Duties & responsibilities of the collective and the individual in the design, delivery, and maintenance of Pervasive Computing Systems, whilst prioritising & considering stakeholders

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INTRODUCTION

Firstly, let us clarify what is meant by Pervasive Computing (aka. ubiquitous computing). Linguistically, the word ‘pervasive’, is similar in meaning to the word ‘pervade’. The concise oxford English dictionary defines pervasive as ‘widespread’ (Pearsall, 2002, p.1066) whereas the word pervade is defined as:

“Spread or be present throughout; suffuse”
(Pearsall, 2002, p.1066)

Etymologically, pervade comes from the Latin word ‘pervadere’ where per- translates to ‘throughout’ and vadere to ‘go’. This is also confirmed by ‘the etymological dictionary of modern English’ where pervadere translates to ‘to go through’ (Weekley, 1921, p.1076).

In computing terms, this implies how a pervasive computing system (PCS) goes through the visible environment and permeates into the invisible environment thus ‘allowing technology to recede into the background’ (PostNote 263, 2006, p.1). Weiser (1991), the father of the idea, in describing his early ubiquitous computing vision concurs accordingly.

In addition:

“It is the idea that almost any device, from clothing to tools to appliances to cars to homes to the human body to your coffee mug, can be imbedded with chips to connect the device to an infinite network of other devices.”

Applications include:

- Wearable computing
- Smart sensors in the home
- Kitchenware

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1 Devices that can sense the mood of the user, thus triggering changes in the environment via. actuators e.g., temperature control, or lights being dimmed. Also known as Affective Computing. (Sharp et al., 2007)

2 Smart electrical appliances that are able to self-diagnose what is wrong with them resulting in messages being sent to their manufacturers. A smart fridge, for instance, may be able to compute what food is lacking and then automatically send an order to the local supermarket.
- IT intensive domiciliary care$^3$ - Elite Care (www.elite-care.com) is already offering something in line with this vision (Stanford, 2002)
- Future health-care$^4$
- Intelligent transport systems$^5$, and
- Military$^6$

Undoubtedly, if such technologies find their way into our society, we can safely say that never before, in the history of mankind, has the potential for so much data to be gathered, stored, retrieved, or transmitted existed. Naturally this gives rise to dozens of issues: ethical, moral, legal, technological, professional and so on. The questions are: who mediates the discourse? Who or what will ensure that the people who research, design, deliver, and maintain PCS’s act with responsibility, with an ethical conscious? More profoundly, who or what defines responsibility, duty and ethical action? Indeed, the magnitude of PCS’s necessitate the need to ask such questions. One can imagine the consequences of such a technology; computers and microprocessors absolutely everywhere, collecting data about us, only they are so invisible, it is as if they aren’t there at all. As PostNote 263 delineates, pervasive computing is exciting, challenging$^7$, and dangerous. Clearly and naturally, the IT profession has a huge stake in PCS. Since the IT professions relationship to IT - pervasive computing being an application of IT - is like a mother to her child: this essay aims to explore the duties and responsibilities of both the IT profession as a collective and the individual IT professional in designing, developing, and maintaining pervasive computing systems (PCS).

For purposes of clarification let us define what is meant by the term ‘professional’. According to Charles Hughes (former BCS president), contrary to popular perception, a professional isn’t

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$^3$ Sensors embedded in the clothing and homes of the elderly that monitor their movements and physiological variables inc. heart-rate, body-mass index, blood pressure; alerting care-workers to any irregularities.

$^4$ Remote sensors and monitoring technology that continuously captures patient physiological data, wearable sensors that track patients around the hospital, tagged wrist-bands containing digital photo-graphs and medical notes. All these offer improved administration.

$^5$ Giving vehicles the capability to send and receive real-time data to and from devices integrated within the transport infrastructure, thereby ‘alerting drivers to traffic congestion, accident hotspots, and road closures’ (POSTnote 263, 2006, p.3).

$^6$ Military uniforms packed with sensors that can transmit data about a soldiers physiological condition to field-medics, as well as having in-built cooling and heating facilities. Helmet visors acting as computer displays wirelessly linked to weapons, sensors and comrades (Armies of the Future: Brains, not Bullets, 2007). Also, remote-controlled robot armies, minute omnipresent surveillance technologies that digitise real landscapes in intricate detail which when layered with other data can visually track the movements of potentially any living creature anywhere in the world. And Smart Dust whereby minute sensors that respond to heat, light and sound are fanned in multiple directions; directed by these sensors, unmanned drones build up an audio-visual picture of every street and building within an area (Graham, 2006).

$^7$ For pervasive computing to see the light of day, a number of challenges have to be overcome. We shall discuss these later on.
someone with *just* a technical qualification. Rather he or she is an embodiment of the following 3 pillars:

1. Competency:
   a. Technical competence and the experience that goes with it.
   b. Soft skills: interpersonal skills, management and leadership skills where relevant, and understanding of the business domain.

2. Personal responsibility/obligation: a professional is required to make decisions based on the ethical repercussions of his/her work.

3. Contribution to Society: In reference to the BCS royal charter. Hughes says the ethos of professionalism demands that people work for the benefit of society i.e., public good. This includes making a contribution to the IT profession.\(^8\)


By IT profession, it is meant: the collective set of qualified peoples who work in the IT industry. These (people) are overlooked by professional bodies; the BCS is a prominent one. Bott (2005) discusses the functions and characteristics of a professional body (p.12, p26-29).

Today’s IT professional operates in an environment\(^9\) which consists of internal and external elements. The external or macro environment consists of the following elements:

- **Political:** The laws governing the target markets region might constrain the product or service that can be offered, the existence of governmental initiatives that may support a product or service.
- **Economical:** Is there demand for a particular type of good or service, does the target market have enough disposable income to be able to afford the product.
- **Social:** Number of people in the target location; their culture, number of students taking IT at A-levels (future labour force), demographics e.g., a large elderly population influences IT application development relatively,
- **Technological:** the existence of correct technological infrastructure amongst the target market e.g., broadband coverage, wi-fi hotspots, communications infrastructure.

