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Demystifying 21st Century Healthcare Practice

The world has changed, healthcare is changing and design practice is reacting to keep pace with a world in transition. Healthcare providers throughout the world are facing the prospect of unprecedented change as costs and demand escalate. Designers are well placed to contribute to the transformation of a global industry and shape how future healthcare is delivered and experienced, as we have the capacity to see things differently, think differently and do think things differently.

Healthcare design is now emerging from the shadows to be recognised as a distinct design discipline in its own right. A new discipline with patient safety at its heart, a practice that requires systems thinking and collaboration to tackle complex challenges and a practice conducted within a stringent ethical framework. This new territory is sparsely populated with high quality design exemplars. This chapter seeks to demystify these practices by providing a textual roadmap to support and inspire the *new agoras* who wish to engage with 21st healthcare design. Conversely it is hoped its content will also serve as a catalyst for healthcare providers who wish to reap the rewards associated with embracing a design-led approach with design practitioners at the very core of their service innovation teams.

My own tacit knowledge and experiences that have led to the creation of a multi-award winning nursing bag will be used as a case study exemplar. NHS at Home: co-designing a 21st century nursing bag commenced in April 2008 as a PhD by practice project based at the Royal College of Art (RCA), London. The research was closely aligned to the RCA's Engineering Physical Sciences Research Council (EPRSC) funded Smart Pods project - a multi-institutional research project that examined technologies and systems for the delivery of emergency/ urgent care through vehicle-based solutions. To complement this stream of activity, NHS at Home traversed the product/ service nexus to assist mobile healthcare workers in the delivery of planned healthcare in patients' homes through product innovation. This project was supported directly by NHS East Riding of Yorkshire and their neighbourhood care teams.

At a structural level, this chapter will look at the challenges of securing project support from healthcare providers - an imperative starting point for any healthcare project; discuss the governance measures that will need to be adhered to when working with a NHS provider; offer constructive advice on project and intellectual property management; outline useful strategies to navigate the NHS ethical approval process. On a practical level, this chapter will seek to demonstrate the importance and value of using an evidence-based approach to healthcare

design, highlight the benefits that professional diversity can bring to the design process and expose new creative and experimental methods that have perfected and authenticated design decisions: Lego Serious Play and UV analysis.

The rationale for embarking on a journey into healthcare design practice can be varied. From a student perspective your motivation may have been sparked by your own first-hand experience of co-existing with a medical condition or your contact with healthcare services. Or like me, you have arrived at this point due to a combination of factors: new opportunities, networks or career aspirations. Whatever your rhyme or reason your decision is a timely one. Healthcare is the largest industry in the world, a practice that transcends all geographical boundaries and a theme that unites each and every one of us. By its very nature healthcare is complex and diverse which bodes well in terms of finding a research focus that resonates with your personal interests and future career ambitions. However a wealth of opportunity brings with it its own challenges as the range of available literature can be all consuming as you will soon discover. This voluminous array of dialogues, critiques and analyses in the public domain amplifies a severe shortage of high quality design exemplars where applied research activity has translated into tangible outputs to the benefit of patients. For designers this is fertile ground as your creative thinking supported by clinical expertise and a robust evidence base will undoubtedly attract the attention of a diverse range of audiences.

Origins of evidence-based healthcare practice

The Royal College of Art has led the vanguard of evidence-based healthcare design practice, dating back to the original King Edward's Hospital Fund for London's hospital bed project of 1963. The 'King's Fund' bed as it became known established the British Standard for future hospital bed design. A design team lead by RCA research fellow Leonard Bruce Archer developed the parameters for a standardised hospital bed that continues to be used in 85% of NHS hospitals to this day. The King's Fund bed project is an important reference point for all budding and early stage healthcare design practitioners, as the research methodology it developed during this ground-breaking project introduced for the first time evidence-based healthcare design practice. A first phase of the project consisted of an information gathering exercise that involved a detailed literature review and the engagement of relevant stakeholders through design workshops. A second phase involved clinical evaluations of design prototypes through a study that compared the performance of the original bed against the new proposal using observational research methods. Through this exemplary project, Bruce Archer and his team established the fundamental principles for inclusive and evidence-based design research. These principles and methods have continued to shape contemporary design research practice at the RCA and beyond: Design for Patient Safety, Future Ambulances, Smart Pods, Resus:

Station, Design Bugs Out and Designing Out Medical Error and Redesigning the Emergency Ambulance.

Your project's timescale will inevitably define your project's aim, objectives and methods used and as such, is it an important factor to consider from the outset when defining the centre of gravity and scope of your study. Considering the ethical implication of your study is a second factor that requires careful and detailed examination and planning prior to starting any project. We shall return to this a little later and discuss its implications from an undergraduate and researchers' perspective.

Understanding drivers of future healthcare

As someone who might be fresh to the field of healthcare design a thorough examination of the available literature around the social, economic, political and technological drivers that are shaping the future delivery of healthcare is paramount. It is vital not to underestimate the value of this phase, as at some point you will need to engage with senior management teams within a healthcare organization and put forward a convincing case to them in order to secure executive sponsorship. As a first port of call I suggest you touch base with the following sources: the Department of Health, Office of National Statistics, The Cabinet Office, NHS Institute for Innovation & Improvement, The King Fund, Demos, National Audit Office and PubMED. To test your rapidly acquired knowledge base and gain a deeper understanding of emerging challenges do not hold back in engaging with the principal stakeholders across the healthcare continuum. Upon reflection I found this process to be an extremely valuable exercise as these conversations opened up new networks, revealed new knowledge with respect to NHS procedures or new strategies, and directed me to named individuals who could further assist with the momentum of my project. One of the additional benefits that you come to appreciate further down the line is that engaging and developing your network relationships at an early stage facilitates on-going dialogue and allows you to draw upon their tacit knowledge at the time when you need it most. This approach is far more successful than a cold-call during the latter stages of your project. View dissemination as a continuous process and not something that only occurs at the end of your project. I shall use my own personal experience to demonstrate the value of such a tactical strategy. My first year of study was structured into three distinct phases of activity: a literature review involving more than 500 reports, a process of stakeholder engagement and a project scoping exercise to sharpen the direction of the project. A critical review of the literature concluded that the home was rapidly gaining momentum as a primary healthcare setting for the 21st century. In formulating this hypothesis, a suitable working title was established to communicate succinctly the very essence of the project to both clinical and commissioning audiences: NHS at Home. What's in a name you might say? Actually it's a decision that requires more thought that you think. With email now

the number one communication tool give some consideration to how you introduce your project within the limitations of a subject field to someone who is unfamiliar with your project. This subject field is a first touch-point; where possible avoid lengthy and overtly academic project titles and instead opt for brevity. To ascertain the internal drivers that propel the process of service transformation and improvement within the NHS, interviews with influential figures at all levels were arranged - from the Cabinet Office through to Primary Care Trusts. If you decide to adopt this strategy I suggest that you organize your approaches tactically with your first point of contact being at the highest level possible. Securing a meeting with a cabinet advisor to the Prime Minster on service transformation (as I did) provided added leverage to secure future face to face meetings with individuals and organizations in both vertical and horizontal directions. It is a small tip, but one that works every time: start your email communication by stating, 'Following my recent meeting with XXX…". Traversing my own project hierarchy eventually led me to a meeting with the Service Transformation lead at Yorkshire & Humber Strategic Health Authority. It was during this meeting that I discovered that NHS East Riding of Yorkshire (NHS ERY) had just embarked upon a new initiative to bridge the divide between hospitals and GP practice by introducing a new intermediate healthcare tier to deliver planned healthcare in a patient's home. As a result of this conversation I had a subsequent meeting with the Assistant Director (AD) for Design & Innovation at NHS ERY and this led to an agreement to sponsor 'NHS at Home' to the mutual benefit of both parties.

