RESEARCH REPORT:

Construction Design Safety in the Marketplace

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Abstract

This report presents an overview of the financial impact of the failure to address construction safety at the time of design or construction planning. The cost of construction mishaps that result when engineering remedies to control hazards are not pursued at the time of design and/or construction planning presents a significant expense to the public. The text of this report provides a method of evaluating the benefits of physical features and alternative designs that prevent hazards for a fraction of the cost of injury or damage due to unchecked hazardous circumstances. It also includes an evaluation of the estimated impact to the marketplace from injuries caused by specific, well-known hazards that could have been avoided by a program of hazard abatement by design. This analysis of the marketplace provides insight as to why a priority for design improvement to control hazards often lacks acceptance from construction industry management. Further, the report shows how, in the long term, the marketplace facilitates the implementation of hazard prevention through engineering and technology.

Introduction

The long-standing industry supposition that “safety does not sell” is a myth of convenience propagated to excuse the failure to include safety as a paramount consideration at the time of design and again at the time of construction planning. This myth pervades the construction industry, and is echoed in the cultures of architectural firms, designers, construction managers, erectors, material suppliers, and equipment manufacturers. To corroborate this myth, industrial heads have perpetuated the well-entrenched belief that any failure (accident) can be either partly or completely attributed to the action, inaction, or mistakes of the user or worker. (This predisposition is commonly referred to as "human error".) Rarely do industry executives investigate the probability or cost of failure at the time of design or before construction begins and take steps to prevent any possible mishaps. Instead, it has become common practice to transfer the cost of failure to casualty insurance and workers' compensation. Yet the cost of catastrophic construction failure is increasing. As rates continue to rise, safety will become an issue of escalating importance, especially as safe design concepts are increasingly recognized as an important factor in overall project cost. The cost efficiency offered by safe design encourages the market to promote the incorporation of safe design into project planning.

The roots of safety go back to the same time period that our country was making a Declaration of Independence to be a nation of the people, by the people, and for the people. Our Founding Fathers rebelled at an economic system that funneled the earnings of the people of the colonies to the King and the landed gentry of England. These same founders also enacted our Constitution, which in the first paragraph states that: "We, the people of the United States, in order to form a more perfect union, establish justice, insure domestic tranquility, provide for the common defense, *promote the general welfare*, and secure the blessings of liberty *to ourselves and our posterity*, do ordain and establish the Constitution for the United States of America." Such wording certainly indicates the inclusion of safety as an important part of general welfare. Moreover, these two documents include strong tenets that create a philosophy that the safety of our citizens is an integral part of liberty.

The marketplace is an economic system that has been a fundamental part of the very beginnings of organized civilization. The marketplace historically determines the value not only of goods and services, but of *people*. Based on this assumption, "safety" becomes a matter of economics: the cost of allocating money up front to prevent the cost of injury or post-injury consequences.

The savings of design safety can be determined by two factors: the cost of preventing the hazard and the total sum of paying for injury and damage caused by that specific hazard. A figure for total savings can be achieved by comparing the total amount spent on hazard prevention to the cost of damage that the hazard can potentially cause. A dangerous construction project is like a double-bitted ax that cuts both ways: first it impoverishes workers with a dangerous workplace that can disable or kill them; secondly, project funds may necessarily be diverted to pay for the cost of accidents, wherein the finance system fails due to an inflated cost of construction.

At the time of the American Revolution, two Scottish philosophers were identifying the role of marketplace as the ultimate control of enterprise and its impact on the public. Adam Smith, an economist at the University of Edinburgh, was making an inquiry as to the nature and causes of the wealth of nations, which was published under the same title in 1776. His thesis was that the general standard of living is best raised with the production and exchange of goods and services when unfettered by tampering from enterprise, politics, government, and professional or trade organizations. Likewise, the production of goods and services free from hazards also raises the standard of living. His theory has stood the test of time, as it is still frequently referred to in contemporary financial discussions as an authoritative reference on how to stabilize or influence the economy. It is most interesting to note that at the very beginning of the industrial age he clearly foresaw that any mischief that intercedes to favor any party (or parties) with an economic advantage can unbalance the market system to the point of failure. He intoned that in order for the marketplace to succeed, it must create a prosperous middle class that renders most of the population able to purchase goods and services. When the wealth is channeled to the rich at the expense of the middle class, the market collapses because the middle class lacks purchasing power. It can also be seen that when goods and services fail due to inherent hazards, the standard of living is not raised and the available wealth is channeled to pay for injury and damages. With a market diminished by the lack of purchasing power, the marketplace attempts to preserve itself by reducing costs, which causes the labor force, consumer, and the public to become vulnerable to unemployment, lower wages, and unsafe workplaces, products, facilities, and services. Care for the environment also goes by the wayside, enhancing danger and future costs to the public.

To secure a continuation of profit, the current US marketplace engages in outsourcing to countries where labor costs are a small fraction of domestic salaries. Workplaces in such locales are usually unreasonably dangerous, and the protection of the environment is of little concern. The practice of outsourcing erodes a stable marketplace while diminishing the priority for safe design.

Also in the 1700s a contemporary of Smith, David Hume, a writer in Glasgow, wrote a number of essays proposing that the concept of right and wrong is not a rational ethic but arises from the desire for one’s own fulfillment of conscience and happiness. While Smith was writing the *Wealth of Nations,* Hume’s view of the marketplace was that it only works when every party has an unselfish regard for the general welfare and safety of the entire society. Therefore, the marketplace becomes flawed by those who disregard the safety of others. Unsafe workplaces, products, and services are a form of poverty, and should not be tolerated due to the poverty they perpetuate by channeling the bulk of funds to pay for accidents that could have been avoided for pennies on the dollar by safer design. A perfect marketplace creates a stasis where everyone reaps the benefits of safe design, and no one creates a disadvantage to others based on that factor.

Discussion

Safety issues previously have not been defined as an integrated function of the marketplace. In most circumstances, "safety" concerns arise only when a hazardous condition becomes apparent after causing injury or damage. In this context, it is no wonder that safety historically has been considered an impediment to profit. This view arose due to the reluctance to identify or control hazards at the time of design or during construction planning.

When a hazard is identified as the root cause of an injury during construction or operation after numerous similar occurrences over a period of time, it is eventually recognized that safety standards or requirements are necessary. However, multiple disasters arise from the same hazard before steps are taken to prevent that hazard from occurring. The period between the time a hazard kills or injures someone and the time it is controlled by standards or other means is the **time lag.** Since factors of time lags include geography (location), and various industries, to identify one hazard as the sole factor behind multiple, industry-spanning failures that cause injury, property damage, or loss of life, "connecting the dots" with discovery and consolidation of hazard information, the time lag may stretch many years. This is particularly true when a single defective (hazardous) machine is used in multiple applications like construction, mining, lumbering, petroleum extraction/refinery, agriculture, transportation, etc. Due largely to imperfect recognition and recording methods (some deliberate), it can take decades before multiple and frequent casualties arising from the same source are considered candidates for work site compliance measures to prevent said hazard from causing harm. Unfortunately, “safety” becomes an issue only after a number of people have been seriously injured, maimed, or killed. Safety standards to increase workplace safety are usually developed only after an egregious time lag, when the “dots” are connected between a hazardous condition and occurrences of injury.

A good depiction of a dangerous construction time lag spans over 40 years, beginning when tractors were first developed (around the time of WWI)[1]. In 1908, David Roberts invented a crawler tractor, which he demonstrated at the British Aldershot Military Center. This machine was designed for towing heavy vehicles over rough terrain. Instead of wheels, locomotion came from chainlike feet acting much the way modern tanks and crawler vehicles do today. Because of its unique movement, the soldiers who viewed it called it the “caterpillar”. Later, the patents were sold to Benjamin Holt, a co-founder of Caterpillar Tractor Company.

Absence of any kind of rollover protective structure (ROPS) led to multiple injuries and deaths until the US Army Corps of Engineers and other users first investigated and developed safe design requirements for tractor rollover protective canopies, now known as rollover protective structures (ROPS) in 1957[2]. Not until the mid 1960s did the Society of Automotive Engineers publish the first “Rollover Protective Structure Standards” for scrapers. It was the early 1970s before a ROPS design safety feature was developed (adopted) by OSHA and universally applied to tractors. In short, the time lag for the national acceptance of a necessary design safety feature totaled 55 years. Such a delay in the

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[1] Hewitt, Edward R. *The Principles of Wheeled Tractors*, SAE Transactions Vol. 14, Part 1 PG 83, 1919.
[2] MacCollum, David “Lessons from 25 Years of ROPS”, *Professional Safety*, January 1984.

adoption of lifesaving equipment is an outrage, considering that by the 1970s, approximately 1000 lives were being lost every year to the hazard of tractor rollover[3]. Appendix A-1 includes additional data on the time lag concerning ROPS.

The fact of a gaping time lag before injuries accrue in sufficient numbers to kindle the awareness that *something needs to be done* is a wasteful system. To complicate matters, the proposed cure often does not address the technical failure of the hazard itself. Instead, common measures often require worker compliance with ineffective safety requirements. Such standards usually focus on voluntary worker regulation regarding behavior-oriented rules that provide guidance on how to “live with the hazard,” but little information to show how the hazard can be eliminated by design. A requirement on how to cope with the hazard is developed, rather than a path showing how technology can eliminate the danger. “Safe” work requirements that focus on behavior-based cures do not remove the hazard, but impede the acceptance of design-based safety solutions. This culture creates many time-consuming, unnecessary steps which prevent big savings in terms of both time and money by the use of safe design. Illustration #1 shows the complexity and economic consequences of the time lag.

ILLUSTRATION #1

[3] Armdt, James F., “Rollover Protective Structures for Farm and Construction Tractors- A 50 Year Review”, SAE Earthmoving Industry Conference, April 4-6 1971.

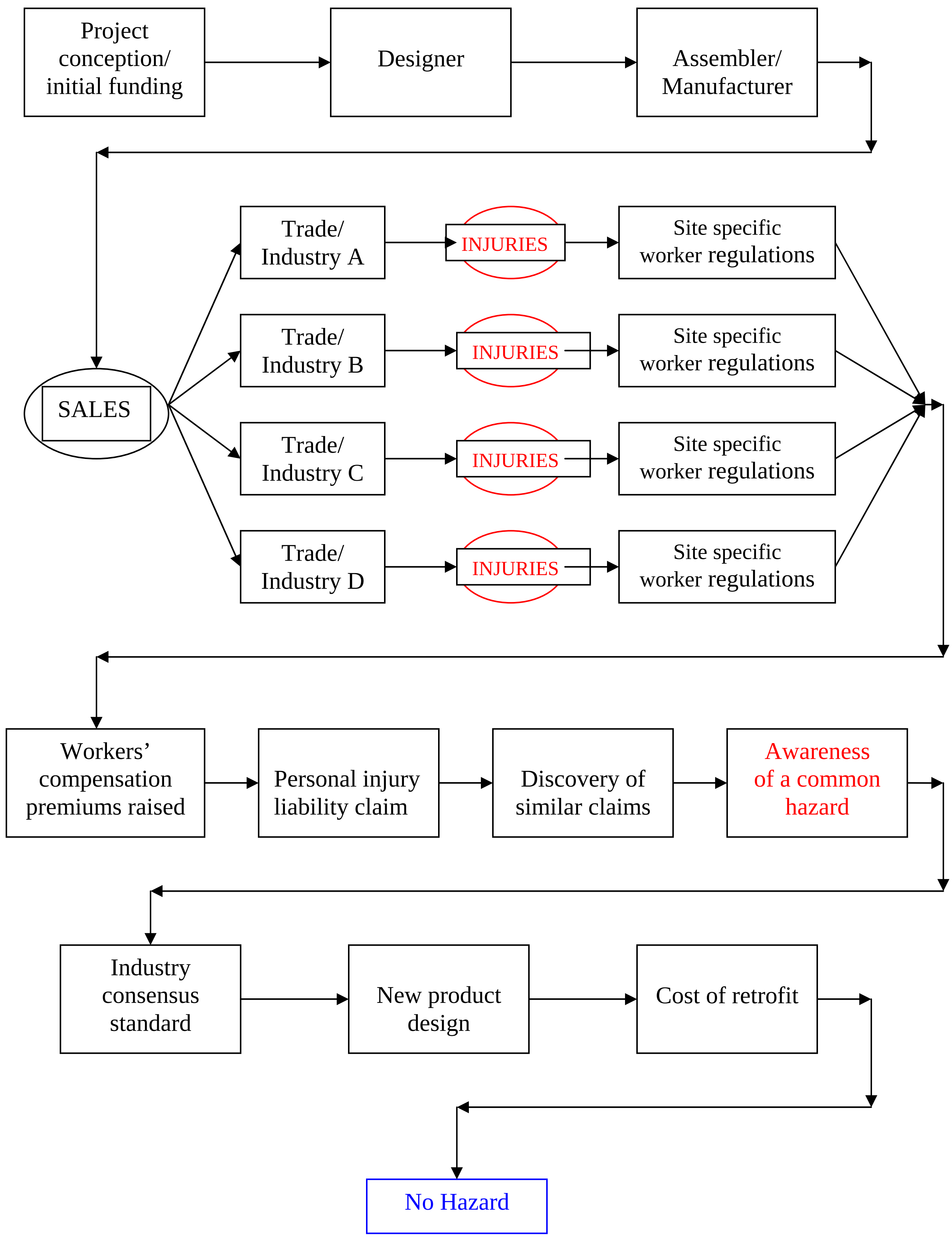
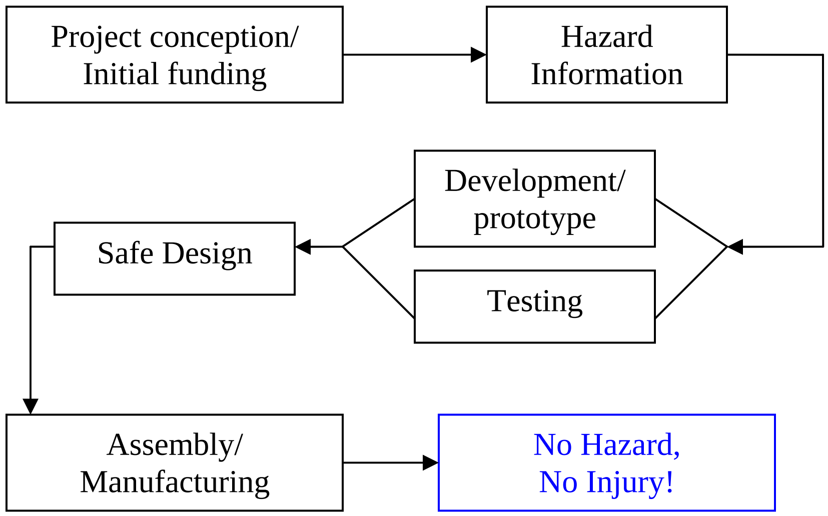

Project conception/ initial funding
Designer
Assembler/ Manufacturer
SALES
Trade/ Industry A
Trade/ Industry B
Trade/ Industry C
Trade/ Industry D
INJURIES
INJURIES
INJURIES
INJURIES
Site specific worker regulations
Site specific worker regulations
Site specific worker regulations
Site specific worker regulations
Workers' compensation premiums raised
Personal injury liability claim
Discovery of similar claims
Awareness of a common hazard
Industry consensus standard
New product design
Cost of retrofit
No Hazard

Illustration #2 shows how including safety at the time of design eliminates the time lag.

