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FIVE FATAL DESIGNS

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ABSTRACT

Five cases investigated by the author are described in which a flawed engineering design process led directly to the death of people or the demise of a company. Four cases are related to specific phases of the design process while the fifth covers broader issues. Together they highlight the importance of using a systematic approach to engineering design and its management.

Case 1 involves the catastrophic explosion of a large replacement industrial heating boiler fitted with a 'low NOx' burner where the **design specification**, although very detailed, omitted requirements to ensure control of the draft from the tall boilerhouse chimney. The disaster would have been avoided had an adequate design specification been developed.

Case 2 involves a Post Office door which literally 'flew off its hinges' on a windy day, killing a woman about to enter the building. The **design concept** included a spring-loaded quick-release mechanism to facilitate door installation and removal. Prior to the accident a modified concept had been introduced on new doors, with a bolted connection replacing the spring-loaded plunger arrangement. Had there been adequate understanding of the working principles involved, the outer door would have been retrofitted with the bolted connection and there would have been no accident.

Case 3 involves total failure of the steering system on a heavy truck when a kingpin dropped out of position, allowing the wheel and stub axle to disengage completely from the vehicle. A head-on collision occurred resulting in one death and several injuries. Investigation revealed an **embodiment design** problem. Collapse of the thrust bearing associated with the kingpin caused the designed load path through the kingpin assembly to change so that vertical loads were taken up by a nut and washer

arrangement at the top of the kingpin. The torsional friction effect was sufficient to cause shearing of a locking pin, loosening of the nut and release of the kingpin from the axle eye. This effect could have been foreseen by use of accepted embodiment design guidelines, and the design layout modified to prevent such an occurrence.

Case 4 involves the **detail design** of a 5 mm threaded connection between two parts inside a valve used to control the air brake system on a heavy articulated truck. The loosening of this tiny threaded connection during service led to a massive vehicle collision in which one person died and several others were permanently injured. The case shows that the tiniest of details can be of critical importance to the performance of a design.

Case 5 involves the design and manufacture of a huge metalworking press, high on the scales of novelty, complexity and cost, with a short timescale. A **deficient design specification** coupled with **inadequate communication** and a **total separation of design from manufacture** guaranteed unacceptable performance of the machine which led to the demise of both the designing company and the manufacturing company.

Each of the above failures and accidents could have been prevented by use of a simple systematic engineering design approach and the paper highlights the need, above all else, for proper management understanding and participation in every phase of a design project.

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