Teaching smart phone ethics: an interdisciplinary approach

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ABSTRACT

The phenomenal rise of the smartphone, and the rapid diffusion of mobile computing generally, are amongst the most notable developments of recent times in information and communication technologies (ICTs).[1] The smartphone has become a ubiquitous communication tool, evolving into a digital Swiss Army knife, with an ever growing number of functions, from personal communications manager, navigation system, gaming terminal and camera, to payment device, internet access point and all-round digital lifestyle hub. For these reasons, the smartphone represents a prime topic for teaching and thinking about ICT ethics. This paper proposes an inter-disciplinary approach to this task.

Categories and Subject Descriptors

K.3.2 [**Computers and Education**]: Computer and Information Science Education - *computer science education, curriculum, information systems education*

K.4.1 [**Computers and Society**]*:* Public Policy Issues – *ethics, privacy, regulation, use/abuse of power*

K.5.2 [**Legal Aspects of Computing**]: Governmental Issues - *regulation*

K.7.4 [**The Computing Profession**]: Professional Ethics – *codes of ethics, ethical dilemmas*

General Terms

Design, Economics, Security, Human Factors, Legal Aspects.

Keywords

Smartphone, ICT Ethics, Pedagogy, Inter-disciplinary, Framework

1. INTRODUCTION

This paper draws on several years experience of teaching computer ethics to a culturally heterogeneous body of undergraduate computing students across different global campuses. The approach proposed here emerges partly out of a growing dissatisfaction with the standard approaches to computer ethics pedagogy, articulated in the existing body of textbooks in the field. I have discussed some of the limitations of these approaches in greater detail elsewhere [19]. In brief, multi-faceted technologies like the smartphone threaten to overrun the traditional topic boundaries and theories that underpin many of these texts which draw on quite specific strands of European classical moral philosophy. There is a tendency to present these theories in terms of various oppositions and dichotomies, such as deontological versus teleological, or moral intentions versus consequences. Ethical theories become abstract schema of rules that are applied to specific dilemmas in the ICT field. While ICTs are acknowledged as having a social impact, the complexity of the inter-relationship between technology and society is often lacking. When applied to current, real-world cases in a classroom context, the explanatory power of these classical ethical theories can be limited. They can result in prescriptive approaches that are disembodied from complex scenarios which generate a range of social and ethical issues around ICT. Most problematically, they don't offer much help in resolving these issues or generating feasible practical solutions.

The approach outlined here proposes a revised pedagogic and analytical approach. Rather than laying out the available ethical theories first, and treating the social effects of ICT as an addendum, it places the social and economic context of ICT upfront, methodologically. It then proceeds to explore ethical and legal issues, before concluding with questions of professional practice. In doing so, this approach draws on various theories, including elements of science and technology studies, information systems research, sociology, critical theory and communication and cultural studies. These theories are brought to bear on different moments of the framework to illuminate the different issues generated by a multifaceted phenomenon such as the smartphone.

2. PUTTING SMARTPHONES IN THEIR PLACE: THE SOCIO-ECONOMIC CONTEXT

ICTs don't just appear, or fall out the sky, to land on our desks, or in a shop. It's an obvious, yet important point, in pedagogical terms. ICTs emerge out of particular social and historical contexts. What they look like, how they work, and what they are

[1] For the purposes of this paper, *smartphones* are distinguished from *featurephones* by an advanced operating system, 3rd party applications, location awareness, a large, touchscreen interface, and wireless broadband Internet connectivity, amongst other features.

used for, are inextricably bound up with those contexts. This much we know from the long traditions of research into technology and society in the disciplines cited above, and their numerous sub-fields [2][23][18][28][38]. From this diverse body of work, we can confidently state that ICTs are always developed and implemented for a purpose, according to particular agendas. They are shaped by fundamental forces and recurring drivers, be they industrial, military or political. Who is funding the research and development of ICTs are powerful influences on the direction of their development, and on their properties and capabilities.

ICTs are always accompanied by social practices and values. These enter into all stages of the software development process and get baked into computer systems [15][18][39]. They are embedded in fine-grained code, algorithms, rules and patterns of reasoning [10]. Engineers make decisions about the architecture of systems and the physical characteristics of devices. Design embodies fundamental assumptions about users, their cognitive abilities and bodies, their imagined needs and wishes. The defaults and options embedded in architectures structure and shape users' choices [40]. In all of these ways, ICTs play a configuring role, shaping the possibilities of what can be done with them by enabling certain options or closing them down, by allowing certain uses while preventing or limiting others. All of these dimensions and properties therefore have an inherently ethical dimension, and ethical analysis requires these embedded values to be disclosed and critically examined [3].

