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Guest Contribution

The paper below was given as an invited address by Prof Roode at the July 1992 Conference of the South African Computer Lecturers' Association. (Editor)

The Ideology, Struggle and Liberation of Information Systems

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In 1989, Denning *et al* presented the final report of the Task Force on the Core of Computer Science in an article entitled "Computing as a Discipline" [3]. This was said to present a new intellectual framework for the discipline of computing and proposed a new basis for computing curricula.

In the words of the authors, "an image of a technology-based discipline is projected whose fundamentals are in mathematics and engineering." Algorithms are represented as the most basic objects of concern and programming and hardware design as the primary activities. Although there is wide consensus that computer science encompasses far more than programming, the persistent emphasis on programming "arises from the long-standing belief that programming languages are excellent vehicles for gaining access to the rest of the field" [3].

The new framework sets out to present the intellectual substance of the field in a new way, and uses three paradigms to provide a context for the discipline of computing. These paradigms are *theory*, rooted in mathematics; *abstraction*, rooted in the experimental scientific method and *design*, with its roots in engineering.

Programming, the report recommends, should still be a part of the core curriculum and programming languages should be seen and used as vehicles for gaining access to important aspects of computing.

The following short definition is offered of the discipline of computing [3]:

The discipline of computing is the systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation, and application. The fundamental question underlying all of computing is, "*What can be (efficiently) automated?*"

In the same issue of Communications, tucked away towards the end of the journal, an article by Banville and Landry asked the innocent question "Can the Field of MIS be disciplined?" [1]. It is not clear whether the use of the word "discipline" in both articles was purely coincidental – however, the implications were quite clear: computer science was able to talk about "computing as a discipline," and indeed, could present a report which, in a sense, was a culmination of more than twenty years' efforts. Yet, its sister discipline was still asking questions of a very introverted

nature about itself.

It has become quite clear that the fields (leaving aside for the moment the questions of "disciplines") of computer science and information systems (or MIS, informatics, or whatever other name we want to attach to it) have different aims and objectives, different problems that confront it, and, yes, if we want to be truly scientific, different paradigms. To support the latter statement, it is sufficient to contrast the three paradigms of computing with the four paradigms of information systems development described by Hirschheim and Klein [5]. It can be said that a central activity in information systems is the development of information systems, and that therefore, these paradigms have implications for the field of information systems. The four paradigms can be characterized briefly, as follows:

- The analyst as systems expert
- The analyst as facilitator
- The analyst as labour partisan
- The analyst as emancipator or social therapist.

In the same spirit, Lyytinen sees the "systems development process as an instrument in organizational change" [6] and remarks that analysts' principal problems are "in understanding the goals and contents of such change instead of solving technical problems." Already in 1987 Boland [2] observed that: "designing an information system is a moral problem because it puts one party, the designer, in the position of imposing an order on the world of another."

This is clearly a far cry from Denning *et al's* statement that the fundamental question is "what can be automated?" At the same time, within the context of the field of computing, there is nothing wrong with this question, and it is probably the right question for practitioners of computing to continually ask themselves. But it is a disastrous question for a practitioner of informatics to ask. And it has taken us quite a long time to realise this – that the two disciplines have fundamentally different roles to play. These roles are complementary and supportive, and not destructively opposed.

The liberation of information systems lies in realising this elemental truth: that information systems are man-made objects designed to effect organisational change and that, as such, they can ill be studied using the paradigms of abstraction and engineering mentioned above.

What then is needed? Banville and Landry offer the consolation that we need not concern ourselves too much about the lack of discipline, and that we can indeed even pride ourselves in being a fragmented adhococracy. It is, in fact, even healthy to continue in all sorts of directions. During this process of finding itself, a discipline should be allowed a considerable degree of latitude, and many avenues should be explored. This obviously makes the field of information systems extremely exciting: it is in the process of discovering remarkable truths, discovering that there are in reality people out there using the systems which analysts design and build, and that the most intriguing problems centre around the role of people in all of this: the analyst, the user, their interaction, the impact of systems on the work lives of workers on all levels, the impact on organizations. These are questions which have mostly been ignored or lightly treated over the years, but which have emerged as *the* problems to be solved. We do not have the tools to solve them – not yet; but a good starting point would certainly be to first understand more about our field and its research tools, for the empirical, positivistic approach so often employed will not suffice to solve the above problems.