Communicating your aims an objectives

Securing executive sponsorship from a host organization is an imperative factor - especially if you are seeking to engage NHS personnel at any level in your study. One of the critical skills in which you will develop proficiency is the delivery of coherent presentations that succinctly capture the challenges ahead, outline the opportunities and positive impact of a design-led approach in terms of productivity, safety and service quality. For me, there is only one methodology that I now use in this situation to distil a multi-faceted and complex healthcare challenge into an unwavering and coherent narrative. The instinctive choice would be to produce a Microsoft PowerPoint but as we all know the number of slides we use keeps on growing and we are often distracted by tangential discussions midway through our presentation. For such situations I now provide a short iMovie using a combination of text and images/ slides, enhanced by an appropriate piece of instrumental music. Working to a backing track of a fixed duration forces you to consider carefully the most salient points and the sequence in which your message is revealed - especially when you consider that a text slide consisting of two/ three short sentences requires 10-15 seconds of reading time. iMovie and other similar software packages are very intuitive to use and mastered with extreme ease. While to our visually educated eyes the use of such simplistic software may seem naive do not

underestimate the impact of this medium on a non-design audience. More proficient users may prefer to use Final Cut Pro but with similar outcomes. Once again, from personal experience I have used this technique many times to secure high level project buy-in from high ranking managers, senior executives and academics. It has worked successfully for me and no doubt could work successfully for you too.

Securing the support of a sponsor such as NHS East Riding of Yorkshire will help you to navigate through a lengthy process necessary to secure ethical approval for your study, especially if this is new ground for you, your university or organization. At this stage the design of the study project really needs to be very precise in terms of its aims, objectives and methodology - it will be the criteria that you will be judged against by any ethical panel: NHS or University. This process may involve the completion of a project initiation document (PID). The primary purpose of these documents is to identify and address issues of interdependencies with other projects, associated risks, financial implications, benefits and measures and key project outcomes. While the specific content of such a document may vary from organization to organization, ensure a statement regarding ownership of intellectual property is discussed and included. It may be difficult to determine the value of contributions and future tangible outputs (unrealized or realized) so an agreement of understanding from the very outset will be beneficial. Depending on the nature and length of the project support, a dedicated project steering group (PSG) involving relevant people from across the organisation may be established. In my case, my PSG consisted of the AD for Design & Innovation, Service Development manager, Service Improvement manager, Clinical services programme manager and Community Matron Leads from three Neighbourhood Care Teams (NCTs) located across the county. The remit of the PSG was not only to facilitate the delivery of the study, its activities and code of conduct but also to be accountable to the Trust's Clinical Executive Committee (CEC). No doubt you have already provided a project plan outlining key milestones. From the outset agree the frequency and dates of when the PSG shall convene as this group of individuals is your gateway to organizing and co-coordinating fieldwork activities, identifying and securing participant consent, draws upon their tacit knowledge of vulnerable patients and protocols and is a captive audience for design workshops and reviews and enables you to update the group of any developments or emergent findings. The difficulties experienced by Bruce Archer of co-ordinating and gaining access to healthcare professional as study participants due to work demands and commitments remain to this very day. By anticipating this operational problem and scheduling frequent meetings (e.g. every 4-6 weeks) it provides a fixed timetable in which qualitative design workshops/ evaluations can be dropped into. Operating with little a forethought as opposed to a reactive approach will alleviate stress as the project accelerates but also eliminate an impossible task of co-ordinating 6-8 people's diaries.

Navigating research ethics

At this point you will have addressed issues of operational management and governance. The final piece of the jigsaw is research ethics. If you are located within a university you will need to adhere to their regulations, procedures and systems for approval which will be well established and expedient. In a NHS context this process can involve an organization called the National Research Ethic Service that has a dual mission:

- To protect the rights, safety, dignity and well-being of research participants
- To facilitate and promote ethical research which is of potential benefit to participants, science and society

In recent years the transparency of the process has increased dramatically and become more streamlined but may have degrees of variation in different parts of the UK. However one of the benefits of establishing a Project Steering Group is that this team can advise and guide you smoothly through this process in consultation with the organization's research ethics advisor who will be able to determine whether your study is likely to be classed as 'service evaluation' or 'research'. While it is preferable to be classed as service evaluation for expediency, regardless of the definition you will need to prepare an identical comprehensive pack of documents before approval is granted and an honorary contract issued by the host organization. These materials will include a support statement from your organization and your NHS host, completion of a research protocol, an application for an honorary contract and exemplar consent and information sheets for both patients and NHS professionals involved with the study. For the uninitiated this process can take months and needs to be considered from the very beginning. A useful piece of advice for undergraduate students is to design out any potential research ethics issues by adopting a study strategy that targets leading academics that have worked and completed in-depth studies in your area of interest. Use Google Scholar to identify your prospective sources and mine their tacit knowledge for insights and information.
Alternatively seek an expert opinion from within your university's Faculty or School for Health, Healthcare or Medicine.

The process can be the cause of much frustration and has possibly deterred the wider engagement of design practitioners/ researchers. However there are benefits as this process instils a high level of accuracy in your project as it necessitates you to precisely state your aims and objectives that in turn adds clarity to your research methodology. The process brings robustness to your practice too as you are adhering to the conditions and protocols as used by

seasoned clinical researchers. This is especially important if your research findings and design outcomes are to be taken seriously by clinical audiences. The rewards of your perspiration and tenacity are eventually realized once ethical approval is finally granted enabling you to proceed with your project.

Hopefully, we have revealed new insights, highlighted unfamiliar obstacles and offered useful operational strategies to help you navigate through the early stages and to gain external traction for your study. We shall now turn to the practical aspects of the study and discuss in detail several experimental methods, new methods pertinent to any healthcare product, that have been used to great effect in shaping the finalized design. At this juncture it would be useful to provide you the reader with some context and identify explicitly the aims and objectives of my study. Observational research identified that while new organizational structures are emerging to bridge the divide between acute and primary care settings, little dedicated equipment exists to support nurses working in this challenging and inconsistent healthcare setting – the patient's home. The black nurse bag used by community nurses throughout the world has remained impervious to design innovation for almost 150 years. To support a global paradigm shift, new ways of working and new types of equipment were perceived to be necessary as the traditional nursing bag has been proven to be both dangerous and outdated: 21st century professionals using 19th century kit. The specific aims and objectives of the study are:

- To study how planned treatments are delivered in patients' homes.
- To examine nursing bags used in practice: delivery, design, materials and cleanliness.
- To capture the professional challenges of nurses in greater detail.
- To co-design a 21st century nursing bag that improves productivity, service quality and patient safety.
- To validate the effectiveness of a proof of concept demonstrator.