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9 We admit that the actual environment is far larger and more intricate than what has been mentioned. However we have provided a general overview of the environment in the context of PCS; in so far as it is relevant to this essay.
• **Legal** – Data protection laws. Privacy, disability, electronic waste, and trading laws governing target market.

• **Ecological** – the move towards sustainable development, eco-friendly organisations, avoiding use of harmful materials in products.

Whereas the internal or micro environment - the organisation the IT professional works for - consists of the following elements:

• **Organisational culture**: dedication to quality products and services, sensitivity to the needs and wellbeing of society, customers, and the natural environment, awareness of latest industry trends,

• **Employee skill set** – do the employees have the skills to deliver quality goods and services, what kind of training and development programme is on offer?

• **Finances**: Is there enough capital to output quality?

On a more macro level, there are also factors which relate to the intellectual and emotional/super rational condition of the IT professional; these factors include training, qualifications, motivation for working for his/her company, membership or lack of to a professional body, awareness and adherence to codes of conduct, codes of good practice, knowledge of industrial trends, and strength of action in accordance to ethical issues surrounding technologies. Each of these elements have their own distinct influences on the IT professional, constraining or inspiring what type of hardware or software is developed. These influences shape an individual IT professional, who in turn shapes the IT profession, which in turn impacts society.

Everybody can see that IT is everywhere. Every day people interact with IT systems either as users, or indirectly in the form of their data being processed by computer systems in the companies they work for, banks, credit-card transactions, hospitals, e-mails and so on. The IT profession consists of professionals who develop and work with IT systems (for customers) that go onto impact society; hence the activities of the IT profession have a huge impact on people. These people include staff working on development teams, shareholders, and customers. The IT profession has a responsibility to serve the interests of each group. Staff within development teams should be well trained and led with a moral and responsible conscience, shareholders want profit, whilst customers want quality products, value for money, and transparency with regard to the project schedule. The following diagram\(^\text{10}\) illustrates the typical stakeholders for an IT project.

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\(^{10}\) Please note; this is not an exhaustive diagram.
IT projects are notorious for delays, running way ahead of budgets, not meeting requirements, and complete failures. This has led to information systems professionals being sometimes ‘perceived as behaving in an unprofessional manner’. (Bott, 2005, p.27-28). In fact According to the Standish Group’s (2001) research, only 28 percent of software projects in 2000 succeeded. 23 percent were cancelled, and the remainder were substantially late (by 63 percent on average), over budget (by 45 percent), lacking features (by 33 percent), or, very often, all of those issues combined. The figure to the right depicts the state of I.T projects in 2000 (Stepanek, 2005).

Moreover, all professional activity should be legal and environmentally friendly. Cases like DoubleClick’s super-plans for targeted user-specific web advisements are clearly unacceptable and succeed only in damaging the social fabric as well as throwing the IT profession into disrepute (BCS Code of Conduct, Passage 1). DoubleClick is a New York based internet advertising network which places advertisements on over 1500 client sites. Personal details that users entered as well as their browsing habits were collected from the 1500+ sites (without their being aware), stored, integrated, and formed part of an individual user’s ongoing browsing history. A few years ago DoubleClick paid $1.7 billion in stock to acquire Abacus Direct, a database marketer with names and purchase histories of 88 million households that were characterized by large purchases from retail stores and mail order catalogues. DoubleClick planned to merge Abacus Direct’s database with its own. However, shortly after these plans were made public, large amounts of public complaints followed (De George, 2006, p.494).
In summary, the IT profession impacts both the projects it works on, the people who work on these projects, the stakeholders affected, and then the social context in which these projects are situated. With the advent of PCS, it is more critical than ever the profession act with ‘due care and diligence’ (BCS Code of Conduct, Passage 6) when designing, delivering, and maintaining IT systems. This essay will focus on the IT professions and the IT professional’s duties and responsibilities in designing, delivering, and maintaining PCS’s relevant to stakeholders, in relation to what was raised in PostNote 263. ✤
Abbreviations:
PCS – Pervasive Computing System(s)
PN – PostNote No. 263
BCS – British Computing Society
COC – BCS Code of Conduct
CGP – BCS Code of Good Practice

For purposes of coherence, we have divided the duties and responsibilities of the IT profession and the IT professional into two categories. The requirements of this essay can be fulfilled under the umbrella of these two categories:

1. Practical: Which relate to: overcoming engineering challenges, duties and responsibilities due to clients and users, ensuring quality and transparency, the design, delivery, and maintenance of PCS according to external and internal environmental factors, and trends and opportunities posed by PCS’s.
2. Ethical – Which relate to threats posed by PCS, individual as well as co-corporate social responsibility (CSR), privacy, security, health, and other related concerns. In essence, a response to dealing with the implications of PCS’s.
3. Conclusion
MAIN

1. Practical duties & responsibilities

1.1 Overcoming Challenges

PostNote 263 raises a number of challenges that PCS’s pose. These challenges emerge from current and future trends. Envisaged PCS applications require the profession to overcome the following:

- **Interoperability**: Development of PCS’s depend on interoperability and convergence of standards for wired and wireless technologies.
- **Power supply/battery technologies**: Need to be energy efficient and robust.
- **User Interface**: PCS’s will receive input via. visual data, sound, scent, touch, and gestures, with output being in similar formats. These channels present considerable challenges as pointed out by the UK CRC (U.K Computer Research Centre\textsuperscript{11}).
- **Cost effective ways** of building devices.
- **Environmentally friendly** devices (see section: Devices).
- **Fault Tolerance**: The complexity of PCS’s means their ‘communications, software and hardware are likely to suffer from faults’ (PN, p.3). In addition faulty systems may be **harder to repair** because of their degree of interconnection.
- **Determining Liability**: High degree of interconnection will make it difficult to determine who is responsible if something is wrong. Liability also causes legal ramifications with respect to legislation.