In the spirit of contributing to the liberation movement of information systems, we have embarked on a study of research on research in Information Systems, and will report on the results more fully in the near future. We define Information Systems as follows [4]:

Information Systems is an inter-disciplinary field of scholarly inquiry, where information, information systems and the integration thereof with the organisation is studied in order to increase the effectiveness and efficiency of the total system (of technology, people, organisation and society).

In Information Systems then, we see the fundamental question underlying the entire discipline, to be the problem of balancing the need to contribute, through information sys-

tems, to the achievement of the mission of the organisation with the moral responsibility to develop and implement socially accepted information systems.

Each of the fields, computer science and information systems, benefits enormously from the activities of the other. Nonetheless, we must recognize the different approaches used by the two disciplines and allow them to complement each other. It should not be our business to convince one another that the universal truth is that which we use in our discipline – whether that be computer science or information systems. Instead, we should seek out the opportunities for synergy, and for complementing each other. If we succeed in doing this at SACLA, then we could indeed do ourselves proud.

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Editor's Notes: To Compete or Collaborate

Human interaction invariably brings with it a blend of competition and collaboration. Competition means that one enjoys the exhilaration of winning while the other endures the shame of loosing. Because of this reward/punishment mechanism, it is a widely assumed that competition enhances performance and efficiency. This dogma pervades not only commerce, sport and politics, but is found in practically all areas of human endeavour, including research.

The competitive spirit in research is found in the well-known saga of Watson and Crick racing to unravel the double helix structure of DNA. Not so well-known, though equally illustrative, is the intensity of Newton's stratagems to oust Leibnitz from receiving any credit for differentiation. Recently there have been reports of scientists who have either tolerated or manufactured fraudulent results in order to win some or other scientific race. The space race,

the arms race, the race for an AIDS cure, the scurry for faster smaller hardware, the race for awards, the drive for publications, Nobel prizes: all of this attests to a profoundly competitive international research culture.

But while competition might be the handmaiden of commerce and sport, it is the harlot of research – an unfortunate concomitant of the silly side of human nature. The archetypal researcher not only rises above the incidentals of human accolades; he disdains them. By tradition, the definitive research qualification is a PhD – a Doctor of Philosophy – a lover of thought. Discovery and thought are not only by their very nature rewarding, they are also humbling. When the archetypal researcher moves outside his interior thought-world, it is to share his discoveries. If he is childish, it is not the little boy flexing his biceps and saying: "I'm stronger than you" but the child rushing to

tell everyone: "Wow – look at this!" He is forgetful of self: Pythagoras, oblivious of the invading enemy and his impending death while he researches in the sand; Archimedes shouting "Eureka" without care for his nudity. The competitive spirit is a crass intrusion into this ancient legacy of innocence and selflessness.

By its nature, collaboration thrives in a climate of easy social intercourse. It may initially feel uncomfortable for researchers, who are inclined to be socially inept and are wont to bury themselves in work away from society. However, once the plunge to collaborate is taken there is ample evidence that it leads to successful research. In maximizing the use of available talent, it brings about a synergy in which two heads are better than one. All participants enjoy its rewards and no individual has to endure the full weight of its failures. In fact, the notion of collaboration is now so commonplace that significant research seems impossible without it. The tendency, however, is to encourage research collaboration within an organisation, but to emphasize competition in relation to outside organisations.

During a forum discussion at the July South African Computer Lecturers' Association (SACLA) conference, an appeal was made for greater collaboration between universities. Not surprisingly, the information technology disciplines at local universities have always had both a competitive and a collaborative relationship. The competitiveness usually takes the form of friendly rivalry, while the very existence of SACLA bears testimony to a rather unique collaborative relationship. In latter years the competitiveness seems to have intensified, while electronic mail and other developments have improved the prospects for collaboration. At issue, then, is whether there is an imbalance between these dual forces. The appeal at the SACLA forum implied that there is, and I would strongly agree. It is my

view (my prejudice, if you will) that competition between universities is a self-indulgent and wasteful dissipation of energy.