In realizing these aims and objectives we shall explore three specific methods that might be pertinent and applicable to your healthcare design project: scientific methods for capturing microbial flora, use of Lego Serious Play as a design research tool to capture service narratives and to envision aspirational service products and the creative use of UV analysis to perfect product forms that maximises the effectiveness of decontamination through hand wiping.

Determining the cleanliness of nursing bags

Patient safety is a primary concern for any designer seeking to (re)design a medical device or equipment, but particularly the prevention of MRSA and C.Diff. (Dancer, 2007). Science and

food industries typically use three systems for the screening and identification of bacteria: Adenosine Triphosphate (ATP), swabs and agar plates. The growing media attention surrounding the prevalence of HAIs within hospitals has led to the adoption by hospital trusts of portable ATP bioluminescence systems. ATP is a fuel molecule that exists in all living things, including bacteria. A major benefit of the ATP system is that it is simple to use and provides quick but generalisable results. The system is able to monitor the effectiveness of cleaning practices by analysing ATP levels before and after a surface has been cleaned.

The ATP system works by swabbing a surface with a sterile swab stick. The swab is then exposed to an agent that initiates a chemical reaction. During the chemical reaction light is emitted and level is measured. The level of luminosity is directly proportional to the amount of ATP present. It was 3M's CleanTrace™ ATP system that was used by the RCA's Design Bugs Out project team to determine the presence of bacteria on surfaces. However, one recent study suggests a limitation of such ATP-based systems (Turner et al, 2010). This study identified that the efficacy of an ATP system could be affected by residual disinfectants and an inability to detect gram-negative bacteria. If you wish to achieve a higher level of accuracy and specificity the swab system is a preferable method of detection.

This process involves the use of a stick swab, a sterile template and sponge swab. A sterile plastic template demarcating a 100mm square aperture is withdrawn from its packaging without touching the inside edges of the aperture. Diligence is required in order not to contaminate the inside of sterile package and this be used be to transport the used swab to the laboratory for analysis. The template is then held against the test surface with a sterile sponge swab swiped methodically across the designated area defined by template (Figure 1).

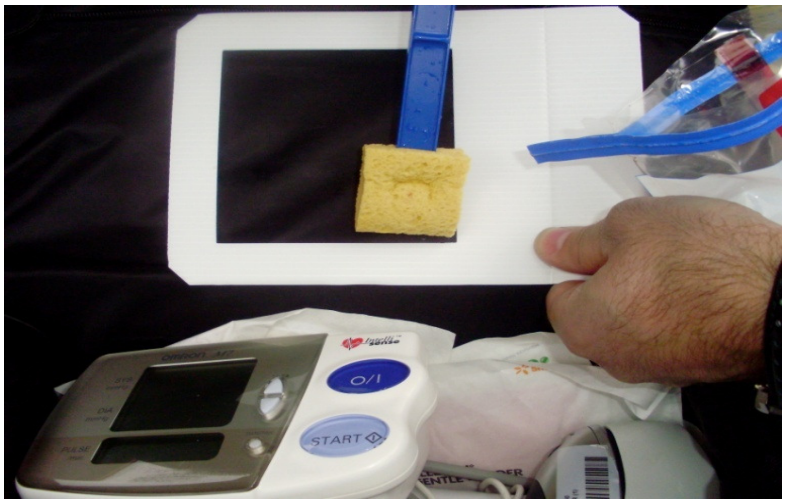


Figure 1: Swab Method

Once completed, the sponge head is detached from the swab stick and fed back inside its original packaging and placed inside a chilled plastic container before being sent by courier to a microbiology laboratory for analysis.

The nursing bags selected for analysis were sourced from two NCT centres: Bridlington and Beverley. Each nursing bag was swabbed in two specific locations: on an internal face and externally on the base of the bag where it was likely to come into contact with household floors or car boot spaces. Initially 12 samples were analysed for the following: aerobic plate count, Enterobacteriaceae, Escherichia coli and Staphylococcus aureus. The first two tests provided a general marker of hygiene, while the remainder screened for two commonly found hospital-acquired infections. To ensure the efficacy of the results, a control test was performed on a brand new bag using the same procedures. To preface the results, the Food Standard Agency recognises that a colony forming unit/cm^2 (CFU) score of $<10^3$ are within acceptable limits of safety. Three of the four test results for the control bag produced non-detectable results with the fourth producing an aerobic plate count presence of <1 CFU. Analysis of the test results (Table 2) produced by the first bag revealed non-detectable results for the enterobacteriaceae, E. coli and Staph. A., with a low-level aerobic plate count of 3 CFUs. However, interior test results showed an unsatisfactory aerobic plate count of 1400 CFUs together with the presence of Staph. A. at 3 CFUs.

	Aerobic Count	Enterobacteriacea	E.coli	Staph A.
Control Bag: exterior	<1	<1	<1	<1
Control Bag: interior	<1	<1	<1	<1
Control Car: boot floor	<1	<1	<1	<1
Bag 1: exterior	4	<1	<1	<1
Bag 1: interior	140	<1	<1	3
Car 1: boot floor	13	<1	<1	<1
Bag 2: exterior	95	4	<1	<1
Bag 2: interior	9	<1	<1	<1
Car 2: boot floor	>1000	>1000	<1	<1
Bag 3: exterior	4	<1	<1	<1
Bag 3: interior	<1	<1	<1	<1
Car 3: boot floor	>8400	>3700	<1	<1

Table 2: Swab test results

The interior and exterior test results for the second bag produced non-detectable scores for E. coli and Staph. A. However, the bag's exterior produced a high aerobic plate count (95) together with an undesirable presence of enterobacteriaceae (4). The final bag's interior and exterior test

results all produced non-detectable results except for a low exterior aerobic plate count score (4).

A high level of 'non-detectable' results highlights the limitations of the ATP system. This was due to the process capturing surface level bacteria only and not the organisms found deep within the textile weave of the bag. To recover precise data on the micro-organisms found beneath the bag's immediate exterior and interior a second series of bags was tested using agar plates (n=24). The methodology and handling procedures are similar with the plates applied with pressure to the interior and exterior of nursing bags before being transported to the laboratory. Following incubation the cultured micro-organisms were analysed through their morphology.

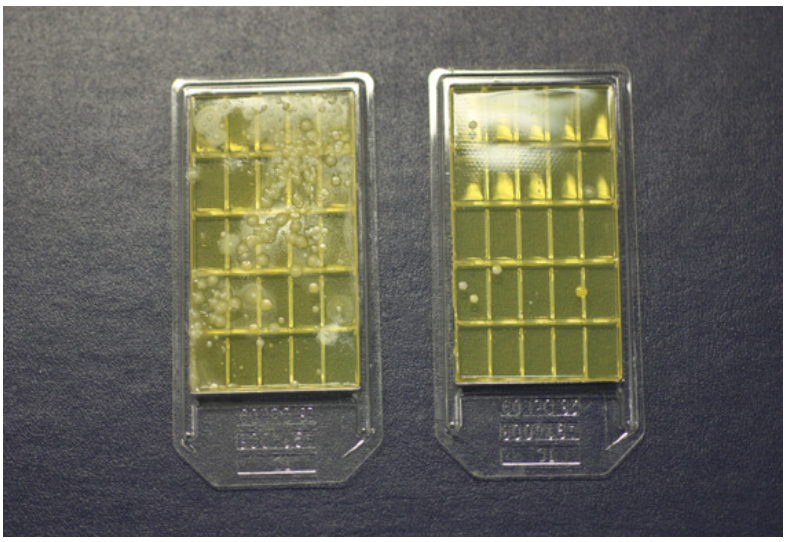


Figure 2: Micro-organisms Cultured on Agar Plates

Reliable data was recovered from 9 bags and captured high aerobic counts, high levels of Staph. SSP . and importantly the presence of MRSA inside three bags (Table 3).

