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# The Educator

VOLUME 8 • NUMBER 3

## RESEARCH



## Research-to-Practice in a Safety Context

BY JOEL M. HAIGHT, PH.D., P.E.

**Intellectual property provisions are something that each researcher needs to understand and account for going into each study.**

**T**he term research is used in many contexts and for many purposes in our society. In literal terms, one might think it to mean to search again or, in essence, to search information that has already been developed. However, it is widely accepted that research leads to the development of something new. This can take many forms and in many cases, the new is a new understanding. Journalists do re-


*For a project to be considered research, it needs to be a contribution to the literature, meaning it cannot have been discovered before.*

search on a known body of established facts and information to form the basis for and to develop their stories; criminal investigators conduct research to discover new information that allows them to solve crimes; and fiction novelists do research to learn factual information around their planned story line that will add credibility to their novels. Historians do research to build the


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body of knowledge about past societies, civilizations, cultures, customs and traditions. In each case, a new understanding is developed or a new position can be stated. Other definitions explain that research is the search for new knowledge through an understanding of existing knowledge or it is described as a systematic investigation to establish or understand facts. Scientific research has to do with the systematic process of discovering, interpreting or developing methods for gaining human knowledge about scientific issues.

Part of the process, called the literature review, allows researchers to not only strengthen the body of knowl-

edge, but also to allow them to determine where they can now fill in the gaps in that information with the new discoveries they hope to make through a multitude of research methodologies. The research that engineers and scientists conduct begins with a literature review phase. Then, through various research techniques and methodologies, these researchers explore how humans, the environment and machines of industry and the working world interact with each other and with natural and physical law. Psychologists and behaviorists explore the interrelationships between and among humans and their environment. This article explores the methodologies and means of research used by engineers and scientists to understand the implications and expectations of safety in the working world and to

explain the process involved to bring new discovery to the practical world.

Research-to-practice is a policy embraced by NIOSH in which emphasis is placed on dissemination of research results beyond just the publishing of results and conclusions in peer-reviewed scientific journals. While publishing results in such journals is still a strong emphasis at NIOSH and many research entities, further development of the results into products, policies, practices and standards is emphasized as well. This article addresses the concept in more general terms beyond NIOSH, but it also contains discussion about some examples of NIOSH research-to-practice results. The author attempts to answer the question, “What is research and what does dissemination of that research mean?” in research-to-practice terms.

Another purpose of this article is to challenge the academics in the safety community to get involved in the research process and begin to teach students studying the

various safety fields to take up the research challenge in its true sense and to contribute to the development of new information, products, policies, practices, processes and standards that will ultimately lead to the protection of workers around the world.

**INTRODUCTION**

There are many different types of research. One might undertake a research effort using methodologies that could be descriptive, correlational, explanatory, exploratory, qualitative, quantitative, rigorous, valid, verifiable, systematic, empirical and/or critical. For a process to be called research, it should have one or more of these characteristics and its results cannot have already been discovered. In this article, the author discusses the process to move from concept to hands-on, applied research output.

**THEORETICAL OR BASIC RESEARCH**

Two general types of research exist—basic research (or theoretical research) and applied research. In theoretical research, researchers attempt to define phenomenon relative to natural and physical law. Its purpose is often more to prove that the phenomenon is true or not true, and the use of this proof often does not appear in society until many years later.

For example, theoretical researchers in chemistry may seek to determine whether a particular molecular structure can exist in nature, under what conditions the molecule may exist and whether it can be synthesized. Theoretical researchers in combustion science may seek to determine whether particular fuel mixtures can be combined in such a way as to create an adiabatic flame but not really care to put this very efficient burn to use in the practical world. Theoretical research results must be transformed in some way in order to be used today in the applied world. Theoretical or basic research can sometimes be considered the foundation on which applied research can be built.

**APPLIED RESEARCH**

Applied research has to do with using theoretical knowledge to understand how to solve practical problems in the applied world. This is research that is conducted to compare the most efficient or most cost-effective solution to a problem from a bank of potential solutions. It may involve comparing the effectiveness of several types of protective equipment to select the best one or analyzing the effectiveness of several fall protection design systems by quantifying and considering the many factors deemed as having a contributing effect on the effectiveness of each system. Applied research takes many forms but is almost always applied in the day-to-day, practical world.

Since safety of workers in a complex environment and complex work system is so multidimensional, no one body of research exists where specific safety-disciplined researchers perform applied safety research. Specific safety-related research is often done within spe-

**Two general types of research exist—basic research (or theoretical research) and applied research. In theoretical research, researchers attempt to define phenomenon relative to natural and physical law.**

cific disciplines, then it is applied in a safety context. Research of various elements and aspects of human systems applied in a safety context include biomechanical, behavioral, physics, medical, epidemiological, fluid dynamics, electrical, psychological, sociological, business, motor learning, educational, etc. While there are relatively few safety-related scientific journals (e.g., *Journal of Safety Research*, *Safety Science*), safety-related research is published in hundreds of scientific journals from many disciplines: business, biomechanics, physics, fluid dynamics, etc. (e.g., *Journal of Financial Economic Policy*, *International Journal of Structural Integrity*, *Journal of Biomechanical Engineering* and *Journal of Fluid Mechanics*).

Safety is an applied field; it could be argued that there is no pure safety research, per se. We try to better understand the safety aspects of human performance in an environmental or industrial system through the study of various elements of the humans and their interface with their environment. This is probably one of the main reasons why safety research literature is found throughout the applied world and body of knowledge.

### SCIENTIFIC METHOD

Even in applied research, rigorous, systematic scientific method must be used so that the results will have credibility. This effort is directed at gaining new knowledge, then either updating existing knowledge or integrating the new knowledge into the old. The use of rigorous and disciplined techniques is a necessity so that we can ensure consistency, validity and repeatability of the results. To provide confidence that the phenomenon being studied is, in fact, how and what we think it is, we must gather information and evidence that is observable, empirical and quantifiable or measurable in some way.

Once the phenomenon has been defined, through a literature review, we arrive at a research question that must be answered and we formulate a hypothesis as to what the answer to the research question is. Then, through the implementation of the chosen scientific method, we seek to prove or disprove the hypothesis.

The process first involves developing an experimental design that will allow us to statistically prove, with a reasonable level of confidence, that our hypothesis is true or is not true. It involves the collection of some form of data that represent the phenomenon of the study. These data represent actions or events that have occurred and that we have observed and quantified. Through statistical analysis of these data, we are able to compare across and between the performance-defining variables that the data represent. These data and the variables they define often represent a level of dependence upon the system studied.

Independent variables are usually those that are manipulated (or are observed as they naturally vary) through experimentation so that the effect on the dependent variables (dependent upon variation in the independent variables) can be quantified and analyzed. One is

looking for some measure of response in a dependent variable that can be explained by the variation in the independent variable. This mathematical relationship can be used to explain the phenomenon and to help predict any future performance of the phenomenon. Since the results must be repeatable and since a high level of certainty in the results is desirable, various techniques that involve the use of control groups, blocking and isolating of variables are common and, in some cases, necessary.

Many aspects of experimentation must be addressed to help ensure validity, reliability and repeatability, such as eliminating bias, identifying and eliminating confounding effects, and reducing experimental error. While it is not in the scope of this article to teach experimental methods, it is important, at least to describe the basics of the process to show the lead in to the dissemination of the research results through the concept of research to practice.

### THE RESEARCH PROCESS

For a project to be considered research, it needs to be a contribution to the literature, meaning it cannot have been discovered before. One of the first steps in the research process is to perform a literature review. In this literature review, the researcher consults the body of knowledge or body of literature on the subject of interest to ensure that s/he understands what is already known about the subject. The researcher should read all of the applicable peer-reviewed scientific literature on the topic; however, a significant amount of effort should be expended on reading other types of literature (e.g., texts, proceedings papers, professional journals). Through this process, the researcher will identify gaps in the body of knowledge, that can now be filled through the intended or proposed research.

Techniques and methodology can be defined through the literature search by extending the methods of a previous researcher or by applying the same methodology to a different application. Since a researcher's goal is to contribute to the literature, this step is very involved and can take a significant amount of time and effort. The literature review write-up is a summary of what has been reviewed and a summary of the current body of knowledge on the proposed topic, but it also includes some discussion of what is not yet known or is not yet integrated into the body of knowledge.

Once these gaps have been defined, the researcher should then draw a connection in the writing to his/her proposed work. This literature review helps support one's argument and helps build a case for the proposed research. How will the researcher fill the gap? This step allows a researcher to pose the main research question(s), then to formulate the hypothesis.