Those who are inclined to compete should seriously examine what is to be gained. It is unconvincing to argue that winning makes a significant impact on the way in which students select universities: in the main, this is a matter of geography and language preference. To some extent, the same might be said about staff, although research reputation perhaps plays a more important role here. Neither are research funding agencies (e.g. the FRD) influenced by whether X is "better" in some or other sense than Y. On the contrary, it has wisely been decided to fund on the basis of criteria that are believed to be objective, without any reference whatsoever to the performance of competitors. True enough, funds are limited, but it is precisely for this reason that it is wasteful to divide the little there is between divergent research efforts.

It seems to me that there is a wealth of research talent out there, but that each researcher selects an area of interest almost as a matter of whim. There is an urgent need for well-coordinated collaboration on focussed research areas that have been carefully selected as directly relevant to the country. It is especially incumbent on those who finance, manage and lead research to identify such areas and to encourage collaboration in every possible way.

I look forward to the manifestation of such collaboration in SACJ publications authored by researchers from different university departments. To date there have been none of consequence. If we fail to collaborate, we are in danger of becoming little Don Quixotes who spend our lives attacking windmills and defending castles of xenophobia and irrelevance.

Social Responsibility for Computing Professionals and Students

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Abstract

In our desire for technical excellence, an appreciation of the human factors of computing is often overlooked. This paper proposes that the social and ethical implications of computers need to be understood by computer professionals and hence should be included in undergraduate computing courses. University computing courses tend to produce graduates who are technically competent yet who have had little exposure to the psychological, sociological and philosophical issues of computing. A recent South African survey supports this observation.

There are a wide variety of topics about which we should be aware and a list of these is discussed along with a justification of why and how such topics could be scheduled in already crowded computing courses. It is recommended that students of computing encounter such topics both implicitly (incorporated into existing subjects) and explicitly (in a separate subject specifically addressing this topic). Further details and a brief literature review are presented.

Keywords: University computing curricula, social impact of computing, computer ethics, professional responsibility.

Computing Review Categories: K.4.2, K.3.2

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1 Introduction

Computers are supposed to be tools which help people and organisations to achieve their goals. The rapid advances in computing technology force us to constantly consider the effects such technological change have on the human context. Successful computing system must be used within a social context to meet some human need and those who design and implement such systems will fail in their task unless this is taking into account.

Furthermore, educators of computing professionals are constantly forced to reconsider the structure of the courses offered by our schools and universities. In reconsiderations of course structures it is easy to be driven purely by the technological issues and to lose sight of the human effects of that technology. This paper calls us back to examine the importance of these human effects and of our responsibility to teach social and ethical issues to our students.

The results of a survey of current South African university computing courses is presented. After some comments on this survey I list a range of human effects of which computing professionals and students should be aware, and discuss how such topics could be scheduled in already crowded university syllabi.

2 Survey

During March 1992 a survey was sent to all departments of computer-related disciplines throughout South Africa¹. This survey sought to establish three things:

1. How many computing lecturers and researchers hold computer ethics and the social impact of computing as areas of interest;
2. The range of topics covered in these areas in undergraduate courses, and the type of reference material used; and
3. The proportion of students who are being exposed to these topics.

Of the 23 departments surveyed an encouraging 19 responded. In five of these responses the department shows no activity in this area, and in another five the interest is minimal (typically only two lectures to first-year students). The remaining nine responses indicated that computer ethics and social impact were given more serious attention by their department.

Assuming that the survey responses are representative of the total South African situation, the following observations and conclusions may be made:

¹See Appendix.

Interest by academic staff

Roughly thirty lecturers/researchers see this as an area of interest. As a rough estimation this might amount to 16% of the total number of computer-related academics in SA. However, this interest rarely finds any place in research.

The exception to this is that three postgraduates in the University of Pretoria's Department of Informatics are completing theses which address social and ethical issues (one Masters and two Doctorates).

