Design Bugs Out:

A design study of hospital bedside chairs and commodes

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Abstract

Healthcare Associated Infections (HCAIs) can affect both patients and healthcare workers. They are difficult to treat, and can complicate illnesses, cause distress, and even lead to death. HCAIs are also a huge financial burden on the UK's National Health Service (NHS).

Aiming to identify and fast-track the implementation of new technologies and design-led innovations to combat HCAIs, the UK's Department of Health (DH), in partnership with the Purchasing and Supply Agency of the NHS and the Design Council, launched the Challenge 'Design Bugs Out' in September 2008.

The design challenge invited teams of designers and manufacturers to redesign hospital furniture and equipment to make them easier to keep clean, and so help reduce patients' exposure to HCAIs and improve their hospital experience.

As a research partner of a winning team (PearsonLloyd Design Consultancy and Kirton Healthcare Manufacturing) selected to answer this Challenge, the Human-Centred Design Institute (HCDI) at Brunel University conducted intensive design research focussing on bedside chairs and on-ward commodes.

The research findings were used to inform the design process of the ward objects, towards the delivery of working prototypes in April 2009, to be displayed in a public exhibition and then taken on a national tour of selected hospitals for trial. This paper reports on the research process, aiming to extract useful information on a human-centred approach to healthcare design innovation.

INTRODUCTION

The infection rate in UK hospitals is high. Estimates suggest there are at least 100,000 cases of hospital acquired infection in England each year causing around 5,000 deaths, and costing the National Health Service (NHS) as much as £1 billion a year (National Audit Office, 2004). Healthcare Associated Infections (HCAIs) can affect both patients and healthcare workers.

HCAIs are often referred to as 'superbugs', for example, Meticillin-resistant Staphylococcus aureus (MRSA) and Colostridium difficile (C. difficile). Superbug contamination can be spread through contact between healthcare workers, hospital visitors or medical devices and equipment. Data produced by the Health Protection Agency in 2008 (Health Protection Agency, 2008), demonstrated that infection is most evident in the sixty plus age range (i.e. older patients are prone to HCAIs.)

The challenge to the UK's design and manufacturing community was to design and prototype new furniture, equipment or services for hospital wards that help to reduce HCAIs.

Five specific design briefs were identified (Design Council, 2008) by the Design Council's early scoping study, namely:

1. *Hand Hygiene*: design a new product and/or service or system that improves hand hygiene of hospital staff, patients and visitors.
2. *Bedside Environment:* design a specific item of bedside furniture or a complete bedside system that will fit with existing ward

environment and is easy to clean and maintain, cost-effective, and sustainable.

3. *Commode* (portable toilet typically wheeled to a patient's bedside)*:* design a commode which is easy to clean and enhance usability, patient experience, comfort and dignity.
4. *Patient Transport:* design a means of patient transport that is easy to clean and will reduce the potential for the spread of HCAIs.
5. *Open Brief:* design a piece of equipment, furniture or system which directly or indirectly reduces the spread of common HCAIs in the healthcare environment.

Thirty-seven designer/manufacturer teams entred the challenge, and five winning teams were selected by a panel of experts including design, healthcare, microbiology, nursing and patient care.

The London-based design consultancy PearsonLloyd (well-known for their design of the Virgin Atlantic's Upper Class seats) and the specialist seating manufacturing company Kirton Healthcare won two projects: bedside chair and the commode. As their research partner, the Human-Centred Design Institute (HCDI) at Brunel University conducted intensive design research focussing on issues surrounding the design and use of bedside chairs and on-ward commodes.

This paper reports on the design research process and initial findings. It provides a live case study of real world ergonomics research and a human-centred approach to healthcare design innovation.

METHODS

"If the burden of healthcare-associated infection is to be reduced, it is imperative that architects, designers and builders be partners with healthcare staff and infection control teams when planning new facilities or renovating older buildings" (Wiseman, 2001). This suggests the importance of adopting a stakeholder approach to tackle HCAIs.