Illustration #2



Simply coping with a hazard through compliance with worker safety standards or minimum requirements does not eliminate the hazard. Consider a crane operator's requirement to maintain a 10-foot visual "thin air" clearance between powerlines and crane booms or their hoist lines when working in close proximity to energized powerlines[4]. This clearance requirement on every work site adjacent to powerlines in the nation continues to result in numerous powerline contacts that cause crippling injuries or worker deaths each year. However, these consequences could be eliminated by identification of the hazard of equipment powerline contact at the time of design or planning of a project and the creation of specifications to include relocation of the powerlines from the work site before cranes are brought onto the job. The use of proximity warning devices, insulated links, and range limiting device are also features that will significantly reduce the incident of human error of users of cranes equipped with these devices. Thorough prevention measures such as these

[4] "Safety Interventions to Control Hazards Related to Powerline Contact by Mobile Cranes and Other Boomed Equipment"" HIFI 2004, CPWR

eliminate the chance of any failure associated with powerline contact. A bonus to this approach is the elimination of the need for compliance with the ineffective ten-foot clearance requirements. Safety by design eliminates injuries and deaths as well as the inherent burden of ineffective, costly compliance standards and other hidden costs to the marketplace. For further information see Appendix A-2

Looking "upstream" by designing to promote worker safety is a well-founded moneysaving objective. To achieve this objective, a better understanding of how the marketplace does, indeed, create financial incentives for safer design is required. A first step is to identify the short and long term problem areas in construction.

Short Term

- First and foremost, the most frequent source of design-related injuries can be attributed to construction equipment hazards. These hazards need to be eliminated or minimized using engineering to apply technology. Currently, OSHA has identified that crane and aerial lift, including scissor lifts, are a source of fatalities from tipover. It is well within machine technology to include electronic sensor and interlock systems that can preclude operator error that leads to tipover. See Appendix A-5 for a detailed analysis of a US Court of Appeals for the sixth circuit, concerning a crane upset cause by failure to include interlocks that would prevent unsafe boom movement when the outrigger are retracted.
- Secondly, improper and unsafe construction methods are often the result of an absence of or poor construction planning which fails to clearly communicate hazardous circumstances or conditions. Construction managers are inclined to remove themselves from active supervision of their sub-contractors. As a

consequence, they can have little knowledge of how sub-contractors perform their tasks and the equipment that is used. Construction management's practice is to let the subcontractor use the methods they use to get the job done as quickly as possible, with little oversight to ensure the methods are safe. Such an attitude was an open invitation for hazardous jobsite conditions. Construction managers are often unfamiliar with basic construction safety engineering principles, and are unaware how construction drawings, change orders, and temporary circumstances are all potential sources of unanticipated hazards.

- Third, building materials can be the source of a hazard if they are unsafe for the proposed use. Specifications pertaining to those materials must clearly state limitations or hazards of use. Material shortages bring about substitutions that can create new hazards.
- Fourth, the design of the facility to be built has inherently unsafe structurally or interior features. The builder needs to be provided special conditions in the plans or specifications on how the structure can be safely erected or features installed. Design engineering needs to become familiar with construction safety engineering principles.

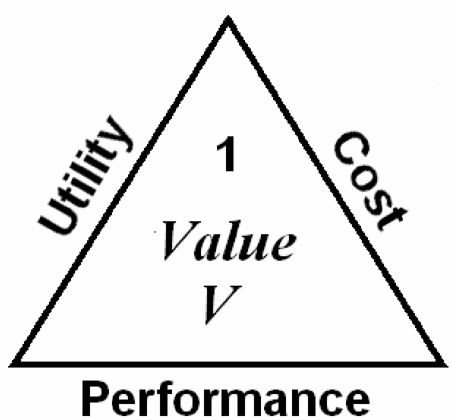
Long Term

- The design for the facility to be built should include design that will control the hazard during its entire life cycle to ensure **safe** use. (The principles of design safety of a facility are the same as for construction.) Safety in the marketplace applies to all parties in the construction process. The landowner/developer is a stakeholder whose goal is for the project being completed on time and within budget. The constructor has the same priority. Subcontractors and suppliers of construction equipment and materials are also participants in the construction marketplace. A failure from a hazard can financially impact all parties, as injury, damage, government intervention, and liability all increase the **total cost**, regardless of legal contracts, agreements, insurance, and liability, including the cost of defending the hazard when claims are filed.

To visually develop a model of how safety fits into the marketplace, a four sided, equilateral pyramid has been developed.

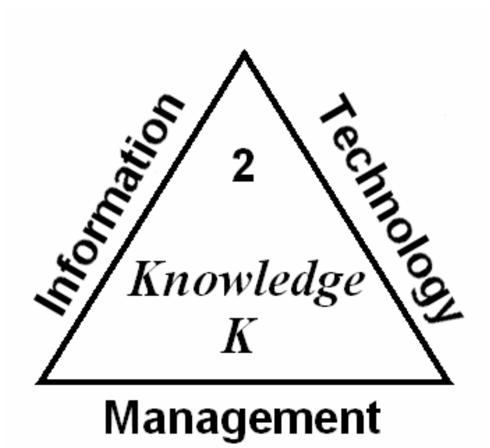
The first equilateral triangle (or the first face of the pyramid) denotes **value**, surrounded by the sides of utility, cost, and performance. Utility and cost are evaluated by performance. If performance includes occurrence of injuries, utility and cost are of little benefit, and value is reduced.

ILLUSTRATION #3



The second face of the pyramid is **knowledge**, which relies on the sides of information, technology, and management. Knowledge has always been recognized as a source of power. The information concerning previous injury from a hazard provides insight on how it can be eliminated by technology increases that power, yet occurs only when the information and technology are managed. The lack of information or research, or the failure to heed information and apply technology, is a function of management. When management fails to exercise oversight to research and review hazard information to ensure that proper technology is used to achieve optimum safety, management is of little benefit, and can actually decrease the amount of knowledge available to the project.

ILLUSTRATION #4

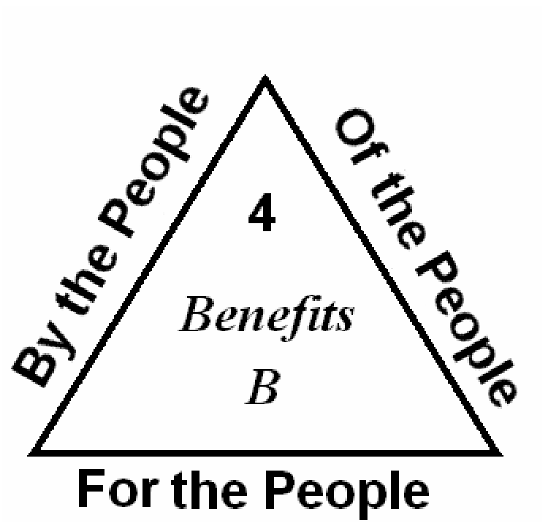


The third face of the pyramid denotes **safety**, which includes engineering and design to achieve hazard prevention. In most circumstances, good engineering can develop safe design. When engineering fails to provide design that overcomes any hazards revealed in side one (determined by poor performance) or in side two (by poor management), hazard prevention is difficult to achieve.

ILLUSTRATION #5

The goal is to look at the bases of sides 1 (value), 2 (knowledge), & 3(safety) and achieve a safe design as a financial necessity. The base of the pyramid (side 4) shows the **benefits** of safety. These benefits serve all the people involved in all aspects of construction, from developer to ultimate user.

ILLUSTRATION #6



When these three triangles are folded into an equilateral pyramid, each leg of them shows a relationship. For side one, **value**, cost parallels with information. On side two,

knowledge, technology parallels design (side three), and engineering (side three) with utility on side one. The base of the three sided pyramid is formed by sharing the word on the bottom of the three previous equilateral triangles, which line up as follows:

Performance is “by the people”

Management is “of the people”

Hazard Prevention is “for the people”

This equilateral pyramid provides a visual three-dimensional aid to show the relationship of safety in the marketplace. It is constructed to visually show that “design safety” is a viable function of the construction marketplace.

ILLUSTRATION #7

When one or more of the nine above listed components of **value, knowledge, a**nd **safety** are omitted or deleted, the construction market becomes unbalanced and the cost of failure renders the goods or services to be created by the construction project as uneconomical. The construction marketplace responds to the cost of a hazard that results in personal injury, property damage, loss of production, cost of insurance, government fines, and legal costs of defense litigation, settlements, or court awards.

The term "risk" is a misnomer, as the actual cause of failure to eliminate hazards stems from ignorance, oversight, negligence, greed, or criminal behavior. It is a term that has been used to transfer the costs of failure to other parties. It arose from the financial practice of insurance, or "bonding" to cover monetary losses from any failure. Since we do not live in a perfect world with perfect people, hazards (a form of failure) continue to exist, and are considered a pass-through cost.

As previously stated, a traditionally pervasive industry mindset often clouds the assessment of hazards and focuses on personnel actions, portraying an unsafe act as the primary cause of injury or failure. It is important to recognize that a fine line exists between personal irresponsible behavior that deliberately gambles with a known hazard, compared to circumstances which create an incentive or reward for the victim's chance taking, or contain error provocative conditions which entrap but are not perceived as dangerous. Failure from either misbehavior or defective design *costs money* and *time.* Error free design eliminates such losses.

The cost of failure caused by hazards can be considered to increase exponentially where foreseeable misuse or entrapment occurs. A dramatic example is the Tropicanna parking garage collapse in Atlantic City, New Jersey, which killed four people and injured 21. Four levels fell due to an omission of rebar steel in the shop drawings, failure to imbed web mesh with columns, failure to connect the vertical steel in columns/walls to the longitudinal rebar and inadequacy (and premature removal) of shoring to support wet concrete slabs being poured and cured. While material shortcuts are obvious causes of failure in this example, this can be considered entrapment by a hazard due to inappropriate curing practices and unconnected steel beams. Litigation was settled for $101 million, spread among several defendants who were responsible for overseeing the project. Such spikes in costs candidly illustrate the necessity of both construction management safety involvement and design safety as an integrated part of project costs. The pyramid illustrates a relationship whereby the probable cost of prevention and failure can be anticipated. When the cost of failure exceeds the cost of design, it provides a starting basis for funding safe design. The conventional business philosophy that insurance will pick up the cost of failure is an outmoded concept, as insurance is a system which profits on an anticipated rate of failure and becomes a “tax” on the marketplace. Insurance premiums determine the cost of anticipated failure and add the cost of conducting this business plus a profit for the insurance company. In all reality insurance becomes a “tax” that every construction employer must pay. This pass-through cost affects the bid price, as contractors have been known to pad their bids to address unknown costs that may arise during the course of construction. Such estimates may be so high that the developer may choose to cancel the project due to high estimate costs. A safe design that identifies the anticipated hazards and design control can eliminate speculation from the venture. An absence of safe design in the bid proposal leads to costly failures and litigation at a much higher rate than when safe design measures are included in a project's initial plans. There is an old saying that when a hazard hits the fan it is often unevenly distributed to affect the landowner, architect, engineer, general contractor, or equipment manufacturer, rental firm, and even overcome the immediate employer's protection of workers compensation. When tower cranes topple or long reach cranes upset, bridges collapse or shoring for cast-in-place concrete buildings fail, or structural steel framings collapse, the losses are going to be catastrophic; and ultimately the design and/or scheduling is found to have been lacking.

The relationship between the values described in the pyramid offers a three-dimensional illustration of how the marketplace provides a clear incentive for inherently safe design or construction planning with engineering. Management and designers must determine whether the value includes performance, and that knowledge was managed to ensure that the design includes hazard prevention. Management needs to become aware whenever a pattern of misuse or entrapment arises, and should consider that reliance upon user behavior to avoid the hazard does nothing to eliminate the original cause of injuries, fatalities, damage, or loss of production. Liability can involve exemplar awards (punitive damages) as a means to send a message that something needs to be done to stem the stream of injuries, death, or damage.

The court exercises its right to impose punitive damages, particularly when it is shown a history of unheeded hazards and an intentional lack of provision for safe design when reasonable safe design could have been provided. The current state of a so-called "liability crisis" that requires caps on awards allows the marketplace to tolerate hazards that could be removed by design. Thus, the market is manipulated to sustain costs of industry failure that are needlessly high, robbing middle-class workers and laborers of the benefit of a safer workplace. The high cost of repetitive failure from the same hazard, in the form of punitive damages or costly legal services, should be seen as a facilitator that lets the construction marketplace **create a financial incentive for safer design**. When management realizes that the cost of “defending hazards in court” is excessively higher than elimination of the hazard, lower overall costs (and larger profits) associated with design safety become a priority. In the mid 1970s there were numerous third-party personal injury claims filed against crane manufacturers for the injustices resulting from two-blocking. Two-blocking occurs when the headache ball on the end of the hoist line is pulled up to the boom tip, usually resulting in a damaged or broken hoist line which causes the load to fall, which can result in injuries or death.

By the 1980s the excessive cost of these claims brought about the provision for anti-two-blocking devices as standard equipment. The adoption of this safety appliance was done without an industry-wide OSHA requirement, and now it is almost impossible to find a crane in use today that lacks an anti-two-blocking device. The lesson to be learned is that many lives could have been saved with a tremendous cost reduction had crane design safety been made a priority when cranes were first developed. See Appendix A-3 concerning a summary of two-blocking litigation.

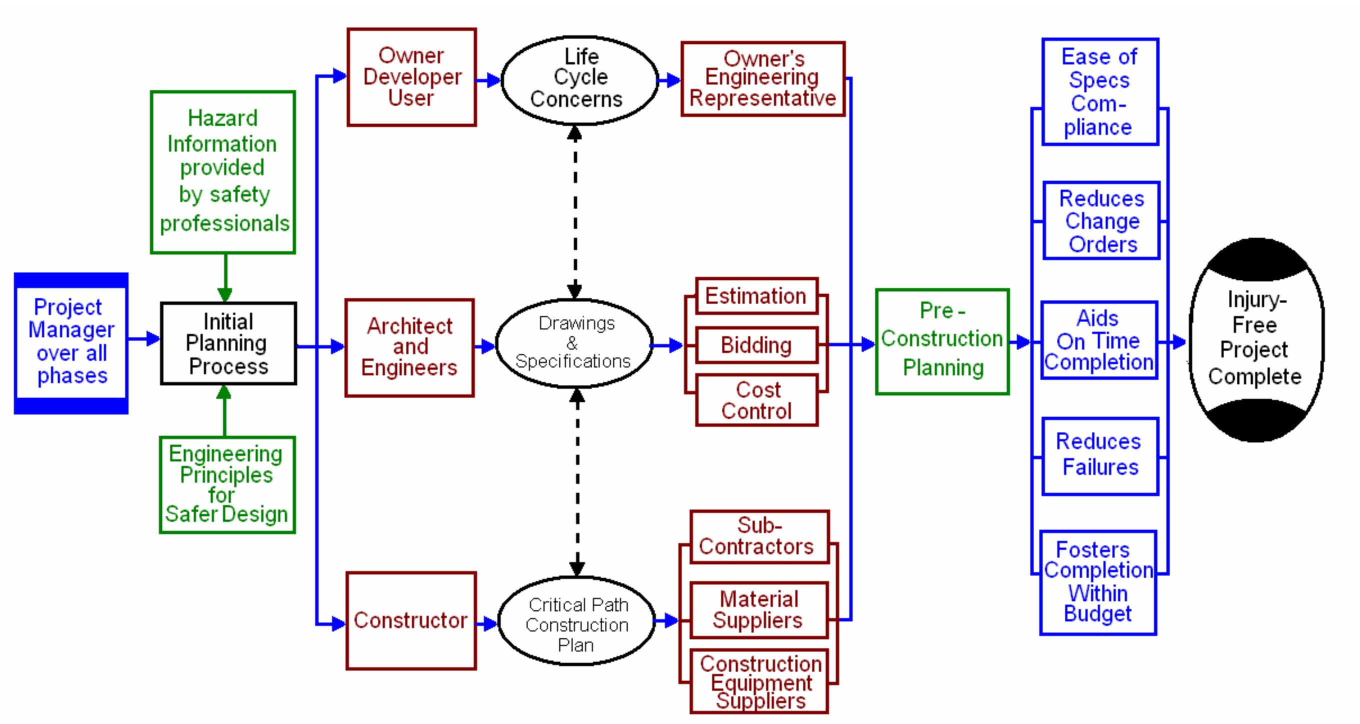
Such an incentive, being naturally achieved with market equilibrium, is a clear path to decreased costs and increased profits in construction and related industries. Efficiency achieved by safe design is a time tested concept. Beginning in the 1950’s the US Department of Defense knew that they could not tolerate missile failure from defective design. In 1963 the US Air Force instituted the first military specification for system safety. By 1969, DOD adopted system safety as a military specification. The construction market cannot continue to tolerate failures (hazards) that result in injury or damage. Investment management must consider the message that the marketplace can increase profit with design safety.

