'SMART PODS': NEW VEHICLES TO TAKE HEALTHCARE TO THE COMMUNITY

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Smart Pods is a two-year study that began in March 2007. Academic partners are the Royal College of Art (RCA), Loughborough University and the Universities of Bath, Bristol and Plymouth. The goal is to provide design direction for a multi-level component system using enabling technologies to bridge the gap between community and hospital provision of care. The research will explore new models for vehicles, treatment spaces and modular components to facilitate the delivery of patient-centred healthcare services and the reallocation of resources between static and dynamic care locations.

This work-in-progress paper will cover the RCA strand of the work, which is focused on vehicle and component design. A wide range of research activities are currently under way including: vehicle, temporary structure and portable equipment typologies; interviews and visits to understand analogous industries; discussions and planned visits with members of the Army and RAF to understand necessary medical protocols in extreme environments; integrating vehicle designers in workshops to visualise and capture issues for discussion and to maximise communication within the multi-disciplinary team; and using 'traffic light' modelling to test the viability of each developing design platform.

Introduction

Urgent and emergency care in the UK is in a state of transition, and it is increasingly recognised that certain groups of unscheduled patients benefit from being treated in the community (Woollard, 2007). New professional roles are emerging to address such issues but the design of equipment and service delivery models is lagging behind. Typically, emergency care vehicles are modified production platforms, rather than specifically designed to meet the demands of providing care on-scene and in the community.

To deliver effective proposals – inline with the recommendations set out in the report, *Taking Healthcare to the Patient: Transforming NHS Ambulance Services* (Department of Health, 2005) – designers and researchers at the RCA (Vehicle Design and Helen Hamlyn Centre) are collaborating with a multi-disciplinary team. The team is made up of specialists in ergonomics, acute and pre-hospital clinical practices, operations management and procurement, and socio-technical sciences. Working closely, the team has developed an innovative approach to healthcare design.

Smart Pods builds on the success of the team's earlier accident and emergency (A&E) vehicle project, Designing future ambulances for patient safety (Coleman *et al.*, 2007). The joint National Patient Safety Agency and Helen Hamlyn Trust report established a range of safety criteria for the purchasing of ambulances, which underpinned current moves towards standardisation within the UK ambulance fleet and as is being implemented by the National Fleet Strategy Group. This research is detailed in other papers at this conference.

Research Aims

The Smart Pods project's core aim is to provide Emergency Care Practitioners (ECPs) with the vehicles and equipment they need to carry out more effective diagnosis, and on-scene treatment to help minimise the number of patients admitted to A&E. The ECP programme was set up by the NHS in 2003 to target the 1,000,000 people currently taken to A&E every year who could be effectively treated in the community (NHS Careers, 2008). ECPs have extended training and utilise the skills of paramedics and nurses to enable them to diagnose, treat and discharge, or refer to an appropriate health provider, unscheduled care patients on-scene. Research shows that ECPs are effective in their new role and have reduced the number of hospital visits while achieving high levels of patient satisfaction (Mason *et al*, 2007). However, the equipment used by this emergent group has not evolved to match their capabilities.

Research Activities

A wide range of research activities are currently under way to drive an evidence-based design approach. Work in progress at the RCA is categorised under five headings, (i) historical overview of ambulance vehicles and the ambulance service, (ii) explore existing and future vehicles, temporary structures and portable equipment solutions that can be utilised or combined to provide effective on-scene treatment solutions, (iii) study best practice examples of existing component-based vehicle and system combinations in comparative fields, (iv) identify mass production opportunities as well as low volume technologies utilised by motor sport and the military, including rapid prototyping and composites, and (v) in collaboration with ambulance and non-ambulance manufactures, identify and develop a series of design platforms for a range of mobile equipment, mobile treatment spaces and delivery mechanisms that could be used in the multi-level Smart Pods system.

(i) Historical overview of ambulance vehicles and the ambulance service

Hospitals began operating dedicated ambulances to transport sick and injured people in 18th century. Patients were transported to and from hospitals by cart, or horse drawn carriage. With the development of steam power and eventually motorised vehicles (early 20th century), ambulances were capable of transporting patients more quickly and over greater distances. It wasn't until 1946 that the National Health Service Act was passed, which required local authorities to provide ambulances where necessary (Kunur, 2007).

The next major development came with the publication of the Miller Report in 1964, which recommended that ambulances should provide treatment as well as transportation. To enable ambulance staff to provide treatment a six-week course it setup and minimum standards of equipment are established. This marked an end to ambulance vehicles solely conveying patients and the beginning of the development of highly trained paramedics working autonomously using a wide range of clinical procedures.

Until 2000, guidelines for the delivery of care were developed regionally, which resulted in variation throughout the UK, and thus quality of care was dependent on patient location. This was resolved with the development of nationally applicable clinical practice guidelines, which are reviewed biennially to meet the changing needs of the ambulance service. The development of these guidelines was fundamental to enable a patient safety design approach.

There are distinct differences between civil and military ambulance service platforms. The military operate under extreme conditions and as a consequence command and control dominates the provision of medical care. The importance of dedicated medical teams (corps) was realised in the American Civil War during 17th century, and this model was adopted by many of the countries fighting in World War 1. Dr. J Letterman established ambulance corps, whose role it was to transfer wounded soldiers on stretchers to a 'primary station'. From these dedicated locations the wounded soldiers were later conveyed to field hospitals for treatment (Kunur, 2007). Conveying wounded soldiers between designated locations ensured that they were in the care of trained medical teams and thus increased the likelihood of survival and recovery. However, the main objective of military medics is to maintain a fighting force, so whenever possible a soldier is treated on-scene and kept out of hospital. Today, three medical platforms are employed by the Army: (i) evacuation; (ii) treatment, and (iii) command and control (Gunter, 2008). Preliminary discussions for a case study with the Army are currently underway. The three medical platforms provide insight into proven acute medical care protocols that have to be effective even in the most extreme conditions. The effectiveness and successful integration of these platforms is informing the design decision-making process.