2.1 Smartphone drivers and properties

The smartphone is the product of myriad drivers and shaping forces which have resulted in particular technical properties, discourses and social uses. It is these unique properties, their design, their implementation and their use in specific domains that lie at the heart of many ethical dilemmas raised by smartphones. A grasp of this "big picture" context is therefore a prerequisite to the ethical evaluation of smartphone technology.

This involves some understanding of the mobile phone industry itself, its particular business structures and shaping forces. The precise mix of these elements differs regionally and nationally, according to numerous factors, such as the existing infrastructure for fixed lines, the marketisation of licenses to commercial telecommunications operators, the apportioning of the wireless spectrum, and the role of government policy and regulation [14].

The two major players in the industry, besides the regulating bodies, are the handset manufacturers and the network operators, each with distinct corporate interests and business models. For example, Apple's premier profit engine as a handset manufacturer is the iPhone. With profit margins of 40%-50% per phone, profitability is the primary driver, and Apple's business is built around iPhone sales to network operators and users. Samsung, by contrast, prioritises sales volumes of different models at lower margins [43]. Google's mobile business strategy is built around advertising revenue. Its operating system, *Android*, and the various services and applications that are pre-installed with it are a lucrative advertising space, and a way of targeting and profiling users demographically. As such, there is a strong incentive to collect as much data as possible about users, and Google collects and mines this data in order to improve the accuracy and effectiveness of its advertising services. A common business strategy of all the major smartphone manufacturers is to lock users into proprietary ecosystems of integrated products and services, that include devices, platforms and native apps distributed through online stores.

The network operators' business model is service-based offering contracts to phone users at the retail end, while reselling services to other virtual network operators at the wholesale end. Of these services, prepaid contracts to subscribers are the most profitable, with the trend towards tiered-pricing based on bandwidth consumption, data and bundled services. Network operators also aggregate and sell phone usage data to marketers, advertisers and retailers.

The monetization of the smartphone, and the services and data that flow through it, shape the direction of its development in fundamentals ways. One area where this can be seen is the steady turnover or "churn" of new products, evidenced by the typical lifetime of a phone (18-20 months) and the approximately 1712 phones that are replaced every hour in the UK alone [7]. This is manifested in a continuous drive to create and sell new models with new features, and to push consumers into more expensive and lucrative contracts. This has direct implications for the ways in which smartphones are marketed, and feeds back into the way they are designed and manufactured to incorporate varying degrees of planned obsolescence [36].

Smartphones, however, are not only the result of intellectual work in product design and engineering. Value is also added through physical and mental labour embodied in the construction of the device itself. This can be seen by looking "upstream" in the smartphone's supply-chain, to the production process, and further back to the sourcing of raw materials. Mobile phone components use various mineral elements, chemicals and materials. LCDs, for example, use indium and tin oxides (ITOs) which are by-products of lead and zinc. ITOs are ubiquitous in touch screen devices because of their unique properties. Tantalum, tungsten, tin and gold (3TG) are also critical to the manufacture of smartphones, as is lithium which is used in batteries. ITOs and lithium are rare and difficult to extract, and their production is limited to certain parts of the globe. Mining frequently occurs in politically unstable and/or impoverished countries, such as eastern Congo where the extraction and trade of 3TGs have been controlled by armed militias. The manufacture and assembly of smartphones also occurs in particular parts of the global economy, especially China, where phones are constructed by contract manufacturers at low-cost, high efficiency and high volume, using just-in-time production models. Churn and the frequent launches of new smartphone models invariably mean short delivery times imposed on manufacturers, which in turn have implications for work conditions in these production sites.

Smartphone functionality is dependent on a plethora of interconnected technologies, including the wireless telephone infrastructure of towers, switches, exchanges and cellular grids, as well as wireless protocols and standards. The development of the smartphone is itself predicated on innovations in batteries, miniaturisation and data processing. These have occurred in close parallel with innovations in the wider infrastructure. The addition of a separate Subscriber Identification Module (SIM), for example, is just one example of an innovation that allowed subscription contracts with operators to be separated from the handset device itself. It is the affordability and flexibility of these payment systems which partly explain the rapid diffusion of wireless telephony as a technological and economic substitute for fixed lines, especially in developing countries.