The IT profession has a duty to provide platforms for academics to research, socialize, and present their findings, to overcome the aforementioned challenges. The Computer Journal, under the aegis of the BCS, held a discussion in March 2006. The event opened with a lecture by Robert Milner (computer scientist, Cambridge university) and was entitled “Ubiquitous Computing: Shall we understand it”. 13 other academics from prominent U.K institutes and universities contributed to the discussion. Milner (2006) said that PCS technology posed the following questions:

- **“Social questions**: what ubiquitous computing systems (UCSs) do people want or need, and how will they change people's behaviour?
- **Technological questions**: how will the hardware entities - the sensors and effectors whose cooperation represents such a system - acquire power, and by what medium do they communicate?

\textsuperscript{11} www.ukcrc.org.uk
Engineering questions: for the populations and subpopulations - including software agents - that make up a system, what design principles should be adopted at each order of magnitude, to ensure dependable performance?

Foundational questions: what concepts are needed to specify and describe pervasive systems, their subsystems and their interaction?" (Milner, 2006, paragraph 1-2)

Milner also said the UK Computing Research Committee (UKCRC) has already initiated exercises to tackle these questions. Though these questions have been addressed for conventional software, they are magnified for PCS due to the following qualities:

"First, since we shall be largely unaware of the activity of such systems, they will continually make decisions hitherto made by humans. Second, new technologies will allow such systems to be vast - orders of magnitude larger than any we know, including the Worldwide Web - and the difficulties of designing and understanding them will surely grow nonlinearly with their size. Third, the systems must adapt continually to new requirements, retaining reliability and without interrupting service (on whose continuity we shall increasingly depend). Fourth, though individual systems may be designed independently, their pervasive nature will inevitably lead to unplanned interaction between them.” (Milner, 2006, paragraph 2-4)

Clearly efforts to overcome the challenges mentioned in the PostNote are already underway, the IT profession should maintain this. An individual IT professional should ‘seek to upgrade your professional knowledge and skill, and shall maintain awareness of technological developments, procedures and standards which are relevant to your field, and encourage your subordinates to do likewise’ (COC, passage 14).

1.2. Devices

As mentioned in the introduction, the IT profession belongs to an environment, a sub-world, which is affected by a number of factors. One such factor which affects the design stage of a PCS is the ecological or natural environment factor. Decades of exploiting the natural environment in the form of usurping its resources, deforestation, biological and chemical warfare, releasing harmful gases like carbon monoxide into the atmosphere, have led to troubling climate change (De George, 2006, p.580) and a shortage of natural resources particularly oil, which is a primary source for plastics and other materials popularly used in the construction of technological devices. Hence 21st century humanity has no choice, except to tread carefully. ‘Environmentally friendly ’ is the buzz word of the day. Environmental or green initiatives have popped up everywhere, even in our very own

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In an IT context, WEEE, the EU directive that makes European producers and importers of electrical goods responsible for their eventual disposal, came into force on 1 July. The US IT research firm Gartner revealed the IT industry has a carbon footprint the size of the airline industry! An example of a good response to the ecological factor is the work of Judy Grove (Specialist Computing Centres) who points out that data-centres can be much smaller, and that there have been great advances in terms of heat production and power consumption. She says 'We recently did work for a bank that resulted in a 50% reduction in the data-centre's power demand.' Also Virgin has a campaign called 'give a monkeys' where they remind their workforce of their duties to the environment each week (Rigby, 2007).

PostNote 263 highlights concerns over ‘microelectronic waste embedded in other objects’, such materials have recycling implications ‘because of the possibility of such waste contaminating recycling channels’ (PN, p.4). Here, the EC Directive on Waste and Electrical and Electronic Equipment laws apply. Individual IT professionals must thus act in accordance with similar legislation, even in countries/markets that don’t have such prohibitions since it is in the interest of public health and environmental safety. The IT profession has a duty to encourage the usage of non-harmful, environmentally friendly materials in their training, seminars, and codes. Whereas the IT professional has a duty to keep his knowledge and training up to date with these matters, practicing accordingly (COC, passage 14 and passage 3). The COC states “In your professional role you shall have regard for the public health, safety and environment” (COC, Passage 1).

1.3. User Interface

Shifting away from conventional graphical user interfaces (GUIs), PCS interfaces will utilise more channels of communication: visual, speech, touch and gesture input. In some cases the interface will be invisible, whereby sensors, instead of keyboards and mice, will act as input devices. Hence, the profession and professionals have a duty to take a principled approach to design:

Usability must play an important role. PCS’s must be easy to interact with. The last few decades have witnessed a move away from the traditional function-centred approach to interface design. The new trend favours a user-centred design approach. This has given birth to a new field known as Human Computer Interaction or User Centred Design which draw upon theories from

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13 The university’s environmental policy is available at: [http://www.campus.manchester.ac.uk/medialibrary/policies/environmentalpolicy.pdf](http://www.campus.manchester.ac.uk/medialibrary/policies/environmentalpolicy.pdf). Also, see the Manchester Leadership Programme: according to Prof. Alan Gilbert (vice-chancellor), this is the only module of its kind in the whole country. The MLP raises the sustainable future issue, with major guest speakers delivering lectures each week ([http://www.careers.manchester.ac.uk/mlp/](http://www.careers.manchester.ac.uk/mlp/)).

cognitive psychology to motivate the design of interfaces. (Preece et al., 2007). Norman (2002), author of ‘The Design of Everyday Things’, is a prominent figure in the field. Both the profession and its professionals are advised to follow this trend. In addition, the PostNote raises the issue of considering the needs and capabilities (during early design stages), of the ill and elderly, since according to some: healthcare and domiciliary-care PCS applications could improve their lives (PN, p.4). The CGP states “Check the products of your designs can be used by both experienced and inexperienced users…” (CGP, p.24).

