Preparing IT Professionals of the Future

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Abstract. *The underlying aim that should be instilled in future IT professionals is to deliver fit-for-purpose systems which accommodate recipients' needs rather than recipients having to adapt to systems. Those entering the IT profession today are faced with a plethora of application areas using a vast array of technological armoury. The responsibilities of young IT professionals and their obligations to society are onerous. Yet it is uncertain how well they are prepared for such challenges and whether they have been educated to understand that they are the custodians of the most powerful and flexible technology mankind has invented. This paper discusses the type of challenge to be faced; the practical tools that might be used in addressing such challenges and the style of educational preparation that could be used. The aim is to provide the stimulus to rethink the manner in which we should prepare IT professionals of the future.*

Keywords: Ethics, Experiential Learning, IT Professionals, Professional Responsibility

1. Introduction and motivation

J. Lyons & Co. was renowned throughout the UK for its fine teas and cakes which were mainly sold through its chain of more than two hundred high street cafés. In 1951, it built and programmed its own computer, LEO which was used to manage the daily restocking of the Lyons tea shops [Ferry, 2003]. It was the first computer to be used for business data processing. In many respects this commercialisation of computing heralded the beginning of the IT profession which today spans the world in terms of application reach and social impact.

As a young graduate, I entered the IT profession in 1972. It was well established as a vital corporate resource but it was still a back-office function. Fast forward to 2014 and we find that IT pervades almost every human activity. It no longer is restricted to scientific or commercial endeavour that typified the era in which I joined the profession. It is a far cry from 63 years ago and the age of LEO. Those entering the IT profession today are faced with a plethora of application areas using a vast array of technological armoury. Not only that but IT has been democratised to the extent that many applications are built by non-IT

professionals. The responsibilities of young IT professionals and their obligations to society are onerous. Yet it is uncertain how well they are prepared for such challenges and whether they have been educated to understand that they are the custodians of the most powerful and flexible technology mankind has invented.

The commercialisation of IT is not without its problems. To see IT as a powerful corporate resource simply to facilitate the prosperity of the organisation is wrong. Unfortunately this perspective is commonplace. For example, the *2012 Cost of Cyber Crime Study* published by the Ponemon Institute [p24, 2012] uses two separate cost streams to measure the total cybercrime cost for each participating organisation. These streams relate to internal security-related activities and the external consequences experienced by organisations after suffering an attack. The report fails to recognise the societal cost of cybercrime in terms of society at large or individuals directly or indirectly affected. A second example concerns SAS, a leader in business analytics software and services, and the largest independent vendor in the business intelligence market. On its website [SAS, 2014] it states, “and big data may be as important to business – and society – as the Internet has become. Why? More data may lead to more accurate analyses. More accurate analyses may lead to more confident decision making. And better decisions can mean greater operational efficiencies, cost reductions and reduced risk.” Again the focus is very much on commercial wellbeing with only a passing remark about society. These two examples are indicative of the sort of emphasis given to IT potential or worth. There appears to be imbalance in this emphasis.

However, there are some hopeful signs of a more balanced view being adopted by some. Here are just two examples. The winner of the 2012 Australian Government ICT Young Professional of the Year Award, Christopher Giffard from the Department of Education, Employment and Workplace Relations, was quoted as saying in his acceptance speech, “It is my hope that the award will draw attention to the importance of accessibility and standards on the web, both for multimedia and for general web content, and the obligation that our industry has to ensure equal access for all Australians to information services and technology”[ACS, 2012]. In India, the Al-Ameen Movement helps in the education of the young in the socially and economically deprived sections of the society in the region of Bangalore. As part of this, the Al-Ameen Institute of Information Studies prepares the youth of today to become future IT professionals. Its Principal explains, “Students are entrusted to our care for integrated development which includes technical, moral, physical and spiritual development, besides imparting knowledge in their disciplines. We at Al-Ameen nurture them … to develop into confident, proactive and ethical young IT professionals ready to take up the corporate challenges in the international arena.” [AISS]

This paper discusses the type of challenge to be faced; the practical tools that might be used in addressing such challenges and the style of educational preparation that could be used. The aim is to provide the stimulus to rethink the manner in which we should prepare IT professionals of the future.