The digitalisation of the wireless infrastructure, and the configuration of the telecommunications network as a whole, have had significant implications for the processing and tracking of data flowing through these networks. Whenever a phone is powered on and registered with a network, it can be located using triangulation, by analysing the signal strength that different towers observe from that phone. This also gives network operators, and other interested parties, the ability to intercept and record data about calls, devices, SIM cards, and their numerous attributes.

This location awareness and tracking ability was further enhanced by the equipping of smartphones with GPS receivers, by which phones could calculate their position in relation to signals transmitted by satellites. This location data can be transmitted over wireless networks to location-based services, but also to other GPS-receiving devices in the phone's vicinity. Smartphones also have other shorter-range wireless radio transmitters in the form of Wi-Fi and Bluetooth, both of whose signals include a unique, device-specific serial number or address assigned by the manufacturer.

These, and other signals emitted by smartphones, mean that the smartphone is continuously receiving and narrowcasting information about its location and movements. This data can be intercepted and observed by different receivers, then aggregated and analysed to build intelligence about particular phones and their users. Location analysis companies, for example, use strategically positioned devices to locate and track smartphones in retail environments, in order to understand customer behaviour, and send location-based ads to those phones [29].

These capabilities, combined with developments in context-awareness and machine-sensors, have made the smartphone a key point of convergence of wireless and geo-spatial technologies. They have put the smartphone at the centre of emerging networks of smart objects and sensors which are perpetually Internet-connected and communicate wirelessly. As these networks proliferate, mobile computing has extended into a wider range of public, private and domestic environments, endowing physical spaces with the interactive character of the Internet.

2.2 Smartphone language

If ICTs are always accompanied by social values, they are also always accompanied by *discourses* that frame the way they are represented and thought about. Putting ICTs in their social and economic contexts therefore also involves thinking about the *language* of ICT. Critical theory, social scientific and humanities-based approaches can shed light on how these discourses work, through various rhetorical devices, to present a particular set of narratives about technology. They can tell us how these discourses are reproduced, how certain representations of ICT become naturalised, and how these, in turn, serve to maintain particular vested interests and power relations [38]. This kind of critical unpacking and deconstructing of these discourses is an important part of computer ethics pedagogy.

In terms of smartphones, this means looking at the language and imagery used in corporate websites, advertising, and both new and old media. It entails looking at the cultivation of brand worship and the construction of the smartphone as a centrepiece of a consumer culture. These are part of wider discourses of consumerism and "upgrade culture" which pervade the marketing of electronic devices in general, and are a direct consequence of churn. They are rooted in more general technologist narratives about innovation as a process of continuous, linear progress, and the fetishising of the "new". Other recurring discourses that have been identified are ideologies of "speed", "convenience", the need to be perpetually contactable, and the valorising of aesthetic features as a means of expressing individual identity [27]. It is worth trying to foster an awareness of such discourses, not only because they shape common-sense attitudes and "school" us to consume smartphones in certain ways [41], but they also because they feed back into design, development and research.

2.3 Smartphone uses

While these discourses undoubtedly shape the ways in which smartphones are experienced and used, they are also interwoven with a whole range of creative uses and meanings. This much is evident from the swathe of studies in media and communication, and social science, which show how ICTs in general and mobile phones in particular are creatively appropriated in different contexts [14][21][22][37]. These studies show that consumer technologies are always subject to a process of meaning-making by their end users [5]. The used of SMS-based texting is just one example of how phone users have adapted features and developed uses that are not necessarily in the cards of product designers and business strategists. Texting was taken up en masse as a cheaper, alternative mode of communication to voice calls, spurred by the need to optimise messages and reduce the cost of transmission. SMS subsequently evolved into a non-standard "writing orality" with its own vocabularies in different languages [4]. The camera is another example of how smartphone functionalities have been creatively appropriated and incorporated into everyday life. Camera functions, in combination with social networking platforms, have placed the means of image-making and sharing in the hands of smartphone users with various cultural and political implications.