Between October and December 2008, much of the research was focussed on identifying stakeholders and capturing user requirements. The stakeholders spoken to included patients, carers, visitors, nurses, cleaners, infection control specialists, tissue viability specialists, and procurement personnel.

Opportunities for experimental methods, which are typically designers preferred means of engaging with users to test prototype products and experiences (Nickpour and Dong, 2008), were extremely limited due to the sensitive nature of the subject, and the ethical implications. The research team's intention was therefore to capture information on behalf of the designers and where gaps existed simulate environments. Meetings were held with the design company and the manufacturing company to communicate findings and develop and discuss the impact of these findings on the holistic picture.

Table 1 lists the studies conducted to capture user requirements and identify relevant issues.

Table 1. Studies conducted to capture requirements

Time	Studies
Nov. 08	Visit to local hospitals
Nov. 08	Product and process analysis
Nov. 08	Stakeholder interview (patients, carers, cleaners and nurses)
Nov. 08	Expert Consultation at Design Council
Nov. 08	Exploratory workshop with designers and manufacturers
Dec. 08	Detailed questionnaire to nurses
Dec. 08	Work-in-progress workshop with designers, manufacturers, patients and nurses (involving product test and role-play exercise)

Visit to local hospitals

The researchers arranged visits to three hospital wards with considerably different patient groups. Nurses were shadowed, audio-recorded interviews were made on wards, pictures were taken of the environment and the specific items discussed. Video footage was also taken of the cleaning process typically carried out on commodes.

Product and process analysis

Since both the design and the manufacturing companies have expertise in seating design, the focus of the analysis was on the product they were less familiar with: the commode. Benchmarking was carried out on existing products, detailing costs and

features. Parallel to this the purchasing habits within hospitals were investigated to identify the most popular current commode in use, and treat this as the datum product, for comparison and analysis. The unit identified was a 'Vernacare' commode known as Vernachair (Figure 1).

Figure 1. Vernachair

Once this product had been identified a unit was purchased to allow thorough interrogation, and analysis of the functionality and parts (Figure 2).

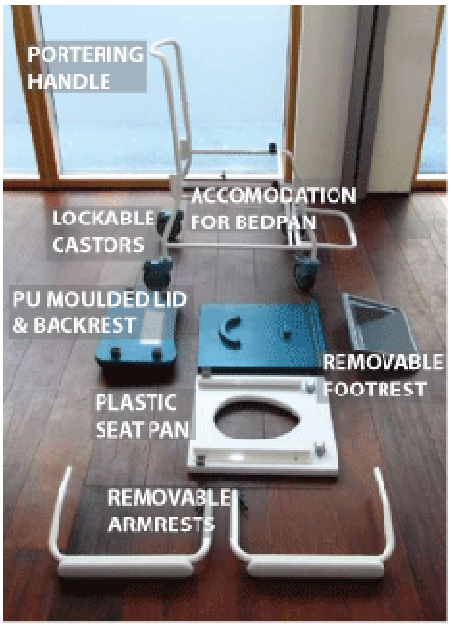

Figure 2. Identified commode parts

Stakeholder interview

Ten people were interviewed, including five patients from different age groups and with various experiences in hospital wards, three nurses, one cleaner and two carers. The interviews were based around 50 questions (10 general questions, 20 on bedside chairs, 20 on commodes). The interviews were video recorded with the consent of the interviewees.

Expert Consultation

Informed by initial research the team compiled a set of questions for a meeting with an expert panel arranged by the Design Council and the Department of Health, which consisted of 10 experts in related fields, such as nursing officers, infection specialists, and policy implementers.

The panel engaged in a one and a half hour discussion around the topics of concerns for the project, as identified through initial product research and the early hospital study.

The research team also explored new routes to 'expert' user groups (such as online forums and social networks), from which information could be gathered and communicated.

Exploratory workshop

The designers from PearsonLloyd Design and Kirton Healthcare were invited to an exploratory workshop in November to discuss the key issues of concern with the researchers and a few users interviewed.

Detailed questionnaire to nurses

Based around the identified issues a detailed questionnaire (with 26 questions) was developed and distributed to six staff nurses from three different hospitals to obtain more in-depth opinions and insights into the use of commodes and to compare the consistency of approaches and procedures. The questionnaire used a combination of open ended, closed ended and likert-scale questions. For example:

Typically how many commodes are on a ward?