2 Issues to address

The underlying aim that should be instilled in future IT professionals is to deliver fit-for-purpose systems which accommodate recipients' needs rather than recipients having to adapt to systems. They should be encouraged to move away from the traditional view of 'one solution fits all' to the view that 'one solution is no solution'. Rights, justice, care and empathy should pervade practice. The IT environment should be considered through two lenses; relationships and timeframes. This will have an impact on the manner in which IT is developed and implemented as illustrated by the Big Data example at the end of this section.

IT Relationship Trinity

The first lens is a high level issue which focuses on the actual delivery of IT. The identification, development and use of IT occur within a set of interrelated entities. These entities can be categorised into vendor of both hardware and software; developer of both infrastructure and application; and recipient both direct and indirect. Direct recipients comprise clients and users whilst indirect recipients comprise individuals, the general public and society as a whole. Relationships exist between these entities and are defined as a relationship trinity as shown in Figure 1. If the trinity operates effectively then the likelihood of acceptable IT is increased. The IT relationship trinity will both be affected by and affect organisational culture, business strategy and societal norms. Relationships will be two-way between vendor and developer, developer and recipient, and recipient and vendor.

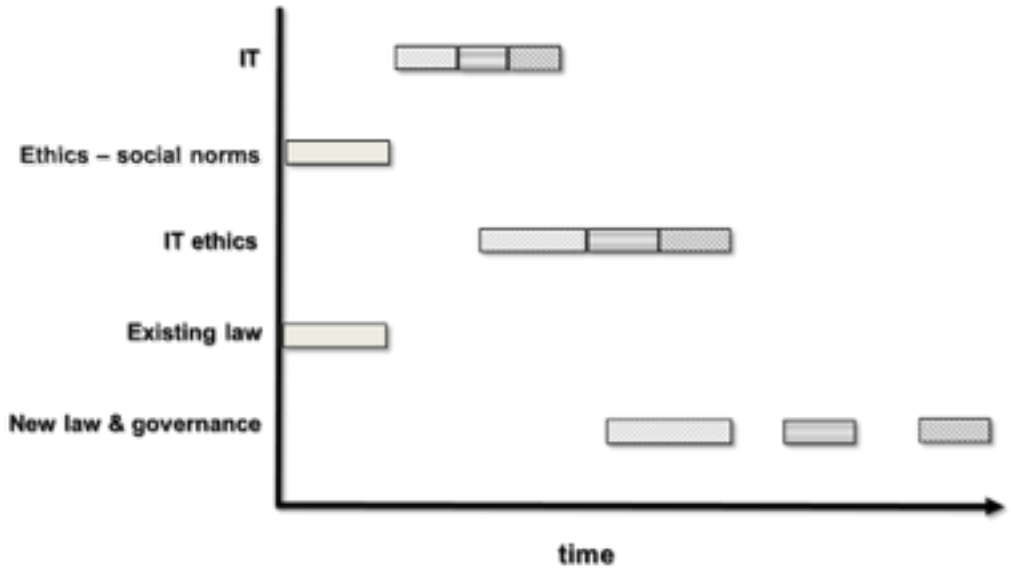

Figure 1
The IT Relationship Trinity

Trust across the IT relationship trinity is paramount. Smith [2011]explains that trust is a social relationship where 'A' trusts 'B' to do 'C. 'A' will only trust 'B' if 'A' believes 'B' to be trustworthy with respect to 'C' and for 'B' to be trustworthy requires that 'B' has both the competence and the motivation to satisfy the requirements of 'C'. Smith further suggests that trust is relational in nature and this implies that trustworthiness is but one component of a larger social relationship of trust between actors. For example, in the delivery of application software running under a graphical user interface operating system (GUI-OS), the user recipient will only trust a vendor if the recipient believes that the vendor is trustworthy with respect to GUI-OS and for the vendor to be trustworthy requires that the vendor has both the competence and the motivation to satisfy the requirements of providing a robust GUI-OS. Similarly, the recipient will only trust a developer if the recipient believes that the developer is trustworthy with respect to the application and for the developer to be trustworthy requires that the developer has both the competence and the motivation to specify and produce acceptable application software. Therefore in the larger social relationship of trust, a recipient may distrust a vendor or developer because either competence or motivation or both are lacking to deliver this new software but at the same time might trust the same vendor or developer regarding ongoing maintenance of existing software because both competence and motivation are present.