### DEFINING THE RESEARCH QUESTION & THE HYPOTHESIS

Once research interests and the gaps in the body of knowledge have been defined through the literature review,



a question can be posed that, when answered, will fill a defined gap in the literature. It is not expected that any one researcher will fill all gaps in the literature; rather, it is more important for any one researcher to focus on one or a few specific and direct questions. This usually will result in a better defined study with less experimental error and, thus, less uncertainty in the results. Such question might be, “Will the use of a particular material function in such a way as to prevent slips on steel surfaces, through an increase in friction between the boot soles and the steel forming the working

surface for steel erection workers?”

A researcher then poses an answer to that question, then seeks to prove that the answer is correct. This is a critical point in the research that is often misunderstood. Many students and early researchers believe that if they fail to prove that their hypothesis is true, they have failed, i.e., they proposed that the material functions to reduce slips and should be used for boot soles. If the research proves that the material is not appropriate for use on boot soles, the research was still successful because through the research we learn that this material should not be used and better materials should subsequently be tested.

As part of a behavioral safety study in the oil industry, the hypothesis was that the more behavioral observations carried out by the workers, the safer the operation would be (Agraz-Boenekar, Groves & Haight, 2005). The research proved that the hypothesis was false; no matter how many behavioral observations the workers carried out, there was no statistically significant effect on the safety performance outcome. While the results were not desirable to the owners of the operation, the research results were successful and much was learned about the process that was studied. The object is not for the researcher to prove that s/he is correct; it is to prove what is correct. The hypothesis is meant to be a tool to allow the systematic proof of one result or another.

In another series of studies, the base hypothesis has been that a statistically significant mathematical relationship exists between the interventions of a safety program and the incident rate that the safety program interventions were intended to reduce (Haight, et al., 2001; Haight & Thomas, 2003; Iyer, et al, 2004 & 2005; Al-Mutairi & Haight, 2009; Shakioye & Haight, 2010). In each of these studies, the relationship was proven to exist but with varying degrees of uncertainty. Because the hypothesis was proven, the research was successful; however, what to do with the relationship and its level of uncertainty has posed many challenges.

Proving the hypothesis can involve extensive analysis, but for the most part, it involves the statistical testing which

allows one to state that a sample from a population truly represents that population. It also can involve proof that the mean from one sample is different from the mean of another sample. To know exactly what one must prove, an experiment needs to be designed so that the correct data are collected, the correct amount of data are collected, the correct assumptions are made about the distribution of the data and the correct analysis is carried out based on the distribution.

## EXPERIMENTAL DESIGN & ANALYSIS

The researcher must decide the level of uncertainty that s/he can tolerate. The researcher must determine how many dependent and how many independent variables are needed to explain the performance of the system studied. Once the variables are defined, the researcher must determine whether the variables are thought to interact with each other or on the other dependent variable/s over time, over a range of one or more of the independent variables, across batches or lots, across subjects, over time and so on.

When this is determined, means of data collection can be established, randomness can be established and the number of levels to be used for each variable (or factor as they are also called) can be determined. It must be determined if a single one-to-one correlation is desired; whether analysis of variance (ANOVA) or multivariable analysis of variance (MANOVA) will be needed; whether multivariate regression analysis is required or if more elaborate techniques, such as three-dimensional response surface methodologies, will be used in the analysis. The design and type of experimentation undertaken depends on the type of system studied, the level of uncertainty tolerated and the type of result desired. Some examples of specific designs include randomized block designs, Latin squares, split plot designs and nested designs (Montgomery, 1991).

If one is trying to determine the perception among workers as to how effective a particular intervention is, the researcher may conduct a survey of the workers. The researcher would draw a sample from the total worker population, analyze survey responses and quantify the results.

The next step is to perform the statistical analyses to allow the researcher to state, with an acceptable level of certainty, that the mean of the sample represents the mean of the population. If trying to prove that one particular type of protective equipment is more effective than another (e.g., one type of safety glasses lens is more impact-resistant than another), the researcher would design the experiment to collect quantified representative data describing each particular type of equipment and through ANOVA and other mean comparison techniques prove that, with an acceptable level of certainty, the mean of the impact resistance of one lens material is greater than the mean impact resistance of the other lens material.

If one wanted to prove that several interactive variables defining a company's safety efforts have an individual and combined or interactive mathematical relationship with the criterion that defines the safety performance (e.g., incident



rate), the researcher may collect quantified data representing the interventions and their output over time. With this, s/he would perform a multivariate regression analysis to define the mathematical relationship, then determine the extent and the strength of the relationship of each and all of the variables.

In an epidemiology study, researchers may collect data about certain disease states thought to exist to a greater extent in certain populations relative to demographics, over certain periods of time or in certain geographic areas. Then, through various comparative analytical methodologies (i.e., ANOVA), determine whether the rate of disease occurrence or the depth or extent of the particular disease state of interest is any greater than would be expected in the general population.

If one is trying to develop and test the performance of a mathematical model to represent a safety process (e.g., the performance of a particular sensor to show where a human operator is spatially, relative to a piece of equipment that s/he is operating), one would collect quantified positional data over time (throughout a shift, or more likely, many shifts) to develop the mathematical equation that defines the operator's position throughout a representative day. With this equation, the programmer develops the program to show how the operator's position may change as the equipment changes. With this information, the researcher would then collect the data for actual position and movements throughout the shift, and perform the comparative statistical analysis to compare the predicted movement from the model to the actual movement of the operator to show how close the model predicts actual positioning.

In some cases, a researcher may want to determine the effect of a safety intervention on a part of the population by comparing the behavior of the target exposed group relative to people not exposed to the intervention. In this case, the design would need to include the use of a control group. The comparisons are made between the two groups with the unexposed group functioning as the control group.

Depending on the type of results the researcher is finding, s/he may decide that various transformations of the data are necessary to draw meaningful conclusions (e.g., if absolute data values are not showing any meaningful relationships, log or log normal transformations may show something entirely different). Since experimental design and analysis are the core of the research process, much importance must be placed on this stage. The experimental design and the expected analytical methods must be defined ahead of time so that funding proposals can be written and required approvals for the use of human or animal subjects can be acquired (Montgomery, 1991).

### **HUMAN OR ANIMAL SUBJECTS TESTING**

When the experimental design has been established and defined, one must determine whether human or animal subjects are needed to carry out the research. Within most bona fide research institutions, such as research

universities, government agencies, research foundations, corporate research and development departments, as well as commercial research organizations, an entity is charged with the approval of research proposals that involve the use of human or animals. This organization, often called a board, is made up of people who are experienced in research as well as in the ethical and safe treatment of human and animal subjects.

A history in research shows that fair, safe and ethical treatment of humans and animals has not always been important to the research community. In a study done at Tuskegee University around the time of World War II on the racial differences of how syphilis progresses in the body with and without treatment, some were not treated for the infection and others were given treatment that was known to be inadequate. They were not necessarily informed and consenting subjects and, while they were given medical examinations, they were not told that they were infected with syphilis.

This study remains one of the strongest examples of research done in which humans were put at risk, and the basic principles of ethical treatment of human beings was strongly violated, in the beginning of the study and over a 30-year period. This study contributed to some of today's current conduct and treatment rules as they apply to human and animal subjects.

For most human and animal subject review boards, the researcher must provide the research proposal in its entirety for review. This should include the experimental design, the data collection methods, the resources available and the researchers' expertise. Thus, the reviewers can determine how humans or animal subjects would be used; how many of them will be used; how they will be recruited; if they require any training prior to the study; the physical and cognitive demands on the subjects; the extent to which they have been informed of the process and its risks; if they will be adequately compensated if required; what will be done with the data after the study; and how it will be protected. The board requires that the wording to be used in the informed consent process be provided, so that the reviewer can tell whether adequate information on the risk and demands will be provided to the subject. If the safety of the subject has not been adequately guaranteed, the researchers may be required to add provisions for additional protection or additional information sharing.

The process can be involved, but the level of review depends upon the extent of the risk of physical or mental harm to the subject. An invasive medical study, such as one that involves taking various medicines or involves the collection of blood or other tissues, is likely to receive a much more in-depth review and evaluation than one that only involves subjects answering survey questions. Basically, in any study that involves humans and the data resulting from the study can be directly attributed to the specific individual from whom it came, a human subjects' board review and approval are necessary.

## **RESEARCH PROPOSAL, RESEARCH PARTNERS, COLLABORATORS & FUNDING**

Developing the proposal requires that the researcher fully understand ahead of time what s/he plans to do in the study, what outcome is expected, what kind of resources might be necessary, what type of travel may be required to collect data and so forth. Because the scientific methods must be rigorous, systematic, unbiased and disciplined, it is important that the plans for study be detailed so that others can ensure that these expectations of science be assured.

This is the first place where members of the scientific community begin the peer review process. While the level of review a research proposal receives differs depending on what organization or for whom it is carried out, each research proposal receives some level of scrutiny. If government or commercial funding is required to carry out the research, the review and approval process can be extensive. The proposal can be reviewed by several peer scientists and, before a study is approved and funded, it may need to undergo several revisions to satisfy the reviewers that it will be carried out systematically and in a rigorous and unbiased way by qualified, experienced researchers who are known to carry out relevant and impactful research.