Do you clean the commode after EVERY use?

How important is space for storing the commode in the sluice? (Rating 1-5, 1 being unimportant, 5 being very important)

Work-in-process workshop

In December 2008, a work-in-process workshop was organized for several of the identified key stakeholders: two nurses, two recent patients and an occupational therapist. Representatives from the design company, the manufacturing company, and the HCDI attended the workshop, so the discussions could cover all concerns. Group discussions were held followed by interaction with the bedside furniture through role-play (Figure 3) where the full routine of commode use was demonstrated by a nurse using team members as 'patients'.

Figure 3. Role-play

FINDINGS AND RESULTS

Visit to local hospitals

The recordings from hospital visits gave an overview of the product features and construction, first insights into the ways in which nurses interacted with the commode, such as the techniques used for cleaning and problems encountered. Through shadowing nurses the researchers identified issues that would otherwise been more difficult to recognize by simply examining the product, such as inter-relationships between staff, and details of use such as the following comment made by a Head Nurse at St Mary's Hospital.

"*It doesn't take long* (to clean). *Obviously if someone has had an accident it takes longer. Then sometimes it gets in here* (wheels), *which I have had and that takes some time to clean.*"

Product and process analysis

As the commode use is dynamic, details of its static use and basic knowledge of operations was not sufficient to understand the holistic use. The designers found it was necessary to develop a storyboard (Figure 4) to illustrate the details of the commode in use.

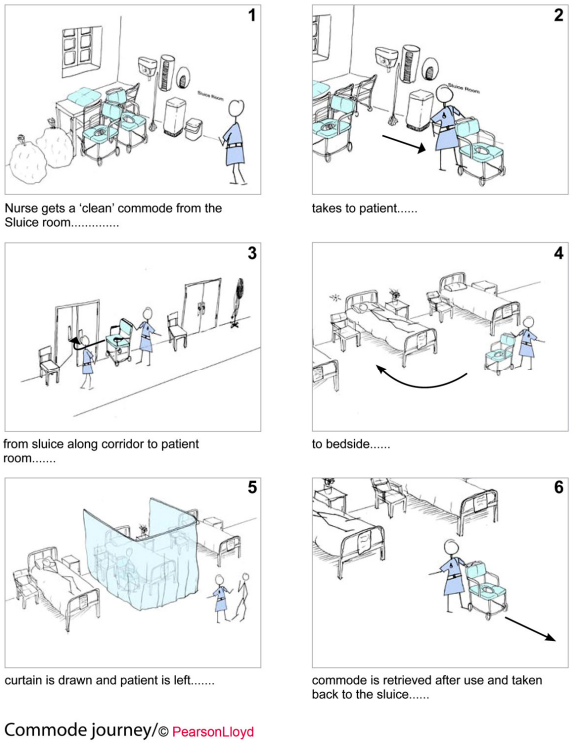

Figure 4. Commode journey storyboard

Stakeholder interview

Seven personas were created based on the interviews, and populated with real quotes, in order to give the designers a diverse range of example users that they could consider in concept creation.

An example of the persona is give below:

Suzan Williams – The bug-phobic

Suzan is a fifty-year-old primary school teacher living with her husband Pat. Last year she had to spend three weeks in the hospital for a hip operation.

She was really worried about getting an infection so she decided to bring a bag of all types of hygienic stuff with her. One thing which really concerned her was the young girl beside her, Cindy, who used the commode in the ward which was usually kept near her bed, not only did she worry about the hygiene but she also got quite annoyed that it was left un-cleaned for long spells, as she found the smell really unpleasant. Suzan only had to use the commode once, for a urine sample. She didn't like the idea of using it but made sure she first sprayed and wiped the surface herself. When she was on it she didn't feel very secure, "it felt a little unstable, and having to go on it just didn't feel right."

Suzan woke up quite early every morning and used to sit on her bedside chair for long hours reading books. When Pat came for visits, he also sat on the chair but got bored quite quickly and would go for a walk around.