It is important that future IT professionals understand the trustworthy nature of the IT relationship trinity. This becomes increasingly important the more pervasive IT becomes. It is simply wrong to instruct future IT professionals in technological subjects alone in isolation of the complex social structure in which systems design, development and operation exist.

Timelines

The second lens is a high level issue which concerns the respective timelines associated with evolving IT. This is illustrated in Figure 2. The horizontal axis represents time and the vertical axis has five separate, though interrelated, timelines.

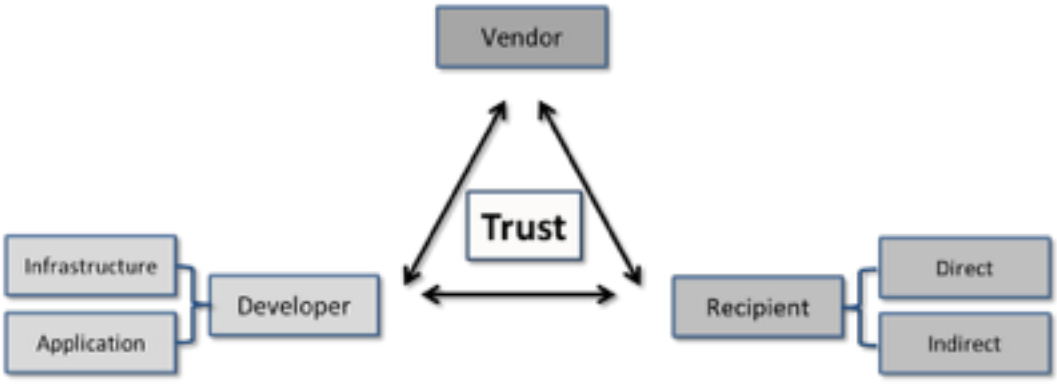

Figure 2
Respective Timelines

In the beginning there exist ethics and social norms which people subscribe to. These might change over time, but very slowly. There is existing law which provides a practical perspective of such ethics and social norms. A piece of IT is developed over a short period of time as shown in the IT timeline. This timeline has three elements representing the evolution of the piece of IT through three generations. Typically, the ethical implications of the piece of IT only come to light after the first generation is implemented. The ethical consideration continues but at slower pace than the technological evolution as illustrated in Figure 2. Indeed, it could be by the time that this consideration is concluded the IT has passed through 2 further generations. It may be that the IT requires a new or amended law or governance regulation. This legal consideration takes considerable time to bring new laws onto the statute book and for these to become operational as shown in Figure 2. By the time the law is in place the third generation IT may be well established operationally. From this discussion, it can be seen that there is a serious misalignment of timescales. As such, the piece of IT is operating for a considerable period in an IT policy vacuum. This will always be the case with evolving IT for ethical consideration will lag behind technological development and the provision of appropriate law or governance will lag even further behind. This is why there will always be a challenge for IT professionals in delivering acceptable IT. Furthermore, it is why the appropriate, balanced preparation of future IT professionals is paramount.