In some cases, if in order to carry out relevant and impactful research, a researcher needs the cooperation and/or collaboration of industry or societal partners and collaborators, either for facilities, equipment or subjects, it is expected that the research will secure these partners and/or collaborators prior to the start of the research. In a proposal, the researcher usually attaches support letters, collaboration agreements and copies of secrecy agreements to the proposal. In this way, the reviewers can tell that there will be adequate resources and cooperation from the organizations that have appropriate resources for the study's expectations.

Funding from outside sources, government funding agencies, foundations or industry, can be a researcher's lifeblood. It is usually a complicated and competitive process of scoring and ranking. The proposals are given scores and are ranked based on criteria, such as scientific merit, relevance and impact. In most cases, the higher-ranked or higher-scored proposals are the ones selected for funding (but NIOSH uses a lower-the-better scoring scheme).

However, as with all systems, there are exceptions. It can be the case that one proposal may address a defined need or problem more directly than another proposal while lacking the quality the other proposal may have. In most cases, the proposals that receive funding are those that expected to minimize the problems which can come from research (loss of subjects, contamination of the data, compromised facilities or equipment and so on).

## **RECRUITING SUBJECTS & COLLECTING DATA & ANALYSIS**

When conducting research involving humans, it is

important to gather data from a population that best represents the characteristics of the people who the research is targeting for the study.

For example, safety researchers would most likely be interested in a population of workers from the industry they are interested in studying. If one is studying the effect of a safety-related intervention on workers in the mining industry or the oil industry, it would probably not provide the most certain and applicable results if elementary school students were used as the subjects. It is also particularly difficult to do applied research on workers while they are exposed to the workday and all of its dynamics. In many cases, they need to be pulled from their work to participate in the research, such as would be required to complete a survey, to be tested for a level of fatigue, level of strength or the amount of force the subject can generate, or what the effect of particular training intervention is on performance.

In many psychology studies, undergraduate students are recruited as subjects. In ergonomics research, military people have often been used. While these types of studies may have applicability beyond the two populations mentioned, it should be the researcher's goal to recruit from the target population. One must pay attention to demographics and variables, such as age, strength, gender, years of experience and level of training, among other factors.

Therefore, for applied and research-to-practice expectant research, it is important to rely on the cooperative agreements and collaboration from industry partners. A minimum of disruption to the workday and the work pressures of the subjects are important to the continued participation of the collaborating partners. Again, the design of the experiment dictates the number of subjects that are required. This is defined by the researcher's tolerance for uncertainty. Another complication in government research is that if the study involves interviewing or surveying 10 or more human subjects, approval from the Office of Management and Budget is required.

Once the appropriate number of subjects is recruited, prepared, trained and informed of any risks, and they have provided consent, the data are collected and organized for analysis. The analysis can be involved and can take several months to complete. The analysis itself is often straightforward work, but understanding the results of the analysis, performing appropriate transformations, interpreting the results, drawing conclusions and defining the limitations of the results are a true test of a researcher.

The level of uncertainty in the results must be defined and given that, the researcher can state whether an intervention worked or did not work; whether one part of the population is more likely to be injured or ill than another part of the population, or whether one hazard puts someone at greater risk than another hazard. It is the expectation for most studies that a claim can be made; however, it is every bit as powerful and useful to be able to state that the safety intervention had no effect or that a hazard did not



affect the risk to a worker. From research we can learn what is true, what is not true or what cannot be determined from the study performed. All of these results are outcomes from which one can learn and from which one can build a safer environment.

### **COMPLETING THE STUDY & DISSEMINATING THE RESULTS**

It is generally expected that research results eventually lead to an improvement in general life, work life or an improvement of the understanding of other aspects of work life or life in general. That is not always the case; sometimes, the results prove that a hypothesis claiming an improvement is false. But in all cases where the research is successful, whether the hypothesis was proven true or false, the level of understanding of the subject is improved.

When the study is completed, the results need to be written up so that they can be evaluated by scientific peers and made available to the public. This is most often done in the form of an article to be published in an appropriate scientific journal. To make this happen, the researcher writes a manuscript defining the research problem or question, describes the methodology and the analysis, presents the results, discusses his/her interpretation of the results, then states any conclusions. The manuscript is submitted to a journal editor, who sends it to two or more reviewers with expertise in the area covered by the research. They perform a double-blind review of the manuscript. The reviewers evaluate the science to ensure that appropriate methodology for both experimentation as well as analysis was done. They then ensure that the researcher's conclusions are defensible and sound.

A recommendation is made to the editor as to whether the manuscript is not publishable, publishable as is or publishable with suggested revisions (this is most often the case). The editor decides whether to publish the article based on the reviewers' feedback. In most cases, the editor sends the manuscript back to the researcher/author to decide if s/he will make the revisions as a condition of publishing. Usually, the researcher makes the revisions and resubmits the manuscript to await publishing.

This is the best way to get the peer-reviewed and accepted findings out to the people and organizations that need it. Even after the work is published, it can be challenged. It can be proven wrong by the reading public, but that is the scientific community's expectation. Constant review of the published literature is how accuracy is ensured over time.

Peer-reviewed scientific journal articles are not the only way to disseminate the research. Results are also presented at scientific, industry and association conferences and are published in the proceedings from those conferences. While these are also peer-reviewed, usually only the abstract is peer-reviewed. Therefore, the assurance of soundness and accuracy is not as great as with full peer-reviewed journals, but they reach audience at the conference as well as all those who read the proceedings.

All research is not adequately disseminated in the peer-reviewed written form only. Sometimes, the results lead to the development of actual products, new designs, improved practices, changes in existing or the development of new policies or new or revised national or international standards. If internal company research is done, the results can be disseminated via corporate intranet sites, company newsletters and so on. While these types of publications do not receive the same level of unbiased peer review, they are still valuable dissemination vehicles of research findings and conclusions. All of these results represent forms of intellectual property that require various forms of protection. Intellectual property is not easy to disseminate while concurrently protecting the rights of the researcher, designer, developer and so on.

### **INTELLECTUAL PROPERTY**

While intellectual property is a name that applies to many entities, as it applies here, it is the generalized name given to the intellectual developments of researchers coming from their research. Some of this is freely shared in scientific journals, as described, and this is protected by the journal through its copyright process. For the most part, these copyrights prohibit others from profiting by using the concepts developed by the researcher in the published literature. This concept of intellectual property, as it applies to research in this context, applies to inventions, scientific or engineering discoveries, and in some cases, as it applies to the safety business, pieces of personal protective or other equipment. It entitles the researcher to some protection against the unauthorized use of or stealing of the concepts, ideas, protocols and designs without appropriate authorization from or compensation to the researcher.

The idea of intellectual property protection was first introduced in 1883 at the Paris Convention for the Protection of Industrial Property and the Berne Convention for the Protection of Literary and Artistic Works in 1886. The World Intellectual Property Organization administered both of these treaties.

There are many ways to share intellectual property so that all interested parties are properly compensated for their research work and/or receive the benefits commensurate with the value of the compensation paid. The means used by researchers to protect their intellectual property and their rights to compensation are through mechanisms, such as patents, research agreements in which payment schedules are established, licensing agreements and the payment of royalties. It depends on the type of property that was developed through the research. If a product has been developed with a new or

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improved design, the appropriate protection may be a patent. If an industrial process or a new management system is developed, a licensing agreement will probably be most appropriate. If the result of the research is a new computer software product, a book or other type of written publication, a copyright arrangement may be the most appropriate protection mechanism. If an industrial company pays an outside agency to perform research to develop any of these types of research, a research agreement between the two entities can be developed in which a royalty payment scheme is used.

This part of the process is complex, interwoven with legal requirements and often requires the input of attorneys to establish the agreement and put it into appropriate writing. Fair use of research information is important to the continuation of the learning process and is necessary so other researchers can build on the work of the original researcher and so the protection of the original researcher's intellectual property rights can be protected with provisions for sharing for the advancement of the science. These protections can be afforded, but provisions for the enforcement of the intellectual property rights must also be included in all agreements. It is difficult to enforce these rights or to find violators, but the responsibility to protect and enforce these rights falls on the shoulders of the researcher who has the rights.

### CONCLUSION

Intellectual property provisions are something that each researcher needs to understand and account for going into each study. The research environment should encourage the free flow of ideas, and this article outlines much of what it takes to put together the work plan to fully develop these ideas and to turn them into actual practice that leads to improvement in safety. Development of this work plan is a rigorous process. It is a process that requires the researcher to do much upfront work and to some extent, project into the future what the outcome of the research might be or look like.