These are just two examples of how users customize smartphones for their own purposes and find innovative uses and workarounds that are often unforeseen by their designers and manufacturers. They suggest that the ways in which smartphone technology is used, by whom, and in what context, is always culturally specific and socially differentiated, and has implications for relations of power, whether in the family, work, or education. The most evident example of this is the central position that the smartphone has come to occupy in youth cultures, globally, where it has become a key tool in the construction of young people's identity, enabling new modes of networked sociability [16]. This is part of a wider process in which mobile telephony has reconfigured communication practices in general by enabling existing networks of relationships and affiliations to be reinforced [4]. This has had positive public safety implications for groups such as the young, the elderly, and the vulnerable, providing an immediate safety link to a personal support infrastructure and to assistance for those in harm's way. Mobile telephony has also enabled new kind of networks and communication flows outside of mainstream media, facilitating the formation of fluid, spontaneous "communities of practice" amongst ad-hoc groups, from flash mobs to political protests [4].

3. ETHICAL PRINCIPLES AND ISSUES

One of the main difficulties that students of ICT ethics have is identifying ethical issues, and explaining *why* these are issues. Ethical issues, to my mind, occur where certain core ethical principles, values or rights are at stake. These issues arise from the particular properties and capabilities of ICTs, and from their

design, production, implementation and usage in particular domains. From a teaching perspective, this means teasing out these underlying principles or rights. It means naming them and sourcing them. The ethical issues raised by smartphones touch on a number of core principles and values. As for the sources, these range in scope from broadly-shared human moral values, through internationally–recognised declarations, treaties and constitutions, to political and moral philosophy, including, but not limited to, the European classical canon.

A useful departure point from which to explore these issues is to reflect on some of the more identifiable controversies related to smartphone *use* as a communication device. While driven partly by media discourses and moral panics about the negative social impact of smartphones, there are issues worth exploring around the consequences of the smartphone's incursion into all areas of public and private life. The familiar scenario of the mobile phone ringing randomly in any given situation, and its potential to disturb or disrupt solitude or concentration—these have highlighted the boundaries of socially acceptable use in different public and private spaces, and touch on wider questions of social etiquette and civility. A related, and oft-noted issue is the phenomenon of "absent presence" where phone users are physically and socially present in any given space, while their attention and mental focus is elsewhere. It is a phenomenon most of us who teach in higher education are probably well familiar with. This touches on a wider problem—the possibility of a communications culture of ***permanent distraction*** being created, one that is decreasing the time available for people to think uninterrupted, at work, at home or in college. Some have suggested that we are becoming so enmeshed in our digital connections that we are neglecting others in our immediate social environment [41].

Another aspect of this redefinition of the boundaries between public and private space is the impact of mobile communication on the work-life balance. Here, the smartphone has become something of a Trojan horse through which work has infiltrated the home. Its "always on" capabilities have helped foster a 24/7 work culture of ***permanent availability*** which threatens the work-home balance in potentially harmful ways. While some of these debates are premised on conjecture and anecdote, the evidence is starting to come in from research in psychology and medicine that heavy smartphone use can detract from inter-personal relationships, interfere with sleep patterns, and lead to higher stress levels [34][35].

Given the large amount of personal data that is narrowcast every time it is switched on, and the nefarious ways in which this data is processed and used, the smartphone has inevitably become a major focus of ***privacy*** concerns. Smartphone capabilities have enabled new kinds of lateral surveillance and privacy incursions *between* citizens, but it is the unprecedented degree of access to the flow of personal information by private and state organisations that is of particular concern. Governments can, and have, forced network operators to turn over location data about users in real-time or as historical records. Concerns have been raised about personal data being gathered in ways that are subject to negligible regulation or oversight. A number of covert surveillance systems, operated by various governments, have been shown to exist, including systems operated by NSA in the United States [PRISM] and GCHQ in the UK [TEMPORA]. These have enabled security agencies to tap into the wireless network infrastructure, and collect metadata, in bulk, about mobile phone use globally. Various techniques for analysing mobile phone usage and call data have been incorporated into these systems. These data analysis tools can be used to determine not only a user's location, but also their historical activities, participation in events, personal beliefs and relationships.