	Aerobic Count	E.coli	Staph A.	Staph. SSP	MRSA
Bag 2: exterior	192	0	1	24	0
Bag 2: interior	179	0	0	71	15
Bag 3: exterior	40	0	0	0	9
Bag 3: interior	114	1	0	1	26
Bag 9: exterior	0	0	1	6	0
Bag 9: interior	21	0	0	29	1

Table 3: Selected Plate Test Results

Conclusions

Capturing detailed microbiology data from bags used in practice became an iterative process too. From the outset, the ATP system was deemed insufficiently rigorous for a clinical audience. The use of swabs yielded quantifiable data and recorded a high proportion of non-traceable results. Plate testing produced a more detailed account of the microbiology and captured the presence of MRSA, and interestingly with higher levels recorded inside bags. However a caveat to both methods is the cost and time to produce such data. As with previous studies (Garvida, 1970; Bakunas-Kenneley, 2009) the plate testing process was restricted to one sampling site.

Finances permitting, a more thorough examination of bags using the plate system is advocated. This methodology would involve the deconstruction of bags whereby individual surface panels and features such as shoulder straps or zip fasteners, are systematically mapped for their microbiological content using a matrix of plates. Although a total sample size (n=12) is not sufficient to produce generalizable results, the tests did produce quantifiable data that is in short supply on the type and frequency of micro-organisms found on nursing bags used in the community (Friedman & Rhinehart, 2000). The identification of MRSA and its higher frequency of occurrence *inside* the bag than its exterior suggest that these pathogens are transient, as there is not a primary 'food' source such as spills/wetness within the bags for the bacteria to grow on. Furthermore, humidity inside bags may exacerbate their growth. This evidence suggested that cross transfer of items to and from nursing bags posed a greater risk than environmental factors. This is substantiated by the very low presence of bacteria found externally. The data also highlighted a greater emphasis needed to designing for cleaning as well as function when designing any healthcare product.

All three methods explored obviously have inherent advantages and disadvantages. My view is that their application is increasingly becoming a prerequisite for most healthcare design projects, particularly where patient safety and infection risk is a primary concern. In creating your evidence base agar plates will generate significantly more data but has higher costs associated with its production. The value associated with creating robust scientific evidence base should not be under estimated as this evidence WILL direct and support your design decisions. In my case the data I acquired influenced the design of the bag immensely:

- Hard-sided bag to resist the absorption of bacteria and to aid cleaning
- Use of drawers instead of traditional bag pockets that are difficult to clean
- Use of gravity and a tapered drawer to eliminate a need for zips, clips and velcro
- Drawers designed to enable a 'wipe-through' cleaning technique to occur
- A totally uninterrupted bag cavity with no protrusions

Capturing the professional challenges of nurses using Lego Serious Play

In 2000 Lego was declared toy of the century by Fortune magazine and the British Toy Retailers' Association (Lego Group 2009). Lego's appeal to children has endured since the first appearance of the 'modern' bricks in 1958 (Lego Group, 2004). Today its appeal as a system for expressing creativity has transcended children and acquiring new disciples - the business community:

> ***Lego is a scientific system arrived at by maths but at the same time it's an endlessly creative system which everyone can understand. There's no right or wrong way of doing anything with Lego, but once you master the system YOU CAN EXPRESS ANYTHING WITH IT.***
>
> **(Jorgen Vig Knudstrop, 2010 cited by May, p.5)**

Lego Serious Play (LSP) was conceived by the Chairman of Lego, Kjeld Kirk Nristiansen, John Roos, Bart Victor and John Owens following a collaboration to explore alternative methods to aid strategic planning. As Rasmussen (2006) states, LSP is the application of story making through the use of constructed metaphors by harnessing our ability to think through our fingers. Lego Serious Play is now widely accepted as a visual linguistic tool (Roos et al, 2001; Gaunlett, 2007; Hasse et al, 2009) and used by major organizations such as Nokia to creatively express new strategic planning opportunities.

To date LSP has received little attention from research communities as a recognised methodological tool. David Gaunlett (2005) demonstrated its potential through as a social science research tool and its ability to express anything through his PhD. Here Gaunlett used LSP to '*explore how people view their own identities, and what they felt to be the most strongest influences upon them.'* The research involved participants producing an individual identity model that was used to determine reoccurring themes of self-expression.

The application of LSP as a creative research methodology in the social sciences is rare, and until this project, non-existent within design research practice. The rationale of using such an unorthodox method in preference to traditional methods such as user questionnaires or focus groups was borne from personal experience. My interest for LSP was heightened further following an invitation to attend a LSP workshop at the University of Huddersfield. Becoming a workshop participant provided an opportunity for action learning and was enlightening. LSP's strength as a research methodology is that it is inherently fun, requires minimal skill and very inclusive. Indeed all qualities needed to actively engage non-design/ non-visual participants.

Furthermore LSP proved to be a very effective tool for articulating an individual's narrative, more so than conventional methodologies. In constructing these metaphoric representations, Roos (2001) believes that the medium projects cathexis, whereby the object takes on the emotional energy of its producer through its production. This was found to be true and manifested itself during structured feedback sessions where the models acted as a visual 'triggers' for the expression of deeper thoughts, feelings and ideas. These real-time narratives not only emerged during formalized feedback sessions but also more importantly occurred informally during breakout sessions.

The workshop highlighted both opportunities and omissions. Firstly, a significant amount of valuable oral detail was systematically lost as a consequence of not using data capturing equipment such as a video camera. Video cameras are viewed as an important tool for ethnographers as they provide a precise record of activity (Fetterman, 2010) and content that can be endlessly reviewed. The camera also captures discrete behaviours and interactions that can be easily missed by a researcher in the race to capture real-time data. Secondly, the building of an aspirational model to represent new operational structures/systems could be extended to include the collective visions for new 'products' to support the delivery of a new service experience.

Building upon these findings a LSP workshop was organized through the PSG. For ordinary people participating in research can be off-putting and create engagement barriers from the outset. To overcome any reticence the room to be used was reconfigured to create a non-threatening atmosphere, with significant amounts of assorted Lego bricks dispersed along a worktable to create a sense of occasion and to reinforce that event would be fun and not onerous. Prior to the workshop commencing a photographic area was created to enable the models to be documented as they were produced. A digital HD video camera was carefully positioned to capture building activities and conversations around the worktable. The primary objective of the LSP workshop was to build upon the ethnographical data acquired through fieldwork observations. The workshop would aim to extract in greater detail the narratives of NHS professionals and to collectively envision an aspirational service, together with the new tools, products and vehicles to underpin a world-class 'NHS at Home' service. The event was structured into a series of sequential building activities during a 4 hour workshop session (Table 4).