Because research is such a complex and involved process, it requires an involved infrastructure to ensure that it is properly carried out and that the results are well-founded, ethically developed and peer-reviewed. This infrastructure includes the input from contract administrators, human subjects' review boards, intellectual property attorneys, laboratory and other facilities, editorial experts and graduate or research assistants. These are the infrastructure components that are found in corporations, commercial or government research institutes, or large research universities.

This creates a bit of a dilemma for universities with safety programs, as most of them in the U.S. are not large research universities and therefore the infrastructure is not available for the conduct of pure safety research beyond analyzing existing data sets or performing survey-based research. Because of this, most of the research in the safety area is done by research organiza-

tions with many different missions and housing many different backgrounds. Safety research is accomplished in business research institutes, such as Rand; in government research agencies, such as NASA and NIOSH; in medical and epidemiological research agencies, such as CDC and NIH; and behavioral research institutes, such as the Institute for Behavioral Research. The people performing and managing the research in these organizations are researchers trained to do research through education (such as a Ph.D.) and experience, and they are trained in specific disciplines of natural and physical law as well as human-based sciences and engineering.

The fact that safety research can be found throughout the literature makes it difficult for safety practitioners who need and use this research information, these products, policies, practices, standards to find and gather. NIOSH Education and Research Center grants have historically been awarded to major research universities and, in most cases, are administered by their schools of public health. While several of the centers have a safety component, the focus seems to be ergonomics or industrial hygiene-oriented, and in many of these cases, the course work and research are administered through industrial engineering or mechanical engineering departments.

It would be appropriate for members of this safety community to become familiar with the research process and to understand all of the organizations, agencies and institutes that conduct safety-related research. It would be a benefit for the safety community to engage in the research process and to work with ASSE and member companies to generate the money necessary to conduct research. This would allow safety community members to ensure that the research is directed to areas that challenge safety practitioners the most. ☺

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## Safety Suitcase

**A** SSE's Safety Suitcase is an informational tool that can be used when visiting schools to talk to fourth to sixth graders about the occupational SH&E profession and safety in general. The intention is to reach out to kids and teach them about safety and potential career options in a fun, interactive way.



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## 100th Anniversary Contests: Help Tell Safety's Story

### GREATEST SH&E CHALLENGE ESSAY CONTEST

What do you think is the greatest challenge facing the SH&E profession in the 21st century? Share your thoughts by entering ASSE's 100th anniversary essay contest. Submit an original 1,000- to 2,000-word persuasive essay that outlines a specific challenge and highlights possible solutions/strategies.

Entries must be written by a single individual and must be submitted by Feb. 28, 2011. The top entry, to be selected by a panel of ASSE judges, will receive \$1,500. The winning essay will be announced April 1, 2011. It will be highlighted during Safety 2011 and on ASSE's website. In addition, the top 10 ranked entries will be compiled into a digital publication for distribution to ASSE members and interested parties.

### LIGHTS, CAMERA, VIDEO

Not a writer? Then enter ASSE's 100th anniversary video essay contest, "Why the World Needs More SH&E Professionals." At work, at home and places in between, safety touches everyone. Help show the world that SH&E professionals play a vital role in keeping the world safe. Create a short video (no more than 2 minutes in length) that explains the importance of occupational safety and health, and highlights the professionals who safeguard it each day. Whether it's a testimonial, performance art, a comedy routine or one clever sentence recorded with a web cam, as long as it is original, it can be entered.

Submissions are due Feb. 28, 2011, and judging will occur throughout the month of March. The grand-prize entry, which will be announced in April 2011, will win \$1,500. This video will be featured on ASSE's website and will be showcased at Safety 2011 in Chicago. In addition, the entry identified by the most visitors to the ASSE website as their favorite wins \$1,000. ☺



# Blueprints

VOLUME 10 • NUMBER 2



## Prevention of Fall Fatalities & Injuries

**Best Article  
of the Year!**

Construction is and will continue to be one of the most dangerous industries. Falls account for approximately one-third of the 1,200 fatalities per year in construction.

BY JOHN W. MROSZCZYK, PH.D., P.E., CSP

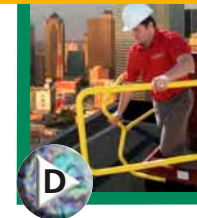
**C**onstruction is one of the most dangerous sectors of the economy in which to work. Roughly 1,200 construction workers lose their lives every year (Table 1 on pg. 19). This should not be too surprising. Construction projects move very quickly. Construction workers are exposed to many types of hazards, such as falls, toxic chemicals, electricity, trenches, material han-

*Roughly 1,200  
construction  
workers lose their  
lives every year*

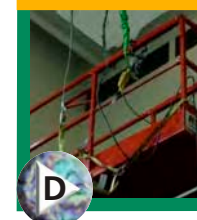
dling, ergonomic, dangerous power tools, heavy equipment and noise.

Of those 1,200 yearly fatalities, approximately one-third are from falls (Huang & Hinze, 2003; BLS, 2008). Fall fatalities occur repeatedly even though the hazards and safety measures are well defined by OSHA regulations. This article discusses the nature of fall hazards, contributing causes of construction

*continued on page 19*



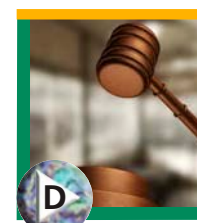
**PAGE 4  
WORKER  
SAFETY**  
Protecting  
Personnel



**PAGE 8  
FALL  
PREVENTION**  
Fall Arrest  
System



**PAGE 14  
SAFETY  
MANAGE-  
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Rewards



**PAGE 17  
RULE-  
MAKING**  
Acetylene  
Standard

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## Prevention of Fall Fatalities & Injuries

*continued from page 1*

fall fatalities and how a team effort between design professionals, contractors and construction workers can have a favorable impact on the number of construction fall fatalities.

### THE HAZARD OF FREEFALLS FROM ELEVATIONS

One of the earliest recorded falls in history is in the Second Book of Kings, 849-850 B.C. King Ahaziah fell through the lattice of his roof terrace at Samaria and was injured. He later died. The notion of an uncovered opening as a fall hazard can be found during the period of Moses in the Book of Exodus: "When a man uncovers or digs a cistern and does not cover it over again, should an ox or ass fall into it, the owner of the cistern must make good by restoring the value of the animal to its owner."

Ancient philosophers put much thought into the motion of bodies that freefall to the surface of the earth. Galileo recognized that while the presence of the atmosphere prevents true freefall, air resistance is small at low speeds, allowing freefalling bodies to move with uniform acceleration. The distance traveled by a freefalling body initially at rest,  $S$ , is related to the acceleration of gravity and the time,  $t$ , of the freefall by the following relation:

$$S = \frac{1}{2} g t^2$$

where  $g$  is the acceleration of gravity 32.2 ft/sec<sup>2</sup>.

A good human reaction time is 0.5 seconds. In 0.5 seconds, your body travels approximately 4 ft. For a more typical one-second reaction time, your body will fall approximately 16 ft. This means that a person will move at least 4 ft down from where they were standing before they even react to the fall. Grabbing onto something at the moment of the fall is virtually impossible.

**Table 1**  
**Fatal Injuries in U.S.**  
**Construction Industry:**  
**2003-2007**

Year	Number of Fatalities
2003	1,131
2004	1,234
2005	1,192
2006	1,239
2007	1,204

Source: BLS, June 24, 2010.

It is not too surprising, therefore, that falls from elevations result in very serious injuries and death. One study reported that two-thirds of construction workers involved in falls are killed (Huang & Hinze, 2003). Fall injuries include fractures, concussions, bruises, contusions and abrasions. About half of injuries are head injuries. Other body parts include the chest, neck, back, abdomen and legs.

While the potential for a fall injury exists at any height, OSHA's Regulation Subpart M 29 CFR 1926.501(b) requires fall protection whenever the potential to fall 6 ft or more exists. Fall protection is also required on scaffolding 10 ft or higher. Fall protection and prevention systems include guardrails, safety nets, personal fall arrest systems, positioning devices and covers. Other measures include warning lines, controlled access zones and monitoring systems.

***Fall injuries include fractures, concussions, bruises, contusions and abrasions. About half of injuries are head injuries. Other body parts include the chest, neck, back, abdomen and legs.***

### CONTRIBUTING CAUSES OF CONSTRUCTION FALL INJURIES & FATALITIES

In a perfect world, falls in construction should be rare. Fall hazards, fall prevention and fall protection are well known and defined in OSHA regulations and related standards. However, the world is not perfect, humans make errors and even the most experienced workers may misjudge a particular situation. Several studies emphasize the human worker aspect of construction fatalities. One study identified behavioral issues, human error and deficient management as related causes of construction accidents (Toole, 2005).

For example, an employee is sent to work on a sloped roof without proper training in the use of fall restraint systems (deficient management). An experienced worker may just forget to tie off due to fatigue or distraction (human error). In another study, misjudgment of a hazardous situation, distractions and perception errors were found to be related to falls (Huang & Hinze, 2003).