Private corporations also have a major commercial stake in accessing and mining this data. Cellular tower connections, when combined with GPS, wi-fi and other signals represent a powerful dataset that can be used for behavioural profiling and targeted advertising. Passive location services that operate without any clear indication or visibility to users have been particularly contentious [6]. Where users' personal data is gathered, processed and shared between organisations without their knowledge or consent, these privacy questions are closely intertwined with ***data protection*** issues. These scenarios highlight the fundamentally asymmetrical distribution of privacy rights around smartphones. In order to use applications and access services, phone users must enter privately-owned networks which require them to surrender their personal data and consent to varying degrees of monitoring. While users are increasingly transparent to such monitoring, the organisations doing the monitoring are increasingly opaque and protected by a shield of privacy [1].

Smartphones have specific technical vulnerabilities which throw up a number of ***security*** issues. The very nature of wireless radio signals, and their technical properties, makes smartphone communication data vulnerable to interception. Default levels of encryption of transmitted data are relatively weak in both smartphones devices and in the mobile communications network as a whole. Smartphones themselves are particularly susceptible to malware distributed via insecure applications or software updates. Unauthorised access through such malware can be used to read private data, make a phone pretend to power off while remaining on, or activate its sensors and functions (such as the microphone, camera or GPS) in order to monitor the phone's location or immediate environment.

As with many technical threats in the computing field, the ethical issues revolve principally around the *response* to those threats, the adequacy of such responses, and underlying issues raised around responsibility and trust. While security is a key ethical principle and a fundamental right, it is also itself a contested discourse. Tensions exist between users' wishes and demands for appropriate protection and security measures, on the one hand, and corporate priorities around cost on the other. Security is also a commodity that can be exploited economically, invoked to protect certain interests, or used to serve particular agendas and override other legitimate rights, such as privacy and anonymity [39].

Moor's notion of the "invisibility factor" inherent in computer technologies remains as pertinent as ever when thinking about smartphone ethics [24]. The fact that smartphone operations are, to most users, hidden from view, raises some important issues around ***transparency***. Entranced as we are by the seductive, tactile interface of the smartphone, most of us do not fully know how all of its applications and location-based features work. Smartphone technologies, like many ICTs, are "blackboxed," their inner workings opaque to non-technical users. They announce their whereabouts, and they collect and process data, in ways that are invisible to their users. As smartphones become increasingly intelligent, working autonomously in the background, predicting and making decisions on the user's behalf, this is likely to become even more the case.

Many of the systems that run on smartphones are "closed", not reprogrammable and updated remotely by the manufacturers themselves. Access to the underlying code, even in apparently "open source" programs, is partially restricted. 3rd party apps which are developed for Android or iOS are carefully vetted and screened, and can often only be distributed from a manufacturer-maintained online store. Most smartphone devices are deliberately designed to prevent access to their inner physical workings through the gluing together or encasing of key internal components. This makes them difficult to disassemble and repair.

Some have argued that these features result in "tethered", appliance-like devices which can only be modified on the manufacturer's terms, curtailing the ability to customize, and thereby suppressing innovation and generativity [42]. Compared to desktops and laptops, smartphones give the user much less ***control*** and ***autonomy***. The net result is a device where it is more difficult to replace the operating system, harder to investigate malware attacks, harder to remove or replace undesirable bundled software, more difficult to prevent 3rd parties from monitoring how the device is used and harder to block ads embedded in mobile apps through anti-advertising technology [6]. These issues touch on many of the core principles of the Free and Open Source Software (FOSS) movement and cross over into issues of intellectual property rights.

The status of the "user" in phone design, in the business strategies of network operators, and in regulatory frameworks, is another contested area. Key issues here are the extent to which users are involved in design decisions by manufacturers, or consulted in decisions about policy and regulation. Design assumptions are often based on anecdotal evidence rather than structured engagement with intended users [43]. Here too, major tensions exist between the agendas of phone manufacturers and network operators, on the one hand, and users, on the other, struggling for fairer and cheaper charges, more control over their data, enhanced security, and clearly understandable privacy policies and permission requests. Users struggle against being locked into misleading service contracts in which subscribers are routinely overcharged, resulting in unused capacity for calls and data, and thus surplus profits to network operators. These struggles are manifested, for example, in online campaigns by users to get manufacturers to install "kill switches" on devices to enable data to be erased remotely from stolen phones [6]. They can be seen in struggles around the right to unlock phones from being tethered to a single network, or to "jailbreak" them by obtaining access to their underlying programs and file structures.

