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ETHICAL ANALYSIS OF AUTOMATION: A COMPARISON OF DIFFERENT ETHICAL THEORIES THROUGH CASE STUDIES

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Abstract: This paper briefly presents some of the main theories of ethics and then illustrates their application to a case study of the application of new technology in the form of genetically modified organisms. The case study illustrates the differences between the different ethical theories and the need for a more wide ranging 'multi-criteria' theory of ethics. *Copyright © 2002 IFAC*

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1. INTRODUCTION

The terms ethics and morals are frequently used interchangeably, but it can be useful to distinguish morality as concerned with right and wrong conduct and motives and ethics as the philosophical study of morality (Gluck, 1986). Thus ethics provides a framework in which to study and resolve moral dilemmas (Bennet, 1996; Vesilund, 1998). However, in practice the term ethics is generally used to describe right and wrong conduct and motives in a professional context. As professionals working in the areas of science and technology, scientists and engineers are potentially in a powerful position to shape society. The privileges resulting from professional power also bring ethical responsibilities to society as a whole. Choices about technology involve a wide range of ethical and other issues, relating to whose interests science and technology should serve and the type of future society technological developments should contribute to shaping. This paper presents a case study to illustrate the application of ethical theories. The paper is laid out as follows: a brief overview of ethical theories is given in section 2; several of these theories are applied to a case study in section 3 and conclusions are presented in section 4.

2. BRIEF SURVEY OF ETHICAL THEORIES

There are a number of different ethical theories of appropriate professional and personal conduct, which can be divided into virtue ethics, utilarianism, duty ethics and rights ethics (Baccock, 1991; Madu, 1996; Martin et al, 1996). Utilarianism only considers consequences and that actions should result in the greatest good for the most people (and sometimes also animals), whereas duty ethics focuses on actions rather than consequences and is based on the idea of duties or responsibilities and respect for persons. Rights ethics considers actions to be wrong if they violate fundamental moral rights, whereas virtue ethics supports actions which build good character. Utilitarianism can be divided further into positive and negative utilitarianism (Lappé et al, 1999). Positive utilitarianism assesses new technologies in terms of their benefits against the risks and costs, an approach which generally favours new technologies. Negative utilarianism is mainly concerned with offsetting or mitigating present or future harms and is more obviously compatible with the precautionary principle (Agenda 21, 1992).

A frequently used and simpler categorisation of ethics is into consequentialist and deontological:

consequentialist approaches are concerned with consequences and the balance between benefits and harms, whereas deontological ones also consider the intention and the innate virtue of a course of action. Ethical principles can also be classified as universalist or absolutist and situation based. Absolutist approaches assume that a particular set of ethical principles is always valid, regardless of the surrounding circumstances, whereas situation-based ethics modifies ethical principles or prioritises them differently to take account of the particular situation. Although in many ways more realistic, care has to be taken to ensure that situation-based ethics is not used as an excuse to avoid hard ethical issues.

In normative ethics basic principles and virtues, such as beneficence, justice and autonomy, govern ethical behaviour. The application of these principles to specific ethical problems is referred to as applied ethics. Beneficience involves the active promotion of acts that benefit others, helping people to further their legitimate interests and removing or preventing possible harm. Justice involves behaving fairly and in accordance with what is owed or due. Distributive justice requires the just distribution of social benefits and burdens and equal treatment. However, unequal treatment may sometimes be required to alleviate structural or other inequalities and should be considered just in this context (Barbour, 1995) Acting autonomously generally requires freedom from external control. However some forms of 'control' or influence, such as rational persuasion, are generally acceptable, whereas coercion or domination are not. Freedom to choose activities considered to be important or of interest is also considered part of the principle of autonomy.

Less commonly used approaches to ethics include the ethics of care, consisting of a context based approach to preserving relationships (Gilligan,1982); the ethics of social experimentation in which engineering projects and the introduction of new technologies are considered as experiments (Martin et al, 1996); and ecocentred ethical approaches with a holistic perspective based on ecological systems (Callicott, 1992). The experimentation approach explicitly draws attention to the requirement for informed consent based on sufficient and appropriate information and voluntary participation, whereas ecocentred approaches focus on connections and interactions and therefore increase the likelihood of awareness of long-term and indirect consequences. Ethical theories generally recognise that individuals have duties and responsibilities to themselves as well as wider ones to society. However engineers and others who act ethically, for instance by 'whistle blowing' (Hersh, 2001) or refuse to carry out work that they consider unethical, may suffer loss of employment or financial penalties. This individual jeopardy could be reduced by moves to more collective responsibility, and the development of organisational and social cultures of responsibility.