To make matters worse, safety responsibilities are often blurred on a construction site. Many entities can be on a construction site, such as design professionals, owner, construction managers, general contractors and subcontractors. Under the conventional approach to a building project, the owner separately contracts with an architect/engineer and with a general contractor, prime contractor, construction manager, program manager or owner's agent.

An owner may choose to contract with a design/build firm to perform both design and construction. A portion (or all) of the construction work may be subcontracted to specialty trade contractors. Frequently, this comes down





*Photo 1 shows the proper use of a ladder. The ladder is tied off at the top, and the worker is maintaining three-point contact.*

**Contractors should provide a training program on the use of ladders for each employee.**

to managing safety in a somewhat haphazard manner. Some contractors may pass safety responsibilities onto others. A subcontractor may create a hazard without informing the other subcontractors. A subcontractor may arrive at the site ahead or behind schedule, creating sequencing problems. A particular phase of a project may take place out of the normal sequence, creating an unplanned fall hazard.

#### **FALL PREVENTION VS. FALL PROTECTION**

Two types of safety systems prevent and protect workers from falls. Passive systems prevent falls by placing a physical barrier between the worker and the fall hazard. Examples of passive systems are guardrails and covers.

Guardrails should include a top rail, a mid rail and a toeboard. The top rail should be 39 to 45 in. above the walking/working level and be able to withstand a 200-lb load applied in any direction. Covers should be capable of supporting at least twice the anticipated load that may be imposed on it. The cover should be secured against displacement and marked with the word "HOLE" or "COVER" to provide warning.

Active systems protect workers who have already fallen by limiting the fall to a specified distance as well as the force on the worker. Examples of active systems are personal fall arrest systems and safety nets. Anchorages for the attachment of personal fall arrest systems should be capable of supporting at least 5,000 pounds. The personal fall arrest system should limit the maximum force applied to the worker to 1,800 pounds when used with a body harness and be rigged so that the worker can fall no more than 6 ft.

Fall prevention is preferable to fall protection measures, such as personal fall arrest systems (OSHA; Huang & Hinze, 2003). For example, a personal fall arrest system would prevent a worker from impacting the surface below. However, the worker can still be injured from incidental contact with other structures before and after the arrest system stops the downward motion. Fall prevention measures, such as a guardrail or a cover, would also reduce the human component of fall injuries discussed previously.

#### **FALL FATALITIES IN THE U.S. CONSTRUCTION INDUSTRY**

Table 2 (p. 21) is a breakdown of construction fall fatalities in the U.S. Falls from ladders have the highest percentage followed by falls from scaffolds/staging and falls from roof edge. Falls from structural steel, falls from nonmoving vehicles and falls to lower levels also contribute to the overall statistics. Other fall hazards include fall through a roof surface, falls through skylights and unspecified falls from roofs. Focus and energy on these top ten fall hazards could help reduce fall fatalities in construction. Each of these hazards and related safety measures will be discussed in the following subsections.

#### **FALL HAZARD 1: FALLS FROM LADDERS**

Falls from ladders are the number one cause of fatalities from falls. Planning the job is an important aspect of ladder safety. Ladders can be hazardous when placed improperly, not secured or using an inappropriate ladder. Portable ladders should be positioned so that the side rails extend at least 3 ft above the landing. The base of the ladder should be 1 ft away from the wall for every 4 ft of ladder length. Ladders should be regularly inspected for visible defects before the job begins. Damaged ladders should immediately be marked "do not use" and removed from service.

Ladders are mostly used to access an upper level or a roof. When a ladder is used as a work platform, the work should be limited to that which can be done while keeping the body centered on the ladder. A good rule of thumb is to never let the belt buckle pass beyond either ladder side rail. Scaffolds, aerial lifts or other work platforms should be considered instead of ladders.

Contractors should provide a training program on the use of ladders for each employee. Training should include the proper use of ladders, inspection of ladders and recognition of hazards associated with ladders. The 3-point contact rule should be used: two hands and one foot in contact with one foot moving or one hand and two feet in contact with one hand moving. Photo 1 shows the proper use of a ladder. The ladder is tied off at the top and the worker is maintaining 3-point contact.

Design professionals (the International Building Code (IBC) defines design professional as an individual who is registered or licensed to practice his or her respective design profession) can also contribute to reducing falls from ladders by specifying fixed ladders or stairways whenever possible. This would eliminate the need for a portable ladder when accessing a roof or upper level. The chance that a worker may use a defective ladder, an improper ladder or not use the ladder properly is eliminated.

#### **FALL HAZARD 2: FALLS FROM SCAFFOLDS/STAGING**

Falls from scaffolds and staging ranks as the second

**Table 2**  
**Fall Fatalities in U.S.**  
**Construction Industry:**  
**2008**

Fall Exposure	% of Total
Falls from ladder	19.6%
Falls from scaffold, staging	15.5%
Falls from roof edge	13.9%
Falls from structural steel	8.9%
Falls from nonmoving vehicle	6.5%
Falls to lower level	5.4%
Falls through roof surface	4.5%
Falls through skylight	3.8%
Falls through floor opening	3.8%
Falls from roof (unspecified)	3.8%
Other	13.9%

Source: BLS, 2008.



*Photo 2 shows an unsafe scaffold. The scaffold is not fully planked, there are no guardrails and the ladder is not long enough to provide safe access.*

cause of fatalities. Contractors should ensure that the scaffold is fully planked. If the scaffold does not have guardrails and is more than 10 ft high, then personal fall arrest systems should be used. Scaffolds should have a safe means of access. Photo 2 shows an unsafe scaffold. The scaffold is not fully planked, there are no guardrails and the ladder is not long enough to provide safe access.

Aerial lift devices are

another type of scaffold. Photo 3 shows an example of a scissors lift used in construction. This equipment has specific safety requirements.

### FALL HAZARD 3: FALLS FROM ROOF EDGE

Permanent features can be designed into buildings so that fall protection would not be required when working near a roof edge. These features would reduce the reliance on humans to properly use personal fall arrest systems.

For example, IBC, Paragraph 704.11.1 requires that parapet walls be at least 30 in. high. OSHA 1926 Subpart M requires a 39- to 45-in.-high guardrail or other fall protection. A 30-in.-high parapet wall would require workers to either use personal fall arrest systems or add a temporary structure on top of the wall extending it to at least 39 in. While parapet walls are not required for all buildings, if design professionals specify parapet walls at least 39 in. high, then both IBC and OSHA regulations are satisfied. The parapet wall provides fall prevention when working on the roof (Photo 4, p. 22). Other considerations, such as additional snow load, would need to be included in any decision to build a parapet wall.

The need to go onto a roof and/or near the edge of a roof can be minimized or eliminated. Mechanical equipment should be placed at ground level whenever possible. This eliminates the need to go onto the roof during installation and routine maintenance. Roof vents, mechanical equipment and communication equipment should be located at least 15 ft back from the roof edge (Photo 5, p. 22). The 15-ft distance reduces the risk of a fall when servicing the equipment. Permanent guardrails should be considered when equipment must be closer to the roof edge.

### FALL HAZARD 4: FALLS FROM STRUCTURAL STEEL

Falls from structural steel are another cause of fatalities. Design professionals can specify features that make it easier to erect structural steel. For example, hanging connections should be avoided. Safety seats at column connections would eliminate this by providing support for girders during the connection process. Specifying holes in columns at 21 in. and 42 in. above each floor slab make it easy to install cable or wire guardrails. Shop-welded connections should be specified whenever possible instead of bolts or field welds to avoid danger-



*Photo 3 depicts a scissors lift used for construction work. Fall protection must also be provided for aerial lifts such as these.*





*As Photo 4 shows, a 39-in. minimum-height parapet wall can provide permanent fall prevention when working on a roof.*

face. However, falling from a trailer or from the top of a truck load is just as deadly as falling from an unsafe scaffold or from a roof.

Typical vehicles that would be on a construction site include flatbed trailers, tanker trucks and dump trucks. A trailer should have a safe access, such as a stairway with railings. Photo 6 shows a movable stairway/platform/guardrail system that can be used for loading and unloading flatbed trailers. Mechanical tarping systems can be used so that a worker need not climb on the load during tarping. Various fall arrest systems can also be used, for example, when a worker must be on top of a loaded dump truck.

#### **FALL HAZARD 6: FALLS TO LOWER LEVEL**

Falls from height is the sixth leading cause of fall fatalities. This is another example where permanent features designed into a building can eliminate the need for fall protection. Upper-story window openings can be

ous positions during erection.

#### **FALL HAZARD 5: FALLS FROM NONMOVING VEHICLES**

When a motor vehicle is on the road, it is controlled by DOT regulations. OSHA 1926.500 exempts trucks and trailers from the fall protection requirements of 1926.501(b)(1) in their definition of walking/working sur-

designed 39 in above the floor level. Having the window sill at this height allows it to function as a guardrail during construction. It can also eliminate the need for trailers full of wood 2' x 4's used for temporary guardrails.