The role of the construction manager has taken on new responsibilities. He or she can no longer assume that the means and methods of the subcontractor are acceptable as long as the work is completed on time and meets design specifications. The old time “lean and mean” general contractor who does not interfere with the subcontractors’ operations is evolving into a new stakeholder in the construction process, and as such, must ensure that sub-contractors’ proposals, plans, and schedules uphold a safe work site. Increasingly common in construction enterprises is the notion that the “buck” stops with the general contractor and construction manager. Active safety participation and oversight by these entities has become a must, as this action produces a clear chain of responsibility for both safety and task completion.

As construction becomes more complex, there is a growing demand for “safety engineers” who have the skills to participate in design, understand the myriad of mechanics encountered in excavations and tunneling, have knowledge of cost estimating and familiarity with project scheduling. The process of just inspecting for hazardous conditions when they arise is not enough. The new requirements of safety engineering make one able to forecast and predict hazards and abate them before they occur. The research report “Inherently Safer Design Principles for Construction” by the Hazard Information Foundation, Inc., funded by the Center for Construction Research and Training (CPWR), and expanded into the book *Construction Safety Engineering Principles,* published by McGraw-Hill (2007) provides a well recognized process to ensure for safe design of both construction equipment and the facility being built. Leaders in this proactive, safety by design movement have been the Washington Group International, a division of the international design and build firm URS. Where the industry standard for days lost from work per 100 workers per year hovers around 2.1% for engineering and construction, statistics for divisions of the Washington Group International show the rate for them is less than .1%. Washington Group, who is training 1,800 of their engineers in methods of safety by design, was recently contracted by CH2M Hill Construction to train a group of their engineering personnel in safety by design. Other firms who have retained Washington Group to provide safety by design training include Exxon Mobil's process for extracting fuel from Canadian oil sands, and government agencies such as NIOSH and NASA at the John Glenn Space Center US. The US Army Corps of Engineers has also become aware of the value of this training through projects being built by the Washington Group.

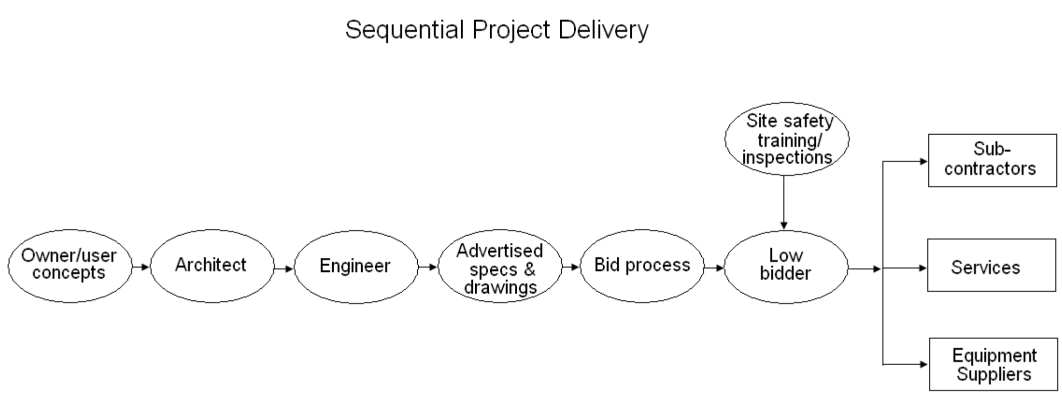
Consider that for years, construction averaged 20% of total workplace fatalities reported to DOL, when it comprised only 5% of the workforce. Even though all fatal injuries have generally declines over the last few decade, this alarming record indicates that a new direction is needed to improve the construction marketplace with an increased emphasis on design safety. New methods are springing up every day. Progressive Project Delivery, a method that relies on increased communication and a single overseer and streamlines both the costs and process of construction, takes steps to avoid hazards during the design and planning stage. Conventional linear project delivery methods isolate the owner, architect, constructor, and sub-contractors into separate identities with little communication between parties. Incorporating safety as a design function affords initial and continuing oversight for the identification and control of hazards. See Illustration #8 where construction management starts at the time of design and puts the owner/developer/user as co-partners with the architect/engineer and the constructor. In this manner, both hazard information and engineering principles for safe design are introduced in the initial planning process and continued until the project is completed.

ILLUSTRATION #8



Compare this dynamic process to the traditional project method depicted below.

ILLUSTRATION #9



A priority for safety at the time of design and construction planning can be considered a profit center. The involvement of the project manager is to ensure for his or her personal oversight of the entire chain of sub-contractors. The role of the safety engineer is to be an advisor and provide technical support to the project manager. Today the engineers who design products, equipment, facilities, and systems, or are in charge of the assembly, construction, and operation have a unique role of applying available technology to eliminate hazards and avoid add-on costs and troublesome compliance supervision. The twenty-first century will bring many changes in civil work infrastructure projects by integrating safety as a critical function of the construction marketplace. This will enhance safety as a key issue in the development of all new enterprise, particularly in the development of alternate energy sources. When safe design is included as the true “low bid”, it is in sharp contrast to the bid that does not include safe design and makes no estimate of the cost of change orders for safe design plus the cost of injuries from uncontrolled hazards. The task is not to saddle the designer with the tedious documenting of a speculative process but to identify possible costs that can arise from an unsafe design. Only sufficient documentation is necessary to advise management that the *ball is now in their court*. The previously referenced research study “Inherently Safer Design Principles for Construction” (expanded into the book *Construction Safety Engineering Principles*) provides a sound methodology that includes a matrix (see Illustration #10) laid out on a grid for easy identification of hazards during the planning stage of a construction project. This tool corroborates each concern identified in the equilateral pyramid.

Illustration #10

	Eliminate the Hazard		Guard the Hazard		Provide a Safety Factor		Provide Redundancy		Provide Reliability
	Hazard	Safety	Hazard	Safety	Hazard	Safety	Hazard	Safety	
Natural									
Structural/ Mechanical									
Electrical									
Chemical									
Radiant Energy									
Biological									
Artificial Intelligence									

The designer's new task of estimating the cost of failure from a hazard can be a daunting undertaking. However, a model estimating the cost of safe design versus cost of potential failures overlooked by unsafe design is indispensable to the creation of a market model that fully utilizes the cost benefits offered by safe design and planning. Data calculated from input detailing parties and duration of exposure to a hazard can create a basic **thumbnail** appraisal that will usually provide monetary justification for safe design. A refinement of this appraisal can determine a dollar value. Such results can exceed millions of dollars if there is a probability that exposure to the hazard can produce lifelong crippling injuries and/or death. Hospital costs and lifetime support medication are not cheap. Further, a defective product/construction can result in the workers' compensation carrier's desire to subrogate their losses (expenses) with a claim against the manufacturer of the defective equipment, resulting in monumentally increased loss[5].

[5] Chapter 15 in the previously mentioned reference text *Construction Safety Engineering Principles*, "The Economics of Inherently Safer Design", provides an easy format for equipment designers to develop a ball field estimate of the cost of even a rare event failure.

Many factors arise when determining the civil rights of the public and the individual as they relate to inherently safe design of construction, production equipment, and the methodology used to manage the construction process. It is difficult to identify what beliefs negatively influence the realization that worksite perils must be eliminated. To assume that injury and death is part of the relationship between construction workers and machines is to allow technology to become an exploiter of people, not the beneficial uses it was developed for. During the building of the Panama Canal, Theodore Roosevelt, the then-president of the United States, addressed this same issue with the following statement: "As modern civilization is constantly creating artificial dangers to life, limb, and health, it is imperative upon us to provide new safeguards against these perils." Alvin Toffler, the celebrated author of *Future Shock*, *The Third Wave,* and other widely read books has consistently written many historical examples that "a corporation is no longer responsible for making a profit or producing goods but simultaneously contributing to the solution of extremely complex ecological, moral, political, racial, sexual, and social problems[6]." Therefore, where design creates an unsafe behavior, provision of an alternative safer design should be an intractable responsibility of the developers. Swing-away jib booms on telescoping hydraulic cranes have a jib stowage system that relies solely upon worker performance to correctly insert an anchor pin. This design defect has resulted in multiple deaths and injuries. Worker behavior is clearly not the problem. Hazardous design is. Analysis of the anchor pin assembly shows that the worker experiences both poor access and the difficulty of seeing whether the anchor pin is properly placed. Review of a number of such systems (developed by multiple manufacturers) shows that the current design available to the market place is error provocative and unsafe. Alternate design could incorporate an automatic latching system

[6] *The Third Wave*, Toffler, 1980, William Morrow and Company, pp 252.

that is failsafe, and must be encouraged. See Appendix A-4 for additional information on why this hazard is not eliminated by design.

Observations

Examination of workforce trends presents a frightening development that necessitates new perspectives on design safety and new worker training. During the last three decades, personnel with skills in trade crafts have radically diminished. The "old timer" baby boomer workers are retiring. Those who remain often take up the slack by working overtime, which leaves few qualified workers to mentor the newcomers. Add this fact to the decrease of employment tasks previously performed by human workers as machines and automated systems are increasingly relied upon to do the work, and the level of skill and knowledge in many trades is rapidly dropping. A good visual representation of the current workforce climate is a mountain slope with a gentle incline to the top and a clifflike precipice with a steep falloff on the far side. All of a sudden, industry will be confronted with a dramatic worker falloff of employees, as few qualified workers are available to keep production going.

New employees without the benefit of mentors or experience in the field are not adept at how to identifying even common hazards that may arise on the job or protecting themselves against them. In the past, the skilled craft workers were aware of hazards inherent to construction equipment and unsafe methods of erection, and were able to avoid the hazards most of the time. As construction equipment and methods become increasingly complex it becomes foolhardy to assume that construction crews will be able to identify and avoid hazards. Therefore, it is necessary for all equipment used in the project to include a hazard analysis as a function of design or planning. Both designers of construction equipment and engineers who manager construction projects need to "look upstream" to ensure that both design and methods do not rely upon the assumption that the new workforce is seasoned enough or have had sufficient training in hazard identification to be able to avoid injuries. Provision to overcome hazards by design and construction methods is vitally important with today's inexperienced workforce. Today's world requires innovative training of both engineers and the new workforce to ensure for the continued productivity of construction and the extraction of natural resources for energy and materials. As proven in the successful training of airline pilots, the use of simulator technology is an invaluable tool in both initial training and retesting. With the high cost of construction equipment, use of this technology would be a cost saving asset and should be applied to the fullest extent. Schools of engineering, particularly in the disciplines of civil, mechanical, and electrical fields need to teach a method of design that goes beyond compliance with existing standards. As a new generation of engineers develops skills that anticipate hazardous conditions and circumstances, applied technology will find new uses and change the face of construction and industrial safety. In time, this movement could eliminate repeated worker training drills and reminders as unnecessary hazards in equipment and processes are identified and removed and inherently safe design becomes a more integrated process.

No longer can the developers and financers only enjoy the isolation from reality in the comforts of the board room and executive offices. They must understand that *their lunch will be eaten* with the monumental costs of foreseeable hazards that lead to construction disasters. Reliance on outmoded minimal standards and assumption that government can avert disasters with inspection is a folly. *The buck stops with management* to ensure for safety by design and planning.

Inherent to most engineering philosophies is the idea that warnings and operating instructions are sufficient to ensure for safe design. The hierarchy of safe design has changed to including only the following four steps:

1. Eliminate or substitute design to prevent a hazard.
2. Guard against the hazard so it cannot cause harm.
3. Provide a safety factor that exceeds possible overstress.
4. Provide redundancy if design features to prevent the hazard from causing harm to any source.

The use of warnings is only an admission that a hazard exists. This “warning” should not be placed on the hazard but should be used as a tool that alerts management and design personnel of the presence of a design flaw. Far too often, managers and designers assume overcoming an error provocative design only requires the “personal responsibility” of the user to heed the warning and (often unclear) instructions. The heart of this syndrome comes from the fact that management personnel may lack knowledge of the dire consequences of hazards. In fact, litigation is proving that management consistently makes insufficient effort to find out that reliance on users’ performance is a recipe for disaster.

Unfortunately, a “ritual of denial” that denies the presence of hazards and avoids the acceptance of ideas to integrate safer design features into the worksite is the prevailing attitude in many major construction and equipment firms. Investigation into this seemingly staunch refusal reveals some almost oxymoronic reasons. Advocacy resisting the use of safety engineering technology usually centers on the question of who will pay for the change. The primary concern is the presumption that innovation initially raises the cost to the purchaser, which may hinder the sale of equipment that comes with safe design features as standard. Trade groups act as advocates to “protect” purchasers such as contractors and equipment rental firms while equipment manufacturers joins the anti-safety-feature advocacy because they recognize that safety is a hard sell to the purchaser on a budget. The most common argument purported by these parties is a challenge to the reliability of said safety feature. Arguments are made that safety features are not one hundred percent reliable. Such a reliability concerned argument exposes the fallacies in reasoning, as the reliability of “programmed” or trained human response is nonexistent. Consensus standards are written by groups dominated by the parties most likely to assume an economic loss if technology is adopted. For instance, manufacturers are fearful that if the feature becomes standard, a cascade of claims and lawsuits could be raised against them because the safety feature was omitted from earlier models. If these standards are suggested to be included in a government regulation, it becomes almost impossible to secure acceptance at hearings or with study groups as a result of the unfounded fear that responsibility leads to liability. As the saying goes, “you can lead a horse to water, but you cannot make it drink.” Sound safety technology has been dismissed due to industry pressure and a single-sighted emphasis on low initial costs. This process of systematic rejection of safety features only extends the time lag in overcoming a hazard by design. In any event, the process to adopt engineering technology to control hazards at the level of a government requirement usually fails to gain universal support. It is also known that professional societies have opposed safety by design in two ways. First, the design engineers are inclined to leave the means and methods to the erector and avoid collaboration on safety issues. Second, members of the safety profession, who predominantly are not engineers, have opposed the states’ role in licensing safety engineers, as they fear employment competition rather than valuable support. This action leads to a dearth of uniform knowledge and up-to-date safety ideas. The key to reversing this issue is to show a clear economic benefit to the manufacturers. Design safety must be embraced by the marketplace for any substantial progress to occur.

Our courts are not an infallible institution, as the justice system is made up of people who are vulnerable to political and social pressures to conform to current and popular ideologies. In all reality, justice usually prevails. Justice Learned Hand of the 12th District US Court ruled on the famous, precedent-setting T.J. Hooper case in the Circuit Court of Appeals of the United States, Second Circuit 1932, 60F2d 73. This case involved the loss of two cargo barges set adrift at sea in bad weather. The tugboat company towing the barges was without a radio receiver to hear the news of the US Coast Guard's storm warning. When the storm weather endangered the tugboat crew they cut the tow line and escaped to the protection of a safe harbor. Justice Hand overruled the two main arguments of the tugboat company to render a verdict to the plaintiff (owners of the barge cargo). To the first argument that radios were unreliable, thus could not alert mariners to bad weather all the time, he countered that knowing about bad weather some of the time was better than knowing none of the time. To the second argument that none of the industry used radios on their tugs, he said that lagging standards of an entire industry was not a valid excuse to not adopting lifesaving technology.

Justice Oliver Wendell Holmes' famous statement, which still retains great currency, pinpoints the frailties of our justice system, which reads as follows: "The life of the law has *not been logic*: it has been experience. The felt necessities of the times, the prevalent moral and political theories, institutions of public policy, avowed or unconscious, even the *prejudices* which Judges share with their fellow-men have had a good deal more to do than the syllogism in determining the rules by which men should be governed."

