Empowering Proactive and Personal Health Care: No Option No Choice.

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Abstract—
The central objective of this paper is to explore the capacity of integrated technology to support an active and independent lifestyle within and beyond the home; it explores the potential of combined leading-edge textile, communications and computing technologies to help the ageing population enjoy an extended safe and healthy life wherever they chose to be.

I. INTRODUCTION

As health and related agencies register the growing impact and challenges associated with the shift in population demographics, the pressure on resources will continue to increase and some argue outstrip the capacity for services to maintain existing levels of care. Health care systems around the globe, not withstanding significant differences between industrialized and developing nations, are facing the prospect of near 40% of their population being over 65 by 2051 (COM(2004)356) [1], as illustrated in Figure 1.

The trends shown in Figure 1 highlight the growth in those aged over 65 predicted over time, and shown as a percentage of the total population, with 2050 showing the attainment, for the first time, workforce ratios (15-64) to 65+ of around 4:1. While the USA, is predicted to experience an increase of overall population in the order of 50% by 2050 (US Census Bureau, 2005) and will see a ratio of one 65+ for every five drop to 1:3. In Europe, predicted to have no such overall population increase, the ratio would have dropped from 1:4 to 1:2, with the trend even more pronounced in Japan with ratios moving from 1:4 to 3:4.

Governments’ and care services will be hampered by a decline in the under 65+ workforce, higher quality of life expectations, the voting bulge of 65+ and the geo-political shift that will enforce greater returns on capita investment. The exigent requirement to deliver affordable high quality health care will need to stimulate personally proactive health care programmes while developing flexible low cost and technologically augmented solutions. Consequently, the role for personal and proactive self-care, for already hard-pressed services, will likely evolve into government priority. Given the potentially pivotal impact of the 65+ population upon government policy, the political need to deliver on quality of care will confront the economic cost of care, fuelling already intense positions.

FIGURE 2

The putative cost of care, shown in Figure 2, illustrates how the existing care structures are predicated on care pathways designed to accommodate a 65+ loading of around 10-12% of the population, with the pathway for intensive care set at a premium, the underlying model assumes that the bulk of population need for this level of medical care would be accommodated within hospitals.

II. INTEGRATED TECHNOLOGY APPROACH: MOBILITY AND SECURITY

The approach focuses on extending the ‘Out of Hospital’ and ‘Smart Home’ concept out into the wider community, combining leading edge communications, sensor, computing and textiles technologies to form a Smart Wearables Mobile Communications platform, providing continuous access to a range of services wherever the user chooses to roam. An active independent lifestyle implies freedom and security of movement to go anywhere, within reason, whilst still having access to home support systems together with additional travel-oriented ones [2]. This would expand the Smart Home concept out into a wide range of Smart Environment scenarios. Achieving this requires a shift away from a static to a mobile system platform hub approach enabled by miniaturised devices, sensors and wireless communications. As any form of separate pack is clearly impractical, the platform itself has to be an integral part of the users clothing. It is here that the role of a three-component clothing layering system [3] designed to meet the varied needs of older people wherever they choose to be, would be pivotal. As clothing is a highly personalised issue, its attractiveness, comfort and ease of use will be a key critical success factor for it acceptability. Each layer would combine advanced textile technology with miniaturised devices, sensors and
transmitters linked within each garment to form a distributed wireless IP hub that is automatically configured to suit the wearer’s needs and location as they dress themselves.

While within the home the inner layers communicate with the home IP Portal via Bluetooth or similar short-range systems and when outside this link would extend to include the outerwear, which provides wireless IP links to remote service providers. This will use either WiFi or similar systems [4] with suitable coverage with subsequent links over landlines.

The overall garment can focus on creating clothes of choice that both enhance an individuals’ self image and provide desired access to appropriate support services/systems. Whilst all designs will aim to protect against physical and health risks such as hypothermia, minor injuries, etc., the main objective is to reduce latent inhibiting behaviours that tend to reduce the range and level of activity and independence.

Where latent or early stage chronic conditions are identified, the aim will be to combat/ reverse its effect through an iterative closed-loop cycle of monitored health status and ‘drip-fed’ clinically supervised personalized remedial programmes. These will provide appropriate advice and guidance spanning exercise, dietary and therapeutic action routine feedback to the users, based on on-going physiological monitoring.

This monitoring will be provided by personalized ‘skin wear’ vests that incorporate medically approved sensor arrays that connect back via the broadband links to a diagnostic center [5]. All user interaction will be subject to appropriately agreed ethical constraints, especially in the context of physiological monitoring and clinical diagnostic output. This latter will be subject to medical governance and information security controls.

II. INTEGRATED TECHNOLOGY: AN APPLICATION

With an ageing work force and expanding numbers of the retired the driving forces behind their work-life balance interests and the pressures on them alter. However whilst the major components do not change [Figure 3] the level of need radically changes. Gone are the pressures of supporting a family and building a home and social network, to be replaced by those inherent in the ageing process – of declining health, loss of social contact and all the difficulties of coping with an ever changing and less familiar environment.