2.1 Discussion of Utilarianism and Other Theories

Each of the theories presented above has both advantages and limitations. There has been considerable criticism, as well as defence of utilarianism (Schleffler, 1994). A particular problem is the lack of consideration of equity and distribution of benefits. There is also a certain lack of clarity about what exactly utilarianism maximizes. A distinction is sometimes made between 'higher' and 'lower' satisfactions, obtained from intellectual or hedonistic activities respectively, to allow 'lower' satisfactions to be excluded (Schleffler, 1994). It has been suggested that utilarianism should be based on maximizing good from an impersonal point of view. Although this may resolve some of the theoretical difficulties, in practical terms it is less useful, since there are probably considerable differences between the impersonal perspectives of, for instance, the chief executive of Monsanto and a small organic farmer. There has also been discussion of the restrictions utilarianism might pose on 'integrity', through the responsibility to prevent harm (wherever it might occur). However the potential benefits of this imperative to avoid harm in improving the ethical behaviour of large multinational companies by prohibiting the majority of their current activities is rarely if ever discussed. Unless an exception is made for the agent prerogative i.e. the ability to prioritise personal over other projects, taking utilarianism to its logical conclusion would totally paralize personal activity. However the problem here is the focus on individual rather than collective action. Although individuals do have ethical responsibility for contributing to resolving serious world problems such as famine, the resolution of such problems requires collective action. Utilarianism is related to economic utility, in which there is a relationship between consumption and increasing utility or satisfaction. Thus it may encourage consumption and consequently damage to the natural environment.

In the literature the concept of agent centred restrictions i.e. allowing 'good' not to be maximized in circumstances where it would require the carrying out of unethical actions, is more controversial. However the discussion is often in the context of extreme examples, such as being forced to choose to kill one person in order to save others (Scarre, 1996), though such choices are rarely put into a historical context in which they would be relevant. This illustrates a lack of flexibility in the theory and the problems that occur when a given theory is taken to be absolute. On the one hand the fact that many of the standard theories of ethics do not function well in extreme situations is not necessarily a drawback, since what could be called the ethics of survival is probably more appropriate in such situations. On the other hand the lack of recognition of the fact that there are circumstances in which an ethical theory is not valid is a problem.

This (extreme) example also illustrates another problem with utilarian and other simplistic consequentialist approaches. The mathematical comparison of one versus many lives ignores long term consequences, issues of uncertainty and virtue ethics. The argument that it is rational to kill one individual to save a greater number of others can too easily be extended to justify wars of aggression. Killing generally violates an individual's integrity and is likely to have long term psychological and spiritual consequences both for the individual and probably also for society as a whole. In the example the death of one individual is certain, but there is no certainty that it will result in saving the lives of other individuals. Although both deontological and consequentialist approaches tend separate to 'means' and 'ends', in practice the means used effect the ends achieved. Thus a society which condones killing in order to achieve other ends is likely to be shaped by this fact. However society accepts the introduction or continued use of technologies, such as road vehicles, which are known to cause deaths which would not otherwise have occurred. More than two hundred thousand people are killed in traffic accidents worldwide each year (Lowe, 1990). It is an interesting question as to whether the majority of the population would call for a ban if it was known in advance who was going to be killed in this way.

This discussion has focused on utilarianism, since this is most commonly discussed in the literature. However deontological approaches are equally open to criticism. Part of the problem is trying to apply a single theory to decision making on complex issues. This is analogous to the use of single criterion rather than multi-criterion optimization. Although optimizing on only one criterion is sometimes appropriate, in general and particularly in more complex problems a number of different criteria need to be considered. Similar considerations hold for complex ethical problems. At the minimum a combination of consequentialist, whether utilarian or other, and deontological theories is required to provide a framework for the ethical evaluation of both acts in and of themselves and the resulting consequences i.e. 'means' and 'ends'. However, continuing the optimization analogy, it may sometimes be necessary to make tradeoffs between ethical acts and ethical consequences and therefore necessary to decide on the relative weightings given to the two approaches. In some cases it may be possible to resolve this problem by what could be called the ethics of lateral thinking or expanding options (Weston, 1997). Some ethical dilemmas can be considered artificial in the sense that they result from consideration of only a limited number of possible actions. However this approach, though of considerable practical value, is less satisfactory in theoretical and philosophical terms. A multi-criteria ethical theory should probably also include elements of virtue ethics, the ethics of care and experimentation and eco-centred ethics.