(ii) Existing and future vehicles, temporary structures and portable equipment solutions

The full spectrum of vehicles, temporary structures and portable solutions are being mapped and analysed. This typological research will provide the foundation for the evidence-based design approach.

Production vehicles have very different constraints to vehicles designed specifically to deliver care in the community. Typological analysis has highlighted bands of vehicle types (some overlapping) with differing constraints and limitations. For example, the class of driving license required is determined in part by vehicle size and weight; 'pinch point' traffic calming measures are designed to limit access to vehicles no wider than 2 m; and 2-wheeled vehicles have consistently outperformed 4-wheel vehicles in terms of response times within inner city and traffic-congested environments (Lomas, 2008).

Treatment spaces are categorised as mobile or temporary. Temporary structures range from erectable canopies and awnings, to large-scale inflatables. There are many opportunities for Smart Pods, such as combining temporary structures with a rapid response and compact vehicle, so that temporary treatment spaces can be created readily on-scene (without an additional vehicle).

Currently, ECPs work as solo responders – supported by a network of pre-hospital clinicians and healthcare professionals – so they are responsible for carrying the necessary kit and equipment to the patient's location. This can be a problem if they are up a flight of stairs or a long distance from the roadside for example. The three main items of kit they take to treat an unscheduled care patient include a responder bag, defibrillator and oxygen (this is standard practice, however, the size, weight and type of kit and equipment varies across the UK NHS ambulance services). A key challenge for achieving modularity is accommodating identical kit and equipment in different vehicles and mobile treatment spaces, so that it can be accessed readily and efficiently regardless of whether the healthcare professional is familiar with that vehicle or space.

(iii) Best practice examples of existing component-based vehicle and system combinations

To date, we have identified and are studying best practice case studies in four key areas: supermarket distribution; road recovery; couriers and parcel delivery; and military medical platforms. Each of these case studies demonstrates component-based vehicle and system combinations. Interestingly, they each have very different objectives. Supermarket distribution is concerned with speed of delivery to store and maximum efficiency. Road recovery focuses on customer satisfaction and delivering the most appropriate recovery vehicle to the roadside as quickly as possible. The efficiency of couriers and parcel deliveries is based on the benefits of advanced communication technologies combined with sophisticated planning software (Lomas, 2008). Military medical protocols have to cope with, 'an epidemic of casualties' (Gunter, 2008) on the battlefield. The structure, logistics and management of each are therefore very different.

(iv) Manufacturing opportunities

Unlike commercial vehicles, emergency vehicles are manufactured and modified in relatively low volumes. Therefore, the emphasis on material and process selection will be based upon low volume flexibility combined with adapting mass-produced components.

Conventional low volume processes currently utilised by the automotive industry (and for emergency vehicle conversion) include composite laminating, thermoforming, rotation moulding and reaction injection moulding. In recent years new technologies have been developed, such as superforming, hydroforming and laser sintering, that allow greater flexibility at relatively low volumes. These processed are already being exploited in high performance applications, such as motor sport and aerospace (Thompson, 2007).

(v) Develop a range of design platforms

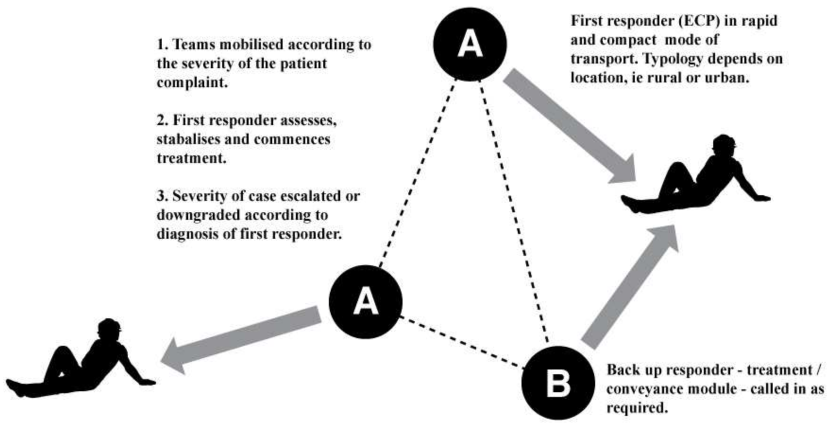

Figure 2. Design platform example – front loaded and rapid response

A series of design platforms have been developed to drive the project forward with the academic and manufacturing partners, and post-graduate student projects at RCA. The design process began in a workshop at RCA, December 2007. Vehicle designers were integrated into the multi-disciplinary workshop teams to capture and visualise the ideas and issues as they emerged. This facilitated discussion amongst the team members and improved cross-discipline communication. Design development has been driven by the team's research findings. The four design platforms that have emerged are, (i) front loaded rapid response, (ii) distributed treatment, (iii) targeted treatment and (iv) dual-manned ambulance.

The effectiveness of each platform will be challenged using a 'traffic light' modelling technique, which will identify their individual strengths and weaknesses. The design platforms are being developed in parallel, and similar to the Army platforms, the final solution may be an amalgam of two or all of them to form the final Smart Pods proposal.

Research Outcomes

There will be an exhibition of the Smart Pods project in March 2009, at the Royal College of Art, London, which will include the research findings and five or six proposals of system and component design solutions. These will be presented as 2D and 3D visuals and models. The exhibition will aim to facilitate consultation and public debate, setting the direction for a subsequent phase of system specification, prototyping, testing, evaluation and ultimately clinical trials.

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