Coverage in undergraduate courses

Topics Covered

The most common topics presented to students were identified as:

- Privacy: the integrity and ethical use of personal information stored on computer
- The broad social effects of computing
- Professional responsibility (often including discussion of various Codes of Ethics)
- Computer-related crime
- Copyright and software piracy

Topics mentioned by at least two departments were:

- Employment displacement
- The possibility of humans becoming redundant
- The 'user-friendliness' of the computer-human interface
- Gender
- Impact on South Africa
- Reliability and the risks of over-reliance

Other topics mentioned included:

- The environment
- Personality effects
- Free will
- Organisational impact
- Economic effects
- Quality of life
- What is 'progress'?

Reference Material

Three departments used Chapter 18 (Security, Privacy and Ethics) in Capron's "Computers: Tools for an information age", and two others used Goldschlager and Lister's "Introduction to Computer Science".

Also mentioned were the books:

- "Computer Science: an algorithmic approach" (Tremblay and Bunt)
- "Principles of information systems for management" (Ahituv and Neumann)
- "The Information Technology Revolution" (T.Forester)
- "Computer Security" (C.Pfleeger)

and the articles:

- "Four ethical issues of the information age" (Mason)
- "The terrors of technostress" (McPartlin)
- "Deterring computer crime" (Rosenblatt)
- "Ethics in an information age" (Spiro)
- The ACM Code of Ethics
- Newsletters of the Computer Professionals for Social Responsibility

Student exposure

Ten responses indicated that at least the majority of first year students were exposed to these topics. Two departments include them in second and third year courses and three departments cover them in Honours modules.

Very roughly one could say that students in a third of South Africa's university computing departments are taught these topics in substantial detail; another third receive a cursory coverage (maybe two hours) at first year level; and the remaining third receive virtually no exposure to these topics.

3 The Importance of Teaching Social Responsibility

In response to the survey one must ask whether the current emphasis (or lack of emphasis) is adequate. Are these topics significant enough to take up time in syllabi which are already bulging beyond capacity?

It is disappointing that so many of our graduates are technically competent yet virtually unaware of broader, non-technical aspects of the computing discipline. (This is also the case with other technical disciplines: it is a travesty that mathematicians can graduate without ever looking at the history, foundations and limitations of maths and that scientists can graduate without ever being exposed to the rich debates in philosophy of science.) If someone is being trained as a technician, then such technical competence is adequate; but our university degrees should be characterised by more than correct technical content.

How can anyone be a responsible computer professional if they have never asked themselves "What is the human need for which computers are the solution?", "What social cost do we pay to gain the benefits of computing?", "How can computing systems be designed and implemented so as to maximise their beneficial effects and minimise their detrimental ones?", etc? Forester and Morrison write:

If computer professionals wish to be accorded the status (and not just the money) of other professionals, then their social awareness and ethical values must be upgraded substantially [13, p169].

Computing educators should not merely be in the business of training technicians. They should be producing articulate information technologists – technologists endowed with communication skills, 'people skills' and possessing an appreciation of the social and ethical implications of information technology. They must prepare people for the messy real world, not the tidy, imaginary one inside a VDT screen. They therefore have a duty to stimulate discussion about these issues and to generate awareness of the choices available to us [13, p7].

Forester and Morrison are not the only ones concerned at the lack of emphasis on social awareness and responsibility in the computer world: similar quotes can be found throughout the growing literature on ethics in the informa-

tion age.

The ACM/IEEE Joint Curriculum Task Force comments that

Undergraduates also need to understand the basic cultural, social, legal and ethical issues inherent in the discipline of computing. They should understand where the discipline has been, where it is, and where it is heading. They should also understand their individual roles in the process, as well as appreciating the philosophical questions, technical problems, and aesthetic values that play an important part in the development of the discipline [3, p11].

Computing technology has created new problems for society, not the least of which being the psychological trauma of rapid change. New legal issues, new crimes and new methods of crime prevention, new work environments (even a new work ethic), new modes of communication, new possibilities for education, and new approaches to warfare have all arisen from the creative application of computer technology.

