ABSTRACT
It is by now widely accepted that social and professional issues are an important part of any computer science curriculum. The approach taken in most social issues courses is to articulate the social impacts of different computer technologies and then apply macro-ethical theories to those impacts. This paper argues that this approach has a number of drawbacks. First, it is based on a technological deterministic style of social explanation that has been in disrepute in the academic social sciences for decades. Second, it uses an algorithmic approach to ethics that simplifies the social complexity and the uncertainty that is the reality of socio-technical change. It concludes by suggesting that the alternative to the ethical evaluation of impacts is to focus the course instead on the social context; that is, on clarifying and unpacking the complexity involved in the relationship between technology and society.

Categories and Subject Descriptors
K.3.2 [Computers and Education]: Computer & Information Science Education – computer science education.

General Terms
Design, Experimentation.

Keywords
CS Education, Computer Ethics, Social Issues, Impacts, Pedagogy.

1. INTRODUCTION
“Students need to be challenged to see the impact of computing from different perspectives, confronted with complexities that they have not considered previously, and engaged in situations having unexpected consequences or undesired behavior” [16]

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Beyond Good and Evil Impacts: Rethinking the Social Issues Components in Our Computing Curricula
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One of the many breakthroughs in the teaching of computer science over the past two decades has been the relatively widespread recognition of the importance of social and professional issues in the education of computing professionals. The 1991 ACM/IEEE computing curricula report argued that students “need to understand the basic cultural, social, legal, and ethical issues inherent in the discipline of computing” [38]. Subsequent ACM curricula reports have maintained this claim. The current CS-2008 assigns sixteen core hours to Social and Professional Issues (SPI): five of those are to ethics, three to the social context of computing, and the remaining hours cover some key issue areas such as privacy, intellectual property, and security. The report also touches on the pedagogy of teaching this material. It recommends “a single required course along with short modules in other courses,” [1] a recommendation that appears to have been widely accepted. A recent survey of American universities found 88% of computer science programs included ethics in their computer science curricula [36]. Another survey that also included non-American universities found a full 95% of their respondents included SPI content in their computer science programs [16]. When one examines the past decade of papers at SIGCSE, ITiCSE, and ICER, while there have by no means been an overwhelming number of papers about the teaching of SPI (only 21 or about 1% of the total), there certainly have been a number of interesting attempts at articulating the best ways of teaching these issues and integrating them into the computer science curriculum [6,7,13,23,25,30,32,33,36].

From the very beginning this concern over social and ethical issues has been dominated by a very specific analytic approach, namely, the articulation of the impacts of information and computing technology (ICT) and the ethical evaluation of those impacts. In the 1991 report, for instance, the authors argued that computing “practitioners must be able to articulate the impact of introducing a given product line to a given environment” [38]. The NSF-funded ImpactCS project [22] of the mid-1990s explicitly continued this focus on social impacts and through its analytic framework and its description of the main SPI content became an important resource for faculty in constructing their SPI courses. More recently, a working group at ITiCSE 2010 expressed concern that many computer science programs were “neglecting broader issues of societal impact” [16]. In each of these examples, the impact approach has a specific goal: the analysis of the outcomes or social practices created or strengthened by the technologies in question.

But the required social and professional issues course has always been about more than just awareness of social implications. A
strong prescriptive element (under the categories of Analytic Tools and Professional Ethics in CS-2008) is required. That is, students are expected to apply existing moral theories to construct guidelines or even rules to correct or prevent the wrongs caused by a particular technology. Examining textbooks or published reports of these courses [2,7,25,31,32], one can see a very particular teaching approach. First provide the students with at least two substantive ethical theories, generally utilitarianism and a Kantian deontology. These two forms of ethical evaluation are then used to evaluate the impacts caused by computer technology in a paradigmatic impact area such as privacy, intellectual property, security, and access to information in order to both articulate and to ethically evaluate the effect various computing technologies have had on those areas.