Suzan believes her bag saved her from getting infected at the hospital; "The person beside my bed actually got an infection, If I didn't have my bag, I guess I could have as well!"

If any of the material from a persona was of particular relevance the recordings could be accessed for further information. Another example of the information contained within the personas follows.

"… even when you're dying you must sit on the chair, they'll say – you'll develop sores, and water on the lungs". The person interviewed spent around 8 hours a day in his chair *"I did everything in that chair - read, ate, puked".* He liked the *"nice cheery colour"* of the chair, but was suspicious that it might have been chosen to blend in with the muck.

Expert Consultation

The expert consultation elicited the following interesting comments:

Bedside chairs (User Types, Function, Adjustability, Weight, Ergonomics, Clean-ability, Price, Evaluation)

- People are likely to put a cushion on top of the chair, thereby negating the built-in ergonomics.
- Items like the armrests come in contact most often thereby creating cracks and degenerating quicker. The ability to replace these parts should be considered.
- Formica or any material requiring glue is not recommended, as bacteria grows in glue very well.

Commodes (Clean-ability, Existing Bed Pan System, Seat Pan/Cushion Lid, Functions, Storage, Market)

- Another route is to sit the commode over a toilet, as it gives the patient more sense of privacy.
- Splash prevention is very important, as any severe incident could cause an aerosol effect of 8' around the source.
- Storage of equipment in general is always an issue within a hospital. Stacking or nesting, could be an advantage.

Exploratory workshop

Through the exploratory workshop, a number of issues of concern had been identified.

Bedside chairs:

- The wide range of chairs in different hospitals, ranging from very basic types to more sophisticated ones with adjustable features.
- The height is often a key problem and if adjusted is done so in makeshift ways
- Surface contours are difficult to clean. Minimal cleaning is carried out
- 'Useless' features included (such as the head wings)
- 'Traditional' and 'basic' colour and material usage
- Poor body support
- Armrest issues (removable armrests are useful for patient transfer but readily capture dirt) Often rendered useless by placing pillows/cushions under patient
- Patient spend extended times in chairs (typically 4-6 hours a day, at times much more)
- Size

Commodes:

- Unfamiliarity (compared with conventional toilet bowls)
- Misuse (as a mobile chair or shower chair)
- Wheels are very difficult to clean, and have ineffective braking system.
- Small size of the disposable pans
- Storage problems
- High risk of spreading bugs through touch, and obscured surfaces
- Patient's lack of confidence in using the commode
- Concerns for privacy and dignity
- Poor body support
- Commode design does not promote easy bowel evacuation

Detailed questionnaire to nurses

Of the five nurses participated in the questionnaire survey fully, one nurse partially completed the questionnaire, where appropriate all contributions were included in the analysis. The following are example of some of the main findings.

There was a significant difference in response as to the time taken to clean a commode (see Figure 5).

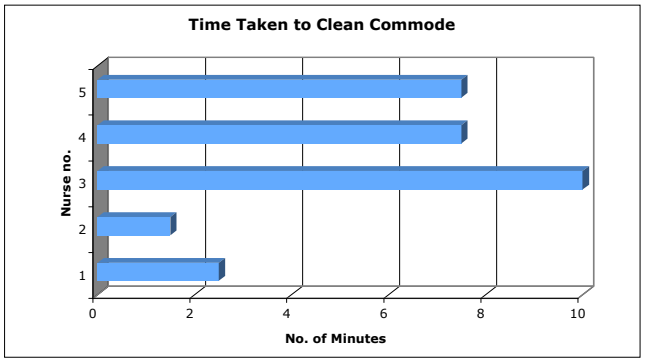

Figure 5. Time taken to clean Commode

It can be concluded from this that some nurses carry out a more thorough clean, dismantling components and cleaning the underside, however, it is apparent that some nurses carry out a more superficial cleaning process. One nurse commented,

"*for a full MRSA clean it would take 20 minutes*", suggesting that a cleaning time of three minutes or less is highly unlikely to protect against HCAI's. When questioned as to how often they dismantle the commode for cleaning it became apparent only one did this, the others giving responses such as,

"*once, at the beginning of my shift*"

"*never, I just clean the seat area, and wash the footrest*"

The process for thoroughly cleaning the commode is currently time consuming, awkward and not intuitive, these areas could be improved through appropriate design measures.