Accessibility legislation and the Disability Discrimination Act (October 2004) applies particularly in the U.K, whereby interfaces have to cater for visually impaired, and deaf people. The COC states ‘You are encouraged to promote equal access to the benefits of IT by all groups in society, and to avoid and reduce social exclusion’ from IT wherever opportunities arise’ (COC, passage 4). In addition, the CGP states ‘Concern yourself with the needs of people with, for example visual impairments, dyslexia or physical disabilities’ (CGP, p.6).

Related to this is ensuring the wider society as well as customers are trained on using PCS’s. The BCS as well as the U.K government run initiatives like U.K online (see http://www.bcs.org/server.php?show=conWebDoc.2419 for a list of BCS community partnerships) which train communities in IT. With the advent of PCS, the profession has a responsibility to ensure these are maintained. The CGP states ‘contribute to the education of the public whenever you have the opportunity so that they can be aware of and form an objective and informed view on IT issues’ (CGP, p.9); which is also connected to fairly informing the public about PCS’s. As we shall discuss in Section 2: Ethical, whilst raising awareness of the usage of PCS, stakeholders like the government, customers, and users also have a right to be aware of the kinds of data PCS shall process. This COC states ‘you shall have regard to the legitimate rights of third parties…’. Third parties include any person(s) who ‘might be affected by an IT system without their being directly aware of its existence’. (COC, passage 2). This is where the Data Protection Act (1998), Computer Misuse Act (1990), and Public Interest Disclosure Act (1998) apply.

Some PCS applications including: smart appliances\(^\text{15}\), affective computing in the home, and cars similar to the 2006 Mercedes S-Class that feature an automatic active breaking system which can detect slowing vehicles in front (PN, p.4), will require user-documentation. Professionals here should ‘Strive to understand the potential readership, their expectations and abilities; be aware that some readers may have difficulties with reading, language or comprehension’ (CGP, p.26).

The PostNote reports banking, education and retail services are likely to be delivered through PCS’s in smart-homes. This means that some people will be deprived of access out of

\(^{15}\) We have already detailed these applications. See footnotes 1-6.
choice or low-income. Industry trends shouldn’t force people into adopting PCS’s, people should have a choice - a characteristic of our democracy. Hence, these people should be considered during future PCS trends.

1.4. Connectivity

Current and future trends in PCS’s demand interoperability between different devices since they ‘will rely on the interlinking of independent electronic devices into broader networks…with the devices themselves being capable of assessing the most effective form of connectivity in any given scenario’ (PN, p.2). Future PCS will have to communicate with existing systems as well as legacy systems. Hence, as mentioned earlier, the whole profession is challenged. ‘IBM has been working on standards including Bluetooth, a standard for short-range wireless communication….and NIST (National Institute of Science and Technology) is working with hundreds of companies to bring together the pieces necessary to make pervasive computing a reality’ (Anderson, 2000, paragraph 25-26). The IT profession should ensure that training resources and events are provided for, whilst the duty of the individual professional is to make use of these and advise his colleagues to do likewise. The BCS currently encourages its members to make use of: courses, computer based training (CBT), technical publications, discussion groups for specialists, as well as the acquisition of qualifications for purposes of continuing professional development (CPD) (CGP, p.6). The COC states ‘You shall seek to upgrade your professional knowledge and skill, and shall maintain awareness of technological developments, procedures and standards which are relevant to your field, and encourage your subordinates to do likewise’ (COC, passage 14).

Interoperability is already a ‘big thing’ in the I.T industry, with governments and business demanding it (Espiner, 2007). Take for instance the off-the-shelf software market: Adobe recently acquired Macromedia and now Adobe CS3 products integrate well with Macromedia, now Adobe Flash (http://www.adobe.com/products/flash/). To give a possible PCS scenario: An N.H.S PCS application might employ remote sensors and monitoring technology for continuous data capture of a patients physiological condition – the PCS will have to be able to communicate with existing N.H.S systems and data. In the example given, this might be accessing patient past medical history. Consequently, I.T professionals have a duty to employ robust testing techniques. The CGP states ‘Devise integration tests that build upon component tests already performed and demonstrate that the components interface correctly with each other’ (CGP, p.25).
1.5. More on Design, Delivery and Maintenance of PCS’s

In my view, an important part of designing and delivering PCS’s is transparency. The IT profession has received a lot of media exposure over failed projects. Indeed, as a result, IT projects are now connoted with being over-time and over-budget. It is well known that our modern world relies heavily on IT. Banks for instance are work-systems entirely composed of an information-system (Alter, 2002). The same with airlines, hotels, retail-stores, supermarkets, B2B firms etc. With the advent of PCS, the demand for IT systems amongst the commercial sector is likely to increase, especially because as O’Brien and Marakas (2006) mention, technology offers competitive advantage and curbs new entrants into the marketplace by increasing set-up costs. Considering, the infancy of PCS’s and the associated uncertainty and risks surrounding their development: individual IT professions and companies working on such projects have a duty to be more transparent with their customers than ever. Customer satisfaction has to take precedence. Sometimes ‘time-boxing’ (Dennis et al., 2005) isn’t the best way to manage a project that will exceed its deadline. This is especially the case for Government projects. As PN 263 mentions, in 2001 the government launched the Next Wave Technologies and Markets programme. In the summer of 2007, the programme drew to a close. According to PN 263, by 2006, 7 PCS projects were funded encompassing applications in health care, domiciliary care, integrated home environments, cities/buildings and environment sensing (PN, p.2). The U.K economy and the profession can not afford such outcomes as those of Accenture and the £12 billion N.H.S information system project (Arnott, 2006). Hence, the BCS is strategizing on increasing professionalism amongst its members.

The IT profession has a duty to ensure this continues alongside working on ways to reduce risk, and managing projects and customer relations better. Individual professionals are advised as follows:

- “Report any overruns to budget or timescales as they become apparent; do not assume that you will be able to recover them later.”
- “Ensure that you have the necessary resources to complete assignments within agreed time scales.”