The advent of Big Data

Returning to 1951 and the first business data processing system, it is clear that the data collected and generated was localised, impersonal and unlikely to be shared with other systems, be they mechanised or manual. By 1972, the world had changed. Business data processing systems were commonplace. Data relating to people was being processed and generated. Systems were sharing data within single organisations. Transfer of data across organisations was limited but did exist. Concerns began to be voiced as personal data collection increased and relationships were established between data which was collected for very different purposes. These concerns grew as data was now accessible not only offline but also online. This prompted the Organisation for Economic Cooperation and Development (OECD) to publish its *Recommendations of the Council Concerning Guidelines Governing the Protection of Privacy and Trans-Border Flows of Personal Data* on 23 September 1980. Those concerned about the ethical issues surrounding the use of IT were similarly moved to publish. For example, Mason [1986] published his seminal paper in which he stated the four ethical issues of the information age: privacy, accuracy, property and accessibility (PAPA). It was not until 24 October 1995 that the European Parliament issued Directive 95/46/EC *on the protection of individuals with regard to the processing of personal data and on the free movement of such data*. “The UK Government was required to implement this Directive which it did in the form of the Data Protection Act 1998. It came into force on 1 March 2000 although some provisions did not commence until October 2007.” [The Data Protection Society].

This account illustrates the misalignment of timelines. The business data processing systems had evolved through many generations before growing

ethical concerns eventually prompted legislation to be drawn up. It took many years for this legislation to be implemented in practice. During this period of concern which lasted in the region of 15-20 years the only thing individuals had to rely on was the trustworthiness of the IT relationship trinity and there were many instances where the trinity was perceived as being untrustworthy.

There has been yet another technological shift in data processing in recent years. This is now known as Big Data. Big Data is data which is too large, complex and dynamic for any conventional data tools to capture, store, manage and analyse [WIPRO]. According to Laney [2001] Big Data is defined by three attributes; volume in terms of the large amounts of data, velocity in terms of the need to analyse large amounts of data quickly and variety in terms of the vast range of structured and unstructured data types. To illustrate this it has been estimated [ASIGA] that everyday businesses and consumers together create 2.5 quintillion bytes of data. Each month 30 billion pieces of content are added to Facebook. Each day 2 billion videos are watched on YouTube. By 2015, 3 billion people will be online sharing 8 zettabytes (8 by 10^21) of data. There have been growing ethical concerns about Big Data. For example, Matzner [2014] argues that the vast array and variety of data coupled with new data mining and knowledge discovery techniques create new types of privacy invasion and indeed challenges the very notion of privacy. If this is so then the current and proposed approaches to personal data protection are likely to be inappropriate.

On 25 January 2012, the European Commission unveiled a draft *European General Data Protection Regulation* that will supersede the Data Protection Directive. Will this address the ethical issues surrounding Big Data – probably not. Even if it does, how long will it take for this to be implemented - probably many years based on the previous data protection legislation track record and by that time technology will have morphed yet again. Alexander Solzhenitsyn [1969] wrote, “As every [wo]man goes through life, [s]he fills in a number of forms for the record, each containing a number of questions. There are thus hundreds of little threads radiating from each [wo]man, millions of threads in all. If these threads were suddenly to become visible, people would lose all ability to move.” It would seem his words have come true with the advent of Big Data.

3. Toolset for practical IT ethics

IT is a practical endeavour which is supported by many design and development tools. If the ethical dimension is to be taken into account through every step of design and development, and ultimately in implementation and operation then this consideration must either be embedded in existing tools or new tools produced which are compatible with existing technologically-oriented tools. For nearly 20 years I have been involved in the development of a toolset for practitioners. In many instances this has been in collaboration with professional bodies such as BCS and IMIS in the UK, ACM and IEEE-CS in the US and ACS in Australia. A set of five tools are very briefly described here, of

which three are then discussed in the next section as part of the experiential learning approach put forward as a way to prepare future IT professionals.

Product-Process (see Rogerson, 2010) The decision-development-delivery cycle of IT is surrounded by complex interrelated ethical and social issues. These need to be addressed during the IT process and embedded within the IT product. Process concerns the activities of ICT professionals when undertaking research, development and service/product delivery. The aim is for professionals to be virtuous in Aristotelian terms. In other words a professional knows that an action is the right thing to do in the circumstances and does it for the right motive. Product concerns the outcome of professional ICT endeavour and the potential impact of these products on people, society and the environment. The ethics focus of the product perspective is technological integrity from, for example, a Kantian or utilitarian perspective. This can be addressed by embedding ethics within ICT products themselves. This tool provides a simple framework to consider issues from the two perspectives.