The issue that "safety" is a civil right was reviewed by the United States Supreme Court and was *unanimously* rejected as a concept in the case of *Collins v. Harker Heights*, 503 US 115; 112 S. Cr.--; 117 L. Ed. 2nd 261 (1992). The opinion was authored by Justice John Paul Stephens. (At that time, the US Supreme Court was comprised of Chief Justice Rehnquist, and Associate Justices Byron White, Harry Blackmun, Sandra Day O'Connor, Antoin Scalia, Anthony Kennedy, David Souter, and Clarence Thomas in addition to Stephens.) Mrs. Collins' husband was a sanitation worker for the City of Harker Heights, Texas. He was directed by a supervisor to enter a confined space for the purpose of unplugging a sewer main. He died of asphyxia. His wife filed a lawsuit brought under the Civil Rights Act of 1871, the principal vehicle for vindicating the deprivation of Federally-Constitutionally guaranteed rights by State actors. Her Complaint alleged that her husband "had a right to be protected from the city of Harker Heights' custom and policy of deliberate indifference toward the safety of its employees. Her Complaint further alleged "that the City violated that right by following a custom and policy of not training its employees about the dangers of working in sewer lines, not providing safety equipment and job sites, and not providing safety warnings." The Complaint further alleged that City had actual knowledge of the hazards of confined space entry because Collins' supervisor had lost consciousness on a different project some months earlier, and "that the City had systematically and intentionally failed to provide the equipment and training required by a Texas statute. The court's reasoning is questionable, since the Constitution refers to "welfare" and does not use the word "safety". The real issue appeared to be that the court was reluctant to hold local government responsible for a transgression of this nature. It is believed that in due time this stumbling block will be overcome, as it is recognized that a government “for the people” includes safety as a civil right.

State courts, too, often err on safety issues. In the matter of *Jackson v. Bomag* GMBH 836 NYS 2d 819 (NY App., Div 1996) ruled that the defendant, a German manufacturer of road rollers, did not have to provide ROPS as standard equipment. The trial judge who dismissed the case was unaware that the US manufacturer had been held accountable for the same hazard in other states, setting a precedent for the court. A number of previous litigation concerning the absence of ROPS on similar road roller cases in other states had ruled in behalf of the victim. To this day, OSHA does not require ROPS on road rollers even though their absence contributes to a number of fatalities each year. (See Appendix A-1)

The good news is that US manufacturers currently provide ROPS as standard on new equipment. The bad news was that a one-half page article appearing in the August 19, 1996 issue of *Engineering News Record* (page 33), reports that Judge Rose dismissed the case, and his ruling was upheld by the NY Court of Appeals, which clears the manufacturer of liability. It appears that Judge Rose’s dismissal of the case and the failure of the NY Appeals court to recognize the magnitude of the hazard denied recovery of any type to the deceased’s family. Actions such as this send a wrong message to the public that design safety is unnecessary.

Conclusions

1. The philosophy that construction injuries are just part of a cost of business for the erection process is no longer viable. With the rapidly developing new

technology in construction, it should be unfathomable to assume that "accidents" are just part of the construction process. The luxury of "waiting to see what happens" is creates a time lag that kills too many people. New construction disasters reported by the news media on an almost daily basis show the need to change to improve construction management. The marketplace cannot afford the bankrupting cost of construction disasters for a lack of ensuring for the use of safety engineering.

2. Throughout human history, natural environment has determined behavior, and as civilization began, society organized into a social structure. Civilization brought rules and laws. In today's world with the advent of construction projects, machines, design, erection planning, materials, and the facility being built all become factors in an environment which determines worker behavior. The *context* in which the machinery used during the construction process can create a hazardous environment in which the worker may not be able to reliably cope. Use or operation changes working behavior, and behavior dictates what design should be. If the machine creates opportunities for worker error, the design of the machine must change to eliminate any such opportunity. The only solution is to ensure for safe design of construction equipment *before it enters the marketplace,* and no construction project should commence before all aspects of a project are examined and hazards are abated.

3. Before the erection process begins, hazard analyses must be able to ensure that design includes features of both safe constructability and life cycle use.

Construction equipment is complex and costly, and hazards need to be removed to avoid user error. The skills to identify these hazards and to ensure that hazards cannot cause injury or damage is a reasonable expectation. These same skills for hazard prevention are practical for those who design, plan, and manage the construction process. Materials and components should be examined for hazards, and non-hazardous substitutes provided. Safety must be an overriding priority of the facility being designed.

4. Management's cost cutting philosophies can make for a love/hate relationship with the idea of training and usually reveal a stunning lack of respect for the labor force it employs. Behavior-based training to encourage the employee to curtail negative "unsafe" actions is the most widely used element of workplace safety programs. The idea that workers are capable of learning how to act in a limited set of circumstances while simultaneously incapable of grasping a new set of skills for the further promotion of their well-being is outmoded. Training should be expanded in the field of engineering or technical advancements that, when applied properly, enhance the safety benefits of such technology. In today's workplace, a vital element of training is to provide information of available safety devices and alternate safer design.
5. Hazard identification training of the workforce is becoming an inevitability. Educational opportunities to integrate this point for both executives and engineers becomes a must. Construction equipment designers need to have

workshops on how to identify and control hazards as a function of design to eliminate the time lag inherent with improving design *after* injuries occur. Construction managers need to know that their role is to learn the value of looking upstream to eliminate hazards when selecting construction equipment. This need for training needs to be extended to project financing of new facilities to be built, suppliers, and even our black robed presiding judges. Trade apprentice programs need to include the basics for hazard identification and control. Construction methods and equipment are much different than they were just ten years ago, so retraining the experienced construction managers is an immediate imperative.

6. The role of the safety engineer will be expanded to involve a great deal more than to ensure for OSHA compliance. As companies look upstream at the design, the first priority is to determine whether the machine or facility will be safe for its intended use and foreseeable change of use. Construction of infrastructures such as bridges to processing facilities is never truly finished. When completed, maintenance and upgrades involve future use of the construction process. This requires a review of the original design to determine whether it can handle the changes involved in remodeling. Even during construction, shop drawings and change orders deserve a second look to prove that they were indeed reviewed and found to be safe. The safety engineer becomes an auditor of design and the construction process to ensure that what was specified was appropriate and correctly installed (were explosion-proof fans for a battery specified and installed?) There is a great

need for our colleges of engineering to include *safety engineering* as a degree program that provides the tools (in the form of course materials) to students, so when they enter the construction field they have the expertise to be innovators, and also (as the term goes), "inspector generals" that ensure that safety is part of design, planning, and the actual construction process.

7. Profit incentives drive the marketplace. The time lags that occur when waiting for sufficient injuries/ damage to occur to identify the hazard offers little priority for safer design. The carrot (incentive) needs to be devised so rewards are promptly discernible. The cost of safety features up front should show immediate returns in reduced construction costs. The concept of relying upon previous experience of injury and damage needs to be reexamined to develop projections of how each safety feature can reduce the probability for failure (commonly mislabled as "accident"). Electronic navigation systems and pilots trained in their use has been a boon to commercial aviation. Likewise, electronic Load Moment Indicators (LMIs) on cranes and operators trained, tested, and certified as competent in their use can be a boon to the construction industry. The contractor who submits a bid proposal stating that cranes will be equipped with LMIs and crane operators are certified as competent in their use provides an added value to hoisting operations at the job site. This is just one example of many that show how safety features will increase construction performance in addition to reducing injuries. See Appendix A-5 and Appendix B for more information on outrigger positioning sensors.

Appendix A

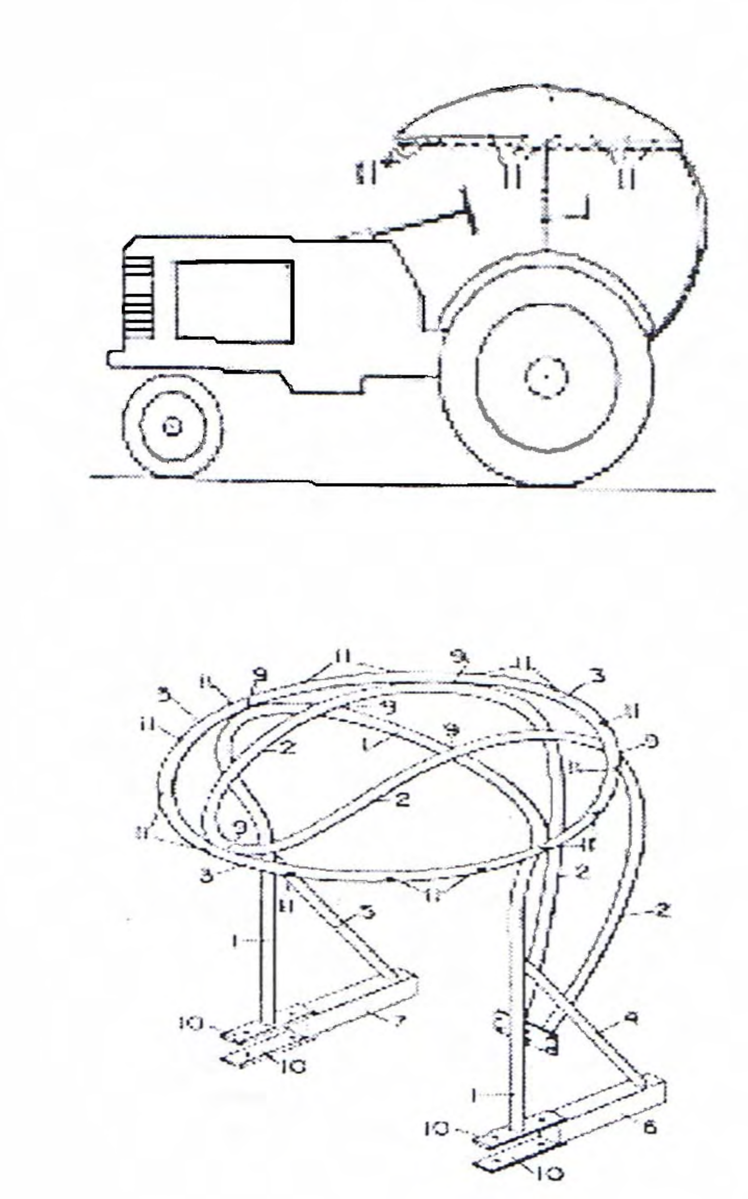
This appendix provides several examples of hazards that were never controlled by design requirements or construction planning, even when a time lag spanning a large number of years existed. Such an approach to design without safety is ludicrous. Waiting until injuries occur before the hazard can be eliminated by design can be compared to the foolish practice that necessitates a sufficient number of collisions at an intersection before a traffic light is installed. Hazards are predictable, and design improvements should not depend upon verification of sufficient injuries before the design improvements are installed.

A-1

Tractor Rollover Hazards

During the middle of World War I (1916-17), both wheel and crawler type tractors were being developed and marketed to farmers, construction, and other industries as a replacement for horses. It soon became apparent that three-wheeled farm tractors could easily tip over sideways, and could also tip backwards when the large drive wheels could be caught, "gearing over" the tractor. Starting in 1916 some patents were issued for protective canopies. In is interesting to note that patent # 2,921,799 filed in 1958 by, F. P. Hutton of Lincoln, Nebraska, a woman without any engineering experience but who saw the need for protection and created a design for a steel canopy that looked like a bonnet, because she was tired of seeing her friends killed from tractor overturns. Illustration #11 shows her original patent drawing.

Illustration #11



Several articles regarding the widespread danger of tractor rollover were published in the 1920s[1], but tractor manufacturers ignored the issue until the 1960s. The first design drawings for rollover bars were developed by University of Southern California but withdrawn from circulation at a farm safety conference because of a lack of standards necessitating rollover protection and a fear of liability purported by the

[1] "Kinematics and Dynamics of Wheel-Type Farm Tractor" 5 articles by E.G. McKibber, Feb-July 1927.

University’s legal counsel. It is outrageous that the legal profession will abet the construction and manufacturing industries’ disregard for engineer expertise on structural designs and ignore the sanctity of human life due to the absence of rollover protection, effectively saying that it is better to endanger lives than to speculate that money could be at risk. The focus on design should be on reducing hazards, not whether the hazard is covered or not covered in existing regulations. The US Constitution has created a provision for the “welfare of our citizens” that becomes a contradiction when provisions for safety features are deleted and manipulated by parties totally unknowledgeable in design engineering.

Finally, in the 1970s, crawler tractors and wheel loaders and scrapers started becoming equipped with Rollover Protective Structures (ROPS) as standard equipment. As older models without ROPS are steadily declining, today rollover fatalities for this equipment are practically nonexistent. Road rollers and compactors are still lacking ROPS, and continue to be the source of rollover injuries and fatalities. A brief summary of roller/compactor occurrences identified in a sample of 91 litigation discovery cases from 1971 to 2001 is as follows:

- 38 (41%) resulted in fatalities
- 28 (31%) resulted in serious injury
- 7 (8%) resulted in no injury, as the operator was able to escape
- 17 (18%) insufficient data was available to determine the outcome.

The good news is that US manufacturers now provide ROPS on all new road rollers as standard, regardless of the lack of OSHA requirements and the inappropriate court ruling in the State of New York, as previously discussed in the Jackson v. Bomag case. This ruling created much press for the anti-safety viewpoint. Such a ruling continues and condones the anti-safety legal tradition.

Appendix A-2

Crane/Aerial Lift Powerline Contact Hazards

Powerline contact still remains a principle source of construction fatalities and gruesome injuries. These occurrences often become the basis of third party injury liability. Defendants often include the landowner, general contractor, rental agency, electric utility, and any party who had the opportunity to intervene and alter the circumstances surrounding the occurrence. As a result, the ritual of denial holds strong along the entire chain of command, as each defendant's legal counsel seeks to blame the victim or shift their liability to another party in their arguments.

Current focus on hazard appears to be the extension the visual thin air clearance from its current 10 feet to 20 feet from any live powerline, rather than to mandate a removal of powerlines from any long term construction site. Short term exposures of cranes and aerial lifts to powerlines should include rules that identify the danger zone on the ground so that all can be aware of the danger zone and restrict the lifting with a crane outside the danger zone.

Illustration # 12

Map and Barricade the 30 foot wide Danger Zone (15 feet on each side of the powerline poles).

Details on how to map the danger zone have been well publicized[2] and should be included as OSHA regulations. There a number of safety accessories, such as insulated links, proximity alarms, range limiting devices, and protective insulated baskets with protective insulated frames or cages. All of these innovations have a value in preventing or protecting against powerline contacts that maim and kill. Instead of hiring lawyers to defend these occurrences and allege that none of the above listed remedies are practical or reliable, it is far less costly and exceedingly more humanitarian to include the appropriate safety feature or practice as a job site requirement.

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[2] Published information includes: MacCollum, David V., *Construction Safety Engineering Principles*, McGraw-Hill, 2008. Chapter 7: Crane Hazards, Section 6; MacCollum, David V., *Construction Safety Planning*, John Wiley and Son, 1995, Page 89; "Safety Interventions to Control Hazards Related to Powerline Contacts by Mobile Cranes and Other Boomed Equipment", study performed by the Hazard Information Foundation, Inc. (2004) for the Center for Construction Research and Training (CPWR); MacCollum, David V., *Crane Hazards and Their Prevention*, ASSE, 1993.

Appendix A-3

Crane Two-Blocking Hazards

In crane operations, when the lower load block (or hook assembly) contacts the upper load block (or boom point sheave assembly), there is sometimes an inadvertently applied life-threatening force that breaks the hoist cable and causes the load to fall.

A sample of 110 two-blocking injury litigation records for the period of 1969 to 1998 show:

- 25 (23%) fatalities
- 85 (77%) serious injuries

It should be noted that the discovery process allows the depositions of defendants to determine their knowledge of previous occurrences. In such circumstances the defendants have a record retention program which allows destruction of records after three years to create a shrinking, deceptive record of injuries. Defense attorneys are inclined to minimize these records further so that they have nothing to disclose. This practice was designed to suppress both public knowledge and private records and disguise the length of the chain of disasters caused by two-blocking.

Nevertheless, throughout the 1970s and 1980s, litigation from injuries caused by the lack of anti-two blocking devices cost billions of dollars in damages to crane manufacturers and construction companies. The effect of these persistent, accumulative lawsuits was to motivate the industry to take action independent of OSHA.

In the mid 1980's, an OSHA hearing was held for rulemaking and anti-two-blocking devices were required only when personnel were being lifted. By the mid 1990s, virtually all US crane manufacturers voluntarily made anti-two-blocking devices standard equipment.

