

# Ethical Considerations When Implementing Advanced Technologies

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## ABSTRACT

This paper reveals that ethical considerations absolutely must be regarded at all three phases of advanced technologies implementation: 1) before origination, 2) during deployment and 3) after deployment. Authorities in the advanced technological areas of expert systems, fuzzy logic and artificial neural networks were conferred with, leading to this conclusion. Since each had strong opinions about what happens after deployment, the body of this paper is organized in reverse chronological order- beginning with after deployment, then during deployment, then before origination. The paper concludes with a brief comparison that provides high-level insight into the ethics to consider when implementing any advanced technology verses "commodity" or regular/off-the-shelf technologies.

## Preface

This paper was originally written for the course called "Business Law and Ethics", in the Engineering Management Master's degree program, at the University of Michigan - Dearborn. The approach used to collect data for the paper included interviewing authorities or "subject matter experts" from both the academic and the non-academic fields. The original audience of this paper included those with working knowledge of the basic ethical principles and to a lesser degree, the different types of advanced technologies. In order to meet the perspective of a larger audience, a brief summary of some basic ethical principles will be summarized in this paper.

## INTRODUCTION

During the mid-eighteenth century, numerous people manually harvested the textile cotton. Later, in 1793, Eli Whitney invented an "advanced technological" machine called the cotton gin [1]. This technology greatly expanded the economy of the era and assisted in the Industrial Revolution. However, many people were harmed when they lost their jobs. Was it ethical to replace these people with an advanced technology machine?

As the Industrial Revolution progressed for about another one-half century, other machines were invented. Gigantic blast furnaces that produced vast amounts of metal using extreme heat emerged [1]. A by-product of this once "advanced technology" machine was pollution. Was it ethical to harm the environment for the sake of more metal products for consumers to purchase?

Advanced technologies exist today that are still in their infancy relative to a full scale, widespread deployment, namely: expert systems, fuzzy logic and artificial neural networks. These advanced technologies have the potential to radically impact business and society--and therefore cause potential ethical issues. Most authorities would agree that there are many technical challenges

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involved with implementing them. As this paper discloses, there are also ethical considerations. The technical manager needs to understand how to deploy them ethically and effectively, since someday these technologies will also become more readily available "commodity technologies," like the cotton gin or the blast furnace.

After a brief description of these advanced technologies and some basic ethical principles, this paper will cite some of the ethical considerations of implementing them during their life cycles: after deployment, during deployment and before origination. Using the considerations originated from the authorities interviewed, a generalization is formed to extend these considerations to all advanced technologies and to "commodity technologies".

## **THEORY AND BACKGROUND**

### **Advanced Technologies**

Expert systems, fuzzy logic and artificial neural networks are classified as "artificial intelligence" technologies. Each of these is a component of intelligent systems. Other types of intelligent systems include natural language processing, automatic programming, speech understanding, intelligent tutoring, automatic programming and robotics [2]. (Authorities in these other, later areas were not conferred with for this paper.)

An expert system is typically a computerized advisory program that attempts to emulate the reasoning processes of experts in solving difficult problems. Knowledge engineers, together with software programmers construct the system after interviewing experts. These systems can be used for a number of applications ranging from advising and training computer aided design people, to retaining the corporate knowledge of a critical employee prior to his or her retirement.

Fuzzy logic is a technique that addresses the uncertainties in computations using a systematic and reproducible manner. It can deal with the "gray areas" of computerized human decision making like "almost hot" or "possibly cold". Fuzzy logic was created by Zadeh in 1965. Examples of this technology include washing machines that can figure out how to wash clothes, video cameras that automatically focus and engine controllers.

Artificial neural networks (ANN) emulate certain processing capabilities of the brain by using computers. They are trained and learn from experiences. Applications of ANNs include: financial services, loan application evaluation, airline forecasting, and automotive engine control.