(CGP, p.7)

- “Maintain good working relationships with colleagues, customers and users, even if you strongly disagree with them, however, ensure that such disagreements are recorded”
- “Accept only those assignments which you are qualified and competent to undertake…”

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16 See [http://www.nextwave.org.uk/](http://www.nextwave.org.uk/) and [http://www.designbase.co.uk/folio/38_bb_dti.htm](http://www.designbase.co.uk/folio/38_bb_dti.htm)
17 [http://www.connectingforhealth.nhs.uk/](http://www.connectingforhealth.nhs.uk/)
“Seek to identify potential hazards, failures and risks associated with your work…and seek to ensure that they are appropriately addressed.”

(CGP, p.8)

Perhaps with PCS’s, initiatives of informing the commercial sector about the inherent difficulty in predicting anything other than an approximate project-schedule are needed to be thought of. In relation to uncertain technologies, the CGP advises: “Where risk is created by virtue of the scale or novelty of a solution for which there is no reliable benchmark for estimation, consider a modular or incremental approach to reduce risk.” In addition, the CGP prudently advises professionals:

- Advise your customer, if, in your opinion, any stage in the programme will not deliver the anticipated benefits”
- Adopt transparent reporting based on quantitative, objective measures that are shared by your customer and supplier(s) to ensure a common understanding of the status of the programme, the risks and any variances from plan.
- Offer constructive challenge to your customer if:
  - The requirement is unrealistic
  - Any of your customer's expectations are unreasonable
  - There is a better way of meeting the requirement
  - A relatively minor change to the requirement might significantly reduce the cost, risk or timescale.

Note; this type of relationship with a client depends on the organisational/team structure employed for the project. As Bott (2005) writes, whilst centralised structures (top-down control) come with the advantage of flexibility in terms of e.g., moving around programmers from one team into another (without worrying about adaptation), they do not facilitate team-members - working on a micro-level - to air their concerns about things like: efficiency, design and development techniques, choice of programming language or engineering method. Whereas decentralized structures allow this at the cost of flexibility. The best firms are those which can strike a balance between the two aforementioned structures, however this is challenging (Bott, 2005, p.105). The responsibility of the profession therefore is to advise the industry accordingly since the internal environment of a firm has a domino-effect relationship with I.T projects and then the industry as a whole (Bott, 2005, p.106-109). Continuing the subject of transparency and customer-relations, the CGP advises:

- Devise an acceptance strategy that will fairly demonstrate that the requirements of the project have been met.
Openly and frankly discuss with your customer the options for allocating, managing, mitigating and insuring against the risks.

Avoid accepting responsibility for a risk that would be better owned by your customer.\(^{18}\)

Maintain metrics on all project activities, so that later projects can benefit.

Accurately record the effort spent on each task; do not hide overruns by booking to other tasks.

Provide early warning of any possible overrun to budget or timeline, so that appropriate actions can be taken.

Instil in your customer a well-founded confidence in the products and services to be delivered, and your commitment to performance, risk, timescales and delivery.

Another equally important part of designing, delivering and maintaining PCS’s is quality. A PCS will typically comprise of: sensors, processors, actuators, software, and different materials. Hence, a rigorous raw materials and resource selection criteria should be adopted by professionals, which is overshadowed by a concern for public health and safety as well as cost-effectiveness and quality for customers. In this regard the CGP states ‘Ensure that there are procedures for the acceptance, storage, and maintenance of all externally-supplied materials’ (CGP, p.18) and ‘Consider the needs for scalability, connectivity, capacity, performance, resilience, recovery, access, security and create cost-effective solutions that meet those needs’ (CGP, p.23). Moreover, ‘Consider the impact of new systems on the public and avoid solutions that impose unacceptable levels of risk on their mental or physical well being’ (CGP, p.23). As regards programming, ‘Only use evaluated and validated software languages or accredited components…’ (CGP, p.16). Professionals in I.T organisations should be responsible when applying for quality accreditation and when undergoing an audit. According to the CGP, their responsibilities include to ‘welcome external auditors into the organisation: benefit from their experience rather just hide shortcomings from them to pass the audit’ and ‘follow up the audits and make sure actions are being taken to make real improvements’ (CGP, p.19). Fears of being seen as incompetent have to be put aside.

\(^{18}\) The following 3 points as well as this one are well suited to the nature of a PCS.

\(^{19}\) We have attempted to condense the broad issues of transparency, customer-relations, project management, and risk management. Even in the context of PCS, there are many; we have addressed the central ones.
This requires courage, honesty and uprightness. The COC charges a professional with this responsibility. Aristotle is known to have said ‘the courageous man isn’t the fearless man’.

The diagram below is based on the CGP. It shows how and what the IT profession is doing, and can do to encourage quality:

As regards delivering PCS’s duties of professionals include continuing the spirit of quality by

- Looking at previous installations if any, and not repeating their mistakes.
- Providing documentation of outstanding problems: if professionals fulfil their duties during earlier stages, these should be few.
- Ensuring users are capable of taking over the installation beforehand.
- Contact-details should be given to users for post-delivery contact.
- Ensure the customer agrees to develop a disaster recover plan

(Adapted from (CGP, p.27))

Due to the novel nature of PCS’s and we have already mentioned the interconnectedness of PCS’s with other networks, the profession has a responsibility to ensure professionals are informed of the best techniques and advice available at any given time.
1.6. Finance

PCS’s are still in their infancy, because of this uncertainty, organisations working on PCS projects may be challenged with forecasting profit and determining cash flow (DCF). Hence, the I.T profession has a responsibility to address the needs of IT organisations, startups and professionals in terms of reliable finance knowledge. As mentioned earlier, I.T organisations and individuals have a duty to keep their knowledge up to date.