We cannot be blind to the fact that the technology we design and propagate has broad and deep influences on our personal and social existence: 'broad' in that all people and all aspects of life are affected and 'deep' because the changes cut right to the core of our existence. It is insufficient to propagate technology without taking account of the human context in which that technology will be used. This 'human context' includes the physical and psychological abilities of individual users, the worldview within which people interpret their self-identity, the social structures within which computer users relate to each other (the work environment, education, political, health and welfare systems), and our interaction with the ecosystem. Thus, computer professionals should not avoid mixing technique with psychology, sociology and philosophy.

4 Content

There is a wide range of topics in what can broadly be seen as the 'human factors'² of computing and a wealth of reference material on which to draw. This section outlines a range of important issues which should be discussed by computing professionals and to which computing students should be exposed. These are grouped under the headings 'Psychology', 'Sociology' and 'Philosophy': a reasonable categorisation, at least as a first pass.

Psychology

Hardware and software ergonomics

The direct effect of computers on humans happens at the point of interface between an individual person and an individual computer. There is much to discuss about this

²The term 'human factors' in some circles only denotes the ergonomic issues of the interface between one computer and one user, but I am using it in its broadest sense. 'Human factors' includes everything to do with the human context in which computers are used: the dynamic system involving computer technology, individuals, organisations and societies.

interface and frequent conferences on Computer-Human Interaction (CHI) which focus on this aspect.

At an introductory level, one can discuss the colloquial idea of 'user-friendliness' and question whether people should become 'computer-literate' or whether machines should become 'human-literate'. People have some task to perform and use a computer as a tool to help achieve that task. How can hardware and software be designed to be of maximal 'help'?

This, of course, simply opens the questions which can then be answered in full technical detail: keyboard layout, monochrome vs colour screens, repetitive strain injuries, structure of menus, layout of data-entry forms, modelling user knowledge etc.

Dehumanisation

People's reactions to computers range from excitement to fear. Why do so many feel dehumanised by computing systems? Is it simply that computers are impersonal? Is it the threat of job redundancy? Is it the sense of powerlessness in the face of a computer which reputedly never makes a mistake? What can be done about this computer-phobia? Is it just a matter of educating people?

Coping with change

All change carries with it a cost. Adjusting to new technology is psychologically traumatic and humans have never before been required to adjust so often or so radically as they have had to in the past 40 years. Why is such adjustment hard? Can we continue to cope with such rapid change? How can new technology be introduced in less traumatising ways?

Sociology

Crime

Computers have given rise to a new range of crimes, a new type of criminal (the rise of white-collar crime) and new forms of criminal investigation. Is it true that reported computer crime is only the tip of the iceberg?

Work and leisure

The use of computers in the workplace has radically changed work practices: some job categories have been made redundant and others invented; many people have the opportunity of working from home; more people now work in service industries than either agriculture or manufacturing; automation and specialisation replace craftsmanship etc. How can workers be involved in the design and implementation of the technology which will so drastically affect their employment?

Most social commentators claim that we have entered a second industrial revolution and should properly call ourselves a 'post-industrial society'. Hours of work, the rate at which people change jobs and patterns of unemployment have changed in such a way that the 'Protestant work-ethic' no longer makes sense.

Closely associated with changing work patterns is a changing attitude to leisure and the associated growth of the whole leisure industry.

Legal issues

US law courts are full of copyright and patent infringement suits. Whether the 'look and feel' of a software package can be protected from copying is still an open question. Software piracy and options for software protection should be examined. Terms such as software licensing, public domain, freeware and shareware should be defined.

When a computing system makes a mistake, who is legally responsible?

Privacy

There is a growing suspicion about the integrity of personal information stored on computer. Should it be possible for governments or commercial organisations to use and distribute personal information arbitrarily? What happens if incorrect information is recorded? Several countries have Data Protection or Freedom of Information Acts (but not South Africa!).

Risks

What are the risks of replacing human decision making with computers? What accidents or near accidents have been caused (or avoided) by computers? How can computer systems be designed to minimise such risks, especially in life-critical situations?

