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Second semester- Third Lecture

3. Computer Ethics

Computers have rapidly become a ubiquitous tool in engineering and business. There are ways in which computers have brought benefits to society. Unfortunately, there are also numerous ways in which computers have been misused, leading to serious ethical issues. The engineer's roles as designer, manager, and user of computers bring with them a responsibility to help foster the ethical use of computers. We will see that the ethical issues associated with computers are, for example, many ethical problems associated with computer use relate to unauthorized use of information stored on computer databases and are thus related to the issues of confidentiality and proprietary information. Ethical problem-solving techniques used for other engineering ethics problems are equally applicable to computer ethics issues. There are two broad categories of computer ethics problems: those in which the computer is used to commit an unethical act, such as the use of a computer to hack into a database and those in which the computer is used as an engineering tool, but is used improperly.

3.1 Computers as an Engineering Tool

Computers are an essential tool for all engineers. Most often, we use computers for writing documents using a word-processing software package. We also keep track of appointments with scheduling software, use spreadsheets to make financial calculations, databases to keep records of our work, and use commercially available software to develop plans for how our projects will proceed. The use of these types of software is not unique to engineering—indeed, they are useful in various areas of

business. Unique to engineering are two uses of computers: as design tools and as components integrated into engineered systems.

3.2. Computer Design Tool

Numerous software packages are available for the design of engineered devices and structures. This software includes CAD/CAM, circuit analysis, finite element analysis, structural analysis, and other modeling and analysis programs. Software also exists that is designed to aid in the process of testing engineered devices by performing tests, recording data, and presenting data for analysis. These all serve to allow an engineer to work more efficiently and to help take away some of the tedious aspects of an engineer's work. However, the use of this type of software also leads to ethical issues.

For example, who is responsible when a flaw in software used to design a bridge lead to the failure of the bridge? Is it the fault of the engineer who designed the bridge? or is it the fault of the company that designed and sold the defective software? Who is at fault when a software package is used for a problem that it isn't really suited for? What happens when existing software is used on a new and innovative engineering

These questions all have the same answer: Software can never be a substitute for good engineering judgment. Clearly, the engineer who uses software in the design process is still responsible for the designs that were generated and the testing that was done using a computer.

1- Engineers must be careful to make sure that the software is appropriate to the problem being worked on, and should be knowledgeable about the limitations and applicability of a software package.
2- Engineers must also keep up to date on any flaws that have been discovered in the software and ensure that the most recent version of the software is being used—software companies make patches and updates available, and engineers must check to make sure they have the most up-to-date version.
3- Finally, it is important to verify the results of a computer-generated design or analysis. Sometimes it's a great idea to sit down with a piece of paper and a pencil to make sure that the output of a computer program makes sense and is giving the right answer.

Integration of Computers into Engineered Systems Computers have also become a component of many engineered systems. For example, modern automobiles contain multiple computers, dedicated to specific tasks. Computers control the emissions and braking systems on automobiles and allow modern vehicles to operate more efficiently and safely. However, the ability to control aspects of system performance using software removes humans from the control loop. There are numerous examples of situations in which computerized systems malfunctioned without giving the operator any indication that a problem existed. In some cases, the operator was unable to intervene to solve a problem because the software design wouldn't allow it. It is essential when designing systems with embedded computers and software that engineers ensure that software is adequately tested, that humans can intervene when

necessary, and that safety systems have enough hardware redundancy without relying solely on software to ensure the safe operation of the system.

3.3. Autonomous Computers

Other ethical concerns arise because of the increasingly autonomous nature of computers. Autonomy refers to the ability of a computer to make decisions without the intervention of humans. There are applications for which autonomy is valuable. For example, manufacturing processes that require monitoring and control at frequent intervals can greatly benefit from autonomous computers. In this case, the autonomy of the computer has very little impact beyond the interests of the manufacturer.

Other autonomous computer applications are not so benign. For example, by the 1980s, computers were widely used to automate trading on the major U.S. stock exchanges. Some brokerages and institutional investors utilized computers that were programmed to sell stocks automatically under certain conditions, among them when prices drop sharply. This type of programming creates an unstable situation. As prices drop, computers automatically start selling stocks, further depressing the prices, causing other computers to sell, and so on until there is a major market crash

Autonomy of computer systems has also been called into question with regard to military weapons. Many weapons systems rely heavily on computer sensors and computer controls. Due to the speed with which events can happen on a modern battlefield eld, it would seem valuable to have weapons that can operate autonomously. However, weapons systems operating without human intervention can suffer from the instability problems described with regard to the financial markets. For example, a

malfunctioning sensor might lead a computer to think that an enemy has increased its military activity in a certain area. This would lead to an increased readiness on our part, followed by increased activity by the enemy, etc. This unstable situation could lead to a conflict and loss of life when really there was nothing happening. This problem is of special concern due to the implications for the loss of human life. It is clear from this example that although autonomous computers can greatly increase productivity and efficiency in many areas, ultimately there must be some human control in order to prevent disasters.