### **Ethical Principles**

Ethical principles can be categorized into two distinct vantage points: Deontological and Utilitarian [3]. The deontological view of ethics has religion as it's roots and favor obligations, responsibilities, and fairness over desirable consequences. The utilitarian ethical view is to look primarily at the consequences to determine if a particular situation is ethical. For example, the automobile, from a deontological ethical standpoint, should never be manufactured since people could die while driving it. The utilitarian ethics practitioner would disagree and site that the automobile called an ambulance could actually save lives.

Generally speaking, when both principles agree, the situation is considered ethical.

## RESULTS

As one can see from this very brief background, the advanced technologies discussed mimic various aspects of human behaviors. This means that they are powerful and have almost limitless long-term potential. But what are the ethical considerations of implementing them? When should ethics be considered?

The results of the interview process indicated that ethical considerations do need to be considered in the three phases of their lifetime (in reverse chronological order): 1) after deployment, 2) during development, and 3) before origination.

The questions and considerations discovered in the interview process include:

- 1) After Deployment
  - How will these technologies affect their business and society?
- 2) During Development
  - How to address potential exposure to insider trading opportunities?
- 3) Before Origination
  - How to manage possible immeasurable high cost implementations due to uncertainties?
  - How to ethically use superior knowledge of the subject and avoid overselling it?
  - How can one be innovative and loyal to the company?

## Considerations

### 1) After Deployment Considerations

#### Business and Societal Effects

At first glance, each technology appears to possess the societal ethical element of "replacing people", just like the cotton gin did. While it is true that this can occur, many implementations of expert systems, for example, seem to be more of the "advisor" or "trainer" variety, versus of a pure "people replacement" type. Productivity gains seem to be the primary rationale for implementing them. Their implementations allowed a few individuals the ability to do more work with higher quality, instead of doing the same amount of work with fewer people. This seems to be fair to all existing workers; however it does not necessarily allow for growing the workforce. All of the authorities that were conferred with seemed to strongly agree that this was the number one ethical consideration. This is the primary reason why the three considerations are listed in reverse chronological order - after, during and then before.

### 2) During Deployment Considerations

#### Insider Trading Exposures

Perhaps not as obvious as the ethical issue of "replacing people" is the possibility that a technical manager may need to address the ethics associated with working closely with a small, specialized "advanced technology" corporation. Since these are "advanced technologies", there is a tendency to only be a small population of companies that can effectively implement them. The chief executive officer (CEO) of the small company may also be a key technical contributor, for example. When a manager works closely with these small companies, with the intent of leveraging

their technical expertise, incidental exposure to stock price information can occur through simple casual conversations with various company officers, including the CEO. This can put the manager in a future adverse "conflict of interest" situation with the Securities and Exchange Commission or his or her place of employment; if he or she were to act upon this information for personal gain. Two of the conferee authorities named this particular consideration.

### **3) Before Origination Considerations**

#### Cost of Implementation

As mentioned previously, many times a technical manager needs to work with smaller companies that possess the niche capabilities of the specific advanced technology that needs to be implemented. It can therefore be difficult to effectively scrutinize the cost of an implementation, since there are few competitors to perform a comprehensive cost comparison with. Is it ethical to spend company resources on an effort that is neither fully understood nor measurable? Sometimes this is precisely what occurs when implementing an advanced technology. How much risk is too much? This can put the technical manager in a difficult situation in the initial phases of a project, especially if timing slippage occurs and upper management wants answers (based on traditional financial justifications). However, once the project is successfully implemented, and upper management sees the benefits, then implementations of future advanced technology can proceed with perhaps less (but not without) scrutiny. One conferee cited this consideration.

#### Over Selling or "Misleading" Advertising

A result of being associated with and directly working in the advanced technology sector is the fact that one acquires superior knowledge in the subject matter. This puts these individuals in a situation that can cause ethical dilemmas when they are selling their wares. Certainly they want to obtain more business and in a free market, they should charge what the market should bear. To the educated "buyer" of their services, this is not an issue. However, with so few educated buyers in existence, it is possible to be duped if one is not careful. Since it is difficult to effectively measure and comparison-shop these technologies, one needs to rely on the ethical experts in the organizations to make proper decisions. This situation is not unique to advanced technology: doctors, lawyers, engineers, accountants and educators may also need to consider the "superior knowledge" issue. Four conferees acknowledged this consideration.