The appeal of this approach for computer science faculty is not hard to see. It is attractive to us because it is so algorithmic. Most computer science faculty achieved their position through their knowledge and research in traditional computer science topics, and, as a consequence, the SPI course is often not in a computer science professor’s primary knowledge area. As Grodzinsky has noted, the “many gray areas of computer ethics are often frightening … to professors who are worried about how to answer things of which they themselves are unsure.” [17] Not surprisingly then, a clear-cut methodology for teaching this course has in fact been argued [25,32] to be the way to make this course less imposing for computer science faculty; this algorithmic approach is perhaps especially appealing since, as one survey found, the vast majority (84%) of all computer ethics courses are taught by computer science faculty [36].

Despite these attractions, this paper is going to argue that both this algorithmic approach and the understanding of the relationship between society and technology that it is grounded upon has some real limitations and may in fact give our students an impoverished understanding of the social issues of computation. It will argue that the way we teach this course needs to move away from the preoccupation with the ethical evaluation of ICT impacts and instead emphasize the social context aspects of the Social and Professional Issues Knowledge area. In particular, the teaching of this material needs to integrate the decades-old insights of researchers in the philosophy, history, and sociology of technology which emphasizes the complex interaction and co-construction between the social environment and any given technology and the resulting radical uncertainty of technological change.

2. WHAT’S WRONG WITH IMPACTS?
Perhaps the first step in recognizing the shortcomings of the ethical impacts approach is to realize the central flaw in the articulate social impacts step in our SPI courses. This flaw is predicated on what seems an obvious and common-sense belief, namely, the belief that technology is simply a tool available for us to achieve our ends. This belief encourages us to examine computer technology in a means-ends manner: that is, the SPI researcher identifies and observes what affect the means is going to have on the social environment. It generally assumes that the means are by and large clear and unproblematic and will always work in the same way for all people at all times. While the impacts approach sees ICT as a tool, it also sees it as a very special type of tool that can have large-scale impacts on society and/or the people using it. That is, while ICT, like a hammer, is just a tool, its special general-purpose nature means it has far-reaching effects outside its tool domain, akin to a hammer that changes the weather or weakens the dollar every time it strikes a nail. This approach to technology is generally called technological determinism by those who study the history, philosophy, or sociology of technology [26,28]. In this approach, technological change is treated as very much the independent variable in societal change. According to this view (see [4] and [35] for a summary of the debates), technological inventions – especially key ones like the printing press, the steam engine, the computer, the internet, and social networking – have transformed the world and thus new technologies need to be subjected to analysis to understand the wide-ranging transformation they have had on us and the world. Or, in Langdon Winner’s evocative analogy, studying technological impacts is the equivalent of picking ourselves up and carefully measuring the tread marks after the bulldozer has rolled over us. “Such is the impotent mission of technological ‘impact’ assessment” [41].

It is understandable why computer professionals find technological determinism attractive. After all, we are the people that are helping to invent some of these new technologies; it feeds our clear desire to be socially relevant [30] and to believe that we computer geeks are actually the driver of social change, and not politicians, business people, or celebrities. This view is so widespread among computer professionals that, for instance, this author’s students and fellow department members find it difficult to believe that most current historians and sociologists of technology firmly reject technological determinism as being theoretically inconsistent as well as empirically under-supported. As one recent historian has noted, sweeping accounts “about machines that shape society remain popular, but they clash with the research of most professional historians of technology” [26]. The academic field of science, technology and society (STS) studies that began in the 1960s has time and time again found that when examined carefully, most technologies rarely have had the effect that was expected (see, for instance, [27] and [29]) and that the reason for this phenomenon is that “new technologies are shaped by social conditions, prices, traditions, popular attitudes, interest groups, class differences, and government policy” [26]. Notice the direction of agency in this quote: it is technology that is being shaped or impacted by society, not the reverse.

Most technological deterministic impact prognosticators do their work by looking at the functional capabilities of a given technology and then imagining the impact of those functions. For instance, internet search engines clearly make it easier to find knowledge; what then will the impact of increased knowledge? Households technologies make it quicker to do housework; what will be the social impact of all that spare time? Antilock disc brakes make it less likely to skid and get into accidents; what will be the social impact of fewer accidents? In all these cases – and practically any other set of prognostications and impact evaluations than begin from an unquestioned belief that the functional capabilities of a technology (i.e., the means) do what is promised (i.e., achieve their ends) – the expected social impacts ended up being wildly wrong because the prognosticators believed in a naïve technological determinism.