One of the large areas of risk is the role of computers in modern warfare. Battle management, military intelligence, smart weaponry, communications and cryptography all rely heavily on computers, and one must wonder at the benefits of such reliance.

Professional responsibility

What responsibility should computing professionals take for the systems they propagate? What moral guidelines could give direction in the murky crystal-ball of new technology? An examination of Codes of Ethics (such as the ACM's) is a useful starting point.

Education

Computer-based instruction could revolutionise education by increasing the focus on informal, self-directed learning. This creates many possibilities for education of children, but will also be important for adults as the changes in work opportunities cause an increase in the need for re-training.

Gender

Whereas one could build a case for discrimination between men and women in physically demanding jobs, it is not possible to do so with more intellectual pursuits such as computing. Nevertheless, computing technology does seem to be more accessible to men and hence reinforces male dominance. Why is this the case, and how can the role of women in computing (in both education and industry) be recognised and encouraged?

Effects which are specific to South Africa

Of particular importance is an analysis of how computers can be used to alleviate some of the problems facing South

Africa. How does technology fit into a first-world/third-world society? Can computers be distributed to schools to make up for the shortage of teachers? Is it practical to spend large amounts on computer controlled equipment to improve our low manufacturing productivity?

Philosophy

Theories of mind

Recent developments in Philosophy of Mind have emphasised that the brain is just a complicated machine and hence that there is no theoretical reason why human intelligence could not be replicated on a computer. This assumption of the mind-as-machine has not only set the AI research agenda, but has also changed our understanding of humanness.

University AI courses are typically oriented towards weak-AI (the idea that we can get computers to behave in clever and useful ways) and hence they focus on AI techniques. I believe we should also spend time examining strong-AI (the claim that computers can have minds) and to discuss how (if at all) humans differ from computers.

If a purely deterministic computer can be made to replicate human intelligence, is human free-will an illusion? If a computer becomes intelligent will it be a morally responsible agent and hence prosecutable by law? What will be left for humans to do if computers can take over decision-making as they have taken over physical work and tasks requiring calculations? Do we *want* to build intelligent computers?

Progress

The concept of 'progress' is dynamic rather than static and our whole belief in technological solutions for human problems stems from a particular set of ideological commitments. Why does our society place so much trust in progress? Does technological advancement necessarily constitute progress? What is the source of our high-consumption 'new is better' mentality?

Other Approaches

The list above is not exhaustive (for instance environmental issues could also be covered) and my categorisation is suggestive rather than prescriptive. Various other structures have been suggested.

The ACM/IEEE Joint Curriculum Task Force recommends that all syllabi for computing³ degrees contain a Knowledge Unit on Social, Ethical and Professional Issues. This Knowledge Unit has four components (Historical and Social Context of Computing, Responsibilities of the Computing Professional, Risks and Liabilities, and Intellectual Property) [3, pp 68-71].

In departments more properly related to Information Systems than to Computer Science, one expects to see a greater emphasis on non-technical issues. The ACM's most recent recommendations for courses in information

³The Task Force aimed to cover computer science, computer science and engineering, computer engineering and informatics, but not information systems [3, p2]

systems lists six categories of 'output qualifications': people, models, systems, computers, organisations and society [1, p481]. Some of the areas proposed in this current paper fit into the 'society' category, while others fall into 'people' and 'organisations'. Although the Recommendations have no explicit module covering social and ethical issues, it is clear that their importance is implicit throughout the syllabus. In the earlier (1972/73) guidelines for a one-year *post*-graduate course, one of the eight modules is "Social Implications of Information Systems" [3, p31, see also pp22,53]

5 Scheduling in Academic Courses

It is most probable that departments of computing in all universities are finding that each year their courses need restructuring due to the rapid changes in technology and employer expectations. The breadth of the computing field and the depth of coverage necessary already mean that difficult choices must be made about which topics to include in a three year major and which to leave out. Does one teach a second course in systems analysis or is an understanding of artificial intelligence techniques now more important? Do we still need a detailed numerical methods course or is time better spent on C, UNIX and object-oriented programming? Can a module on graphics be squeezed in? In the not-too-distance future it will become necessary for the Computer Science/Information Systems split to be taken further, perhaps having distinct majors in Software Engineering, Database and Commercial Systems, User Interfaces, and AI.