A number of science and engineering societies have codes of ethics or professional conduct, which could provide a basis for rule based ethics. The specific provisions in these codes (Oldenquist et al, 1979) can be divided into three categories: public interest, desirable qualities and professional performance. Some codes of professional conduct give a degree of support for ethical considerations in system design, though generally without being sufficiently specific. However, the majority of codes do not explicitly consider the impact of engineered systems on humans, society and the environment. They rarely indicate how decisions should be made in the case of conflicting obligations, although ethical problems frequently arise from conflicts of this type.

The deolontological/consequentialist (means and ends debate) in ethics can be expressed in terms of processes and products in engineering and analogous organizations. Therefore, for a particular system or an organisation as a whole to be ethical, both its applications or other activities and the ways in which they are achieved should satisfy ethical standards. For instance, introducing new technology to improve working conditions, eliminate waste and minimise energy consumption, though ethical in itself, is not ethical if, for instance used in a process to make landmines or gas chambers for eliminating 'undesirables'. On the other hand, though ethical in itself, producing safe and politically correct educational toys for children is not ethical if carried out in unsanitary sweatshops by workers paid half the minimum wage using processes that emit toxic fumes into the midst of a heavily populated area. In the first example the processes, but not the product are ethical and in the second the products, but not the processes are ethical. In simplistic terms the first example could be considered to satisfy deontological ethics and the second consequentialist ones. However closer examination shows the flaws in this reasoning, due to the interconnection between processes and products. In the first case producing landmines or gas chambers is in itself not a right action. In the second case the consequences to the workers and people in the surrounding area should be considered in addition to the users of the toys and it is oversimplistic to weigh benefits against harms. Unfortunately the issues in real situations are generally less clear and often involve tradeoffs between different interests and ethical or other principles. In particular in some circumstances it may be necessary to consider whether and, if so, in what circumstances it is ethically justified to perform actions which are themselves slightly unethical in order to achieve a greater good.

3. CASE STUDY: GM FOOD PRODUCTS

The functioning of some of the ethical theories discussed in section 2 will be illustrated by application to a case study about the new technology

of genetically modified organisms (GMOs) in food products. In GMOs genes from one species are inserted into another species in order to transfer a desired characteristic (Anderson, 1999). As gene transfer techniques have a very low success rates, a marker gene which codes for resistance to a commonly used antibiotic is attached to the gene to be transferred. There is a possibility of gut bacteria developing resistance to these antibiotics. Therefore for instance, the Advisory Committee on Novel Foods and Processes has advised the UK Government against authorizing the use of a marker gene resistant to ampicillin (Anderson, 19993,). A promoter or piece of DNA from a virus or bacterium is also transferred to activate the gene in the new host. The promoter may make the gene express its traits at very high, possibly harmful levels.

Most research by the biotechnology industry has focused on making crops resistant to their own broad-spectrum herbicides, so that (in theory at least) spraying a field will kill all plants except the resistant crop. 71% of the 27.8 million hectares of genetically engineered crops planted in 1998 were herbicide resistant (Kollek, 1996). One of the earliest and best known examples is soya beans modified by Monsanto to be resistant to their best selling herbicide Round-up. Although Roundup has been promoted as a benign herbicide, the US Fish and Wildlife Service has identified 74 endangered plant species potentially threatened by the excessive use of glyphosate, its main constituent. Studies have shown that it can damage fish, beneficial fungi and earthworms, even at low concentrations. It is the third most commonly reported cause of pesticide related illness among agricultural workers in California and can cause eye and skin irritation, cardiac depression and vomiting (Anderson, 1999). Repeated application of a single herbicide encourages plants to develop resistance within a short period of time. Herbicide resistance could be transferred to other plants via cross-pollination. The British Agrochemical Association has predicted that the use of GM herbicide resistant crops would increase sales of herbicide in the US (Antoniou, 1998). Conservation agencies such as the UK Royal Society for the Protection of birds are concerned about damage to wildlife when large areas of land are sprayed with broad-spectrum herbicides such as round-up (Anderson, 1999).