Introductory Exercise	A two minute task to build the tallest tower possible. 60 seconds into the task a rule change is delivered. The tower strength is tested when placed horizontal. Models tested to destruction deliberately to demonstrate an emotional connection to their models.
Evalaution of Perceptions	A metaphor questionnaire introduces the concept of metaphors by introducing a series of comparative statements: if the NHS was an automotive brand or type of bag what would it be. Captures stakeholder's perceptions of present service quality.
Metaphor Exercise	Participants asked to build a representation of any metaphor using a limited number of bricks. A second stage requires the models to be modified in a positive way to demonstrate that positive outcomes can be achieved when empowered to shape the future.
'Day in the Life' Models	Participants requested to build an individual model that reflects the daily challenges and pressures faced in performing their professional duties. A 15 minute task with unlimited access to bricks.
Envisioning an Aspirational Service Architecture	The collective building of an aspirational service model: organisation and operational. Extended build time of 30 minutes, unlimited brick access.
Envisioning an Aspirational Support Technologies	Task extended to include the building of aspirational support technologies: products & vehicles.
Determining Value Propositions	Group collectively identifies 3 words that encapsulates the percieved characteristics of a world-class NHS at Home service.

Table 4: Lego Workshop Programme

Following input from a trained LSP facilitator, a sequential programme was conceived that included both generic LSP activities (as used by Gaunlett) and new experimental tasks.
The recruitment of participants did provide a logistical challenge – a familiar challenge experienced by Bruce Archer. Triangulation is a recognized objective of researchers to ensure the efficacy of their results by testing one data set against others. In a wider context it also improves the quality and accuracy of findings (Fetterman, 2010). In this context it was critical that the workshop had representation from each of the Neighbourhood Care Team (NCT) localities. Expected attendance numbers were reduced on the day but the workshop was attended by the NCT Leads from Bridlington, Beverley and Goole as well as the Trust's Service Improvement Manager and a Nurse Consultant for Older People.

Figure 3: NHS Participants Building LSP Models

Capturing Perceptions using Metaphors

Participants were introduced to LSP through an introductory perception exercise. This exercise consisted of a series of metaphorical statements that asked participants to make comparative judgments to identify associated brand values and cues – a methodology used successfully by GM's Design Center. Participants were asked to consider, the following statements, *'If the NHS was a….'*. The range of questioning encompassed tangible and experiential concepts such as an automotive brand, a supermarket chain, type of bag, a hotel chain, an airline or a retail outlet. This open-ended question prompted discursive feedback from the group. Responses from participants were varied, some consensual and others conflicting.

A range of automotive brands was presented to the group for metaphorical comparisons: Volkswagen, Jaguar, Ford and Toyota. The participants systematically evaluated each brand in turn before reaching a consensus. Volkswagen was discounted as it represented the values of quality and being well built, qualities which were not felt representative. Jaguar was felt to be too much of a specialist while Toyota was felt to be ever changing and driven by innovation. Ford was chosen as the brand holding value propositions that were most aligned with the NHS, with participants making the following comparative observations:

we haven't moved on [the NHS] still in Ford mode
a steady output
a generalist

The next metaphorical question asked participants to consider a range of bag typologies: a handbag, a suitcase or a plastic carrier bag. One participant concluded that if it were a suitcase it would be the archetypal image of an over packed case with lots of items hanging out. The group perceived the handbag as effective but not capable of coping with the multitude of demands imposed on it. The consensus was that the NHS was akin to a plastic carrier bag:

> **The NHS is changing, [the bag] is flexible so you can get loads in but not strong enough, it splits and is not effective. Should be a suitcase but at the moment it's a plastic bag that breaks under pressure.**

A third question considered a range of clothing brands that included Gap, Paul Smith, Primark and Marks & Spencer (M&S). Gap and Paul Smith were discounted immediately. The remaining brands were fiercely discussed with common values identified within each. Several members felt that the NHS should be perceived as M&S but in reality it felt like Primark. Primark's focus on trends and not quality resonated with the group. The group also recognized from a service design perspective the poor shopping environment and customer experience - but with customers paying for what they get. Participants felt that some of their NHS delivery was indeed up to an M&S standard and compatible as a brand:

> **it provides a wide range of services**
>
> **lost its old image**
>
> **you always know it will be good and guaranteed a certain level of quality.**

'Day in the Life' Models

The next stage of the process required participants to construct a personal 'day in the life' model that depicted their everyday work challenges. Visual repetitions, metaphors, transitions and contrasts (Ryan et al, 2003) within the content were identified through representations of obstacles, dinosaurs, dysfunctional systems and heavily- laden people and vehicles (Figure 4).

Figure 4: Day in the Life Model

A process of thematic coding extracted generic themes of detachment, barriers, challenges and a dissatisfaction of the present system/products (Table 5). The use of visual recording equipment opposed to the production of hand written notes captured the articulation of each model presentation as well as an impromptu group conversation during a breakout session. Here the group explored the key determinants that defined a patient's experience of hospital/home care services: inconsistencies in environment and support technologies. As they pointed out, no dedicated products exist to support nurses working in this setting and necessitated a need to improvise and acquire products designed for hospital usage. The group recognised the deficiencies of such an approach and its impact on productivity and service experience but highlighted comparable system solutions through generative metaphors (Schön,1963):

P1: We need a core set of tools.

P2: Designed to be transported in something. So we always have a core set of things. I know we have a core set of bits and pieces but it's not a standard set of tools.

P3: You see in hospital, you have a bed and bed space and they have all to be the same size. In a patient's home you don't. You can have a double bed against two walls

P2: Or a chair or nothing else because that's what they sleep on.

P3: There's people in caravans…

P4: Ideally, you probably need a car that's adapted to fit the equipment in it. So you can keep it in your car all of the time.

P2: A bit like an ambulance isn't it.

P1: Yes, with a corporate image on it. It would look good. It's all that. It's quality.

P2: We were set up with nothing, we have acquired things on the way [group laughter] BUT it is, we've acquired things!

P2: And have we got the right thing? And a lot of the time, no we haven't! How many things do we go back to a patient because we've forgotten a piece of equipment with us? Or we get called to a patient and we haven't got everything we need with us because it won't fit in a car.

P4: Then you look at the AA. When the AA turn up in a van, it's all lined out, what you need, where it is. Where as ours it's all chucked in the back seat, it isn't very professional is it?

Aspirational Models

In a final task, the group collectively designed and built a physical representation of an world-class NHS at Home service- reflecting their democratic desires while building an idealised collective future (Jenlink & Banathy, 2002). Here this final model a more considered approach was used in its design and construction with each NCT locality represented identically. Following on from this, this idealized service architecture was enhanced with new vehicular and product visions to support such a world-class service experience (Figure 5).