Appendix A-4

Crane Swing-Away Booms Hazards

To provide insight into the widespread hazard of swing away booms falling due to improper stowage technique, the following incident review is included[3]. This summary reveals the prevalence of anti- safe design attitudes and resulting discovery findings, which show how the manufacturer consistently fails to make worker safety a priority and continues the anti-safety culture.

Occurrence

On September 27, 2000, *the decedent* and three other persons including a mechanic, a laborer, and the operator of the crane cited in this occurrence were all struck by a falling jib boom believed to be safely anchored in the stowage position. The decedent later died from the injuries he sustained from the falling jib boom. He was working in the course of his employment with *a roofing company*. During the reroofing of a *paper plant*, it was found that a mobile hydraulic truck crane *supplied by a rental company* experienced malfunctioning hydraulics. The crane's jib boom was to be stowed for travel so that the crane could be returned to the rental firm for repairs.

The failure scenario occurred in the following sequence: The flatbed mounted mobile telescoping hydraulic boom crane featured a jib boom which folded back on the side of the telescoping hydraulic boom for travel. At the work site was a representative

[3] Report is edited to avoid revealing the actual parties. Changes in court testimony are marked by italics.

from the rental company, who was a mechanic and had no experience or knowledge of procedures on how to stow the boom; the crane operator; and a laborer who had no experience or training on how to safely stow the jib boom. Suddenly and without warning the jib boom fell from its assumed anchorage and struck the decedent and three other individuals, all of whom had no warning or perception of the danger. The decedent was struck on his head, which caused him to collapse to the ground and rendered him unconscious with catastrophic injuries. These injuries required months of hospitalization, rehabilitation, and caused ultimate death. The roofing company laborer who misplaced the anchor pin in the wrong anchor holes when preparing the crane for travel had no experience or training in the process for stowing the crane's swing-away jib boom.

As a result of this unsafe design of the jib boom stowage mechanism being an error provocative stowage system, the decedent was caused to suffer extensive personal injury, enormous hardship, mental anguish, permanent disability, and complications from his injuries that resulted in his ultimate death.

Materials Reviewed and relied upon

1. Depositions of:
    a. A mechanical engineer with the paper plant, who prepared the investigative report;
    b. The Rental Manager, the rental company;
    c. A laborer for the roofing company who swung the jib boom into place and unknowingly misinserted the securing pin
    d. A crane operator employed by the roofing company
    e. The senior vice president of the roofing company

2. Photographs of the truck crane in question.
3. Manual for the crane model
4. Jib boom operating instructions
5. Other depositions:
    a. The manager of product safety and reliability for the crane manufacturer in the matter of a similar lawsuit
    b. The Manager of Product Safety and reliability for the crane manufacturer in question during 1972 to 1976
    c. The Manager of Product Safety for the new owners of the crane manufacturing firm.
    d. The Manager of Sustaining Engineering for the crane manufacturer

Background Discovery

The occurrence of a jib boom falling from stored positions on telescoping hydraulic cranes has been known to be the basis of legal complaints since 1976. The sole reliance upon workers to unfailingly properly install the pin or pins meant to anchor the jib boom in a stowage position on the crane's main boom has created a seriously dangerous and hazardous circumstance. This hazard has been the basis of 21 legal claims for five deaths and sixteen serious injuries. The concept of overcoming hazards has often been expressed in the saying, "To err is human, to forgive: design." In the 20th century, humans have evolved from horse and buggy travel to placing men on the moon and ensured their safe return. Our technical leaps have fallen far short of including safe and reliable systems in machines used every day in the workplace. Laborers worldwide, and especially in developed countries possessing technology to prevent dangerous occurrences, should not have to wait until death and serious injury create a need to change design to overcome foreseeable unintentional human error. It is a well established design principle that any hazard resulting from error is always unreasonable and always unacceptable when reasonable design modifications will prevent the opportunity for a specific error to occur. Design that allows workers to misplace an anchor pin creates a potentially disastrous situation for both the worker and the job site. Improper pin placement may cause a jib-boom weighing 1000 or more pounds to come loose and fall from a height of eight to ten feet above the ground presents a catastrophic hazard to workers using the crane and workers working in the proximity of the crane. A gate type of automatic latching device that allows the latch to slide along a retaining bar on the main boom would eliminate the hazard. Likewise, a tracking guide to ensure movement of the attachment system in order to reliably determine the position of the boom when the telescoping boom is retracted so the anchoring pin holes will align to ensure for safe pin placement serves as a guard. In addition, visual alignment markers to inform both the worker and crane operator (at his station) that the anchor pin is in position to be safely and correctly inserted is a safety factor. A backup pin is a redundant safety feature. Such a design would provide four redundant design features for the jib boom anchor system that would be inherently safer and increase the safety of the worker.

Observations

1. The crane manufacturer has been alerted to this hazard in three previous legal complaints:

    - Filed 1988; US East. District, South. Div., MI, #88-72677
    - Filed August 2004; U S District Court South Carolina, Aiken Div. Columbia, # 1 04-21943-27

- ♦ Jefferson City Court, Div. 8, Louisville, KY, Civil Action # 99-CI-07293

2. A co-manufacturer owned by the parent firm has been alerted to eight similar occurrences by legal complaints.
3. Several personnel of the crane manufacturers have provided courtroom testimony and depositions that if the anchor pin is misplaced the jib boom is likely to fall from its stowage position on the main boom.
4. It appears that both of the two crane manufacturers have been owned by a single corporate entity for a number of years. Further, it is apparent that, rather than invest in the development of an inherently safer jib boom anchor system design, considerable investment has been repeatedly made to retain defense lawyers to tell the court and juries that the existing system is safe (if properly used). This ritual of denial does not promote a safer workplace, and is a deplorable and an unethical practice. Courtroom testimony in the Manor matter in the US District Court, Eastern District of Michigan, Detroit MI # 88-2677 reveals the following facts:

   a. Deposition of the Manager of Product Safety, 1972-1976, taken Monday December 11, 1989

   - ♦ *(Page 51, Line 18)* Q: Is it true that in the terms of design of this product and similar products that the manufacturer foresees that people will misuse the crane or use it in a manner other than which it is intended?

     (Line 22) A: We try to.

- *(Page 118, Line 21)* Q: Would you agree with me that a foreseeable worker misunderstanding or mistake if it's foreseeable should be in the design to prevent it?

  (Line 24) A*:* We try to do this.

- *(Page 118, Line 25)* Q: So you agree with my statement.

  (Page 119 Line 1) A: "We try to do that" Yes.

Deposition of Manager of Product Safety, 1972-1976, Tuesday December 12, 1989

- *(Page 25, Line 8)* Q: My question was, it's foreseeable that there is a risk of harm if the jib falls off unexpectedly?

  (Line 10) A: If the jib falls off there's a risk of harm.

b. Deposition of the Chief Engineer and Vice President of the crane manufacturer 1967, Friday December 15, 1989

- *(Page 80, Line 19)* Q: In your design, the man can do the job the wrong way, can't he?

  (Line 21) A: You can always do the job the wrong way.

- *(Page 97, Line 16)* Q: So now we have three ways that the jib can become detached in an unintended manner, don't we? Is that correct? Let me ask if you agree with this design principle in terms of fastening devices. It is true that the designer of a connecting or fastening device should foresee that at one time or another his design is going to fail and he should study the means of failure and try to eliminate them.

(Line 24) A: Where possible, true.

5. Deposition testimony originates from previous crane manufacturer litigation involving an unsafe jib boom anchor system.

    a. Manager of Product Safety, 1972-1976, US Court in Detroit, MI #88-CV-72677-DT

        - *(Page 13, Line 13)* Q: Do you have any idea as to the date that the jib boom attachment, used in this crane, was designed?

          (Line 15) A: Well, that would have been designed in 1967-1970 when the product was first—you know, as a product design.

        - *(Page 13, Line 19)* Q: Are you aware of any review of the design of the jib boom attachment that occurred subsequent to ’69 to ’70 when the product was first designed?

          (Line 22) A: You mean of a 4T-55?

          (Line 23) Q: Well; no, any review that was made of that particular design attachment?

          (Line 25) A: You mean this generic type of attachment?

          (Page 14, Line 1) Q: Yes.

        - *(Page 15, Line 7)* Q: Outside of that, there haven’t been any tests that particularly tested the jib boom attachment?

          (Line 9) A: Well, other than, you know, field usage over 23 years.

- *(Page 19, Line 1)* Q: Okay, so you have never used numbers in taking that factor of a person leaving the retaining pin out, in the design of a product?

  (Line 4) A: No, there isn't.

b. The Manager of Product Safety and Reliability after 1976. The US District Court of South Carolina, # 1:04-21943-24, matter revealed the following information:

- *(Page 43, Line 25)* Q: Did the crane manufacturer consider— consider redesigning the stowage mechanism in light of a previous incident?

  (Page 44, Line 4) A: Um, in light of a previous incident we certainly looked at the system again, and concurred, and reviewed, and determined the system was very rugged and sound and simple, and it was the injured who did not put the pin in that was the cause of the accident.

- *(Page 45, Line 1)* Q: Did [*the crane manufacturer*], those at [*the crane manufacturer*], ever consider a recall for the jib stowage mechanism, before August of 2001?

  (Line 5) A: There was no consideration that I am aware of, nor any need.

- *(Page 50, Line 9)* Q: All right. What did you consider-- what types of changes did you consider-- what types of changes did you consider after those incidents were talked about?

(Line 12) A: We considered an automatic latch attachment.

- *(Page 50, Line 20)* Q: OK, Tell me about that latch and spring mechanism. Can you describe it for me?

  (*Line 22)* A: Um, some of same bracketry as far as the hook on the side of the main boom was used. And a spring and steel plate mechanism similar concept to almost a door-length setup, was prototyped and tried.

- *(Page 122, Line 21)* Q: Okay. And to this day, you cannot exclude for an absolute fact that possibility, the improper pin placement as a possibility, in each of those incidents, can you?

  (Line 25) A: Well, as I stated, in the other cases, in interviewing of the people shortly after the accident, there was no one that could confirm that they put the pin in at all.

- *(Page 125, Line 23)* Q: I do have one question, as the attorney who represents the equipment rental company. You testified about engineering hierarchy, about designing out hazards. Is that a general engineering concept?

  (Line 3) A: Yes it is.

c. The current Manager of Product Safety and Reliability for both companies who are under the same management, testimony from the case in South Carolina, July 14, 2005..

- *(Page 95. Line 23)* Q: What is your next opinion in this case?

  (Page 95, Line 1) A*:* The reliance on visual verification of proper

"A" pin placement and jib alignment was reasonable and necessary.

- *(Page 192, Line 15)* Q*:* While we're at it, let me show you what I've marked for identification as plaintiff's exhibit number 12. Is that a copy of the complaint for a similar occurrence?

  (Line 19) A: Yes, sir.

- Q *(Page 192, Line 20)*: Are you familiar with that incident?

  (Line 21) A: I'm aware of the name of the case. I was not involved in the investigation or the litigation.

d. Investigative reporter and mechanical engineer for the paper plant stated:

- *(Page 66, Line 21)* Q: And if I understand that, It was difficult for the operator, [name removed] standing in the operator's position, correct?

  (Line 24) A: That's my understanding.

- *(Page 66, Line 25)* Q: And it would be difficult for the second person who was trying to install the pin in place, is that correct?

  (Page 67, Line 1) A: Yes, sir.

- *(Page 71, Line 8)* Q: And so what systems failed, it said "Mitigating devices and training procedures, correct?"

  (Line 10) A: Yes, sir.

- *(Page 112, Line 13)* Q: Okay, so we know for a fact that there's been, that there have been jib stowage events since this accident and there hat to have been some before?

(Line 16) A*:* That is correct.

e. The crane manufacturer's Manager of Sustaining Engineering stated in previous testimony:

- *(Page 10, Line 6)* Q: Before September of 2001 would you have knowledge of allegations made in lawsuits against [*the crane manufacturer*]?

  (Line 9) A: No.

- *(Page 12, Line 15)* Q: Has [*the crane manufacturer*] ever used a different system for the attachment for deploying and stowing of the jib on the 400 series?

  (Line 18) A: The design, the method, and the design of the stowage has always been the same.

- *(Page 12, Line 22)* Q: If we were to compare all of the [*crane manufacturer*] models, is there any difference in the manner in which the jib deploys and stows on all of the various models?

  (Page 13, Line 2) A: They're all the same.

- *(Page 65, Line 5)* Q: All right, manager of product safety and reliability, and you hold that position from when to when?

  (Line 8) A: September 2001 through September 2003.

- *(Page 75, Line 10)* Q: [*The crane manufacturer*] recognizes, though, that if the jib isn't properly stowed it could pose a danger to the end user, isn't that right?

  (Line 14) A: That's correct.

f. A mechanical engineer with The crane manufacturer; was also VP in the matter in South Carolina # 1:04-21943-24

- *(Page 16, Line 24)* Q: Were you involved—well, first of all, was—from 1971 through 1996, do you know whether the jib stowage mechanism was tested during that time period?

  (Page 17, Line 3) A: I'm not knowledgeable that there were any particular tests done.

- *(Page 34, Line 6)* Q: All right. And it's my understanding to this point [*the crane manufacturer*] has not considered redesigning the jib stowage mechanism?

  (Line 11) A*:* To my knowledge, there's no plans to redesign the design concept that—the stow concept.

6. The crane manufacturer's crane operation instructions (Page 38039) state, "Also, on manually extendable jib options: for 'side folding-swing around jib operation' item 18: 'jib stowage is accomplished by reversing the above procedures". These instructions are totally inadequate, because there is no explicit step-by step procedure. Review of the process of placing the anchor pin to secure the jib boom to the main boom can be described as "two blind mice". Neither the laborer setting the pin nor the crane operator at the station can clearly see of the anchoring pin holes are aligned for safe stowage.

7. The rental company had a duty to advise the roofing company on how to erect and stow the jib boom assembly.

8. The paper plant had a duty to ensure that the roofing company used a crane safe for its intended use and to ensure that The roofing company personnel were trained in the use of the jib boom stowage apparatus.

Conclusions

By review of the materials made available to the court, and considering the gravity of the life taking hazard of the jib-boom stowage design, it can be concluded that the crane manufacturer totally lacks a safety culture to look upstream and eliminate hazards by design. It is not sound engineering to substitute a manual system based on an assumption "that workers will always properly place the anchor pin, as they will be well trained and knowledgeable" instead of an automatic latching system as the initial anchoring mechanism. The crane manufacturer experienced three previous lawsuits to alert them to the fact that proper pin alignment is nearly impossible to achieve because a worker cannot see pin alignment holes when the jib-boom is folded into the stowage position. The pin holes are blocked by the folded jib boom, impairing the worker's view of proper alignment and rendering the worker unable to visually determine whether the anchor pin is properly inserted. However, the crane manufacturer made no effort to institute an alternate method whereby a worker could easily determine if the holes were aligned for proper pin setting. Further, the crane operator at his station needs to be able to easily visually verify that the anchor pin is properly placed, which the crane manufacturer also failed to do.

The engineering profession has four methods of controlling hazards by design: first be elimination (with an automatic latch); second by guarding (a mechanism to guide the alignment of the pinholes of the backup manual anchor); third by safety factors (markers to visually show that an anchor system is in place); and redundancy (a manual back up anchor pin placement).

Plaintiff Opinion Presented to the Court and Jury

1. The crane manufacturer created an unreasonable endangerment to the end users who relied upon a reasonable safe jib boom anchoring system. The crane manufacturer's unsafe jib boom stowage system has been the cause of other deaths and injuries prior to the decedent's painful death. The crane manufacturer willfully disregarded the safety of workers using their unsafe design, and considered that fault of the users misplacing the anchor pin was the basis for them to do nothing to overcome known misalignment of anchor pin holes.
2. The rental company, as a crane rental firm, had a duty to ensure that the roofing company received training for the crane operator on how to properly and safely stow the jib boom assembly.
3. The paper plant had a duty to ensure that the roofing company's contractor provided a safe crane for its intended use and was knowledgeable and competent in the stowage of the jib boom assembly on their premises.