The smartphone raises a whole gamut of issues around ***equality***, ***fairness*** and ***inclusion*** at each point in its lifecycle. The rapid diffusion of mobile telephony in developing countries has undoubtedly democratised communication due partly to the proliferation of used and affordable phones, and the lower infrastructural costs of maintaining a cellular tower to serve a whole area compared to laying landline cables into individual households [22]. Examples abound of mobile telephony being used to disseminate public health information, provide access to education, financial services and market information for small businesses [43]. However, it remains unclear to what extent these processes have narrowed the digital divide, or mitigated the disparities in Internet connectivity and access to digital resources, globally.

In those countries with relatively high smartphone adoption rates, it is also unclear what benefits they have brought to those users historically excluded from ICTs, or whether they have simply resulted in new forms of exclusion. With smaller screens and keyboards, and slower connections compared to desktop-based, wired, broadband computing, some have argued that smartphones represent a cheaper, 2nd tier of access. Smartphone-based paradigms of computing are less conducive to creating content, and unsuited to many forms of computer-based productive work [43]. There are questions marks too around the extent to which smartphones have benefitted the elderly, or groups with impaired cognitive, sensory and physical abilities. This raises design issues around the usability of touch-screen interfaces, and the navigability and accessibility of displays and input functions.

Equality issues also arise at both ends of the smartphone's supply chain around the human cost of raw materials extraction, manufacturing and recycling. Where these processes are carried out under hazardous, exploitative or inhumane conditions, or where they serve to exacerbate conflict and suffering, there are serious humanitarian issues involved.

Finally, there are ***environmental*** issues at each point in the smartphone's lifecycle. Many of the chemicals, elements and materials contained in smartphones and their components are either finite, toxic, carcinogenic, or all three. Where the extraction of such materials results in mineral depletion, toxic waste or large spoil heaps, there are issues of sustainability and environmental harm [25][26]. In terms of the smartphone's carbon footprint, most of its energy consumption and CO_2 emissions occur in its manufacturing and usage. Mobile-to-mobile calls use three times more power than landline-to-landline calls [7]. For a single smartphone, the energy used to transmit calls across a wireless network over a 1 year period, is equivalent to three times the CO_2 emissions involved in its manufacture [43]. At the disposal end of the lifecycle, unregulated recycling also poses hazards to both workers and to the environment through the handling of toxic waste, and its accumulation in dumps and landfills.

4. SMARTPHONE LAWS AND REGULATIONS

The law is an important touchstone for both prospective and existing IT professionals. Knowledge of the relevant legislation in any given issue is a crucial part of computer ethics, as is legal compliance in the evaluation of solutions to particular dilemmas. Like areas of new and emerging technologies, however, there is a relative lack of legal and regulatory frameworks governing smartphones per se. The law, with its comparatively gradual pace of legislative debate and enactment, is generally behind the curve of innovation in smartphone technology.

Most countries have government bodies that regulate the telecommunications sector, for example the FCC in the USA, and OFCOM in the UK. In the UK, there is statutory legislation that prohibits the use of hand-held mobile devices while driving in the form of a 2003 amendment to the *The Road Vehicles (Construction and Use) Regulations.* The existing legislation that pertains to smartphones is focussed around data protection, intellectual property, electronic waste, and the sourcing of conflicting materials. Regarding intellectual property, there have been significant legal disputes about corporate control of patented elements of smartphone technology, and the rights to exploit

these, most notably between Apple and Samsung. The collection, treatment and recycling of phones is regulated by the EU's *Waste Electrical and Electronic Equipment* (WEE) directive, 2002/2012. The USA's *Dodd–Frank Wall Street Reform and Consumer Protection Act*, 2010 obliges companies to disclose conflict minerals from the eastern Congo in their supply chains, and to remove illegally mined minerals from them. The EU's *Privacy and Electronic Communications* of 2002 extended the EU's *Data Protection Directive* of 1995 to include prohibition of unsolicited texts and messages distributed to mobile phones. In the area of privacy, UK government proposals under the *Investigatory Powers Bill* 2015 would require mobile operators to log their customers' call data, and provide government access to that data.