DIODE (see Harris et al, 2011) DIODE is a structured meta-methodology for the ethical assessment of new and emerging technologies. There are two different angles for the ethical assessment of new technologies: a strategic/abstract angle and a project/application specific angle. DIODE includes two channels to accommodate this distinction. DIODE comprises five components: Define questions; Issues analysis; Options evaluation; Decision determination; and Explanations dissemination. Without training and guidance, it is difficult for technologists to take ethical concerns into account during the development and deployment of new technologies. DIODE can provide that training and guidance through a practical meta-methodology which should help IT professionals, policy makers and academics.

SoDIS (see Gotterbarn and Rogerson, 2005) Limiting the focus of risk analysis to quantifiable factors and using a narrow understanding of the scope of a software project are major contributors to significant software failures. The Software Development Impact Statement (SoDIS) process extends the concept of software risk in three ways; it moves beyond the limited approach of schedule, budget, and function; it adds qualitative elements; and it recognizes project stakeholders beyond those considered in typical risk analysis. It is a proactive feed-forward approach which enables the identification of risks in the manner in which IT is developed (Process) and IT itself (Product).

Professional code of ethics (see http://www.acm.org/about/se-code) Every IT professional body has a code of conduct. The Software Engineering Code of Ethics and Professional Practice of ACM and IEEE-CS in partnership has international standing having been translated in many languages and adopted by many professional bodies worldwide. It provides a practical perspective within its preamble and principles. The preamble states, “These Principles should influence software engineers to consider broadly who is affected by their work; to examine if they and their colleagues are treating other human beings with due respect; to consider how the public, if reasonably well informed, would view their decisions; to analyse how the least empowered will be affected by their decisions; and to consider whether their acts would be judged worthy of the ideal professional working as a software engineer. In all these judgments

concern for the health, safety and welfare of the public is primary; that is, the 'Public Interest' is central to this Code."

Dependencies Mapping (see Rogerson, Wilford and Fairweather, 2013) This is a method comprising a lexicon, a diagramming tool, relationship tables and structured commentaries. A dependencies map provides a structured way for knowledge of ethical issues to be identified and organised. Dependencies maps go beyond stakeholder relationships by covering multiple types of entities (such as processes and artefacts), and multiple types of relationships. Dependencies mapping is undertaken without the constraints of a pre-defined lens such a stakeholder, data or operation. A dependencies mapping tool can be utilised to raise awareness about the many external influences and impacts resulting from the development and use of IT.

4. Experiential learning for Computer Science and Software Engineering undergraduates

There is an expectation by computer science and software engineering undergraduates that they will be instructed in the theories, methodologies and application of IT. They are usually unaware and therefore have no expectation that their university education must include the ethical and societal context within which IT exists. These technologically-oriented students have a resonance with experiential learning. Consequently, any attempt to expose them to ethical and societal perspectives of IT is more likely to succeed if a varied diet of experiential learning is provided (see, for example Essendal and Rogerson, 2011). As Benjamin Franklin once wrote, "Tell me and I forget, show me and I remember, involve me and I understand." Quite simply, academic philosophers delivering lectures about the nuances of ethical theory is inappropriate and indeed is likely to strengthen the barriers behind which purist technologists will defend their technological ideology. In this section a series of experiential learning examples is discussed. These have been used and subsequently honed over many years to provide appropriate instruction for IT professionals of the future. The opportunity to participate in an active rather than passive manner leads to an experiential journey of maturity from tutor-led activities to student-led activities. Through this process, the IT professionals of the future are more likely to gain the necessary skills and knowledge to act in a socially responsible manner not on the basis of instinct and anecdote but on rigour and justification.

