SafetyInfo

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Safety Engineers Have Obligation to Control Hazards Through Design

"The engineer will hold paramount the safety, health and welfare of the public in the performance of his professional duties".

So reads the first fundamental canon and the first principle of practice in the Institution of Engineers India, Code of Ethics. Similar statements are found in the codes of ethics of other engineering societies and in the justification for state laws governing engineering registration.

Since one thing that sets engineering apart from science and technology is the design function, engineers have a duty to protect the public through designs for products, workplaces, processes and environment. Falling to incorporate adequate protection into design and incorporation of design features into final products has led to many accidents and injuries. Such failures contributed to such notable accidents as Three Mile Island and Union Carbide Plant in Bhopal.

How can products, processes, workplaces and environments be made safe through design? A number of steps can be taken to ensure that safety is successfully incorporated into designs. Seven are suggested below.

***Early Control*.**

Accidents resulting in damage, injury or loss of life consume profits from an otherwise successful company or operation. Correcting problems after accidents occur is an expensive approach. Not only is retrofit more costly than including an appropriate safety solution in the original a design, but losses have already occurred from accidents themselves. Correcting safety hazards on the drawing board during initial concept stages is much cheaper than making a change after a product or process is in use.

***Eliminate Hazards*.**

The main goal for safety in design is to eliminate hazards. A priority scheme often used is the following:

- Priority 1 – Eliminate Hazards
- Priority 2 – Reduce Risks when Hazards cannot be Eliminated
- Priority 3 – Incorporate Safety Devices
- Priority 4 – Provide Warning Devices
- Priority 5 – Develop and Implement Procedures and Training

The goal is to implement the highest possible priority in a design. Some overlook the fact that the latter four priorities leave hazards in place.

Risks are reduced through design features that decrease the likelihood of an error, failure or accident. Redundancy in systems and components is one means of reducing the chances of an accident. Another is selecting materials that have a longer wear life or are less likely to fail from various kinds of loads.

Risks can also be reduced through design features that decrease the severity of an accident if it does occur. An example is lowering voltage and current in electrical equipment. Low voltages and currents are less likely to produce injury. Another example is the use of fuel tanks in race cars that do not rupture easily in a crash. Collapsible steering columns, seat belts, airbags and energy absorbing structures in automobiles reduce the severity of injury in accidents.

Safety devices act automatically. An example is a fire door that closes when a fire occurs. Warning devices, like fire alarms, provide information that there is a danger to people and that they should protect themselves. Procedures are actions one must take to perform a task safely or find protection when there is a danger.

***Design For People*.** Engineers are not trained in the capabilities and limitations of people as well as they are trained in the capabilities and limitations of materials, machines, circuits, equipment and other things. Repetitive-motion injuries could be reduced significantly if tasks were designed to limit loads that must be lifted or moved, if people were not required to assume postures that are likely to cause injury and if the frequency of movements were kept low. Errors would be less likely to occur if more designers understood displays, controls, mental processing and other elements of man-machine interfaces that are detailed in human factors literature. Sizing things to fit human dimensions are ranges of motion and making things adjustable for different people are very important. Some falls on stairs could be prevented if visual distractions and patterned stair materials were not used. Example after example of designing for people could be given. A detailed one will suffice.

A worker was precisely adjusting a machine so that it would not damage products the machine produced. During setup procedures, the worker grasped a plate in the machine with both hands so he could feel any vibrations. He wanted a coworker to lower a “table” in the machine so that any misalignment of parts could be felt. At the appropriate command, the second worker turned a rotary control positioned to the right of the "”table” counterclockwise. The table went up and the first worker lost both thumbs. The key in design was in understanding which way the second worker expected the table to move and to avoid conflicting labeling on the control. An even better design would be the use of up-and-down controls to cause up-and-down motions. Both designs involve a concept called compatibility: expecting a device to respond a certain way to some control movement. We have all encountered a faucet that violates our expectation and sprays us with water instead of being shut off. We would be very surprised if a car turned left when we turned the steering wheel clockwise.

***Increase Knowledge*.** In 1987 the Accreditation Board for Engineering and Technology, a U.S. organization that accredits university engineering programs, added a requirement that all engineering programs must include safety throughout the engineering curriculum. Too many programs have yet to teach engineers how to recognize hazards. Too many have not made engineers aware of the wide range of governmental and voluntary standards that should be a part of design. Too few engineers have been taught to apply safety methodologies that help sort out the array of hazards and controls in the complex processes, equipment and systems. Increasing engineers' knowledge about safety will help achieve safety in designs.

***Use Design Teams*.** No one can recognize all safety hazards, evaluate them and select the most appropriate controls. One cannot be a specialist in the many disciplines that would be required. To achieve safety in designs, many organizations have turned to design teams that bring together engineers, safety specialists, industrial hygienists and others. Working together, they can complement the knowledge of each and achieve the most effective product containing the best safety solutions at tile lowest cost during the design process. Through design teams that include safety specialists, safety can be built into a design.

Concurrent Engineering. Many have recognized that failures of a product or system are not indigenous to a design itself but may be failures in supporting processes. For example, errors in purchasing or maintenance can lead to failure in a device or claims against the producer of the device. One solution to minimizing failures, that has significance for safety, is incorporating safety in the practice called concurrent engineering. Concurrent engineering is a systematic approach to the integrated, concurrent design of products or systems and their related processes, including manufacture and support, throughout the product's or system's life cycle.

Measure Performance. The total quality management program of the Motorola Corporation is called Six Sigma. One element of that program is measurement of two things in every unit of the company: errors (relative to opportunities for errors) and total cycle time. Since errors are often related to accidents, safety is an important part of any quality-management scheme. The key IS measurement of performance. Safety must be an integral part of any performance-assessment method. Field reports, customer complaints, parts re-orders, measures of process down time or reports of product-use injuries are all measures of design quality. Accidents associated with product process, work place and equipment designs unnecessarily reduce the profit produced by a design.

Preventing accidents through engineering design is a key to profitability. Getting safety into a design is the best way to achieve an effective design. The seven approaches described here can be used to help engineers meet their moral and ethical responsibility for creating safe designs.

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