FIGURE 3 Driving Factors

At the heart of these major changes a new substitute for work-life balance has to be found to accommodate the lost structures imposed by the working week – especially as its supposed replacement by a perpetual holiday is rapidly exposed as a false dawn, Figure 4. The familiar stresses are replaced by those of having to cope with an entirely changed ‘life-landscape’ and beset by ever increasing needs imposed by infirmity.

FIGURE 4 Decision Processes - Axes of Influence

As illustrated in Figure 4 the basis for these many judgements, inevitably turn on balancing benefits to be gained against perceived disadvantages or risks - quality and particularly cost which then acts as additional brakes against a positive decision. However value - real or perceived - rarely enters the judgement criteria, although confidence and trust in third party service providers remains a secondary influencing factor to a motivation towards acceptance of the need for change.

Establishing value as a key element in the decision process frequently provides the ‘tipping’ point for accepting the need for radical change as it introduces the perception of relative worth of the benefits to be gained. It also sets the basis for judging the merit of the course of action against its costs and inferred risks.

Even when driven by the necessities of infirmity, imposed change is invariably resisted - as most people will innately wish to cling to the certainties of the familiar ‘status quo’. Getting them to change not only depends on their perception that the benefits outweigh the inconveniences involved, but more importantly that they are helped to take control of adjusting to new ways of living.

In essence this focuses on providing them with an interactive means of assessing their current condition and/or circumstances, and then suggesting options that will help them to plan and manage improvements towards their desired objectives. Wherever possible this should be supported by easily understood incremental guidance and/or routines.

FIGURE 5 Empowering Change

Whilst this process would preferably begin with simple lifestyle adaptations and coping strategies, it could typically
extend to more sophisticated support systems that could monitor physiological parameters [Fig. 6].

**FIGURE 6 Health Improvement Support**

These would be based on Wearable Smart Systems that would incorporate remote diagnostic analysis of parameters such as heart rate variability and respiration rate. Their regular ongoing clinical analysis would provide feedback on health status together with rolling health improvement programmes providing incremental guidance and/or routines.

**FIGURE 7 Smart Support for Health Improvement and Care Support**

Both health and social self-care improvement programmes and background professional care support services would be based on variants of process pathways that took full account of the interactions and dependencies between different self-care routines and professional inputs.

Where the level and complexity of problems experienced are substantial, it is most likely that conventional multi-agency, multidisciplinary Needs Assessments will be required – always with the objective of engaging and empowering the individual concerned to manage their own care with appropriate support. In the more complex cases a ‘radar plot’ approach can be used to monitor progress – with the objective of reducing the size of ‘scab’ of need back to self-manageable proportions.

**FIGURE 8 Extending Smart Supports**

The extension of existing Smart Home Support Systems [Figure 8] to accommodate the need to move anywhere outside the home with confidence and without loss of access to home based services is dependent on the development of an appropriate Mobile Communications Platform [Figure 9].

**FIGURE 9 Mobile Communications Platform**

This is based on the convergence of Smart Wearable Technologies with Compunetics [6]. The latter combines the disciplines of psychology, management science and informatics – focusing respectively on behavioural aspects of change; process change/optimisation/risk management; enabling information technologies.

The approach centres on the development of a multilayered clothing system with each layer IP interconnected via Bluetooth with onwards connections provided via WiFi or WiMax links to the user’s home portal and thence to external service providers. Interaction is provided by voice-activation and/or simple on-screen selection/input methods. At home this uses IP-TV software developed to support multiple service interaction – for on-the-move connectivity development is in hand to replicate this functionality together with GPS and other location-based services distributed within the outerwear.

**FIGURE 10 Development Structure**

The approach used has been to divide the development programme into three interlocking segments [Fig. 9]. A fairly unique feature of this approach has been to drive the whole project from a behavioural compunetics perspective – not only engaging closely with the needs and motivations of as wide a sample of potential users as possible, but also by integrating a number representatives into the design management team.

**REFERENCES**


Elderly Demographic Trends: 65+

Figure 1  Demographic Trends: 65+

UK COMMUNITY SERVICE FOCUS

Figure 2  Putative Costs of Health Care
HEALTH NEEDS

SOCIAL NEEDS

CULTURAL NEEDS

LIFESTYLE NEEDS

ENVIRONMENTAL NEEDS

LOGISTICAL NEEDS

INFORMATION NEEDS

FINANCIAL NEEDS

Figure 3  Driving Factors

Figure 4  Decision Processes - Axes of Influence
Figure 5  Empowering Change

Figure 6  Health Improvement Support
Figure 7 Smart Support for Health Improvement and Care Support

Figure 8 Extending Smart Supports
Figure 9 Mobile Communications Platform

Figure 10 Development Structure