1.7. Maintenance

Since PCS’s are a new technology, it is obvious that successful deliveries must be accompanied by rigorous after sales support i.e., maintenance. The CGP states: ‘Maintain contact with your prospective customer after conclusion of the sales activity; elicit any shortcomings in the sales activity and initiate remedial actions’ (CGP, p.13). This applies to both IT companies and individual professionals. Failure to do this may lead to throwing the I.T profession into disrepute, harming customer and potential customer confidence. This may lead to more bad-press and potentially weakening the financial prosperity of the firm responsible. Additional duties of an I.T professional include:

- “Establish the level of support which may realistically be expected to provide the tools, documentation and suitably trained staff to meet this expectation” (CGP, p.33).
- “Reassure the customer that any complaints about the quality of service are being taken seriously and keep him/her informed of improvements” (CGP, p.33).
- “Even if a problem seems trivial, give assurance that it will be investigated and a response will be given” (CGP, p.34).
- “Recognise that some problems that appear trivial from a technical viewpoint may have major impact on the business.” (CGP, p.34).
- “Be aware of the commercial sensitivity of operational data; keep control of copies of such data and ensure destruction when the investigation is complete” (CGP, p.34).
- “Do not hand over commercially sensitive information without ensuring procedures for the handling, processing, storing and destruction of the information are in place”. (CGP, p.34).

These points contain principles that embody quality assurance, sensitivity to customer data, and a culture of strong customer support which are suited to the novelty of PCS projects. As mentioned earlier, the BCS is updating its strategy for instilling deeper professionalism in the industry. To given an example from the realm of Information systems that should be avoided; is the behaviour of securing contracts to bring revenue whilst over-promising what can be delivered or when it can be
delivered. Another related example is a consulting firm selling a client its product or that of its partner against the client’s best interest – all for the sake of personal revenue (Freedman, 2004).

In closing, below is a diagram illustrating opportunities offered by PCS’s.
2. Ethical duties & responsibilities

“Should you wish to act, ponder well the consequences. If good, carry on; if not, desist.”
- Prophet Muhammad (God bless him and give him peace)

“It is of no use to know something if one does not act upon it. In truth, an abundance of knowledge only increases one in pride if one does not act accordingly.”
- Prophet Jesus the Christ (Peace be upon him)

“Weather or not it draws on new scientific research, technology is a branch of moral philosophy, not of science” – Paul Goodman, New Reformation

2.1. General concerns & threats

PostNote 263 raises concerns over security, privacy, safety, and health. Massive amounts of data will be gathered, stored, retrieved and transmitted by PCS’s: from a person’s buying preferences to their mood and behaviour during different times of the day, from their style of driving (including vehicle location) to their movements around buildings like hospitals and old peoples

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20 Received from and translated by (Yusuf, 2005, p.16). Sayings (Arabic: Ahadith) of the Prophet Muhammad (God bless him and give him peace) are transmitted from teacher to student in multiple continuous chains of transmission that lead back to the Prophet Muhammad (peace be upon him), such that that it would be impossible for so many transmitters (people) to come together in order to forge a lie. The names of every single Hadith transmitter and intricate details about their lives from the strength of their memory to their movements are known and documented by Muslims. Moreover, Muslims have also received some of the sayings of Prophet Jesus the Christ (Peace be upon him) from the Prophet Muhammad (God bless him and give him peace). These sayings speak to us regardless of our personal creed, beliefs, or race. They speak to the humanity all men and women share. Sadly, many of us in the west have never heard the Prophet Muhammad (God bless him & give him peace), nor read about his life (from fair sources) in comparison to what we (have) read about the lives of people who have had less of an impact on history. And yet, 1/5th of humanity hold the Prophet Muhammad (God bless him & give him peace) with the loftiest of loves and esteems.

21 Received from and translated by Hamza Yusuf who mentioned it in a forthcoming book called “Walk on Water: The Wisdom of Jesus”. For a preview see: http://www.zaytuna.org/seasonsjournal/article.cfm?article_id=105

22 This on top of the existing data that companies and governments hold about people. On top of this, there is the information which internet users have transferred online via. blogs, forums, and e-mail inboxes.

23 We have already mentioned Affective Computing. Another example is software that monitors the temperament of users via. keystroke rates and typo’s, thus ‘playing soothing music for agitated users, proposing a break if the number of errors goes up, or suppressing notification of incoming e-mails to avoid breaking someone's concentration’ (The trouble with computers, 2007).
homes via. RFID tags. From data about their physiological condition such as their heart-rate and body-mass index to insect like micro-aircraft that are able to plant sensors in buildings “X-ray eye” sensors that can see through concrete, locating people inside buildings, and software that can identify individual people from scans of their faces, their manner of walking or even their smell, and then track them anywhere they go (Graham, 2006).

With efforts to establish interoperability amongst different systems already underway, ‘the opportunities for data interception, theft and ‘ubiquitous surveillance’ (official and non official) will be heightened’ (PN, p.3). Furthermore, data may be collected without a persons knowledge or consent and on top of this Data Mining is advancing as we write, it is already used by supermarkets to monitor what products different customers buy in order to strategise stock-replenishment (Fernandez et al., 2004). Beyond this, ‘Data Mining activities can detect unknown relationships in data’ (PN, p.3).Were an individuals credit-card/bank card transaction, health record, and inland revenue (IRS) data be accessed or integrated, they would completely lose their privacy!

Then there is the matter of safety and security. What if the security of the controlling software for a vehicle that is equipped with an active breaking system breaches? Or if a U.S Army robot malfunctions 100’s or 1000’s of miles away from its control centre and kills innocent civilians (Graham, 2006). These risks raise questions about giving technology the responsibility for activities human beings would naturally do?

Aside from the aforementioned threats to human-beings, which are largely non-physical, PCS’s also pose physical dangers. Wireless signals are likely to be used to connect pervasive devices into broader networks. Hence human-body tissue will be at risk of exposure to potentially damaging effects of non-ionising radiation (a by-product of wireless signals). This threat becomes all the more serious considering PCS devices will remain constantly activated, with some being carried close to the human-body. The 20th and 21st centuries have been the first periods in human

24 “These tags, which can be as small as a grain of sand, are already being used as an alternative to barcodes in some hi-tech supermarkets…for example, a carton of milk could be tagged with a chip carrying information about its sell-by date which would tell the supermarket when to take it off the shelves. Once purchased, the same chip could be read by a fridge, which could order a new carton over the Internet before the old one goes off” (Hooper, 2004, Paragraphs 10-11).