While legal compliance is an important benchmark of professional practice, on its own, it is an insufficient guarantor of ethical design, implementation or use of smartphone technologies. The law has a number of limitations, around issues of jurisdiction, enforcement and effectiveness that need to be explored. The applicability of EU data protection legislation to US-owned global corporations doing business in Europe remains an ongoing point of legal contention, with Google and others lobbying for EU privacy laws to be relaxed. Existing data protection principles enshrined in the 1995 EU data protection framework are put to the test by smartphone data, particularly around informed consent, disclosure to 3rd parties and data retention. Much of the data that flows through, and is stored on, smartphones, and associated cloud services, could rightly be considered "sensitive" given that it represents user's thoughts, habits, locations and movements. Laws are not necessarily ethical, nor are they politically or economically neutral. Some laws are weighted in favour of users' rights, while others tend to protect the vested interests of private corporations or those of the state. Laws can also be circumvented and loopholes exploited, be they regulations on recycling or hardware disposal, or reporting on environmental impacts. Phone manufacturers and networks, for example, attempted to delay and weaken *The Dodd Frank Ac*t through their corporate lobbyists and trade associations. Laws and regulatory frameworks therefore need to be critically scrutinized, and the issues that they raise explored. Some ethical issues, it needs to be acknowledged, cannot and perhaps should not, be solved necessarily by statutory or regulatory interventions.

5. DOING THE RIGHT THING: SMARTPHONES AND PROFESSIONAL PRACTICE

The approach outlined in this paper is grounded in an *applied* definition of ethics, one which considers the ethical issues raised by ICTs with a view to informing practice and illuminating potential solutions to those issues. A key aim of this task is therefore to look at the implications of the preceding three stages for professional practice. The end goal of the analysis, in this sense, is the practitioner moment. First and foremost, this involves looking at the codes of conduct of relevant professional bodies, and to what extent their standards of practice are applicable to practitioners in the smartphone domain. How can professional responsibilities be balanced with the rights of different stakeholders, with budgetary and time constraints, considerations of technical feasibility, functionality and aesthetics, and with all the drivers and forces which impinge on individual practitioners? This difficult balancing act needs to be explored, while simultaneously acknowledging some of the limitations of professional codes of conduct in resolving the social and ethical issues raised above.

It is useful, at this point, to widen the notion of ethical responsibility beyond questions to do with *individual* professionals, to those which have implications for *organisations*, be they private corporations or government agencies. This means scrutinising the codes of practice and mission statements of companies operating in the smartphone industry. To what extent do their actions and deeds measure up to their public statements and policies, particularly in areas such as environmental impact, privacy and transparency? To what extent are organisations transparent about their operations, whether government agencies about their monitoring and surveillance practices, or phone manufacturers about their supply chains and their environmental impacts? Audits of the latter reveal that most are not living up to their claims, while disclosures about the former reveal a major lack of transparency and independent governance [25][26][7]. Where public pronouncements about ethical goals are not fulfilled or contradicted by factual evidence, companies run the risk of courting unwelcome public scrutiny, boycotts and legal action, resulting in reputational damage and potential loss of business.

Important as it is to identify cases where ethical principles are threatened, whether by unethical design, production or use of ICTs, ethical analysis also needs to provide a vision of what "good" looks like in practical terms. It is important, in this sense, to propose solutions and alternatives, and to imagine how things might be different. How can smartphones be designed in ways that *affirm* principles of privacy, autonomy, transparency and inclusion? How might these principles be embedded in the development process and translated into procedures that can be followed by programmers and engineers in real-life projects? Answering these questions is beyond the scope of this paper, but I'd like to conclude by offering some pointers and concrete examples of how these principles should, and indeed already have, been put into practice.

User-centricity has been repeatedly affirmed as a key principle that should inform the entire ICT development lifecycle, from requirements gathering to evaluation and testing. Value-sensitive design entails the involvement of key stakeholders and prospective users in the design process from the outset [9]. These approaches provide a way of incorporating principles of autonomy and transparency into each stage of the development lifecycle. ICT development, in this sense, should not just be the result of technology "push," but also participation and involvement of users and the broader communities of which they are a part [30].

