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The Grate Debate

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INTRODUCTION

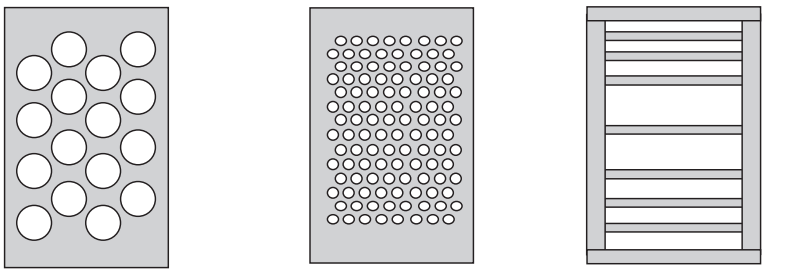
Floor troughs which house screw conveyors are generally covered with grating which allows granular products to be introduced throughout its length to the auger while simultaneously providing protection against the entry of human appendages. The loading environment for floor mounted augers may involve supporting heavy trucks and forklifts in addition to pedestrian traffic.

Auger elevators typically collect grain at a base hopper which is then conveyed by a screw conveyor to an elevated location. Grating is typically used to prevent entry of a farmer's hand into the auger system. The grating in this application must admit various grain products at various moisture contents with various amounts of trash into the hopper at a sufficient rate to efficiently feed the screw conveyor. When clogging occurs, this type of grating must provide access for clearing such jams; this is also true of the floor trough grating.

Grating systems have been proposed for the protection of the inlet port in the floor of a grain storage silo. This inlet is part of the unloading system which includes a horizontal screw conveyor. Here, the grating is inaccessible when the silo is loaded and consequently clogging makes it impossible to unload the silo.

In the three preceding examples, the grating aperture affects the safety and the flow function in an inverse manner. Large apertures increase the flow rate and minimize nuisance clogging; small apertures limit access through the grating preventing human appendage contact with hazardous machinery. The simultaneous achievement of safety and function utilizing grating is often impossible.

To make the tradeoff between safety and function, a knowledge of certain philosophical positions taken by the technical community and the judicial value system is required.



Large Aperture
4.45 cm (1.75 in.)
diameter holes

Small Aperture
1.91 cm (0.75 in.)
diameter holes

Bar Grate
6.51 cm (2.563 in.) x
19.7 cm (7.75 in.)
max. opening

Fig. 1

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The full text of this paper will be presented at the ASME International Mechanical Engineering Congress and Exposition in November of 1996 and will be available from Triodyne Inc. at no cost. To request the paper, call (847) 677-4730 ext. 162.

Engineering Code of Ethics The first entry in the code of ethics of every engineering society or organization requires that: "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties." The "professional duty" of an engineer derives from an obligation to harness technology for the benefit of mankind. "Welfare" is defined as "a state characterized especially by good fortune, happiness, well-being or prosperity." Welfare, therefore, includes economic well-being.

Professional duties arise from the continually changing demands of society and take the form of independent functional requirements or specifications. They are not variables in the design process. Indeed, candidate safeguards that interfere with functional specifications must be rejected. The code of ethics imposes two additional conditions on the functional requirements, optimum safety (health) and optimum economic welfare.

American Society of Agricultural Engineers (ASAE) In 1994, the ASAE Standard on Safety for Portable Agricultural Auger Conveying Equipment addressed the balance between safety and function for grating type guards in the following specification: "Functional components,which must be exposed for proper function, shall be shielded to the maximum extent permitted by the intended function of the components" (1).

Barker v Lull Engineering Co. The engineering code of ethics and the ASAE do not allow product function to be compromised in the design process. Function is not a variable; it would be formulated as a subsidiary condition not to be violated while other considerations such as cost or safety are optimized or varied in some other way. On the other hand, common law has given rise to a unique definition of safety articulated in Barker v Lull Engineering Co. (2). The Supreme Court of California stated that "... 2. a product may alternatively be found defective in design, if the plaintiff demonstrates that the product's design proximately caused his injury and the defendant fails to establish, in light of relevant factors, that, on balance, the benefits of the challenged design outweigh the risk of danger inherent in such design.

"Among the 'relevant factors' the jury may consider when weighing the benefits of the design against the risks, in the second test, are:

(a) the gravity of the danger posed by the challenged design;
(b) the likelihood that such danger would occur;
(c) the mechanical feasibility of a safer alternative design;
(d) the financial cost of an improved design;
(e) the adverse consequences to the product and to the consumer that would result from an alternative design."

The second definition of defect in Barker involves a risk-benefit comparison where risk corresponds to safety and benefit corresponds to function. The Barker philosophy which has been adopted by a number of states implies that a designer can trade off among function, cost, and safety. For the first time function is one of the variables. This risk-benefit concept has led to the almost virtual elimination of the diving board and the trampoline and has placed all recreational equipment in jeopardy in the areas of skydiving, parasailing, and football.

New Restatement of the Law of Torts: Product Liability
The new design defect law proposed by the American Law Institute eliminates the risk-benefit criterion intrinsic to Barker v. Lull Engineering Co. Philosophically, this restatement once again establishes the role of function as a non-variable entity. Because this law is new and unfamiliar to the design community, a summary is included in the following (3):

"A. **Design Defect Law**.

1. **General Liability Rule**. Manufacturers are liable for damages to persons or property resulting from a defective design.
2. **Determining if a Design is Defective**.
   a. **The Standard**. A design should be considered defective only when the foreseeable risks of harm posed by the product could have been reduced by the adoption of a reasonable alternative design and omission of the alternative design renders the product not reasonably safe.
   b. **Obvious Defects**. A defect's obviousness should be weighed when determining if a reasonable alternative design was available.
   c. **Misuse or Modification**. A design will not be considered defective if the risks of harm complained of by the plaintiff arise from misuse or modification.
   d. **Industry or Governmental Standards**. Conforming to industry or governmental standards would neither be a defense nor irrelevant; instead, it would be a factor that would make it difficult but not impossible to find a design defective.

B. **Warnings Law**.

1. **General Liability Rule**. Manufacturers have a general duty to provide warnings of the dangers posed by the use of their products.
2. **When a Warning is Required**.
   a. **The Standard**. A manufacturer should provide a warning when the foreseeable risks of harm posed by the product could have been reduced by a warning.
   b. **Obvious Dangers**. A manufacturer does not have to warn of obvious dangers because the user will already be aware of the danger given its obviousness.
   c. **Dangers Arising from Misuse or Modification**. A manufacturer is not required to warn of dangers that may arise from misuse or modification of a product.
   d. **Industry or Governmental Standards**. Conforming to industry or governmental standards would neither be a defense nor irrelevant; instead, it would be a factor that would make it difficult but not impossible to find that a warning should have been included."

For our purposes, the new restatement's design defect standard does not suggest that a product's function should be altered to produce a safe product. A product is defective only when the foreseeable risks of harm posed by the product could be reduced by a reasonable alternative design. Here, alternative designs focus on safety and reasonable would include consideration of their cost. This is entirely compatible with the engineering code of ethics.

The historical thrust of the entire engineering community is to hold function inviolate. This implies that all candidate grates for a given design will be strictly functional. That is, within some reliability level, they will allow the flow of materials to pass through the grating apertures. It also appears that the latest legal thinking supports this position.