The importance of storage space was also highlighted, and would be a key issue in the design development.

Space considerations within the sluice ranked very highly, therefore suggested design routes such as collapsing parts stacking and nesting should be explored. One nurse commented,

"*If you ever tried accessing a sluice when it's full of commodes, you'd understand why space is very important*!!"

Insight was also gained into the proportion of bedside use (versus toilet based use) of the commode (see Figure 6).

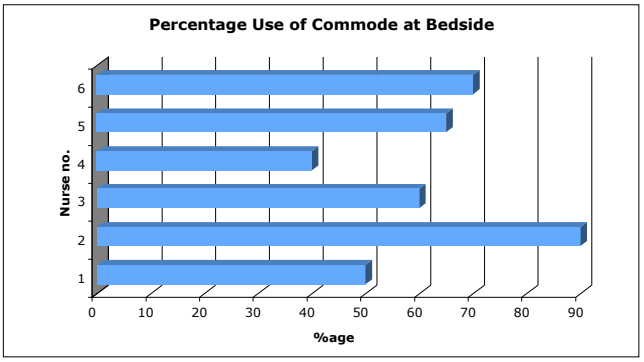

Figure 6. Percentage use of commode at bedside

These two distinct and frequent forms of use need to be catered for, and the suggested frequency of toilet use was significant enough that issues such as mobility cannot be compromised.

Work-in-process workshop

The investigations in the workshop helped to form a comprehensive view of the use of commodes and bedside chairs, with all equipment at hand and nurses on site the process could be interrogated fully and any unanswered questions addressed. The use of role-play gave team members unique insight, as is demonstrated in the following comment:

"*It's really strange, when you sit in the commode you realise how difficult it must be to go. The shape of the pan actually squeezes the buttocks together, it's nothing like sitting on a conventional toilet*."

DESIGN

The research helped to create a clear story in regard to the use of commodes and bedside chairs, and the needs of the various stakeholders, which in turn allowed the key functions/needs to be identified, to specify both primary and secondary needs to be addressed through the resulting designs (Figure 7).

Primary	Secondary
Easy to clean	Removable lid
Minimise parts	Minimise junctions
Mobile	No cavities
Easy maintenance	Braking
Ergonomic	Fit over normal toilet
	Rotating arms
	Footrest
	Wipeable surfaces
	'Clean' signal

Figure 7. Primary and secondary needs

In April 2009, working prototypes will be displayed in a public exhibition and then taken on a national tour of selected hospitals for trial. The final prototypes features are in the process of being patent protected, and hence it is not possible to divulge specific design outputs at the time of writing. Dependent upon the response during exhibition there may be a second develop and deliver phase where the focus will be upon the delivery of a refined detail design output.

DISCUSSION

This project proved challenging due to the sensitive nature of the end users and the environment/use of the products. Being well-versed in furniture design, one product was within the realm of the design teams previous experience, the bedside chair, however as the other product was a commode, it was unlike any previous products they had encountered, and hence they had no prior data they could refer to. The designers found themselves in a situation where their own prior knowledge was limited, availability of existing knowledge restricted and opportunities to compile new data both time-consuming and difficult to arrange due to the sensitive nature of the hospital environment and ethical issues. Access was a major obstacle for the early stages of the development where information is most needed.

The research team responded to the information requests of the design team, and developed strategies for information retrieval. Early literature review had limited effect, as much of the information found was not relevant to design.

We quickly identified that the designers were most interested in the actual ward scenarios but such information enters realms that prove difficult to access. So a combination of methods were adopted to help form the knowledge base, such as shadowing nurses in hospital wards, developing personas based on stakeholder interviews, compiling multimedia data (e.g. video footage) for designers, and engaging the design and manufacturing team in workshops in a simulation room, which allowed the designers to engage with hospital equipment, patients, nurses and occupational therapists, and participate in role-play of use scenarios. Most of these methods proved effective in engaging the design team and help them develop understanding of the issues. However, personas were not as effective as the research team expected (designers did not refer to the personas in discussions). This might be because the method was not familiar to the design team and they did not see the value of it.