The terms of Monsanto's Technology Use Agreement prohibit farmers from saving seed for the following year or using other herbicides. Monsanto has hired Pinkerton private detective agency to check that farmers are not saving seeds (Berlan et al, 1998). A freephone hotline has been set up to encourage farmers to report neighbours for seed-saving. Monsanto has broadcast radio advertisements naming farmers caught saving seed (Anderson, 1999). Terminator technology is used to genetically disable plants to make them infertile. The widespread use of proprietary seed has already led to huge losses in genetic diversity, which will be exacerbated if farmers are unable to save their seed. 1.4 billion farming households around the world are dependent on farm-saved seeds and concerns have been expressed about the impact of terminator technology on poor farmers (UCSUSA, 1998a).

Supporters of the technology tend to play down the environmental risks and point to the large number of trials without incidents or dangerous releases. However a lack of evidence does not imply a lack of risk. This approach also ignores the complex interactions which take place in the environment. It is also counter to the view of some insurance companies. For instance the world's second largest reinsurance firm, Swiss Re, considers that genetic engineering cannot be covered by classical liability insurance models, as the risk profile is extremely diversified and difficult to anticipate, bringing into question whether it can be insured (Epprecht, 1998). Scientists at the University of Chicago have shown that GM plants examined in field tests had a greatly increased ability to transfer genes to non-GM plants (Burgelson et al, 1998; UCSUSA, 1998b).

GM supporters suggest that GM food will be necessary to feed the increasing world population. However according to the United Nations' World Food Programme one and a half times the food required to provide everyone in the world with an adequate and nutritious diet is being produced, but one in seven people is suffering from hunger. A survey in 1997 showed that 78% of all malnourished children under five lived in countries with food surpluses (Knight, 1998). At the height of the 1984 famine in Ethiopia oilseed rape, cottonseed and linseed grown on prime agricultural land were exported as livestock feed to Europe (OECD, 1999) and fruit and vegetables were also exported. Increasing use of GM crops will increase genetic uniformity and the vulnerability of food supplies (Alexandros, 1988). Genetic uniformity in the potato crop was the main cause of the nineteenth century Irish potato famine (Anon, 1998), which led to hundreds of thousands of deaths. Potatoes in the Andes survived the same potato blight due to genetic diversity, with up to 46 varieties of potato, and were subsequently used to restock European farms (Brush, 1977; Lappé et al, 1999).

The GM food industry is generally against labeling on the grounds that GM food is 'substantially equivalent' to non-GM food and that labeling would be discriminatory, but stresses differences between GM and non-GM products when they try to patent GM products. This runs counter to public opinion, which seems to be both strongly in favour of labeling and opposed to GM foods. Recent polls show that 58% of UK respondents are opposed to the genetic engineering of food and 61% do not want to eat GM food (Genewatch, 1999) and that 81% of US

respondents support labeling and 58% would avoid purchasing GM food products (Anderson, 1999). However public concern tends to be dismissed as emotional or uninformed. The independence of the regulatory process is being called into question, particularly in the US, where people on key regulatory bodies have strong links to the corporations they are supposed to regulate. The Executive Director of the UK Biotechnology and Biological Science Research Council was previously the chief executive of Zeneca, a multi-billion company whose activities include GM food (Anderson, 1999). The industry has also exerted pressure to prevent unfavourable publicity. For instance a Florida television station cancelled a series on GM recombinant bovine growth hormone after receiving two threatening letters from Monsanto lawyers, despite having extensively publicised the series and hired two award winning journalists to produce it (Ferrara, 2001).

3.1 Application of Ethical Theories

Several of the ethical theories in section 2 will be now applied to the case study. With regards to virtue ethics, the behaviour of both senior management of firms producing GMOs and members of the regulatory bodies indicates that the climate and context in which GM food products have been developed, produced and marketed is having a deleterious effect on character. Examples include strong arm tactics with regards to farmers who save seed, putting pressure on the media to withhold information, resisting labeling of products, the close relationships between regulators and the industry and the total lack of concern about wider environmental, health and other implications. There is also evidence of some dishonesty in the claims made about GM food, for instance that it is necessary to meet world food demands. Whether the use of GMOs is intrinsincally counter to virtue ethics, or only the implementation is a more complex issue. However persisting in the production or marketing of GM food products in the face of considerable uncertainty about the long term environmental and health risks as well as some evidence of potential problems indicates that the profit motive has been put before environmental security and human health. This is clearly counter to virtue ethics.