Appendix A-5

Crane and Aerial Lift Upset (tipover) Hazards that Occur When One Outrigger is Retracted

A dissenting safety engineering analysis
to the United States Court of Appeals for the Sixth Circuit,
in the matter of Shirley Johnson, as legal guardian of Michael Gilfeather, in Incapacitated Adult v. Manitowoc Boom Trucks, Inc. No. 06-51 45
Appeal from the United States District County for the Middle District of Tennessee at Cookeville, No. 02-00080
Juliet E. Griffin magistrate Judge

Argued: March 16, 2007
Decided and filed April 30, 2007

Before Kennedy, Martin, and Sutton; Circuit Judges

Introduction

In the 1930s, the humorist Will Rogers notes that “It would be a better world if lawyers and judges did not attempt to practice medicine”. Well, in today’s world, it would be a better world if lawyers and judges did not attempt to practice safety engineering.

This respectfully submitted dissent now shows that this court’s ruling is wrongful. A safety analysis shows how known and foreseeable operator error to retract and outrigger and fail to re-extend it can arise during crane operation, and can result in serious injuries and/or death. This Appeal grants a summary judgment in favor of the defendant manufacturer, who failed to provide available safety features at the time of design and manufacture. In my opinion, the court’s ruling is a classic example of the deliberate war on safety in the workplace. Judicial rulings are especially insidious because many are biased to favor big business. These biases repress the benefits of safer design and create an artificial marketplace. The natural savings reaped safer design are never given an opportunity to exist.

Another danger of judicial rulings is that they authorize omission of available safety engineering technology for the following reasons:

1. The *Journal of Safety Research*, November-December 2007 issue, in an article by Mike McCann, states that 44 to 46% of boom lift tipovers are the result of a lack of provision for safety features and/or the defeat of such devices. This article was based upon three data sources: Census of Fatal Occupational Injuries (CFOI),

NIOSH Fatality Assessment and Control Evaluation (FACE) reports, and OSHA Incident Investigations.

2. Crane Handbook 1982, published by the Canadian Construction Association of Ontario by D.E. Dickie, states that 50% of mobile crane failures are caused by improper use of outriggers.
3. *Crane Hazards and Their Prevention*, 1993, (MacCollum, published by American Society of Safety Engineers), states that in the review of over 1,000 crane upsets over a twenty year period, the following statistical breakdown was the cause of them:
    - 39% were making a swing with outriggers retracted
    - 15% were picking a load with outriggers retracted
    - Which leads to the conclusion that 54% of upsets occurred with one or more outrigger retracted

    It was also found at that time that 8% of these upsets resulted in lost time injuries. Further, it was found that 20% of upsets resulted in significant damage to property other than the crane. Page 38 of the 1993 edition states: "**Available Hazard Prevention Measures**: Since such a high proportion of upsets occur when outriggers are not extended, I believe that design changes to overcome this record of consistent human error are needed. When human failure is as predictable as this, the surest way to avoid upset is to make the machine inoperable until the operator extends or lowers the outriggers. Some aerial basket designs include limit switches to prevent boom movement until outriggers are extended and in place to avert upset. Newer aerial basket trucks have hydraulic systems with interlocks that preclude boom operation until outriggers are fully extended and fully supporting the machine, with wheels completely off the ground. Interlocks are required in Military Specification MIL-T-62089(AT), “Truck, Maintenance; with Rotating Hydraulic Derrick, Air Transportable, 34,500 Pounds, GVW, 6x4,” dated March 26, 1968, and its updates, MIL-T-62089(A), December 18, 1973, and MIL-T-62089(B), June 9, 1980.”

4. **ANSI Requirements:** 1. *Boom-Supported Elevating Work Platforms,* ANSI A.92.5-1980, section 5.2.4, Outriggers, Stabilizers, and Extendible Axles, states: “Where the work platform is equipped with outriggers, stabilizers, or extendible axles, interlocks should be provided to ensure that the platform cannot be positioned beyond the maximum travel height unless the outriggers, stabilizers, or extendible axles are properly set. Control circuits shall ensure that the driving motor(s) cannot be activated unless the outriders or stabilizers are disengaged and the platform has been lowered to the maximum travel height (MTH).”

   Self-Propelled Elevating Work Plaforms, ANSI A92.6-1979, section 4.2 states: “Machines shall use interlock means that will prevent driving the unit unless the platform height, platform configuration, or any combination of the foregoing, are adjusted to meet the stability-test requirements…” Section 4.4 states: ‘Where outriggers, stabilizers, or extendible axles are required to meet the side load test described in 4.3, interlocks shall prevent the platform from being raised above the height as which these devices are required unless the required devices are extended. Interlocks shall also prevent the retraction of these devices while the platform is at that level."

These ANSI requirements for interlocks certainly show that since 1979 and 1980, interlocks have been adopted and have served well the aerial lift design. The same design concepts should be a standard feature of mobile cranes equipped with outriggers to prevent needless injuries and costs to the construction marketplace.

5. The appeal opinion on Page 6 states that Manitowoc's own engineers thought such an interlocking system "would be a good thing to put on [our] vehicles". The role of the justice system is to allow the marketplace to provide incentives for these interlocks to be included as a standard design feature, not to provide obstructions for design safety.
6. Examining the propensity of human failure in the hazard of retracted outriggers and applying the concept "to err is human, to forgive, design" it appears that the whole industry failed to voluntarily provide outrigger interlock systems as standard features.
7. The *Daubert* citation is a legal concept that provides a method of challenging an expert's testimony when they present scientific theories. *Daubert* in this case proved to be an anti-safety charade designed to avoid liability. The end of the first paragraph of Page 4 states the basis of the ruling for the defendant: "The only contested issue is reliability". Interlock electrical circuitry has been in use almost as long as electric power has been available. The reliability of these circuits has protected the life and safety of people from aircraft to washing machines. As

stated in the Kumho tire case ruling, testing is essential for *unproven new designs*. Interlocks are proven devices on related construction applications such as crane anti-two-blocking devices and on load moment devices (LMIs), which prevent lifting loads beyond the rated capacity. The charlatan who proposed this defense subverts our justice to impose the burden of care upon the injured and the community.

A. 1971 US Patent (# 3,612,294) provides an interlock design which prevents boom movement when one or more outriggers are retracted. In 1984, Weight Load, a manufacturer of LMIs, included on their device an automatic control to prevent boom movement when one or more outriggers were retracted. Similarly, in 1990 Greer, a manufacturer of LMIs, also provided an interlock to prevent boom movement when one or more outriggers was retracted. In 1996, P.A.T., A manufacturer of Load Moment Indicators, also included an interlock to prevent boom movement when one or more outriders are retracted.

B. It is known that ALTEC Cranes includes the use of outrigger interlocks to prevent boom movement when outriggers are retracted. The defendant's allegation that the testimony of plaintiff's witness Gary Friend should be debunked on the basis that an LMI system must be tested before use is a very broad stretch. The word "testing" has many connotations, but in this circumstance the outrigger safety system had undergone extensive testing before their load moment devices were offered in the marketplace. It is only natural to use the word “testing” to refer to a redundant jobsite practice in order to determine whether an appliance is currently functional. The entire basis of the summary judgment and its affirmation is without merit, and a disservice to construction safety, as the design of outrigger safety systems is well-established and reliable.

The excuse that testing was necessary to ensure that proven design concepts could be transferred from aerial lift design to cranes is shallow and short sighted, given the ease of technological advances. It is a ridiculous affront to reasonable safety engineers to delete the use of well proven interlock technology just because the plaintiff’s expert had not engaged in or was unaware of testing of the system on cranes. It is the duty for the manufacture to ensure for the installation of interlock systems that are safe for their intended use.

8. The magistrate judges’ ruling and the affirmation of the circuit court is an insult to workplace safety, as it endangers construction workers who work around cranes. The use of interlocks has been successfully applied to ensure for user safety in many applications that must overcome human error. It has been installed on many cranes with a record or reliable performance. This crane upset would have been prevented had interlocks on the outriggers been provided. This ruling places workers experiencing similar circumstances in serious danger from the peril of upset when an outrigger is retracted. The ruling represents a deliberate disregard for the life and safety of construction workers involved in crane use.

9. The entire appeal is printed in full text, as pursuant to the Sixth Circuit Rule 206, so that the reader can draw one's own conclusions concerning the need for construction equipment design safety in the marketplace, as is shown in Appendix B.

Appendix B

RECOMMENDED FOR FULL-TEXT PUBLICATION
Pursuant to Sixth Circuit Rule 206

File Name: 07a0149p.06

UNITED STATES COURT OF APPEALS

FOR THE SIXTH CIRCUIT

SHIRLEY JOHNSON, as Legal Guardian of MICHAEL GILFEATHER, an Incapacitated Adult,
Plaintiff-Appellant,

v.

MANITOWOC BOOM TRUCKS, INC.,
Defendant-Appellee.

No. 06-5145

Appeal from the United States District Court
for the Middle District of Tennessee at Cookeville.
No. 02-00080—Juliet E. Griffin, Magistrate Judge.

Argued: March 16, 2007

Decided and Filed: April 30, 2007

Before: KENNEDY, MARTIN, and SUTTON, Circuit Judges.

COUNSEL

ARGUED: Benjamin E. Baker, Jr., BEASLEY, ALLEN, CROW, METHVIN, PORTIS & MILES, Montgomery, Alabama, for Appellant. Patrick W. Schmidt, QUARLES & BRADY, Milwaukee, Wisconsin, for Appellee. **ON BRIEF:** Benjamin E. Baker, Jr., BEASLEY, ALLEN, CROW, METHVIN, PORTIS & MILES, Montgomery, Alabama, for Appellant. Patrick W. Schmidt, Patrick S. Nolan, QUARLES & BRADY, Milwaukee, Wisconsin, for Appellee.

OPINION

BOYCE F. MARTIN, JR., Circuit Judge. In this products liability case, Plaintiff Michael Gilfeather, who was severely injured in a workplace accident involving a truck-mounted crane manufactured by Defendant Manitowoc Boom Trucks, appeals from the magistrate judge's grant of summary judgment in favor of Defendant. Plaintiff also appeals the magistrate judge's decision to exclude his primary expert witness for failure to meet the reliability factors outlined in *Daubert v. Merrell Dow Pharmaceuticals*, 509 U.S. 579 (1993). We now affirm.

I

On October 15, 2001, Michael Gilfeather was working on a job site near Cookeville, Tennessee. He and two other workers, Delayne Williams and Bruce Williams, were installing a new cell phone tower with the aid of a "boom truck crane" manufactured by Manitowoc. This crane, also known as the Manitowoc 2592 (after its model number), is basically a 10-wheel flatbed truck with a crane mounted on the bed. The crane sits on a large turret, and thus can swivel a full 360 degrees. The "boom" of the crane then extends hydraulically, from a length of 28 feet in its fully retracted position to a length of 92 feet when fully extended. The Manitowoc 2592 is capable of hoisting and moving very large materials and equipment at a construction site, up to a maximum weight of 50,000 pounds (25 tons). When the crane is in operation, the truck is secured by two front "outriggers" and two rear "stabilizers." The rear stabilizers extend down and meet the ground at a 90-degree angle, whereas the front outriggers extend out from the frame of the truck at a 45-degree angle, much like the legs of a spider.[1]

Delayne Williams, who had been operating the crane for much of the day, had to leave the job site early but could not do so because one of the front outriggers was blocking his sport-utility vehicle. At the suggestion of Gilfeather, he partially retracted this outrigger, such that it was no longer in contact with the ground. Delayne Williams drove out, but at this precise moment Bruce Williams attempted to use the crane to move some heavy materials. Without its fourth outrigger on the ground, the Manitowoc 2592 fell over, severely injuring Gilfeather.

The accident left Gilfeather physically and mentally incapacitated to the extent that he was unable to bring the present diversity suit against Manitowoc on his own behalf. Rather, he now proceeds through his legal guardian, Shirley Johnson. Gilfeather's primary allegation was that the Manitowoc 2592 was defective and/or unreasonably dangerous, both because of an unsafe design and because of inadequate warnings. Gilfeather proposed only one expert witness, Gary Friend, to support his claims. Friend is a registered professional engineer in the states of Illinois and Missouri. After receiving his master's degree in engineering in 1969, he taught engineering at a community college in Kansas City, Missouri, for ten years. Since approximately 1980, however, he has been employed exclusively as an engineering "consultant" and has testified in a wide range of design defect cases. As the magistrate judge noted, he has rendered opinions on the design of "almost any machine," including a "wheelchair, a deep fat fryer, a passenger elevator, an antique replica shotgun, a hay baler, a meat tenderizer, a forklift, a manure spreader, a lawn mower, a seat belt assembly, a log skidder, a concrete saw, a trampoline, and a tree stand." *Johnson v. Manitowoc Boom Trucks, Inc.*, 406 F. Supp. 2d 852, 858 (M.D. Tenn. 2005).

Friend's preparation for the instant case consisted primarily of document review: deposition testimony, discovery responses, brochures and owners' and operators' manuals for a variety of truck cranes, American National Standards Institute ("ANSI") standards for different kinds of mobile boom trucks, statements of persons in the area of the accident, and the Tennessee Occupational Safety and Health Administration ("TOSHA") report of the accident with accompanying photos. He also personally inspected and photographed the subject truck crane. Based on this research, Friend prepared a report in which he opined that the Manitowoc 2592 was defectively designed because its outriggers were not electronically linked to the crane operation via an "interlocking" system. By means of such an interlocking system, if any one outrigger were not in contact with the ground (as measured by pressure asserted on the foot of the outrigger), the boom crane would "lock" and become inoperable until such time as the outrigger was put back down onto firm ground. An interlocking outrigger system, according to Friend, would have prevented Gilfeather's accident, because Bruce Williams would not have been able to operate the crane with the front outrigger retracted, and thus the boom truck would not have tipped over onto Gilfeather.

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[1] Although we recognize that the Manitowoc "outriggers" (in the front of the truck) and "stabilizers" (in the rear) are distinct devices, for the remainder of the opinion we will refer to them collectively as "outriggers."

Friend focused in particular on brochures and manuals for the Asplundh "line lift bucket truck," a machine that has had an interlocking outrigger system since 1978. The Asplundh truck is significantly smaller than the Manitowoc 2592. Such trucks are generally only rated to carry *people*, in a bucket mounted on the end of the crane arm. They are typically used for jobs such as telephone repair work or tree trimming and removal. They are not rated to carry nearly the amount of weight that the Manitowoc 2592 can lift. At the same time, however, the Asplundh truck is by no means a small machine, and the weight of the crane alone (not to mention the torque placed on the truck when the crane extends outward) is sufficient to require outriggers on the Asplundh when the crane is in operation. After reviewing the mechanics and electronics of the Asplundh, Friend presented a detailed schematic, Joint App'x at 666, in which he attempted to diagram how the Asplundh interlocking system could be fitted to the Manitowoc 2592. He did not actually test his schematic, however — in other words, he conducted no empirical research to determine just how functional his proposed retrofit of the Manitowoc 2592 might be. Friend also opined that the Manitowoc 2592 "should have included a specific warning to operators about the possibility that the crane might tip over with the outriggers in the up position while rotating the boom with no load on it."

Manitowoc moved to exclude Friend's proposed testimony, arguing for a variety of reasons that it was unreliable. The magistrate judge, whom the parties had consented to conduct all proceedings, granted Manitowoc's motion to exclude. Having stricken Friend's testimony, the magistrate judge then granted Manitowoc's motion for summary judgment on grounds that under Tennessee law, expert testimony is absolutely required for a products liability action to proceed. Gilfeather now appeals.