The work-in-progress workshop could have been organized earlier to give the design team insights into the users' concerns and real use scenarios early in the design process. However, establishing contacts with nurses and patients took time. What the research team has learned from the project is that designers want information quickly, and user research takes time – a good time balance has to be found based on mutual understanding of the process.

The project allowed a holistic view of the design process and the typical user related data requirements for such a project. It gave an indication of when user data needs were high, and when they tapered off.

Figure 8 is derived from the project Gantt chart developed by the design team. It illustrates the user data needs which began high and continued at this level through the 'explore' phase, through the 'define' phase with better understanding a refinement of queries occurred, which lead to a reduction in the volume of data needed. During the 'develop' and 'deliver' phases concepts are developed of prototypes require testing, hence user data again peaks for interrogation and evaluation of proposed solutions with user requirements, before the 'deliver' phase, at which point all user data should be in place. In step with this the research team has contributed extensively in the 'explore' phase, and the early stages of 'define' phase. Currently the research team has not contributed much to the 'develop' phase as the prototype features cannot be disclosed before it is patent protected.

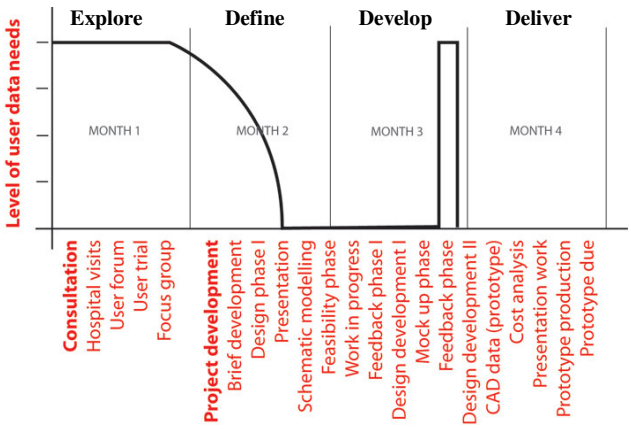

Figure 8. User information needs in design process

Much of the feedback demonstrated a conflict of demands in regard to information needs, often relatively detailed and specific information was desired. However, the retrieval and communication of this information was expected to be heavily summarised, easily digested and engaging.

As the main period of user data needs is at the front end of the design process where designers should be at their most creative, how might the science of ergonomics be translated into something that can offer inspiration to a design project? This is the question that we want to pose to the ergonomics community.

CONCLUSIONS

This project provides a live case study of real world ergonomics research and a human-centred approach to healthcare design innovation.

In sensitive environments such as hospitals user engagement involves additional complexity, and is more difficult to arrange and authorize. However, only through engaging with the variety of actual stakeholders can in-depth understanding and a holistic overview be developed. Nothing can be assumed about such a dynamic, variable and complex environment. Insights gained by engaging all relevant stakeholders during the identification of problems and procedures, lead to the definition of a relevant design specification, and hence effective design concepts could be developed.

As much of the existing literature on commodes did not cover design considerations, collecting primary data was the most informative approach for this project, but was not as time effective as desired by the design team. Having now established connections, routes and information sources, the data gathering and knowledge communication could be a great deal more streamlined (this of course would only apply if a similar hospital based project was being addressed).

An issue remains in that early exploratory research is rich in content and insight, therefore editing this information for fast communication risks potentially losing important detail, or influencing how designs might develop based on researcher deductions. This may in turn cause opposition from designers, who would ideally be engaged in raw data reviewing and editing.

The key challenge therefore remains in how researchers might quickly gather not only accurate and relevant information for use in design, but how this information can be communicated in both engaging and inspiring ways, talking the designers' data language.

Our insight obtained from this real world design project suggests that a more human-centred approach should be adopted in collecting user data for designers.

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