Is it *possible* to schedule time to cover social and ethical issues?

It may seem that social and ethical issues must be given low priority, but the reverse is true. It is precisely because computing is such a rapidly changing field that a basic grounding in non-technical issues is as crucial for the successful graduate as the technical issues. If they are trained solely in what is at best a subset of the current technical issues then their knowledge will be soon out of date. (That of course is why teaching software engineering principles is more important than teaching any particular language.) The sort of topics discussed in this paper give the student a context in which to evaluate technological change, and foster their ability to be critically engaged in the process rather than swept along (or swept aside) by 'progress'.

Salami or Chubby-Bunny

The central question in scheduling human factors into a computing course is whether to slice the topics up and spread them throughout the syllabus (the salami approach) or to squeeze them all into one separate module (the chubby-bunny approach⁴).

The former option has the advantage of showing stu-

⁴Named after that rather foolish but nevertheless entertaining game where one must squash as many marshmallows into one's mouth at once, while still being able to say "chubby-bunny".

dents that human issues are an integrated part of the discipline and exposes them to the varied approaches of different lecturers. There are some topics which can easily be slipped into existing courses in this way. For instance, the ergonomics issues mentioned in the section "Hardware and software ergonomics" naturally fit into a module on user-interface design; user participation in the design process (section "Work and leisure") can be emphasised in Systems Analysis modules; and philosophy of mind could find a place in AI modules.

The ACM/IEEE Task Force follows this salami approach. It has detailed twelve possible curricula in which the Knowledge Unit on Social, Ethical and Professional Issues is sliced up and distributed in a variety of ways [3, pp 79-154]. In each case the topic takes a total of eleven lecture hours.

However, given the pressure of technical content, lecturers may often squeeze the human issues into a corner so small that in practice the students never bring the topic into focus. In contrast, the option of presenting a separate module makes it clear to students and staff that human issues are a significant component and allows the students' understanding to be easily examined.

At UNP we run a thirteen lecture module called "Social Implications" which constitutes a sixth of Computer Literacy (a first year course for Arts and Social Science students). Our first year courses for Science and Commerce students do not contain this module, but get a brief coverage following Chapter 18 of Capron [8]. Science and Commerce students may choose a 25 lecture topic called "Human Factors in Computing" at Honours level.

It would be my suggestion that all students doing a full first-year course in computing (those leading to a major as well as service course) should spend 7-10% of their effort on human effects. Students undertaking majors in computing should hear human factors mentioned in a variety of contexts throughout the syllabus, including a module which explicitly focuses on issues such as those listed in Section 4.

6 Comments on Available Resources

Computing Curricula 1991: report of the ACM/IEEE Joint Curriculum Task Force [3] is available from both ACM and IEEE. It covers goals and design principles of computing curricula as well as giving a number of detailed course descriptions. See especially pages 11 and 68-71 on Social, Ethical and Professional Issues.

The ACM Curricula Recommendations for Information Systems, Volume II [1] was published in 1983. See page 32 for extra references.

The ACM has recently updated its *Code of Ethics* [2]. A very useful exercise for students is to work through the *Self Assessment Procedure XXII* [27] which poses a number of ethical scenarios based on the earlier Code of Ethics.

Computer Professionals for Social Responsibility does not have a South African chapter at this stage, but can be contacted at Box 717, Palo Alto, CA, 94302-0717, USA.

Apart from their quarterly newsletter they have produced a number of books and papers including *Computers and Social Responsibility: a collection of course syllabi*.

Tom Forester has edited several collections of magazine articles and book extracts which provide a rich set of readings for students. The most relevant of these collections is *The Information Technology Revolution* [12] and *Computers in the Human Context* [13]. His book, *Computer Ethics: cautionary tales and ethical dilemmas in computing* (co-authored with Perry Morrison) [14], is quite useful as a prescribed text. The hypothetical case-studies at the close of each chapter provide excellent material for class discussions. Footnotes provide further references (see especially page 8).