II

Tennessee products liability law, which both parties agree applies to this diversity case, recognizes two different tests for determining whether a product is unreasonably dangerous. The first, the **consumer-expectation test**, is used where a product is "dangerous to an extent beyond that which would be contemplated by the ordinary consumer who purchases it." *Ray ex rel. Holman v. BIC Corp.*, 925 S.W.2d 527, 530 (Tenn. 1996); *see also Brown v. Raymond Corp.*, 432 F.3d 640, 643-44 (6th Cir. 2005). The second, the **prudent-manufacturer test**, imputes knowledge of the dangerous condition to the manufacturer, and then asks "whether, given that knowledge, a prudent manufacturer would market the product." *Ray*, 925 S.W.2d at 530. As the Tennessee Supreme Court has articulated, "[t]he consumer expectation test is, by definition, buyer oriented; the prudent manufacturer test, seller oriented." *Id.* at 531.

Both parties recognize that the prudent-manufacturer test is best applied to this case because it involves "establishing the unreasonable dangerousness of a complex product about which an ordinary consumer has no reasonable expectation." *Id.* And where the prudent-manufacturer test applies, "expert testimony about the prudence of the decision to market" becomes essential to a plaintiff's case in chief. *Id.*; *see also Brown*, 432 F.3d at 644. Thus, although Gilfeather raises two issues for review, the exclusion of his expert is really the whole ballgame: without the expert, he stands little chance of overcoming summary judgment.

Fed. R. Evid. 702, which deals with the testimony of experts, provides:

> If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.

This rule, amended in 2000, reflects the Supreme Court's decisions in *Daubert* and *Kumho Tire Company v. Carmichael*, 526 U.S. 137 (1999). "In *Daubert* the Court charged trial judges with the responsibility of acting as gatekeepers to exclude unreliable expert testimony, and the Court in *Kumho* clarified that this gatekeeper function applies to all expert testimony, not just testimony based in science." Advis. Comm. Notes to Fed. R. Evid. 702. As "gatekeeper," the trial judge is imbued with discretion in determining whether or not a proposed expert's testimony is admissible, based on whether it is both relevant and reliable. *Kumho*, 526 U.S. at 147. Relevance is not at issue in this case. The magistrate judge found that Friend's proposed testimony was "clearly relevant," and neither party disputes this finding on appeal. The only contested issue is reliability.

In *Daubert*, the Supreme Court provided a nonexhaustive list of factors which may, in any given case, bear on a trial judge's gatekeeping determination. These factors include: (1) whether a "theory or technique . . . can be (and has been) tested"; (2) whether the theory "has been subjected to peer review and publication"; (3) whether, with respect to a particular technique, there is a high "known or potential rate of error" and whether there are "standards controlling the technique's operation"; and (4) whether the theory or technique enjoys "general acceptance" within a "relevant scientific community." 509 U.S. at 592-94. Six years after issuing *Daubert*, the Court made clear in *Kumho* that these same factors are as applicable in the context of "engineering" testimony as in "scientific" testimony. The whole point of *Kumho*, after all, was that the distinction between "scientific knowledge" (at issue in *Daubert*) and "technical or other specialized knowledge" (at issue in *Kumho*, as here) is fuzzy at best. 526 U.S at 148.

The *Kumho* Court also made clear that in the engineering context especially, the factors listed above do not constitute a "definitive checklist or test." *Id.* at 150 (quoting *Daubert*, 509 U.S. at 593). Rather, "the gatekeeping inquiry must be tied to the facts of a particular case," depending on "the nature of the issue, the expert's particular expertise, and the subject of his testimony." *Id.* This very flexible inquiry requires a reviewing court to be highly deferential when assessing not just a trial court's analysis of each factor, but also the trial court's initial selection of which factors are relevant to the case at hand. As Justice Breyer noted, "[t]he trial court must have the same kind of latitude in deciding *how* to test an expert's reliability, and to decide whether or when special briefing or other proceedings are needed to investigate reliability, as it enjoys when it decides *whether or not* that expert's relevant testimony is reliable." *Id.* at 152 (emphasis in original); *see also Brown*, 432 F.3d at 647 (noting that because our review in such cases is for abuse of discretion, we must grant the judge "broad latitude in determining the reliability or relevance of the testimony") (internal quotation marks omitted).

III

In the instant case, the magistrate judge looked at the four *Daubert/Kumho* factors listed above and determined that only three of them were relevant: (1) the extent to which the opinions of Gary Friend had been tested; (2) the extent to which his opinions had been subjected to peer review or publication; and (3) the extent to which his theory regarding interlocking outriggers had gained general acceptance within the engineering/manufacturing community. Onto these three factors, however, the magistrate judge grafted a fourth, one which had not been mentioned by the Supreme Court in either *Daubert* or *Kumho*. That fourth factor, as the magistrate judge put it, was "the extent to which Mr. Friend's opinions were prepared in the context of litigation."

We now review, under an abuse-of-discretion standard, the magistrate judge's decision using the reliability factors she selected. We note at the outset that the second factor identified by the magistrate judge is largely insignificant in this case, because both parties concede that there is little in the way of published or peer-reviewed information—at least in the sense contemplated by *Daubert* or *Kumho*—on interlocking outrigger systems for truck cranes. *See Johnson*, 406 F. Supp. 2d at 863. We therefore decline to discuss this factor in greater detail, focusing below on: (A) the "testing" factor; (B) the "general-acceptance" factor; and (C) the "prepared-solely-for-litigation" factor.

A. The Testing Factor

The magistrate judge made clear that her decision to exclude Friend rested largely on the fact that while he had drawn up a schematic for how Asplundh's interlocking outrigger system might be integrated into the Manitowoc 2592, he had entirely failed to test his theory. As the following deposition testimony reveals, Friend admitted that no testing had occurred:

> **Q:** Have you ever actually implemented this kind of design concept that you have on Exhibit 12 on any machine?
> **A:** No.
> **Q:** You certainly haven't implemented it or tested it with regard to the Manitowoc machine, have you?
> **A:** That's correct.
> **Q:** And it would be true that you've never implemented or tested this concept on any other machine, correct?
> **A:** That's correct.
> **Q:** And when you were back doing design work, before you would release some new design or modification of the design to the field, you would normally do testing, correct?
> **A:** Depending on what it is. Normally I would say you test, but not all the time, but generally you do, yes.
> **Q:** With this system, you would want to test it, wouldn't you?
> **A:** I would, certainly. Well, certainly, yeah.

Friend Dep. at 145-46.

Given the difference in size (small truck versus large truck), lifting capacity (a few people versus 25 tons), and function (tree trimming or electrical work versus heavy construction) between the Asplundh and Manitowoc crane systems, the magistrate judge concluded that at least a modicum of empirical testing should have been performed in order to determine how easily an interlocking outrigger system could be installed onto the Manitowoc 2592, as well as whether such a system would bring with it any downsides in safety and/or function. After all, "the design of industrial equipment is a complex process and changes to prevent one problem could create other problems, thus increasing the overall danger of using a product." *Brown*, 432 F.3d at 648 (quotations omitted); *see also Dhillon v. Crown Controls Corp.*, 269 F.3d 865, 870 (7th Cir. 2001) (noting that many alternative design considerations "are product- and manufacturer-specific and cannot be reliably determined without testing").

When further questioned about why he did not conduct any tests of his proposed alternative design, Friend responded as follows:

> **Q:** As a design engineer, you certainly wouldn't want to add a system that included or added some downside risks, would you?
> **A:** No.
> **Q:** And that's something you would want to analyze as you went along in your concept development and your testing and then eventually release to production.
> **A:** Certainly.
> **Q:** And you didn't do that in this case, specifically by putting it on a product and testing it and looking at it and considering the downsides, did you?

> **A:** Well, I — I just didn't do the testing part. I really don't see a downside to this system.
> [. . .]
> **Q:** Is it your testimony that you see absolutely no downsides or negatives to the system that you have set forth on Friend Exhibit 12 for use on this particular truck crane?
> **A:** Other than if you want to call adding cost into the machine, certainly that would be a downside — it's going to cost a little more — . . . . From a safety standpoint in — in the use of your equipment, it's — it's all pluses.

Friend Dep. at 147-48. With this testimony in front of us, we must ask whether or not a trial judge abuses her discretion by choosing not to rely solely on the say-so of a proposed expert witness. *See, e.g., Dhillon*, 269 F.3d at 870 (noting that "hands-on testing is not an absolute prerequisite to the admission of expert testimony," but where a theory easily lends itself to testing and substantiation, "conclusions based only on personal opinion and experience do not suffice").

One way to overcome the testing requirement might be to show that the expert has significant technical expertise in the specific area in which he is suggesting an alternative design. For this proposition, Gilfeather relies on *Bah v. Nordson Corporation*, No. 00CIV9060DAB, 2005 WL 1813023 (S.D.N.Y. Aug. 1, 2005). In *Bah*, the district judge admitted the testimony of an expert who suggested that an "interlock switch" on a hot glue dispenser—not dissimilar from the interlocking outrigger concept here—could have prevented an accident to the plaintiff. *Id.* at *3-4. The proposed expert did not "create prototypes or drawings of any of his proposed safety devices," nor did he "test or review others' tests of any of these devices." *Id.* at *5. However, he had for over twenty years been involved with designing safety interlocks in machines very similar to the one at issue in *Bah*. Because the reliability inquiry is a flexible one and may "focus upon personal knowledge and experience," *Kumho*, 527 U.S. at 150, the *Bah* court held that the expert's "extensive experience" with the very types of machines at issue in the case rendered his testimony reliable, "even without consideration of the *Daubert* factors." 2005 WL 1813023 at *8.

The facts in the instant case are not on par with those in *Bah*. On the one hand, based on Friend's extensive engineering expertise, his interlocking outrigger proposal seems like an eminently reasonable one. On the other hand, given the difference between the machine on which the interlocking system existed (the Asplundh) and the machine on which Friend suggested it could easily be installed (the Manitowoc 2592), it also seems reasonable for a judge to have shut the gate on Friend because he had made no attempt whatsoever to test the interlock system in the larger machine. The magistrate judge might have abused her discretion had Friend been particularly experienced in the area of truck outriggers, or cranes, or the like, but the record indicates that he is not. Friend's self-serving testimony that he is qualified to render an opinion on the design of "almost any machine" undercuts any claims of *specific* expertise that he might hope to make. Friend may well be a fine engineer, but he is clearly a generalist. As such, even if the logic of *Bah* were binding on this Court (which it is not, seeing as it stems from a district court in a different circuit than our own), it would not apply to the case at hand.

Gilfeather argues that testing was not required in this case because Manitowoc's own engineers testified that such an interlocking system would be "a good thing to put on [our] vehicle" assuming it did not "impede the utility of the vehicle" and did not "create unsafe conditions." Yet these statements only undermine Gilfeather's position, because they reveal why an expert's testing, at least in some form, is so important in a case like this. To decide the case, a jury would have to be presented with evidence of whether the Asplundh interlocking system could easily have been fitted onto the Manitowoc 2592 when it was produced and sold to buyers in 1999, and whether such alteration would negatively have affected the truck's safety or performance. Should a one-page diagram that is nothing more than an engineer's version of cut-and-paste suffice as such evidence? Of course not.

In fairness to Gilfeather (and Friend), it will not always be clear how an expert is to "test" an expensive mechanical or electrical system such as the Manitowoc 2592 without access to the exact—and potentially proprietary—plans for the system, and without a significant financial outlay. As one district judge in this circuit has noted:

> Given inherent limitations on access to relevant data, the plaintiff is not required to establish with particularity the costs and benefits associated with the adoption of the suggested alternative design. The plaintiff is not required to produce a prototype design in order to make out a prima facie case. "[Q]ualified expert testimony on the issue suffices, even though the expert has produced no prototype, if it reasonably supports the conclusion that a reasonable alternative design could have been practically adopted at the time of sale."

Martin v. Michelin North America, Inc., 92 F. Supp. 2d 745, 753 (E.D. Tenn. 2000) (quoting Restatement (Third) of Torts § 2 cmt. f (1998)). While *Martin* does not require that a "prototype" be built in all instances, however, it still insists on expert testimony that "reasonably supports the conclusion that a reasonable alternative design could have been *practically* adopted at the time of sale." We can imagine innumerable tests that could have been conducted by Friend—all well short of building a full-fledged prototype of the Manitowoc 2592, but all well beyond drawing a one-page diagram—that would have demonstrated the practicality of his proposed design. And yet Friend failed to conduct any testing at all.

B. The General-Acceptance Factor

Although Friend's complete failure to test his proposed design cuts heavily against him, he was able to point to one very important, and very simple, fact about interlocking outriggers: that boom crane trucks similar to the Manitowoc 2592, made by some of Manitowoc's competitors, currently have an interlocking outrigger system in place. This fact, the plaintiff argues, indicates that interlocking outriggers have become generally accepted within the truck crane industry, even for large truck cranes like the Manitowoc 2592, and thus Friend's proposed testimony fits well within one of the *Daubert* factors.

The problem with this argument is temporal. While it may be true that interlocking outriggers have *now* become (or are on their way to becoming) the industry standard, the same cannot be said for the year 1999, when the Manitowoc 2592 was put into the marketplace. As Friend's deposition testimony reveals:

> **Q:** And in terms of the items that were reflected in those brochures, the Altec and QMC brochures . . . the Altec was dated 2004, as I recall, and the QMC was off the Internet I think in December of 2004 — I take it you don't know one way or the other whether those features that you talked about, the interlock on those particular kinds of cranes for those particular manufacturers, were available in '99, do you?
> **A:** I don't know. That's right, I don't.
> [. . .]
> **Q:** Would you agree with me, sir, that based on what you do know about truck cranes — and let's say before the year 2000 — that it was not the industry practice to include interlocks on the outriggers?
> **A:** I would say that you're probably correct. I don't know for a fact.
> [. . .]

> **Q:** And sitting here today, you certainly can't say that there was any manufacturer of mobile truck cranes of the type and style and function and use of the Manitowoc 2592 who had interlocks on their outriggers prior to 2000, correct?
> **A:** I know of no one. . . .

Friend Dep. at 152-54. Under Tennessee law, "[a] manufacturer or seller of a product *shall not be liable* for any injury to a person or property caused by the product unless the product is determined to be in a defective condition or unreasonably dangerous *at the time it left the control of the manufacturer or seller*." Tenn. Code Ann. § 29-28-105(a) (emphases added). Thus, by the very terms of Tennessee products liability law, any evidence that interlocking outrigger systems are currently available on truck cranes similar to the Manitowoc 2592 is unavailing to Gilfeather. The evidence presented by Friend simply indicates that interlocking outrigger systems have been around for a long time on some kinds of truck cranes, such as the Asplundh, but not other kinds, such as the Manitowoc 2592. This is not enough to show that at the time the Manitowoc 2592 was sold in 1999, it was "industry custom"—i.e., "generally accepted"—for all such machines to have interlocking outrigger systems. If we were to bless a rule to the contrary, we would pave the way for retroactive imposition of liability in products liability cases such as this one. We decline to run afoul of Tennessee state law in this manner.

C. The Prepared-Solely-for-Litigation Factor (a.k.a., The Flowing-Naturally-from-Independent-Research Factor)

This Court has recognized for some time that expert testimony prepared solely for purposes of litigation, as opposed to testimony flowing naturally from an expert's line of scientific research or technical work, should be viewed with some caution. For example, in a decision predating *Daubert*, this Court pointed out that "expert witnesses are not necessarily always unbiased scientists," because they are "paid by one side for their testimony." *Turpin v. Merrell Dow Pharmaceuticals, Inc.*, 959 F.2d 1349, 1352 (6th Cir. 1992); *see also Mike's Train House, Inc. v. Lionel, L.L.C.*, 472 F.3d 398, 408 (6th Cir. 2006) ("We have been suspicious of methodologies created for the purpose of litigation."); *Nelson v. Tennessee Gas Pipeline Co.*, 243 F.3d 244, 252 (6th Cir. 2001) ("If anything, *Kumho* supports the magistrate judge's consideration of factors not mentioned by the Supreme Court, including the fact that [the expert's] study was conducted and the experts' opinions were formed for purposes of litigation."); *Avery Dennison Corp. v. Four Pillars Enterprise Co.*, 45 Fed. Appx. 479, 484 (6th Cir. 2002) (noting that the prepared-solely-for-litigation factor is often assessed in addition to those specifically enumerated in *Daubert*); *Smelser v. Norfolk Southern Ry. Co.*, 105 F.3d 299, 303 (6th Cir. 1997) (same).