25 These are military applications that the American military has spoken about. DARPA (defence advanced Research projects agency) have a programme called VisiBuilding part of which is the X-ray eye sensors).

26 The Center for Pervasive Computing is already working on putting PCS infrastructure in place, leading a 13-million euro ($16.7 million) project to devise a European standard for pervasive computing systems.

27 Detects rapidly slowing vehicles in front, thereby activating breaks without driver intervention (PN, p.3).

history to have witnessed mankind being exposed to all kinds of technological emissions\(^{30}\); we do not as yet know the full consequences of constant human exposure to such emissions.

Hence, prominent researchers like Som\(^{31}\) et al. (2004) call for a precautionary principle\(^{32}\) in order to ‘anticipate and minimize potentially serious or irreversible risks under conditions of uncertainty’ (Som et al., 2004, p.787). Though this should be the general case with science and technology, we should be especially cautious with Pervasive Computing. Som et al. (2004) proposes a framework that can be used to minimize the risks of novel technologies. PN 263 mentions:

“It is argued that privacy, safety and security can be better protected if appropriate procedures and protocols are integrated into PCS at the design level rather than implemented retrospectively. Three measures are frequently cited as vital in establishing robust security measures:

- The volume of transmitted data should be kept to a minimum;
- Data that require transmission should be encrypted and sent anonymously (without reference to the owner);
- Security should be treated as an ongoing integral element of PCS\(^{33}\)” (PN, 2006, p.4).

Accordingly, the CGP states “Exercise a sense of social responsibility for the implications of your work” (CGP, p.7) and “keep up to date with the threats, vulnerabilities to those threats and the range of countermeasures available to avoid, reduce or transfer risk” (CGP, p.15). For IT organisations, all these issues come under the purview of corporate social responsibility (CSR) (Fisher and Lovell, 2006).

\(^{30}\) Radio-active emissions from microwaves, mobile phones, wireless devices, satellite dishes and so on.

\(^{31}\) Claudia Som is based in Swiss Federal Laboratories for Materials Testing and Research, EMPA, St. Gallen Switzerland.

\(^{32}\) Though there is debate over definitions of the Precautionary Principle (PP) (Som et al, 2004, p.790). The PP is a (concrete) framework which is already used to defend specific subjects of protection, such as the ozone layer, the North Sea, the climate, biodiversity, the environment in general and human health. Som et al. are calling for one to be applied to ICT particularly pervasive computing systems. (Som et al., 2004, p.789). The IT profession would be wise to pay attention to it.

\(^{33}\) These measures are accepted by most centres of PCS research and development, however the consumer group NCC says that developers need to give more consideration to privacy issues, they also argue that with RFID – privacy issues still need to be fully addressed. (PN, p.3).
The diagram below summarizes some threats posed by PCS’s:

![Diagram of threats](image)

2.2. The Profession & the Professional

Another 5-10 years are required for Pervasive computing to reach a fully operational reality. As PostNote 263 observes ‘some are calling for a debate to take place’, however according to my own exploration of the BCS and the IEEE sites, I have thus far seen nothing of the sort. The IT profession has a duty to ensure a comprehensive debate takes place, that doesn’t exclude any perspective. The CGP (which also applies to professional bodies, otherwise it is hypocritical) allows room for such activities: “Consider the impact of new systems on the public and avoid solutions that impose unacceptable levels of risk on their mental or physical well-being” (CGP, p.23). When performing research: “Pursue research only in those areas that offer benefits to the organisation or its customers but not to the detriment of society or the public” and “Recognize the potential use or misuse of the outcomes of your research and only proceed with the research if you can justify to yourself the consequences” (CGP, p.26).

2.3. Social responsibility and the other side of the coin

Perhaps we should temper that 17th century passionate fervor of unleashing inventions (Postman, 2005) without serious, deep, balanced and comprehensive reflections (involving ethicists and philosophers). These reflections must place the well being of humanity, above the ‘back-pockets’ of co-corporations and individuals. We should not be blinded by commercial gain,

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34 Consideration can be held on a collective level, as well as an individual level.
35 I have underlined the loop holes inherent within the clauses. Considering the magnitude of PCS’s, I feel such clauses must be re-adjusted such that they allow no room for possible abuse; in line with the ‘precautionary principle’ (Som et.al, 2004) Words like ‘unacceptable levels’ need solid definitions. Experts on ‘(Business) Ethics’, and the ‘Philosophy of Technology’ must be consulted.
36 See Postman (1992). Index: Technological Fervor
monetary advantage, dodgy experimental curiosity\textsuperscript{37} or academic fame to the detriment of social, ethical and human disadvantage. If the implications are beneficial, only then should the profession respond to engineering challenges. We should take lessons from our History which is replete with technologies and tools that have been short-sightedly unleashed into the world only to result in harming human-life and ‘what have I/we done’ statements e.g., nuclear warfare, biological and chemical weaponry etc.

Putting aside, for a moment, the chorus of benefits that are attached to PCS’s and sung about constantly (Greenfield, 2007)\textsuperscript{38}. Instead let us look deeper, beyond the form of PCS’s - as the ancient maxim suggests “images can be deceiving”. On the other side of the coin, Postman (1992) notes ‘because of its lengthy, intimate, and inevitable relationship with culture, technology does not invite a close examination of its own consequences\textsuperscript{39}. It is the kind of friend that asks for trust and obedience, which most people are inclined to give because its gifts are truly bountiful… but its gifts are not without a heavy cost.’ (Postman, 1992, p.xii) As well as thinking about what technology does, Postman advises people to think about what technology undoes. Citing the example of Gutenberg’s\textsuperscript{40} press, he warns us about the unforeseen consequences of technology. According to some philosophers and ethics professors future PCS infrastructure could be exploited by political abuse, resulting in the loss of people’s liberties. Their concerns are not unfounded; there are current PCS applications\textsuperscript{41} which support their arguments such as those of ‘Applied Digital Solutions’ (USA). Professor Deborah Johnson\textsuperscript{42} (University of Virginia) “suggests that the public has so far been willing to accept new pervasive devices or applications without question because of a too-

\textsuperscript{37} This is not to deny that curiosity is useful in the pursuit of intellectual progress, however it refers to constraining the ‘just because we can, we should’ with rational reflection and the well-being of mankind.