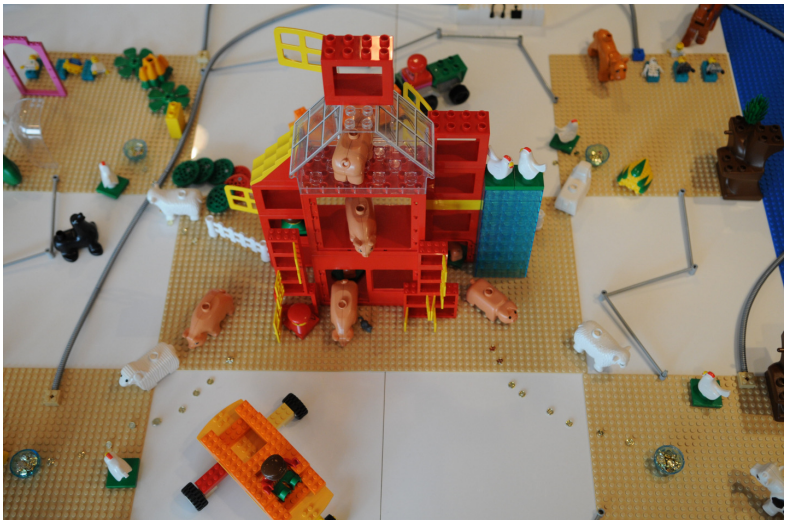


Figure 5: Aspirational Service Architecture & Products

One model stood out in particular. This model (possibly a nursing bag) exuded a corporate image and provided a professional, organized and a uniformed working environment (Figure 6).

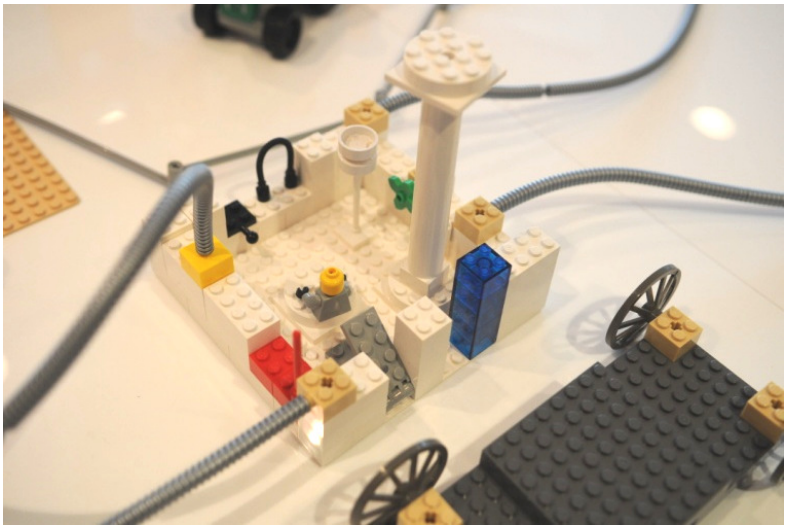


Figure 6: Representation of an Aspirational Treatment Pod

When describing her 'aspirational treatment pod' to the group, she articulated that:

> **The actual pod I have done in white. I have done it white just to bring over the thought that we need a clean feel where we go anywhere. Whether we do our work in hospital or go out to patient's homes. Try to get an image, get a corporate image that's why the white and blue strip; that the strip down, could put NHS outside of it. Now this pod, can be a pod inside a hospital or a clinic or can be in our bags or our environment we are trying to get in our patients' homes. The actual...if I just go through them. What I would like is, when I open, try and get this environment organized. So everybody knows**

when it is opened, this is my field, this is what's in the field. On one side it might be things to do with respiratory. The other side it might be all your technology, your computer and everything to do with your System One. On this side could be your bloods and dressings and whatever. The patient is in the middle and can move round. Okay, because this to me is the restriction that we have working in the home, is absolutely… that needs to be sorted! Here I actually extended things on poles, just to say… our bags, we need to be able to open them up. So like a concertina thing. This will be the rubbish that could go down. We have talked about this before, compact it, vacuum it, okay, so we can take it out easily. And this will probably be our work environment. That would come up as a table so we don't have to go on our knees. We can stand up and work around it. So it's very much mobile. Scales like that. You know, everything is in its place. So, so we open it up and it's all uniformed. Okay, I just put this in front of it so it can be mobile as well. So it can be a bag, it can be a car. So it's all uniformed. So that's my idea.

The workshop concluded by asking the participants to identify three words that characterised the desirable attributes of a world-class NHS at Home service. The words they chose were consistency, quality and teamwork.

Conclusion

Many authors have discussed the relative benefits and limitations of traditional qualitative methods (Aldersey-Williams et al., 1999; Pink, 2001; Bates and Robert, 2008; Fetterman, 2010). A Lego Serious Play (LSP) workshop extended initial findings acquired through fieldwork activity such as shadowing and observation and empowered participants to express themselves through the creation of metaphor models: models depicting daily challenges and aspirational solutions to these problems. The democratic and simplistic nature of the medium should not be underestimated as complex, powerful and emotive representations emerged which informed the design process. The use of video recording proved to be an invaluable tool throughout the study by capturing workflow patterns and participant dialogues with 100% accuracy. The workshop's outputs demonstrate the value and viability of LSP as a research methodology to a wider design research audience. LSP enabled the understanding of complex problem by viewing the problem from multiple perspectives and through the use of constructed metaphors. Professional diversity and a participatory approach can bring new ways of thinking and provide solutions with a greater degree of accuracy, as design knowledge resides in not just designers but everyone (Schön, 1983; Cross, 1999). Elden & Levin (1991) defined the researcher role as a 'co-learner rather than an expert in charge of change'. Their co-generative model emphasizes the benefits of collaboration, where employees contribute their tacit knowledge of organisational systems and processes. This is complemented by an 'outsider' who brings knowledge of process, systematic enquiry and an ability to 'create new knowledge irrespective of content through a generative dialogue'. LSP is extremely adept at capturing and extracting

this tacit knowledge with the process supporting the collective redesign and design of new organisational, structures, systems, services and products.

The value propositions together with the service products envisioned through the LSP workshop determined the primary tenets for an inclusive co-design phase to conceive a 21st century nursing bag.

Optimising patient safety performances using UV analysis

Designing out both design and manufacturing complexity is an imperative goal in order to maximise patient safety performances- as multiple components create unwanted part lines that can harbour bacteria and add difficulty to the cleaning process. To support an iterative design development process an appropriate evaluation tool would be needed to defend design decisions relating to cleanability. One possible method is presently used to educate trainee healthcare workers on the importance of effective hand washing technique to prevent cross-contamination. This tool utilises a UV sensitive gel and a UVA light source and requires trainees to rub this gel into their hands as if it was a hand lotion. Once absorbed, UV sensitive particles contained within the gel glow when illuminated by a UVA lamp, visually exposing areas missed during the hand washing process. This simple and effective tool could be adapted to evaluate how specific design profiles aided or inhibited effective cleaning.

The driving force behind this line of enquiry arose from a stakeholder workshop held to review a low-fidelity prototype. The physical experience of handling this prototype bag prompted nurses to suggest new features such as an ability to store paperwork. One nurse proposed a net structure attached to the exterior of the bag. Whilst this was valid idea this solution only added to the problems associated with infection control. A subsequent sketch programme produced an alternative solution that comprised of two sunken well features joined together by a living hinge (Figure 7). When open this design feature would provide a retaining wall for clinical items and encapsulated any clinical paperwork when closed together.