Principles of sustainability and environmental protection should be implemented throughout the smartphone lifecycle, commencing with the use of alternative raw materials in product design and manufacturing. This also implies the sustainable use and recycling of *existing* materials in order to mitigate the depletion of non-renewable resources. It means green procurement of components which don't use toxic chemicals and materials, and which in turn don't require extraction of rare earths which involve toxic waste or the use of conflict materials. Principles of sustainability might also entail using alternative, organic or bio-degradable casing materials, exploring alternative sources of battery power, or battery-less phones which derive their power from radio signals or solar energy, or which harvest energy from physical movement in everyday human activities though new types of fabric [12]. Reducing the environmental burden

throughout the supply chain also means regulated, transparent and clean disposal and recycling.

Overall, this implies moving away from paradigms of ICT design which are founded on disposability, built-in obsolescence and the upgrade culture of "fast tech" towards new kinds of "slow tech" design which are "clean", "good" "fair" and "open" [30]. "Fair" in terms of ensuring that working conditions throughout the supply chain are humane and non-exploitative; "good" in helping people find an appropriate balance between work time, free time and leisure; "open" through innovation and development founded on openly defined standards and architectures which others can adapt and freely improve upon; "slow" in terms of slowing down the ICT lifecycle and turnover of devices through a greater focus on modular products which enable components, rather than whole devices, to be replaced, and a greater emphasis on repair and re-use. Such models are also "responsible" not only through greater accountability and transparency in the innovation lifecycle, but also through greater public participation and engagement, and more interaction between innovators and end-users, [39]. The following examples provide some brief glimpses of these principles in practice.

Social enterprise smartphone manufacturer *Fairphone* is founded on transparency about its business operations, and uses supply chains that aim to be free of conflict materials. The production of its first smartphone was financed through online crowd-funding [8]. *Modular* smartphones are designed to be upgradable through the insertion of small plug-and-play modules into a smartphone shell. These enable functionality to be added, removed or adapted according to use or context, such as wi-fi connectivity, large screens, cameras, speakers and processors. Examples of modular phones include *phonebloks* [3] and prototypes developed by Google's Advanced Technology and Projects division [11]. *Privacy-enhancing* features that are built into smartphones can provide different levels of privacy and security for different services, and greater protection against rogue apps. These give users greater control over permission requests at both install and run-time, along with the ability to block access to certain phone functions, location services or personal data. Google's "Apps Ops", for example, was designed to be incorporated into its Android M software and allows users to pick and choose which data and functions apps have access to, on a case-by-case basis [13]. Security smartphones, such as the *Quasar IV* cipherphone use self-authenticated verification, bio-metrics and asymmetric strong encryption to safeguard users' digital identity [32]. Online services such as the wiki-based website *iFixit*, allow users to create, edit and share repair manuals for smartphones. *iFixit* uses teardowns and reverse engineering to openly share technical knowledge amongst smartphone users [17]. Finally, local social enterprises, such as the London-based *Restart Project*, focus on extending the lifespan of smartphones through repair and resilience. *Restart* promotes a waste-nothing "circular economy" and encourages people to use their electronic devices longer, by sharing repair and maintenance skills [33].

6. CONCLUSION

This paper has outlined a revised framework for ICT ethics teaching, and illustrated this framework by applying it to the smartphone. This approach consists of four stages of analysis, each driven by a particular set of key questions, which, when combined, provide a holistic multi-dimensional framework, that can be applied to ICTs across their lifecycle. As mobile computing becomes more ubiquitous, intelligent and embedded in everyday life, so its ethical implications cannot be fully grasped within the confines of any single discipline. Phenomena such as smartphones cross over the standard topics and ethical theories used in many existing computer ethics frameworks. This paper points to the potential value of an inter-disciplinary approach which draws on varied theoretical tools with different explanatory strengths, enabling new connections and insights to be generated across disciplinary boundaries. From a teaching perspective, the framework outlined in this paper provides students with a flexible methodology for doing ethics themselves, and a means to explore the ethical issues raised by *any* ICT, in any domain or topic area of interest. This paper suggests that the evaluation of ethical courses of action and potential solutions can be enriched when founded on a deeper understanding of the social and economic contexts in which ICTs are designed, implemented and used. On this basis, the framework has potential relevance not only to students and teachers of ICT ethics, but also to practitioners. How smartphones develop in the future remains to be seen, but the trajectory of that development is by no means pre-fixed or given. The direction of travel lies partly in the hands of our students as prospective future professionals. This approach is a reminder to them, and to us, that how ICTs are designed, made and used, are fluid and mouldable. They are not set in stone, but subject to change and up for grabs.

7. REFERENCES

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