Exercise using Product-Product

In the public domain there are many *Invitation to Tender* documents (ITT) relating to IT. This provides a rich resource of real world requirements for IT solutions. Using the Product-Process approach students, in small teams, are asked to analyse the specification of requirements included in a given ITT. The task is defined as:

- Read the specification in the ITTs
- In groups, discuss the potential ethical issues
- Split these issues into Process and Product

- Complete the Ethics Checklist form
- Present your findings to the cohort as an outline of the system followed by the identified Process and Product issues

This exercise gives students the opportunity to investigate current IT requirements which enables them to place their studies in the context of the real world. This consideration, through an ethical lens, encourages them to look beyond the technical. The requirement to present their small team's findings to the complete student cohort helps them to focus and firm up their thoughts on the identified ethical issues. This is a good way to experience for the first time an ethical analysis of an IT solution at its onset. The tutor can tease out general themes based on ethical theory out of the findings thereby providing the students with some insight of conceptual underpinnings.

SoDIS Project Auditor laboratory

SoDIS has been translated into a software decision support tool called SoDIS Project Auditor (SPA) (available at http://www.softimp.com.au/sodis/spa.html). Students use SPA in a computer laboratory over several weeks. For these laboratory sessions a fictitious company called CHEMCO has been created. Chemco produces polyester and alkyd resins, gelcoats and conventional and inverse water based polymers from four manufacturing sites. It has decided to build a new manufacturing plant in Midtown and this will be operated using a new production control system called PRO-CHEM. (see http://www.ccsr.cse.dmu.ac.uk/staff/Srog/teaching/info3402/Chemco2/index.htm)

SPA computer laboratories of up to 16 students split into teams of three or four are held to investigate PRO-CHEM.There are three phases to this extended activity as follows:

- Case Start-up Session where the objectives are: to review the CHEMCO company; to introduce the requirements of the new production control system; to identify the stakeholders of the system; and to initialise the SoDIS analysis.
- PRO-CHEM SoDIS Analysis Sessions where the objectives are: to undertake a SoDIS analysis for an allocated stakeholder subset of PRO-CHEM; and to produce a comprehensive data set in preparation for distillation.
- Case Outcome Preparation where the objectives are: to review the SoDIS analysis for an allocated stakeholder subset of PRO-CHEM; to identify the main concerns about PRO-CHEM; and to prepare a presentation of findings for the Board of Directors.

This extended activity gives students the opportunity to analyse thoroughly, from an ethics perspective, a system development project in its initial stage. Using a software tool in a computer laboratory to undertake this work places students in a familiar setting albeit the task itself is very different. SPA structures their discussions and they experience a dichotomy of opinions as to what is acceptable and unacceptable in terms of the proposed system. The final output is a board-level report through which they experience the challenge of distilling a large amount of detailed analysis which combines ethics and technology into

a succinct report that is accessible to a board of directors many of whom are likely to have little technical knowledge and experience.

Exercise using the Software Engineering Code of Ethics and Professional Practice

This exercise is undertaken in a large group setting on an individual basis. Students are given a case study of a system which has been developed and implemented. The case focusses on the ongoing operation of the system and provides details of the experience of users and the manner in which IT personnel respond to users, maintaining and modifying the system as a result. The case study has some obvious and some obscure issues within it. The student task is structured as follows:

- Use the Software Engineering Code of Ethics and Professional Practice to consider the case study.
- Did anyone violate any of the ethical principles in the code? If so, was the violation justified? Why do you say so?
- What "policy vacuum" does the case reveal that could be filled by adding a new principle to the code?
- How could that new principle be stated and justified?

The exercise concludes with a large group discussion of the students' findings. This is an opportunity for students to experience the value of a code of ethics if used proactively. The tutor summarises the session through offering a simple checklist in the form of five ethics-grounded questions (shown in parentheses) as follows:

- Who is affected by your work? (Utilitarian)
- Are others being treated with respect? (Kantian)
- How would the public view your decisions? (Publicity test)
- How will the least empowered be affected? (Rawlsian)
- Are your acts worthy of the model computing professional? (Virtue ethics)

Finally the tutor points out that a code of ethics provides a practical justification for action and offers a framework within which to structure professional work.