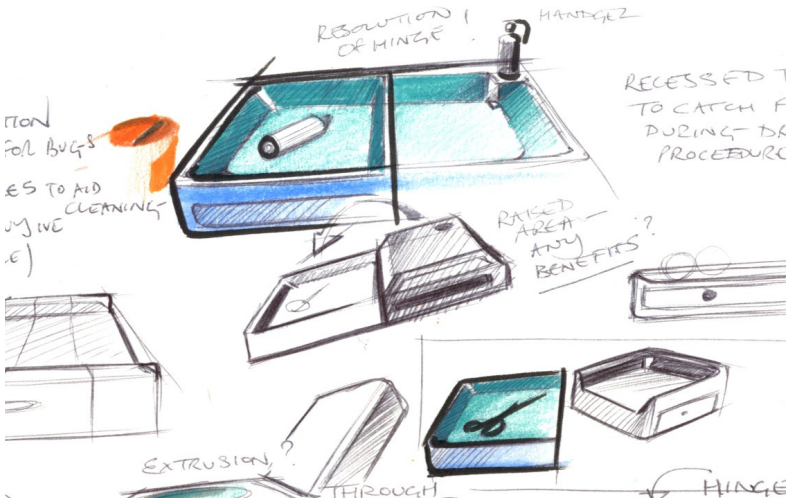


Figure 7: Exploring Storage Options

The precise profile of this beaded wall would be a critical factor as it inclusion potentially added complexity to the cleaning process. For expediency ready-made products embodying a variety of profile shapes were evaluated using UV gel in a controlled method: application of a measured amount of gel, applied in a consistent location and removed in a timed test. The application and removal of the UV sensitive gel provided visual evidence on the impact of design profile. Not surprisingly the tests capture a very positive performance from a product that had no profiling at all, enabling a perfect wipe to be delivered and free from a perimeter obstructions. To verify results, the test was repeated under the same conditions and produced similar results (Figure 8). These two tests validated a decision to prioritize patient safety over product functionality by not choosing to pursue the storage of paperwork in this manner but to increase the size of the drawer compartment to accommodate this need. Furthermore, the results

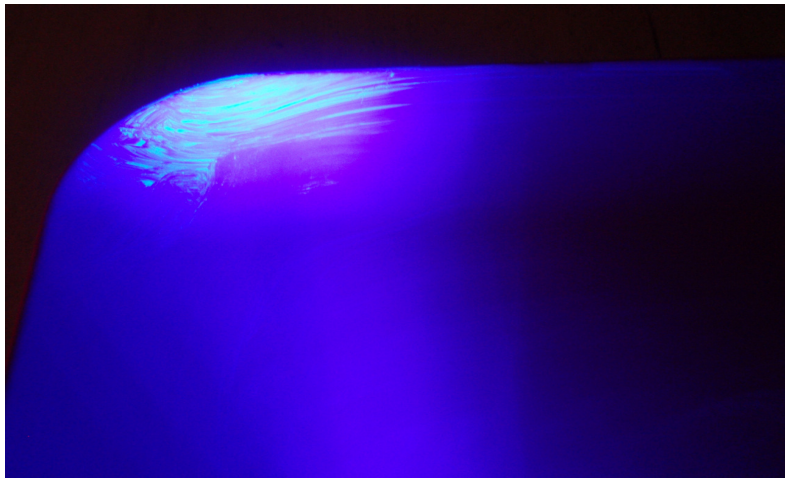


Figure 8: UV Analysis of Ready-Mades Following Cleaning

Previous microbiological testing highlighted patient safety concerns relating to the interior compartments of nursing bags. To overcome this problem a modular drawer system would be used with significant design attention directed to minimize the accumulation of debris in its corners. A process of ideation had generated two solutions to tackle this problem: firstly the addition of a suitably sized hole positioned in the corner of the drawer or alternatively vertical apertures across the corners to facilitate easier access. A 3D CAD model facilitated the systematic analysis of hole/aperture dimensions to optimize functional performance requirements: finger access and retention of small packaged items such as syringes. Following evaluation, a new digital model was constructed and printed as a physical fused deposition model (FDM) with the drawer was sectioned into four distinct quadrants, each representing a different design solution with subtle dimensional differences (Figure 10):

- **Quadrant A: A typical drawer design with no internal radius.**
- **Quadrant B: R50mm base radius and the inclusion of a R10mm corner hole.**
- **Quadrant C: R20mm base radius and a cross-corner aperture of 20mm.**
- **Quadrant D: R13.5mm base radius and a cross-corner aperture of 20mm.**

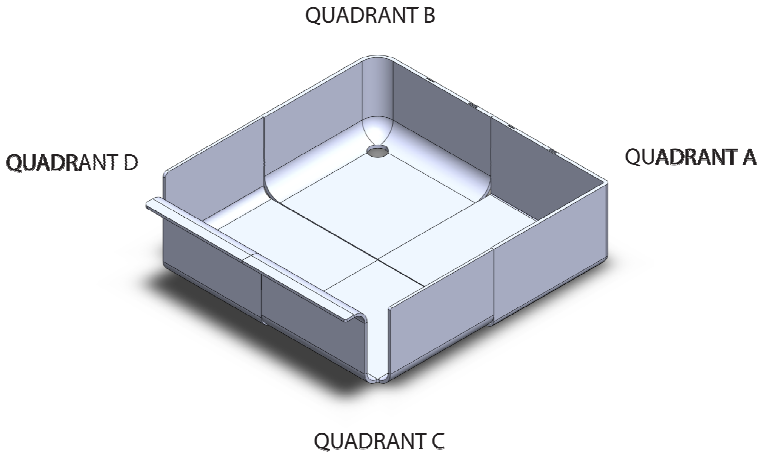


Figure 10: Sectioned FDM Model

This FDM model would enable the cleaning performance for each quadrant to be examined using the same UV technique. Following exposure to hand cleaning using an anti-bacterial wipe for 30 seconds, findings confirmed that a vertical aperture across the corners aided the cleaning process as it enabled a 'wipe through' cleaning technique to be applied base radius of 13.5mm outperformed a 50mm radius (Table 5).

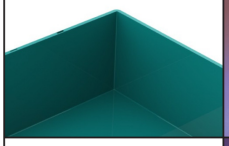
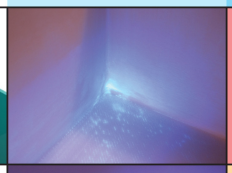
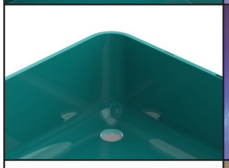
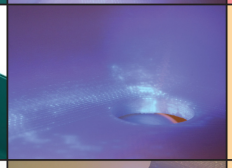
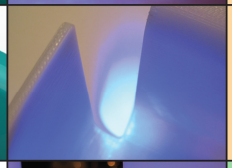
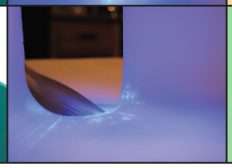
CORNER VARIANT	UV ANALYSIS	FINDINGS
		Inaccessible corner created by sharp transitions of wall/ base leads to deposits left behind.
		Perimeter edge and aperture depth suggests cleaning hindrance and creates a feature requiring specialised cleaning attention. A larger radius (50mm) does not necessarily improve cleaning performance
		Satisfactory performance enabled by a wipe through technique. Small deposits around the intersection point of the walls suggests a more generous transition is needed.
		Gradual transistion of wall intersections achieved a better performance, aided by a smaller wall/ base radius of 20mm.