Raymond Kurzweil's *The Age of Intelligent Machines* [18] is a very glossy but nevertheless well detailed book. It is a wide ranging book containing a lot of original material along with quotes and extracts from other AI and futurist gurus, and in which a lot of semi-technical information is balanced with dreams of future social possibilities.

Chris Rowe's *People and Chips* [24] has some useful chapters, including good discussion on our changing work ethic and on privacy.

Sherry Turkle studied people's relationships with computers (half of them adults and half primary aged) and makes many fascinating and insightful observations in *The Second Self: computers and the human spirit* [26]. An extract from this book is included in *The Information Technology Revolution* (see above).

On how and why users should be included in the design of computing systems, see *Designing Participatively* by Enid Mumford [21]. This book gives a concise introduction to principles along with an extended case study.

A series of lectures by David Lyons was published as *The Silicon Society* [19]. If one is interested in an explicitly Christian analysis of the social impact of computers, this is a light book to start with. Other thought-provoking Christian examinations of computing include *The Invasion of the Computer Culture* by Allen Emerson and Cheryl Forbes [10], Donald MacKay's *The Clockwork Image* [20] and *Christians and the World of Computers: professional & social excellence in the computer world* by Parker Rossman and Richard Kirby [23].

On computer risks, the world guru is Peter Neumann who moderates the comp.risks bulletin board on the Internet and contributes regularly to the *Inside RISKS* column in the *Communications of the ACM*. Alas, he hasn't yet finished his book.

On current legal battles, see the Law Review column in IEEE Software. A number of other useful books are listed in the bibliography.

7 Conclusion

This paper has proposed that all computing professionals should be acquainted with the social and ethical implications of their discipline and hence that courses in computing at South African universities should include an emphasis

on a the human factors of computing.

In some cases this emphasis can be included in existing subjects: for instance Systems Analysis modules could include socio-technical issues such as Enid Mumford's work on Participatory Design; Design and Programming modules could examine the psychological issues which affect the choice of user-interface; Artificial Intelligence modules could cover not just AI techniques but also some of the major debates in the philosophy underlying strong-AI. Further, all full year service courses and certainly all sequences leading to a computing major should include a module which explicitly addresses the social impact of computing.

Many resources exist for computing professionals who wish to explore the various topics mentioned and for lecturers who wish to design courses in this area.

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Appendix A Survey of South African University Interest in Social and Ethical Issues

1. Within your university's computing department, how many staff members consider the issues of computer ethics and the social impact of computing as a major interest?
2. What research does the department do in this field?
3. Are you aware of other departments within your university who are active in this field?
4. To what extent is this field covered in your undergraduate courses? Are there modules which explicitly address this area?
5. With respect to the modules mentioned in Question 4, what topics are covered? (Please include a course outline if one is readily available.)
6. With respect to the modules mentioned in Question 4, what reference material is used?
7. Of all students who study computing for one year or less, what proportion would be exposed to this field? Is this area of study compulsory or optional?
8. Of all students who complete a computing major, what proportion would be exposed to this field? Is this field of study compulsory or optional?

Notes for Contributors

The prime purpose of the journal is to publish original research papers in the fields of Computer Science and Information Systems, as well as shorter technical research papers. However, non-refereed review and exploratory articles of interest to the journal's readers will be considered for publication under sections marked as Communications or Viewpoints. While English is the preferred language of the journal, papers in Afrikaans will also be accepted. Typed manuscripts for review should be submitted in triplicate to the editor.

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 - author's affiliation and address;
 - an abstract of less than 200 words;
 - an appropriate keyword list;
 - a list of relevant Computing Review Categories.
- Tables and figures should be numbered and titled. Figures should be submitted as original line drawings/printouts, and not photocopies.
- References should be listed at the end of the text in alphabetic order of the (first) author's surname, and should be cited in the text in square brackets [1, 2, 3]. References should take the form shown at the end of these notes.

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