Anything that can be built on the ground and lifted into place reduces the time spent at height, thereby reducing the likelihood of a fall. For example, prefabricated stairways and railings (Photo 8) not only reduce the time spent at height, but if put up early in the construction phase, will provide safe access for the upper floors during construction. Prefabricated mechanical system risers (Photo 9), bridge segments, steelwork and wall panels are other examples of how prefabrication can reduce falls.

#### **FALL HAZARD 7: FALLS THROUGH ROOF SURFACE**

Falls through a roof surface are the seventh cause of fall fatalities. The roof structure should be designed so that it can safely support stacks of materials during construction. Hazardous areas and "no-walk" areas should be highlighted with red paint or other visual warnings. Permanent walking/working surfaces can be built as a platform for installing or maintaining equipment, rather than standing on randomly placed sheets of unsecured plywood like the worker in Photo 10.

#### **FALL HAZARD 8: FALLS THROUGH SKYLIGHTS**

Domed skylights with a raised curb should be specified so that a worker does not step directly onto the skylight. The live load of a worker falling onto the skylight should also be considered when designing or specifying skylights. When this is not practical, guardrails or a metal grid capable supporting the live load of a worker should be installed.

#### **FALL HAZARD 9: FALLS THROUGH FLOOR OPENINGS**

Contractors should install guardrails or covers for



*Photo 5: Locate mechanical equipment at least 15 ft from the roof edge so that workers will not work near the roof edge.*



*Photo 6: Movable stairway/platform/guardrail systems can reduce falls while loading and unloading flatbed trailers.*





**Photo 7:** The need for fall protection at window openings can be eliminated by designing upper story windows to be at least 39 in above the floor level. Having the window sill at this height allows it to function as a guardrail during construction.



**Photo 8:** Designing and specifying prefabricated stairways and railings not only reduces the time spent at height, but if put up early in the construction phase, will eliminate the need for fall protection because the floor opening guardrails and handrails will already be in place.



**Photo 9:** Building mechanical service risers on the ground then lifting them into place reduces the amount of time spent at height.

temporary floor openings whenever possible rather than relying on workers to use of personal fall arrest systems. Photo 12 (p. 24), shows a properly covered floor hole. Photo 13 (p. 24), shows a properly guarded opening with a top rail, mid rail and toeboard.

Design professionals can also design features that make it easier for contractors to install temporary guardrails around openings. For example, cast-in sockets provide an easy, convenient means to install temporary railings (Photo 14, p. 25). The sockets can then be used for permanent railings or filled in.

### **FALL HAZARD 10: FALLS FROM ROOFS (UNSPECIFIED)**

Planning the construction and future maintenance of a building can identify areas where permanent anchors should be installed. The idea of identifying anchorage points on construction drawings is taken directly from OSHA 1926 Subpart M, Appendix C:

“(h) Tie-off considerations (1) One of the most important aspects of personal fall protection systems is fully planning the system before it is put into use. Probably the most overlooked component is planning for suitable anchorage points. Such planning should ideally be done before the structure or building is constructed so that anchorage points can be incorporated during construction for use later for window cleaning or other building maintenance. If properly planned, these anchorage points may be used during construction, as well as afterwards.”

Permanent anchors provide a convenient, safe place to tie off when personal fall arrest systems are needed. They also reduce the chance a worker will not use a per-

sonal fall arrest system because there is no place to tie off or the worker connects to something that may not be structurally sound. Photo 15 (p. 25), shows anchors installed on a roof. Floor openings are another area where tie-off points could be designed into the steel structure for use during construction or maintenance.

### **CONCLUSION**

Construction is and will continue to be one of the most dangerous industries. Falls account for approxi-



**Photo 10** shows a worker standing on plywood while checking an air handling unit. The plywood does not provide a safe work platform when installing and maintaining this equipment.





**Photo 11: Falls through skylights are the eighth leading cause of fall fatalities in construction. One might only guess what this worker was doing before he fell.**



**Photo 13 shows a properly guarded floor opening. The guardrail system includes a top rail, mid rail and toeboards.**

**A team effort between design professionals, contractors and construction workers to plan, prevent and protect against fall hazards would be a better approach.**

mately one-third of the 1,200 fatalities per year in construction. Fall hazards, fall prevention measures and fall protection measures are well known. However, injuries and fatalities from the same fall hazards occur repeatedly. It is clear that workers cannot be relied upon to always make the right decision. They forget, are distracted, may be fatigued, untrained, not understand the language or misjudge a particular situation. A team effort between design professionals, contractors and construction workers to plan, prevent and protect against fall hazards would be a better approach.

The idea of identifying hazards, incorporating preventive measures to eliminate the hazard or providing protective measures has existed since the early 1940s. This concept, design for safety or safety in design, has more recently been applied

to construction, providing the basis for the OSHA Alliance Construction Roundtable Design for Construction Safety initiative and the broader NIOSH Prevention Through Design effort.

The first step is to plan the job. Fall hazards need to be identified and discussed during safety meetings so that appropriate measures are put into place. Subcontractors should be held accountable for guarding any hazards that they create so that other workers on the job are not injured. The general contractor should provide overall supervision so that fall hazards are identified and appropriate measures taken as the job progresses. All workers should be trained to recognize falls hazards and to take appropriate measures when needed.

The priority should be on fall prevention over fall protection. Placing physical barriers between the worker and the hazard, such as covers over floor openings and guardrails along opened-sided walking/working surfaces, prevents the worker from falling in the first place. These passive systems also reduce the human behavior and human error component of falls: the reliance on the worker to recognize the need and to properly use personal fall arrest systems is diminished.

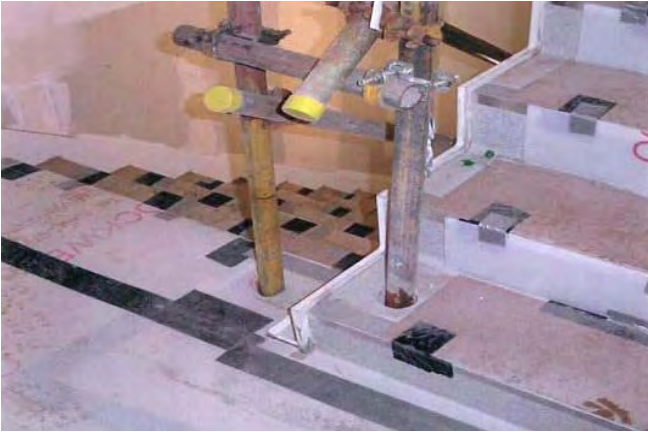
Design professionals can contribute by designing buildings that are safer to build and safer to maintain. Permanent features can be designed into buildings so that fall protection is not required. These features include placing HVAC and other equipment on the ground or away from a roof edge. Parapet walls and windows that are 39 in above the roof or floor are “guardrails.” Designing and specifying prefabricated structures that are built on the ground and lifted into place reduces the time workers spend at height. Permanent anchors provide a convenient place to tie off during construction or maintenance.

The last line of defense is fall protection. Personal fall



**Photo 12 shows a properly covered floor hole.**





**Photo 14:** Designing and installing precast sockets make it easier to install temporary railings. The sockets can be filled in afterwards or used for permanent railings.



**Photo 15:** Designing and specifying roof anchors provides convenient tie-off points during maintenance.

arrest systems should be provided. Workers need to be trained on the use of personal fall arrest systems and when they are needed.

The nature of construction work requires more focus and energy than general industry. The number of construction fatalities, particularly from falls, is not acceptable. A “plan, prevent, protect” team effort between design professionals, contractors and construction workers is a better approach to the problem and should continue as a strategy in reducing construction fall fatalities. ☺

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## RESOURCES

Design for Construction Safety <http://www.designforconstructionsafety.org>.

NIOSH Prevention Through Design <http://www.cdc.gov/niosh/topics/PTD>.

OSHA Alliance Program Construction Roundtable [http://www.osha.gov/dcsp/alliances/roundtables/roundtables\\_construction.html](http://www.osha.gov/dcsp/alliances/roundtables/roundtables_construction.html).

OSHA's Construction Pocket Guide <http://www.osha.gov/Publications/OSHA3252/3252.html>.

OSHA Safety & Health Topics: Fall Protection <http://www.osha.gov/SLTC/fallprotection/index.html>.

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**Design professionals can contribute by designing buildings that are safer to build and safer to maintain. Permanent features can be designed into buildings so that fall protection is not required.**

# Managing the Risk of Your Consulting Practice

Every year at ASSE's annual professional development conference, each practice specialty holds a key issues roundtable as part of the concurrent sessions. These roundtables are billed as "your chance to speak up" and are designed to give attendees (regardless of whether they are practice specialty members or not) a chance to share lessons learned with fellow professionals and to meet others with mutual interests. At Safety 2010 in Baltimore, the Consultants Practice Specialty (CPS) hosted a roundtable on "Managing the Risk of your Consulting Practice."