Table 5: UV Analysis of Sectioned FDM Drawer

The final design solution minimised the width of these apertures to ensure that small items would not protrude or fall out during transportation (Figure 11).

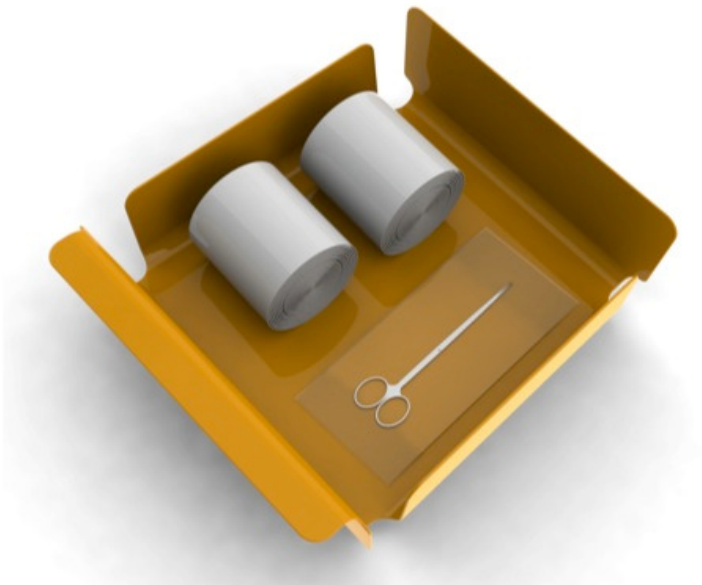


Figure 11: Finalised Drawer Design

The iterative nature of design practice necessitates a mixed method approach, and in my case applied research and experimental development in a co-design context. Traditional, creative, scientific and experimental methods have facilitated the development and sharpened the design

intent for a 21st century nursing bag that delivers improved performances in productivity, service quality and patient safety (Figure 11).

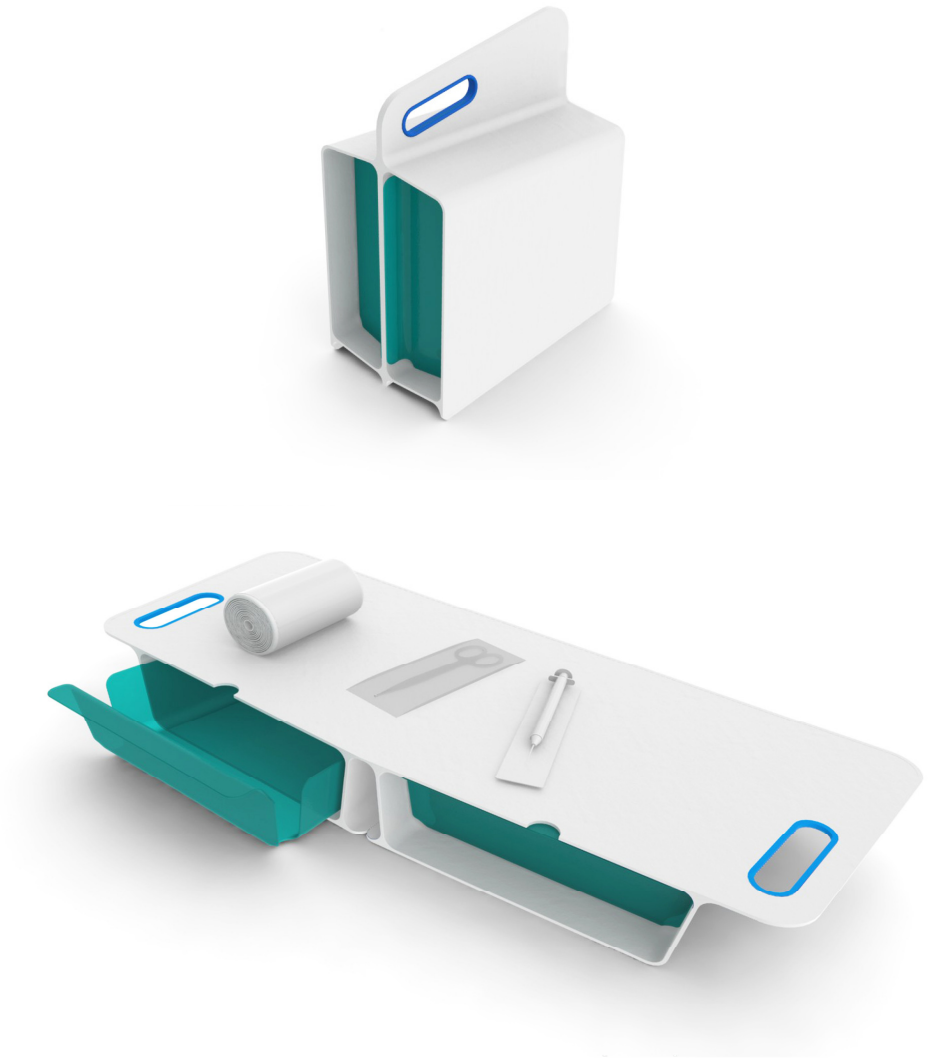


Figure 11: 21st Century Nursing Bag

Traditional methods such as ethnography supported the acquisition of a new knowledge relating to this emergent setting as well the service challenges posed by current nursing bags. The first application of Lego Service Play as creative design research tool revealed new insights, captured discrete attributes and empowered healthcare professionals to collectively envision aspirational service architectures and new healthcare products to support the delivery of a world-class at home service. Microbiological testing highlighted the infection risks associated with the use of improvised bags such as camera bags and hand luggage by nurses, while the

use of UV analysis enabled an in-depth understanding of how design decisions can inhibit or optimize the effectiveness of hand cleaning, and informed design philosophy to systematically 'take the design out of the design'.

Fellow practitioners may perceive the exclusion of patients from this process as a limitation without fully appreciating the fastidious governance procedures that are in place to protect NHS patients and employees. At stated previously his rigorous process can become a protracted affair and potentially prohibitive for short studies or quick-win consultancy projects. For pragmatic reasons this study was deliberately conceived as two distinct phases with an intention to formally engage patients during a continuation study that will evaluates the impact of bag in everyday practice. As I write a field study involving multiple bags and nursing teams is being developed with NHS East Riding of Yorkshire.

Design and designers have a critical role to play in the future delivery of healthcare especially as all healthcare providers and professionals are being urged to think differently about the services and experiences they provide. If we are to engage more deeply with the process of transformation, design practice will need to adapt to address these dynamic complex problems and acquiring new skills to ensure that our creative responses are accepted and implemented by healthcare commissioners and clinical communities (Swann & Caldwell, 2009). It is hoped that this case study has enlightened your knowledge of healthcare design practice and introduced to you new strategies, procedures and creative/ experimental methods to perfect your future healthcare design solutions, as individuals or collaboratively as inclusive members of NHS service improvement teams.

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