Student-led activities

Conventionally, student-led activities take place in small group sessions such as tutorials. The SPA computer laboratories and ethics analysis of case studies (see, for example, Bynum and Rogerson, 2004, Chapter 3) are indicative of this. Large group student-led activities offer a different experience. A variety of approaches can be adopted such as break-out activities, periods of reflection, topic presentations and formal debates (Essendal and Rogerson, 2011), two of which are outlined here.

- Topic presentations: The culmination of a module on IT Ethics is a student-led seminar for which students organise, chair and present papers. A typical range of presentation topics taken from previous seminars is: How to prevent children from accessing unsuitable content; Engaging older, handicapped and other excluded people in ICT; Examples of real situations of professional responsibility; Software with Adware is ethical or unethical?; and New media – forms and reliability of information.
- Formal debates: This provides students with the opportunity to develop their critical thinking, to increase their ability to defend ideas, to improve their communication skills and to be tolerant of the arguments of others. Typical motions used in previous student-led debates are: "This house believes it is acceptable to force on-line services on those who prefer off-line interaction with government or who are technophobes" (Utilitarian focussed debate); "This house supports the development of assistive technologies that exceed human abilities" (Aristotelian focussed debate); and "This house believes it is unnecessary to consider cultural diversity in generalised ICT products and services in order to promote ICT acceptance and effectiveness" (Kantian focussed debate)

5. Conclusion

Based on my experience of the many students I have had the privilege to teach, I believe IT professionals of the future do care about the impact they will have on society. I have had former students contact me about whistleblowing on unethical practice and about how the ethics element of their degree education has helped them to shape their professional lives.

However there are problems that need to be addressed and resolved. Too many IT professionals hide in technological clouds seemingly indifferent to the ethically charged nature of IT. It is unclear whether this is through lack of awareness or a belief such issues are outside their scope of responsibility. Today we have the wherewithal to build fit-for-purpose ethically sound systems by design but I worry that it still happens more by accident.

In the past from the 1980s onwards, progress was made in ensuring the ethical dimension of IT was considered in education, research, government and industry. Sadly today there is a sense of going backwards. It is important to find out why this is so. Perhaps it is because there are not so many headline grabbing IT failures in the media these days. Perhaps it is because the excitement of IT ethics as a frontier has gone as ethics has moved more into the mainstream. Perhaps it is because of the sophistication of new technologies which increases transparency and makes it even harder to comprehend the potential issues. Perhaps it is because ethics has been politicised through target setting and the demand for tick-box compliance. Perhaps it is because public bodies, professional bodies and universities seem to place less emphasis on

ethical issues. Perhaps it is because there is a growing silo-mentality in the delivery of ethics education at the expense of a transdisciplinary approach.

It is for these reasons that we need to educate our future generations of IT professionals in a way that gives them practical skills to address the complex ethical and societal issues which surround evolving and emerging IT. I firmly believe such education should be based on a varied diet of participative experiential learning delivered by those who have a practical understanding of the design, development and delivery of IT. It is for all in the IT profession to rise to this challenge and safeguard not only the IT profession but also society at large.

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Biography

Simon Rogerson is Professor Emeritus in Computer Ethics and former Director of the Centre for Computing and Social Responsibility at De Montfort University, UK. Following a successful industrial career where he held managerial posts in the computer field, he now combines research, lecturing and consultancy in the management, organisational and ethical aspects of ICT. He gave up his fulltime post in September 2010 and now works part time. He has published over 300 academic papers and written 6 books. He conceived and co-directed the ETHICOMP conference series from 1995 to 2013. He received the 2000 IFIP Namur Award for outstanding contribution to the creation of awareness of the social implications of ICT. In 2005 he became the first non-American to be given the prestigious SIGCAS Making a Difference Award by the ACM. He is a Vice President and former Chairman of the Institute for the Management of Information Systems. He is editor of the Journal of Information, Communication & Ethics in Society. He is a Fellow of BCS, The Chartered Institute of IT; a Fellow of Institute for the Management of Information Systems; and a Fellow of Royal Society for the encouragement of Arts, Manufactures and Commerce.