The roundtable was facilitated by Dan McKenzie, CRSP, CHSC, and Debby Shewitz, CSP, who served as the recorder. With 10 enthusiastic attendees, there was no lack of spirited discussion. This article presents a review of the key points that came out of the discussion, some of which were ideas and recommendations and some of which were more questions and items to consider.

McKenzie opened the session by asking attendees to identify the business risks they were interested in discussing. The following list was generated:

- 1) Getting paid.
- 2) Using subcontractors.
- 3) Business development.
- 4) Marketing.
- 5) Would I make a good consultant?
- 6) Contracts (particularly indemnification).
- 7) Insurance.
- 8) Protecting intellectual property.
- 9) What to do if a client's employee suffers fatality/serious injury after you audited the site.
- 10) Personal safety while working on client sites.
- 11) Operating independently vs. being part of a consulting group.
- 12) Business interruption (staying afloat if it happens).

Since there was not enough time to address all of the topics in detail, following are the topics that attendees discussed the most (with notes from their discussions).

## GETTING PAID

- a) Get a deposit unless there is a good credit history (the percentage you ask for "depends"). This is especially important for government clients.
- b) Get set up as a vendor in the client's purchasing system and understand the client's purchasing and accounting requirements so you do not slow things down by not following them.
- c) Invoice at regular intervals for longer projects

(monthly or at the end of significant phases).

- d) Address payment requirements in contracts.
- e) "Bird dog" (e.g., "Did you get the invoice?" "Do you need more info?"), especially for new clients.
- f) Hire a collection specialist.
- g) Adjust your rate based on how quickly the client pays.
- h) Is it okay to request a donation to charity in lieu of a speaker fee? (The consensus is generally yes.)

## USING SUBCONTRACTORS

a) Require them to get their own insurance at the same level as yours (or put them on yours and adjust their rate accordingly). Typical:

- \$1MM/\$1MM each for both general and professional liability, maybe higher for industrial hygienists;

- Auto.

b) Understand/follow government rules to ensure that they are truly subs and do not inadvertently become employees.

c) Consider structure—corporate, LLC, more than one LLC.

d) Network to find subs who meet your standards (verify then trust).

## MARKETING/BUSINESS DEVELOPMENT

a) Do not overcommit (taking on more work than you can do). If facing this, raise rates.

b) Consider the risk of putting out helpful information that can get stolen. You can get in trouble for how it is used.

c) Do not misrepresent yourself.

d) How do you price services to optimize resources?

- Do costs of certification impact?

- Fixed prices versus time/materials.

- Properly setting scope of work and how modifications will be handled.

- Concern of getting undercut on pricing.

e) How much can you discuss fees with colleagues?

f) Decide which clients you want to work for (and market to). If all they care about is low cost, do you even want them for a client?

## WOULD I MAKE A GOOD CONSULTANT?

- a) How much do I want to work?
- b) How important is flexibility?
- c) Am I a good time manager?

*Consider the risk of putting out helpful information that can get stolen. You can get in trouble for how it is used.*



***If a client's standard indemnification language is too broad (you must indemnify them against everything in the world) and they will not indemnify you, consider walking away.***

d) Do I understand the administrative demands? (For accounting, Quickbooks and a good accountant are recommended.)

e) Do I have a "passion" for running my own business?

#### **GOING INDEPENDENT VS. JOINING A FIRM**

a) Independent often gives you more control over doing the work you want.

b) If independent, you need a good network off which you can bounce ideas.

c) Joining a firm gives you more structure for support.

d) To try to get some of the best of both, consider sharing office space and administrative resources with other consultants (possibly offering different services).

e) If using a home office, set up proper space.

#### **CONTRACTS/INDEMNIFICATION**

a) Always have contracts with clients and with subs.

b) If you do not have any paperwork with a client and the person who hired you leaves, it can jeopardize your pay.

c) At least use e-mail for an oral (informal) contract to document an understanding of scope, fees, etc.

d) Use plain language rather than legalese for contracts.

e) If a client's standard indemnification language is too broad (you must indemnify them against everything in the world) and they will not indemnify you, consider walking away.

- f) Read the back of the purchase order in addition to the contract. It often contains many terms and conditions.
- g) Have a good cancellation clause.

#### **INSURANCE**

a) Have it!

b) Know whether you can renew your policy if there is a claim.

c) Be clear on applications for what type of work you do. If it changes, notify the insurance company and ask whether you are covered.

d) Know what is excluded in the policy.

e) Have your carrier/broker help you review your contracts to ensure that you are covered.

f) For health, disability, life, etc., insurance consider joining groups that offer group rates to members (e.g., American Chemical Society).

g) Also consider:

- premises;
- business interruption;
- critical equipment;
- business vehicle;
- life insurance on partners.

#### **INTELLECTUAL PROPERTY**

a) Consider protecting:

- logo/brand name;
- databases;
- presentations, publications, etc.;
- client list;
- website and URL.

b) Consider patenting something tangible.

c) Put copyright statement on presentations (with name and date).

d) Realize the client's contract will likely claim rights to work you develop for them.

Thank you to all of the attendees for their active participation and willingness to share experiences openly.

The CPS Advisory Committee is aware that business-related topics are typically of the most interest to our members (who generally have plenty of resources for information on SH&E technical topics). We are always looking for your input as to which topics are of most interest to you. We have many avenues for addressing the information, including future roundtables, webinars, *Advisor* articles and discussions on the CPS LinkedIn site. If you would like to see other topics addressed in more detail, please notify any member of the CPS Advisory Committee (see p. 2). ☺

**Debby Shewitz, CSP**, has been a member of the Consultants Practice Specialty Advisory Committee since 2003 and currently serves as The Advisor editor. She is the principal of Shewitz Consulting LLC in Cleveland, OH.



# ByDesign

VOLUME 10 • NUMBER 2



## NFPA 70E & OSHA

### *Electrical Safety Requirements*

BY DENNIS K. NEITZEL, CPE

**M**any OSHA regulations, as well as consensus standards, address the hazards of electricity and the work practices and PPE required for the protection of employees. Over the last 10 to 15 years, there have been significant revisions and additions to electrical safety standards and regulations, which were needed to increase the knowledge and understanding of electrical hazards by employers and employees.

*The three main hazards of electricity are electrical shock, electrical arc flash and electrical arc blast along with the physiological effects on the human body.*

NFPA 70E-2009, Standard for Electrical Safety in the Workplace, is the base consensus standard used by OSHA to establish electrical safety regulations and requires an electrical hazard analysis to be performed prior to employees working within the limited approach boundary of exposed energized electrical conductors and circuit parts operating at 50 volts or more. These requirements are especially critical if the circuits

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New Energy



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**NFPA 70E & OSHA***continued from page 1*

have not been placed in an electrically safe work condition (deenergized; lockout/tagout).

The three main hazards of electricity—electrical shock, electrical arc flash and electrical arc blast—along with the physiological effects on the human body, must be understood by everyone working on or near electrical circuits and equipment (NFPA, 2009).

NFPA 70E introduces terms related to these electrical hazards that must be identified through the electrical hazard analysis process. These terms include the shock protection approach boundaries of limited, restricted and prohibited. The standard also identifies the arc flash protection boundary that must be established to protect employees from the arc flash hazard (NFPA, 2009).

The NFPA 70E standard is divided into three chapters:

Chapter 1: Safety-Related Work Practices

Chapter 2: Safety-Related Maintenance Requirements

Chapter 3: Safety Requirements for Special Equipment

This article focuses primarily on the NFPA 70E, Chapter 1 requirements for electrical hazards analysis and the safe work practices and procedures required for the protection of employees from the hazards of electricity (NFPA, 2009).

**ELECTRICAL HAZARDS**

NFPA 70E provides a means of protecting employees

from electrical hazards through the development and use of safety programs and procedures. To fully understand the NFPA 70E work practices requirements, one must also understand the electrical hazards (NFPA, 2009).

Statistics show that several hundred deaths occur annually as a result of electrical shock. NIOSH statistics show that electrical contact results in 4,000 nondisabling and 3,600 disabling injuries annually plus one death in the workplace every day in the U.S. alone. Figure 1 illustrates statistics for nonfatal electrical incidents, resulting in electrical shocks and burns, in various industry sectors.

**BUREAU OF LABOR STATISTICS**

Other studies show that 10 to 15 employees are hospitalized every day with arc-flash-related burns.