For instance, the introduction of household technology did not end up creating, in the words of Ruth Schwartz Cowan, less work
for mother, but in fact more work because of a series of social changes that could not have been predicted if one limited one’s analysis just to the functional capabilities of the household technologies. As Cowan demonstrated [11], household technologies created more housework due to changing expectations of what constitutes cleanliness (e.g., clothes changed daily instead of weekly), new unexpected technologies enabled by the technology (e.g., wall-to-wall carpets were unknown before vacuums), and the gradual displacement of household work done by external agents (e.g., laundry services, maids, nannies) to housewives partly as a consequence of household technologies and partly due to exogenous changes in the social and economic realm. Similarly, efficient internet search-engines have not resulted in people with too much knowledge; instead, unpredicted changes in how people interact with words (scanning replacing reading) and even possibly cognitive decline due to the brain’s plasticity have arguably resulted in the exact opposite consequence [8,10]. And as is readily apparent to anyone who actually drives an automobile, the introduction of anti-lock disc brakes have not reduced accidents at all, partly because drivers tend to drive faster and tailgate more closely due to the improved braking technology and also partly because of increases in the intensity of traffic due to unexpected changes in urban geography [39].

The first step then we should take in our Social and Professional Issues course is to communicate how rarely technologies achieve their exact promise, and indeed, how many do the opposite. This so-called Revenge Effect is well-documented [37] and yet this author was unable to find it discussed at all in existing computer ethics textbooks or in published accounts of this course. As well, an equally important step we need to make in the teaching of the SPI course is to reject naïve technological determinism and help students understand the complex agency issues in the relationship between technology and society. One way to achieve this goal would be by beginning the SPI course with examples and readings in how certain vital technologies had little impact on some societies, or on how certain technologies were strongly modified and differently adapted in different cultures and countries. This more historically-nuanced (and significantly more empirically accurate) approach is what is generally called social constructivism [4,12,26,27,28,29]. In this approach, one looks at how technologies are researched, invented, financed, developed, adopted, marketed, and propagated within a very complex system generally referred to as society. If one carefully examines a given technology within the social system in which it is embedded, it becomes extremely difficult to maintain a belief in technological determinism. Instead one sees technologies much more strongly “impacted” by society rather than vice versa. Thus, the SPI course should integrate the historically-grounded insights of the STS research community. In other words, the SPI course should look more like a historical sociology course and a lot less like a philosophic ethics course.

3. IMPORTANCE OF UNCERTAINTY

The reason why revenge effects occur is due to the fact that “socio-technological transformation is a highly complex process which involves many uncertainties” [24]. While uncertainty is a key concept in fields like economics, management, medicine, environmental science, and a variety of other disciplines, within moral philosophy in general, and computer ethics in particular, it is underappreciated [40]. This is an important problem because the substantive moral theories (such as deontology and utilitarianism) that are the bedrock of the usual computer ethics course require relatively clear and unambiguous information about effects in order to make judgments [14,15,40]. Typical problems or dilemmas for which macro-ethical approaches are applied are most often done in a context of complete knowledge (if you do action X, then Y people will be harmed, but Z people will be benefited). This is appealing for computer scientists, who often work with problems modeled by idealized abstractions for which complete knowledge is possible. The ethics of technology, by contrast, should be recognized as residing in a context of at least partial uncertainty or ambiguity. Furthermore, the degree of uncertainty is greater for emerging technologies, and the more complex the technology, the more uncertain we are as to the developmental trajectory of a technology [29]. As Collingridge noted in the context of ethically controlling technology, control (i.e., ethical evaluation) is difficult, “and not rarely impossible, because during its early stages, when it can be controlled, not enough can be known about its harmful social consequences to warrant controlling its development; but by the time these consequences are apparent, control has become costly and slow” [9].

There are many places where uncertainty intersects with the lifecycle of a technology. Following Sollie [34], we can visualize this as shown in Figure 1.