\textsuperscript{38} Greenfield talks about digital dreamworlds that provide one seamless experience of being immersed in information (The Trouble with Computers, 2007).

\textsuperscript{39} Postman also quotes Plato via. a story says: “Theuth my paragon of inventors, the discoverer of an art is not the best judge of the good or harm which will accrue to those who practice it”, (Postman, 1992, p.4)

\textsuperscript{40} Postman mentions that: Gutenberg was a devout catholic. He invented the printing press. As a result writing was made accessible to anyone who wanted it. Later, Luther would use the printing press to mass-produce the Bible thereby placing it on ‘every kitchen table’; making each Christian his own theologian. Discord amongst Christians followed, and the unity of the Catholic Church was harmed. ‘We can assume that this possibility never occurred to Gutenberg’ (Postman, 1992, p.15).

\textsuperscript{41} One amongst many is when CEO Richard Sullivan suggested in an interview that non-US citizens might be involuntarily implanted with microchips to make it possible to track their whereabouts. Applied Digital Solutions have developed a pervasive computing device which they have dubbed the VeriSign chip, it is implanted in the human. As well recording biometric details, it can also be used to detect the precise movements of a person. A family in America has volunteered to have the chip implanted in them (Stone, 2003, p.5).

\textsuperscript{42} Professor of Applied Ethics at the University of Virginia; She works specifically in the technology, culture, and communication arena.
enthusiastic faith in the present commercial and political systems. “but conceit is all set up in place, it will only take a slight shift in political ideology for it to be used in other ways.”” (Stone, 2003, p.6). A Scanner Darkly (2006) - a Hollywood film, set in a future where the government has the facilities to monitor anyone, any-time, any-place due to minute pervasive surveillance technologies - all in the name of combating a drug called substance D. As the film unfolds, it turns out Substance D is a cloak behind which the government keeps an eye on its people. Similarly, Minority Report, set in the further future, is a Hollywood film about a society transformed by pervasive computing. Both films were adaptations of books written by the famous sci-fi author Philip K. Dick. He, alongside (George) Orwell (2000), (Aldous) Huxley (1932) were envisaging technology and the intricacies of totalitarianism decades ago. It seems, their science fiction is partly becoming science-fact. 🙇
3. CONCLUSION

To conclude, PostNote 263 raises a lot of issues. Each issue corresponds to the duty and responsibility of both the IT profession, and the IT professional. Documents like the COC and CGP are paving the way to what is expected of a professional. The challenge is ensuring that these are practiced. Documenting something or rather saying something is one thing, whereas practicing something is another thing, and how far apart are the two! Ensuring practice will result in high levels of quality permeating throughout the stages of a PCS from their design to their maintenance. As well as quality, we elucidated the importance of transparency in PCS projects as means of not only learning from the history of IT projects - using the experience as a compass - to ensure future success for all stakeholders, but as a springboard to raise the profession out of the hole of bad reputation and avoid it falling back into such a hole.

On the one hand, the profession is giving the impression that it is taking this initiative via. community partnerships, codes of conduct, membership grades, and CPD facilities, on the other hand – in terms of reflecting, discussing, and debating the social and future implications of PCS, it clearly isn’t. Individual professionals should be aware of both sides of the coin; the profession has a responsibility to ensure this happens in a balanced and fair manner.

There is a trend in the industry to overcome engineering challenges associated with the widespread application of pervasive computing, but no such trend in deeply debating and reflecting on future implications of PCS. The profession is training members of the community in IT usage, what about IT misusage? thus a debate that extends beyond the profession is required.

As well as having many advantages which are constantly mentioned, PCS’s also raise questions about social, health, political, and philosophical implications. As George Orwell, Aldous Huxley, and current Philosophy and Ethics professors warn, such technologies have the potential to erode democracy in the world, through their steady misuse by governments, which may eventually result in a totalitarian political process. Some argue that policy and laws such as the Data Protection Act may have to change. Since the implications of PCS will be huge and considering there are still 5-10 years still left: perhaps we should also question if such technologies are actually neutral i.e. the notion of PCS’s being both beneficial and harmful like a kitchen knife, depending on who uses it.

Finally, and as some would argue, most importantly, there are ethical and social responsibility issues. Undoubtedly, the profession has to be more responsible and socially conscious
than ever before. Everyone, from an engineer to the people who commission PCS applications have a role to play. Total transparency with the public is a duty which should be honoured, since they will be greatly affected. The public should be given the democratic choice of choosing weather or not to use PCS’s: as opposed to the steady erosion of their choice, whereby not using PCS’s will mean isolation, lack of accessibility and thus marginalisation from the sectors adopting PCS’s e.g., banks, health, domiciliary care, and public transport.

32 years of the P.C and 12 years of widespread internet usage (sites like Google, eBay, Blogger, mySpace which has over a million users, and YouTube) prove just how massive an impact technology has on society. Us IT folk are actually steering the whole of humanity. Only our Ship is larger than the titanic – it’s called TECHNOLOGY (especially pervasive computing) – carries more passengers, and is sailing on the seas of history – on an ocean called the future. The destination? Well that’s what we need to be more clear about. I don’t think we are. We need to be more responsible than ever and responsibility like the ex-president of Czechoslovakia, Vaclav Havel, once said: ‘We are still incapable of understanding that the only genuine backbone of our actions-if they are to be moral-is responsibility. Responsibility to something higher than my family, my country, my firm, my success’. This is the type of responsibility both the IT profession, and the individual should adopt, a responsibility that encompasses the whole of mankind. ☀️
REFERENCES