In terms of normative ethics, GMOs often provide considerable (financial) benefits to shareholders, but do not benefit the much larger number of consumers or small farmers and there is generally no active intention to benefit others. The introduction of GMO crops has generally reduced the autonomy of farmers, particularly small and/or organic farmers, by making it more difficult for them to compete with larger GMO outfits or forbidding them to retain seed for use in the following year. Threats to the organic status of crops due to pollution by GMO crops are, to a certain extent, a consequence of the inadequate distance between GMO and other crops. However, the limited available evidence seems to indicate that there is no safe distance for preventing transmission of GMO seeds. The evidence indicates that large and powerful multinational companies, such as Monsanto, are imposing GMOs on small farmers and consumers, counter to the interests of justice. Preventing farmers from saving seed contravenes their autonomy and, in the case, of small farmers, threatens their livelihood, contrary to the principles of autonomy, benificience and justice. There is some evidence that, by reducing genetic diversity, GMO food could threaten world food supplies, at least in some areas. Lack of labeling of GM food is counter to the principles of autonomy and justice, as it prevents individuals making informed choices or avoiding food products with unknown risks. It may also prevent individuals avoiding food products to which they have allergic reactions and may also violate religious rights, if genes from forbidden foods are incorporated into other products.

With regards to positive utilitarianism, GMO food products and crops have positive benefits to producers and manufacturers and probably also to governments in terms of increased or more secure tax revenues and increased control of the food supply. Costs are to small and/or organic farmers and risks to consumers. There may also be costs to the world population as a whole or, at least, the poorer sections of it in terms of threats to food supplies and food security. There are also costs to animals and birds in terms of loss of habitat and reduced diversity of the plant life on which they feed. However, positive utilitarianism tends to stress the positive aspects and ignore the costs. In terms of negative utilitarianism, the most significant issues are the likely dangers to ecosystems and biodiversity from the dispersal of GMOs into the environment, with a consequent reduction in plant robustness to disease and predators and threat to long-term food supplies, and possible health risks from eating GMO food. Engineering codes generally stipulate duties to employers, the general public and the environment, often augmented by somewhat vague statements about prioritising the needs of the general public. Therefore in terms of rule based ethics or engineering codes, duties to employers to develop GMOs would be in conflict with duties to protect the general public and the environment and to act responsibly in the presence of uncertainty. However, most codes give little guidance as to how this conflict should be resolved.

In terms of the ethics of care, current implementation of GM products by Monsanto could seriously disrupt community relations, for instance by encouraging neighbours to spy on each other. In terms of the ethics of social experimentation, GMO food products have been introduced without informed consent and counter to public opinion. The lack of labeling may force some individuals to participate in the

experiment against their will. Little accurate information, including on possible risks and uncertainty, has been provided by the industry or government regulators and in some cases the industry has tried to suppress information or make it more difficult for individuals to access it. With regards to ecocentred ethics, GM food products have been introduced with little or no attention to possible long term consequences to the natural environment and health. Evidence and warnings of threats to biodiversity and habitats have been ignored. There has been no attempt to take account of the precautionary principle which advises caution and delay in introducing new technologies with uncertain (long term) effects.

4. BRIEF DISCUSSION AND CONCLUSIONS

This work has discussed several ethical theories and illustrated their application in a case study of the implementation of new technology, namely genetically modified food products. All the ethical theories indicate one or more ethical problems with GM food products in general and/or the way they are currently developed and marketed (by Monsanto) in particular. However the different ethical theories highlight a number of different ethical problems and none of them gives the full ethical picture. This indicates that a combination of the different theories would be necessary to give a more complete understanding of the full range of ethical issues and problems associated with GM food products.

The case study also illustrates the fact that advanced technologies are often developed or implemented without any attention being paid to ethical issues. This indicates a need for increasing weight to be given to ethical issues in technical and professional education. Despite their inadequacies, the various theories of ethical discussed in this paper can provide some support for incorporating ethical considerations into professional practice and decision making. However there is a clear need for the development of a multi-criteria approach which combines a number of the current theories and gives an indication of their relative importance and how tradeoffs should be made when the requirements of the different theories are in conflict.

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