![Figure 1. The Uncertainty of Technological Change](image)

For the evaluating agent $x$ (the professor or the student or the developer or the journalist) examining emerging technology $y$ at time $t_1$, the agent must have knowledge of the development trajectory in order to morally evaluate it. Unfortunately, as we have already seen, we very often cannot know the actual development trajectory and if we hypothesize one based purely on its functional capabilities, we more often than not will be woefully wrong. Thus, in reality, we need to recognize that technology $y$ has multiple trajectories ($o_1, o_2, o_3, \ldots$) and that it might be more important to attempt to understand which trajectories are more likely (by unpacking the web of interests and agents) than applying a prescriptive ethical judgment on a single trajectory.

4. BEYOND MORAL EVALUATION

One could argue that while uncertainty may be a feature of many aspects of life, we still manage to make practical and ethical decisions. That is, just because the arc of technological development is uncertain, that doesn’t suddenly excuse us from making moral judgments. While this may be true, the argument
made in this paper is that moral evaluation in the uncertain realm of socio-technological change should perhaps be only tentative at best. That is, the ethical discussion in the SPI course should be purely descriptive ethics. As a consequence, it is this author’s belief that the approach we should be taking in the SPI course is to expose the students to the many levels of uncertainty in the domain of technological evaluation, thereby allowing the students to achieve a level of critical awareness that weaves some ethical analysis into a richer understanding of the complex nature of socio-technological change.

As Brey has noted [5], the main problem with contemporary computer ethics is that the analytic effort is limited to evaluating well-recognized morally-controversial technological practices for which there is a policy or legal vacuum. While not unimportant certainly, the problem here, as discussed previously, is that it either depends on a level of epistemic certainty that may be unwarranted, or it may be evaluating a technological system that is so firmly established that its momentum has moved it beyond the effective reach of moral prescription. Furthermore, it tends to ignore the problems embedded in morally nontransparent computer practices. The alternative approach offered here to the usual macro-ethical evaluation in SPI courses is sometimes referred to as disclosive ethics [5] and is more closely connected to a social constructivist understanding of technology. In this approach, rather than applying big ethical theories to well-known impacts, the focus is on disclosing the assumptions, values, and interests built into the design, implementation, and use of technology [20]. Thus, an alternative way of satisfying the Analytic Tools part of the CS-2008 SPI area would be to focus the SPI course on guiding the students in the unpacking of the normative assumptions of computer practice which in turn requires clarifying the complex web of social interactions that play a role in constructing the different trajectories a technology may take.

This approach is not about providing bright-line tests for evaluating the moral rightness and wrongness of technological practice but about opening up the black box of technological practice for understanding and to interrogate the assumptions, the embedded power relations, and the rhetorical and ideological contexts that we bring to those practices. While this may seem to some an abrogation of moral duty, it is perhaps the path that may end up being ultimately more socially responsible because it exposes our students to a more socially-nuanced understanding of their profession. Looking at the description of the core components in the SPI knowledge area in CS-2008 (and of the hours assigned to each), there is in fact recognition that it is equally important to have students appreciate the social and historical context of computing as it is to ethically evaluate it. We need to return our principal analytic focus in the SPI course back to this social context, and as the epigram that began this paper argued, focus the students’ attention on different perspectives and on the complexities of socio-technological change.

5. CONCLUSION
Computer science has been immeasurably improved by the many dedicated scholars who have worked tirelessly to convince the rest of the field about the importance of social and professional issues. While most computer science programs do include a dedicated SPI course in their curriculum, there is often some anxiety associated with teaching this course due to a perceived lack of the appropriate knowledge by computer science faculty. As a consequence, there has been a convergence on a particular approach to teaching this course: articulate the impacts of different computer technologies and then apply a macro-ethical theory such as utilitarianism or deontology to those impacts. This paper argues that this approach is based on an old-fashioned social theory, namely technological determinism, which is both theoretically unsound and empirically under-supported. Furthermore, this paper also argues that the use of macro-ethical theories is inappropriate for domains in which there is a strong lack of epistemic certainty. Since the field of technological change is indeed characterized by substantial uncertainty, this paper concludes that we need to transform the way we teach the SPI course so that it is more closely allied with the insights of the broader science, technology and society research community.

Doing so would make the SPI course much more focused on explicitly understanding the social contexts of computing and significantly less focused on its ethical evaluation.

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7. REFERENCES