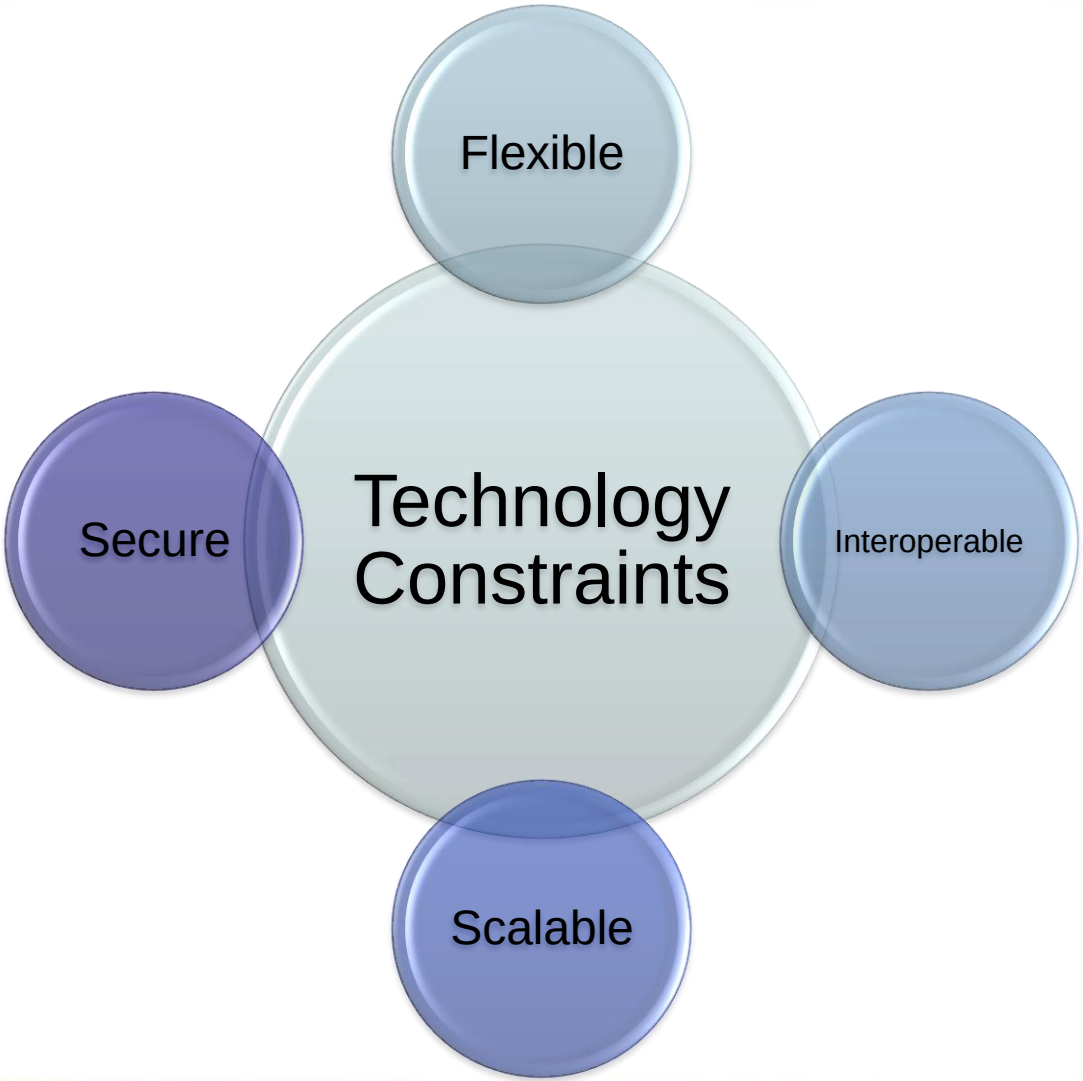
Summary

Constraints



- It is recognised that today's healthcare system is fragmented.
- Although one of the most data intensive sectors of the economy it is the least computerised.
- Politicians need to be convinced, via for example large scale evaluations.
- More ICT skills are required to use new solutions to their full potential.
- Negative perceptions from stakeholders.

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Conclusions

- Consider the design process carefully in conjunction with the amount of time available.
- Ensure you think in advance what is it that you really wish to evaluate.
- Ensure your questionnaires are well structured and thought through.
- Document everything throughout the entire process.
- Ensure that feedback received is carefully analysed and prototypes are updated accordingly.