#### Company Loyalty

Innovation is usually associated with advanced technology. Sometimes this may put the "innovator" in a precarious situation with respect to company loyalty. Company processes and practices tend to be a part of the corporate culture. Is it ethical to create new processes and practices? Or should one leave well enough alone and be loyal to the company? Implementing advanced technologies requires those involved to occasionally ponder these questions. One conferee was adamant about this consideration.

## CONCLUSION

When one implements advanced technologies, one must consider the ethical ramifications. As unveiled in this paper, ethical questions and considerations occur in all three life-cycle phases of implementation: before, during, and after. But what are some ethical "answers" to these questions? Perhaps the traditional deontological and utilitarian ethical theories can assist.

From a deontological stand point, are advanced technologies ethical? The answer seems to be relative to the main components of this standpoint: obligations, responsibilities, and fairness over desirable consequences. If one has the obligation to the company to implement advanced technologies, then "yes", their actions are ethical if implemented fairly. If one does not have that obligation, then according to a deontologist, implementing advanced technologies are unethical.

Since utilitarian ethical theory places all importance on looking at the consequences first, one can conclude that implementing advanced technologies are ethical - no matter who in the organization does it. Long term, these technologies will positively impact society; just as the cotton gin did two hundred years ago. More work will be accomplished with the same number (or fewer) resources.

For all of the ethical considerations mentioned, using Bowie and Duska's [3] four questions about any action seem to apply: 1) Is the action good for me?, 2) Is the action good for the company?, 3) Is the action good for everyone affected by it?, and 4) Is the action fair and just? According to Bowie and Duska, answering "yes" to all four questions leads to an ethical action. So how does the ethical considerations for implementing advanced technologies compare to ethical considerations of commodity technologies? The following table compares the "Degree of Ethical Considerations" required for implementing both "advanced" and "commodity" technologies.

Degree of Ethical Considerations Matrix

Deployment Phase	Advanced Technology	"Commodity" Technology
After	<b>High</b> (Societal – loosing jobs)	<b>Medium</b> (Most societal effects already addressed or known)
During	<b>High</b> ( Insider trading)	<b>High</b> (Insider trading)
Before	<b>High</b> (Immeasurable, high cost implementations; superior knowledge)	<b>Medium</b> (Many cost issues and technology capabilities are common knowledge)

Generally speaking, the engineering manager needs to be highly aware of the ethical considerations of implementing technologies when they are "advanced". Commodity technologies have had some exposure to the world and therefore have the same ethical considerations as most other business practices.

This paper has presented the important ethical issues and considerations required in implementing both advanced and commodity technologies. From this, along with the historic knowledge and experiences gained from the past, one can see that engineering managers need to be

aware of the "deign-for-ethics" considerations along with the traditional "design-for-manufacturing" or "design-for-assembly" methodologies to effectively perform their job functions.

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In total, five people were confidentially conferred upon for this paper. Three were directly involved with the advanced technologies described (expert systems, fuzzy logic and artificial neural networks) and two have been indirectly involved (have implemented technologies, but not necessarily advanced). All are very trustworthy, ethical individuals. The following table highly summarizes their credentials and backgrounds:

	Person	Degree	Married	Children	License	Born	Religion	Advanced Technology (yrs)	Title
<b>Direct</b>	A	MS (x2)	Y	Y		Canada	Episcopalien	AI/ES (>10)	Technical Manager
	B	PhD	Y	N	P.E.	W. Africa	Islamic	Fuzzy Logic (>5)	Engineering Specialist
	C	MBA/BS	Y	Y		S. E. Mich	Catholic	Intelligent Systems (>3)	Manager
<b>Indirect</b>	D	MBA	Y	Y	P.E.			Fuzzy Logic & Adv Mfg Sys	Manager
	E	PhD	Y	Y	P.E.	India		Several	Professor

**REFERENCES**

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3. N. Bowie, R. Duska, *Business Ethics*, pages 10-11, 1990.