Perhaps the best explication of the prepared-solely-for-litigation factor comes not from this circuit, but from the Ninth Circuit, when it revisited the *Daubert* case after the Supreme Court sent it back on remand. *See Daubert v. Merrell Dow Pharmaceuticals*, 43 F.3d 1311 (9th Cir. 1995) ("*Daubert II*"). In that case, the prepared-solely-for-litigation test was layered onto the four factors previously articulated by the Supreme Court. The Ninth Circuit stated:

> One very significant fact to be considered is whether the experts are proposing to testify about matters growing naturally and directly out of research they have conducted independent of the litigation, or whether they have developed their opinions expressly for purposes of testifying. That an expert testifies for money does not necessarily cast doubt on the reliability of his testimony, as few experts appear in court merely as an eleemosynary gesture. But in determining whether proposed expert testimony amounts to good science, we may not ignore the fact that a scientist's normal workplace is the lab or the field, not the courtroom or the lawyer's office. . . . That an expert testifies based on research he has conducted independent of the litigation provides important, objective proof that the research comports with

> the dictates of good science. . . . If the proffered expert testimony is not based on independent research, the party proffering it must come forward with other objective, verifiable evidence that the testimony is based on "scientifically valid principles."

43 F.3d at 1317-18 (internal citations omitted). Of course, *Daubert II* involved scientific experts, not technical or engineering experts as is the case here, but the Ninth Circuit's reasoning is equally sound in both contexts. And the Ninth Circuit continues to apply this formula today. *See, e.g., Clausen v. M/V New Carissa*, 339 F.3d 1049, 1056 (9th Cir. 2003); *Metabolife Int'l, Inc. v. Wornick*, 264 F.3d 832, 841 (9th Cir. 2001).

In the instant case, the magistrate judge viewed the prepared-solely-for-litigation factor as a very important one. This factor, along with Friend's failure to test his model, was largely responsible for the magistrate judge's decision to exclude. As the magistrate judge concluded:

> The plaintiff's expert in this case appears in many ways to be the quintessential expert for hire. Though he is indisputably a mechanical engineer with good qualifications and an impressive resume, he has nonetheless spent the last twenty plus years of his life testifying as an expert in a wide variety of design defect cases. . . . Consideration of the context of an expert's opinion is especially important given the potential for abuse in light of the incredible benefits of hindsight. Here, the expert's opinions were conceived, executed, and invented solely in the context of this litigation. The expert here does not even offer a proposed design that would necessarily make this crane safer; he merely offers a mechanism that might have prevented a very specific accident that occurred under very specific conditions.

Johnson, 406 F. Supp. 2d at 865-66.

We find the magistrate judge's above analysis to be quite lucid and quite correct. If it is clear that a proposed expert's testimony flows naturally from his own current or prior research (or field work), then it may be appropriate for a trial judge to apply the *Daubert* factors in somewhat more lenient fashion. This would not mean that such an expert is to be accorded a presumption of reliability, but it would be in line with the notion that an expert who testifies based on research he has conducted independent of the litigation "provides important, objective proof that the research comports with the dictates of good science." *Daubert II*, 43 F.3d at 1317. However, if a proposed expert is a "quintessential expert for hire," then it seems well within a trial judge's discretion to apply the *Daubert* factors with greater rigor, as the magistrate judge seems to have done in this case.[2] Such an expert is not be accorded a presumption of *un*reliability, but the party proffering the expert must show some objective proof—such as the expert's extensive familiarity with the particular type of machine in question, as in *Bah*—supporting the reliability of the expert's testimony. *Daubert II*, 43 F.3d at 1317-18 ("If the proffered expert testimony is not based on independent research, the party proffering it must come forward with other objective, verifiable evidence . . . ."). The magistrate judge in this case searched high and low for such objective proof and found it sorely lacking. *See Johnson*, 406 F. Supp. 2d at 866 ("Mr. Friend's opinions were prepared entirely in preparation for this litigation, and therefore lack any indicia of reliability they may have otherwise possessed by virtue of arising naturally and independently.").

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[2] A trial judge's assessment of the prepared-solely-for-litigation factor is not, of course, a totally binary exercise. We recognize that many experts may look neither quite like the "quintessential expert for hire" in this case nor quite like a pure research scientist/engineer whose loyalties are to the laboratory/field and not the courtroom.

D. Summary Judgment

Gilfeather all but concedes that without the testimony of Friend, he cannot survive summary judgment. Appellant's Br. at 43 ("[I]f the Plaintiff is allowed to present the expert testimony of Gary Friend, the Plaintiff will have met her burden under Tennessee law and summary judgment is inappropriate."). Gilfeather does make a brief attempt to argue that even without Friend, the testimony of the experts put forward by his opponent, Manitowoc, should suffice to get past summary judgment. *See id.* at 17-18; Reply Br. at 9-10. This argument is without merit. An appellant cannot overcome summary judgment in a case such as this simply by cherry-picking statements from an appellee's experts' opinions, when the overall conclusions of those experts run contrary to the appellant's position. The appellant could introduce a reliable expert to dissect the opinions of the appellee's experts, but that of course is what Gilfeather has tried and failed to do with Friend.

In sum, given our conclusion that the magistrate judge did not abuse her discretion in excluding Friend's testimony, we must also affirm the grant of summary judgment in favor of Manitowoc.

IV

Based on the magistrate judge's thorough analysis of the testing factor, the general-acceptance factor, and the prepared-solely-for-litigation factor, we conclude that she acted well within her discretion to exclude the testimony of Friend. The most obvious cure would have been for Friend to have produced at least *some* empirical testing data on his proposed alternative design. This he entirely failed to do. Another cure would have been for Gilfeather to have found someone with expertise more directly related to the large truck and/or truck crane industry. Such an expert might have been spared the *Daubert* testing factor, as in *Bah*. And such an expert would probably look much less like the generalist "expert for hire" epitomized by Friend. In any event, if the trial court is to be granted "broad latitude" both in selecting appropriate reliability factors for a given case as well as in applying each of those factors to the case's facts, *Kumho*, 526 U.S. at 152-53, then we cannot conclude that the magistrate judge exceeded this latitude in the instant case.

We therefore affirm.

Appendix C

This research report was conducted to assess the effect of “Safe Design Principles for Construction” on the American marketplace. The study revealed the factors which delay or impede adoption of a management culture which looks upstream to include the application of engineering technology to eliminate hazards at the time of design. Analysis included a comparison of two situations. In the first situation, hazards were not addressed until an extended time lag produced numerous injuries from the same source. The second situation focused on groups who explored the benefits of eliminating hazards at the time of design and/or at the time of construction planning by selecting means and methods to eliminate hazards before a project begins. The conclusion of this study is that the marketplace can create an overriding priority for finding engineering solutions for the elimination of hazards when the cost of perpetuating a dangerous workplace and/or defending it in court exceeds the cost of the safety feature.

The principal investigator is David V. MacCollum P.E., CSP. In addition to the information listed in his resume (Exhibit C-1), his personal experience includes a detailed review of thousands of depositions of injured workers, witnesses, engineers, and managers taken during the discovery process of construction personal injury litigation. Additional information is gained by examinations of work conditions during on-site visits, review of engineering reports, photos, and other discovery documents. Personal involvement in many facets of construction starting over 65 years ago as a construction equipment operator for the Navy in WWII has bolstered his interest and given him a keen understanding of both the physical and legal ramifications on construction job sites.

This report reflects valuable peer observations made during one-on-one discussions with the following extremely well-qualified individuals:

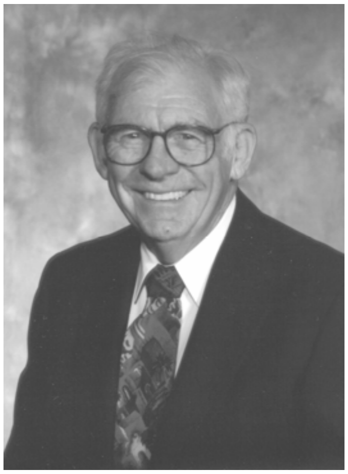
1. Bob Topping, PHP

Before joining the WETC team, Dr. Topping served as Department Chair and Campus Administrator for the Wilsonville Training Center (WTC), a satellite campus of Clackamas Community College in Oregon. During his tenure at WTC, he developed training programs, administered partnership requirements, managed student and collegiate services, and supervised operations of the campus. Through the collaboration of the Center's partners, Dr. Topping was instrumental at the Wilsonville Training Center in developing a 'corporate university model', which has received national attention. Dr. Topping not only brings 14 years of experience educating at the collegiate level, he also brings 26 years of hands-on experience in the construction industry. While working in construction, he held positions such as: Apprentice Field Trainer, Foreman, Supervisor, and Field Superintendent. Dr. Topping earned his Bachelor's degree from Portland State University and his Master's and Doctorate from Oregon State University. His Doctoral dissertation in Education addressed learning environments, career education, and workforce development especially for the energy industry. Within his dissertation his study focused on the community college's role in the learning processes, design features, and major issues that affect workforce development and career succession planning.

2. Rick Callor

Rick is the Corporate Safety Training Director for Washington Group International in Boise, ID. He holds an AAS in Occupational Safety and Health from Trinidad State Junior College. Mr. Callor has been a Safety and Health Professional for the past 30 years in Mining, Construction and the Environmental Restoration Business. He obtained the Safety Trained Supervisor in Construction in 1999 and has since obtained his CSP Certification from the Board of Safety Professionals. Mr. Callor is also an authorized Occupational Safety and Health Administration (OSHA) Instructor and an Instructor Trainer in all aspects of mining with the Mine Safety and Health Administration (MSHA). Mr. Callor currently sits on the Board of Directors of the Council on Certification of Health, Environmental and Safety Technologists (CCHEST). He resides in Eagle, ID.

3. Richard Hislop P.E.
4. T.J. Lyons, Safety Professional, Turner Construction
5. Gary Friend, P.E., BSME-MSME, Plaintiff's expert on Gilfeather matter.



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Since 1972, a consultant specializing in safety research and technical assistance for high-risk hazards, including hazard analysis and evaluation by referencing applicable safety standards, literature, and available technology.

1951, B.S. degree, Oregon State University, Corvallis, Oregon. Special education: System Safety, University of Washington; Safety Management, New York University; Radiological Safety, Ft. McClellan, Alabama; and has attended numerous other Army service schools.

He is a Registered Professional Engineer (Industrial), AZ; a Registered Professional Engineer (Safety), CA; and a Certified Safety Professional (CSP).

1975-76, National President, American Society of Safety Engineers (ASSE). 1961, President, Portland, OR Chapter, ASSE.
1968, President, Cochise Chapter, AZ, Society of Professional Engineers.

Member of:
- ASSE
- System Safety Society
- National Society of Professional Engineers (NSPE)
- Veterans of Safety.

Past member of:
- Society of Mining Engineers
- National Safety Council
- Human Factors Society
- Military Engineers.

2007 he authored book *Construction Safety Engineering Principles* published by McGraw-Hill; 1995, he authored book *Construction Safety Planning*, published by John Wiley & Sons; 1993, author of book, *Crane Hazards and their Prevention*, published by ASSE. Is a well-known author of articles appearing in *Professional Safety*, *Western Construction*, *National Safety News*, *Rural Electrification*, *Power*, *Professional Engineer*, *Prentice-Hall's* "Newsletters", *Business Insurance*, *Journal of Industrial Hygiene*, *Hazard Prevention*, *Control*, *CraneWorks*, *Lift*, and numerous other professional and trade journals.

He has spoken before international and national groups: the British Ministry of Technology, the American Medical Association, the Edison Electric Institute, the National Rural Electric Cooperatives Association, the National Institute of Cooperative Education, the National Safety Council, the American Society of Safety Engineers, the System Safety Society, and the Crane Inspection and Certification Bureau.

AWARDS

1999, elected *Fellow* by ASSE for superior achievement in the safety profession.

1970, *Engineer of the Year*, AZ Society of Professional Engineers.

1969, *First Place for Outstanding Contribution to Safety Engineering Literature*; 1983-1984, another *First Place*; and 1990-91, *Third Place*, by ASSE and Veterans of Safety.

Listed in *Who's Who in Engineering*.

ACCOMPLISHMENTS

2000, principal founder of the Hazard Information Foundation, Inc., a nonprofit foundation that maintains a resource library of safety and hazard information.

1995, established the Center for Hazard Information, which published the monthly *Hazard Information Newsletter* for three years.

Has prepared system safety hazard analyses and safety program management evaluations and given expert court testimony covering a broad range of safety engineering applications, especially as to cranes and other heavy construction equipment, application of rollover protective systems (ROPS) on a wide variety of equipment, and construction safety planning.

1972-76, provided technical assistance for construction of tunnel support systems in Europe and the U.S. for Bernold of Switzerland.

1972-74, served on the advisory body that drafted the Arizona Occupational Safety Act; was a member of the Arizona Review Commission of Appeals for state citations.

1972-73, retained as an instructor by the University of Arizona for a series of courses on System Safety, Safety Management, and Safety Program Evaluation; developed special safety engineering seminars for University of Arizona, Michigan Technological Institute, University of Oklahoma, University of Wisconsin, and NIOSH (crane safety).

March 1970, testified before a US Senate hearing for the Product Safety Commission on hazards of unvented heaters; April 1977, before US Senate hearings on product liability insurance; and 1984 before a US Department of Labor hearing on cranes and derricks.

1969-72, served on the US Department of Labor's Construction Safety Advisory Committee; was chairman of the subcommittee for Subpart V of OSHA for power transmission and distribution; and was on the board investigating tunnel disasters.

1958-62, was a member of a standards setting committee for the State of Oregon, for material handling equipment.

1956-58, developed design criteria for ROPS (10 years before the Society of Automotive Engineers (SAE) developed its standard) that was adopted by the US Army Corps of Engineers (CofE), US Bureau of Reclamation, and State of Oregon and later incorporated into OSHA standards; and made studies on cost-effective and safe use of scaffolding and on crane load- testing on construction projects that was adopted by the CofE.

EMPLOYMENT

1955 to 1972 employed by the Department of Army:

<u>Director of Safety</u>, Strategic Communications Command, Ft. Huachuca, AZ, a worldwide command with sixteen subcommands.
<u>Safety Director</u>, Electronic Proving Ground, Ft. Huachuca; developed doctrine for product testing for safety.
<u>Safety Director</u>, 4th and 32nd Infantry Divisions and support functions, Ft. Lewis, WA; responsible for maneuver and tactical safety in large-scale field exercises for combat training.
<u>Assistant Chief</u>, Safety Branch, Portland, OR District, Corps of Engineers; developed design criteria for ROPS, reverse signal alarms, emergency braking systems, and haul-road safety.

1951 to 1955 employed as a safety engineer by the State of Oregon Industrial Accident Commission.

OTHER

Served 9 years on the Board of Directors, Sulphur Springs Valley Electric Cooperative, Inc., serving southeastern Arizona. Past member of Sierra Vista, AZ, Planning and Zoning and Utility Commissions.

Married with three grown children.

LIST OF PUBLICATIONS

David V. MacCollum, 1515 Hummingbird Lane, Sierra Vista, AZ 85635

"Report on the Collapse of the Owyhee Bridge Reconstruction", 1952.

"How Crane Load Tests Prevent Accidents" *Pacific Builder & Engineer*, Mar.1957.

"How Proper Scaffolding Cuts Costs" *Western Construction*, Sept. 1957.

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"Testing and System Safety" USAEPG, November 1967.

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"Construction Safety", Professional Engineer Letters, *Professional Engineer*, December 1968.

"Arizona Cities - Fuel for Firestorms" *AZ Professional Engineer*, Jan. 1969.

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"A Systems Safety Approach to Mining" National Safety Congress and Exposition, Chicago, IL, October 1970.

"Executive Action," Tucson presentation as Director of Safety, USA STRATCOM, Ft. Huachuca, AZ, 1971.

"Systems Approach to Safety", Oklahoma Center for Continuing Education, The University of Oklahoma, April 19, 1971.

"Getting Back to the Fundamentals of Safety" Construction Industry Sessions, 1972.

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