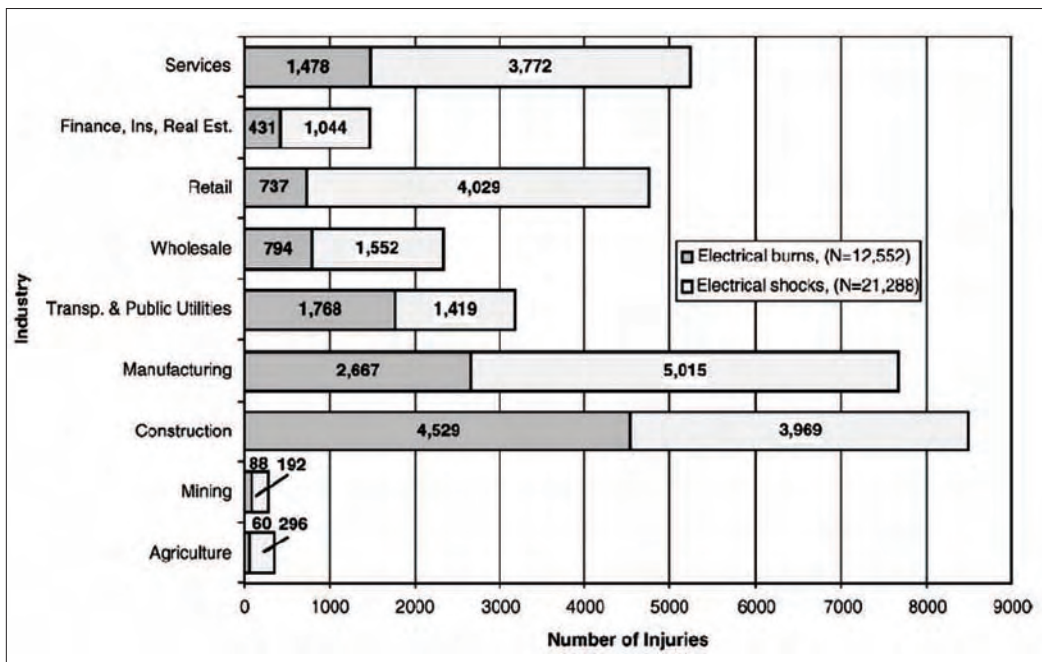
Surprisingly, more than half of those killed in electrical accidents are not in traditional electrical fields but are contractors, outside service personnel, painters, laborers and drivers. (Detailed surveillance data and investigative reports of fatal incidents involving workers who contacted energized electrical conductors or equipment are derived from the National Traumatic Occupational Fatalities surveillance system maintained by NIOSH).

Electricity is no respecter of persons; it will injure or kill a contractor, custodian, manager or office worker just as fast as it will injure or kill an electrician. The laws of physics for electricity apply to everyone. Some employees work with electricity directly as part of their everyday jobs and therefore have greater exposure to electrical hazards. Others work with electricity indirectly, primarily by the use of cord- and plug-connected equipment, portable tools and extension cords.

**ELECTRICAL SHOCK**

Electrical shock occurs when a person's body completes the current path between two energized conductors of an electrical circuit or between an energized conductor and a grounded surface or object. Essentially, when there is a difference in potential (voltage) from one part of the body to another, current will flow. The effects of an electrical shock can vary from a slight tingle to immediate cardiac arrest. The severity depends on several factors:

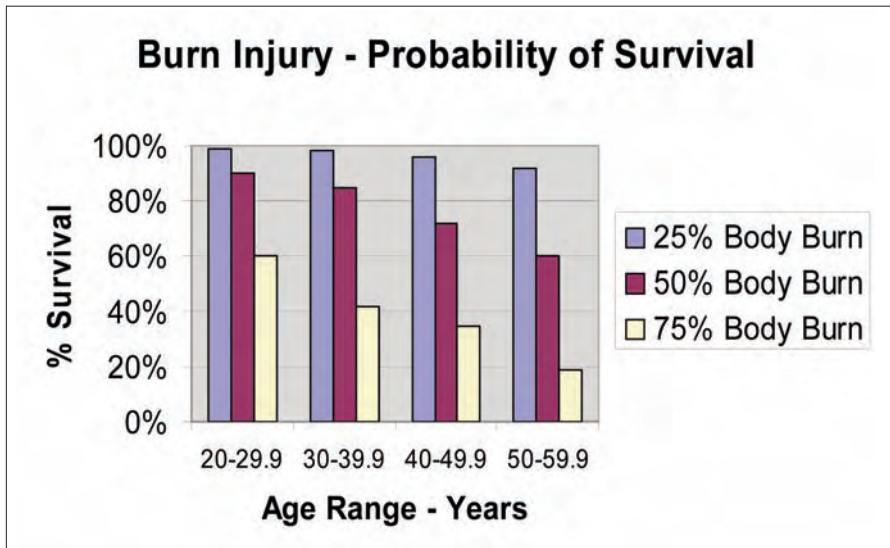
- body resistance (wet or dry skin are major factors of resistance);
- circuit voltage (50 volts or more);
- amount of current flowing through the body (determined by the voltage divided by the resistance of the body);
- current path through the body (through a vital organ will generally be fatal);

**Figure 1****Nonfatal Electrical Incidents, Industry Sector vs. Nature of Injury, 1992-1998**

Source: BLS



**Figure 2**  
**Burn Injury & Probability of Survival**



Source: American Burn Association

- area of contact;
- duration of contact.

The shock hazard analysis required by NFPA 70E, Sections 110.8(B)(1)(a) and 130.2, provides the guidance for determining the level of shock hazard. This analysis also determines the shock protection boundaries, as well as the approach limits for qualified and unqualified employees (NFPA, 2009).

### ELECTRICAL ARC FLASH

Various studies on the causes of electrical injuries show that many serious electrical injuries involve burns from electrical arcs.

Three different issues are involved in the arc flash hazard: 1) the arc temperature, 2) the incident energy and 3) the pressure developed by the arc. The main concern with the arc temperature is the flash flame and ignition of clothing. At approximately 203 °F (96° C) for one-tenth of a second (six cycles), the skin is rendered incurable or in other words, a third-degree burn (Lee, 1987). The incident energy threshold for the onset of a third-degree burn is 10.7 cal/cm<sup>2</sup>. The threshold for a second degree burn is approximately 174 °F (78 °C) (Lee, 1987). The incident energy threshold for the onset of a second degree burn is 1.2 cal/cm<sup>2</sup>. It does not take a very high temperature or very much incident energy to cause severe burn injuries, which can result in extreme pain and discomfort and even death to the worker.

The American Burn Association provides statistics concerning the survivability of electrical burns, based on the worker's age and the percentage of body burn (Figure 2).

The arc flash hazard analysis required by NFPA 70E-2009 is used to determine the incident energy of an elec-

trical arc and to establish the arc flash protection boundary. This standard also requires that the arc flash hazard analysis be performed to provide PPE for personnel working within the arc flash protection boundary. The best way to avoid the arc flash hazard is to stay away from energized electrical equipment, especially when disconnecting devices are operated. Never use electrical equipment rooms for storage, break rooms, offices, shops, etc. If a failure of the equipment was to occur and the room was occupied, injuries or fatalities could occur.

### ELECTRICAL ARC BLAST

Another major hazard of electricity is the arc blast,

which is the rapid expansion of the air caused by an electrical arc. This occurrence is referred to as an electrical arc blast or explosion.

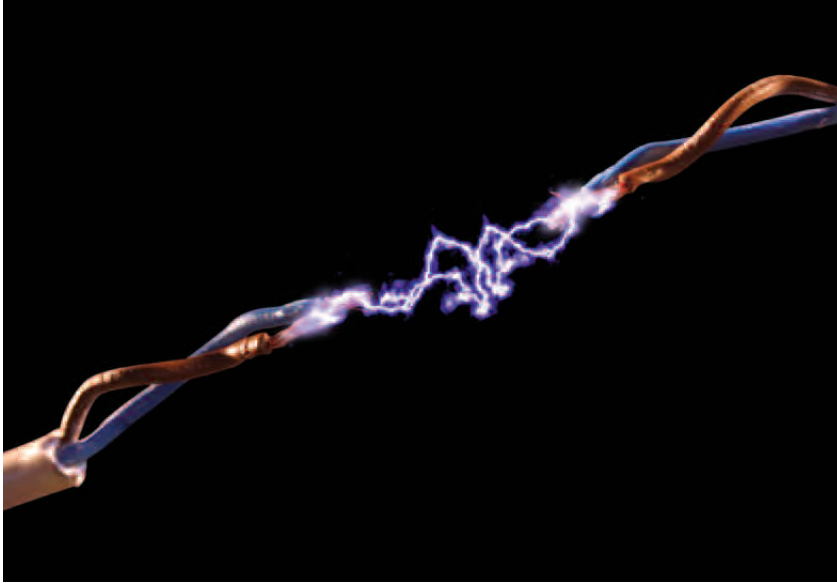
According to studies on the subject, the pressures from an arc are developed from two sources, the expansion of the metal in boiling and vaporizing and the heating of the air by passage of the arc through it. Copper expands by a factor of 67,000 times when it vaporizes. One cubic inch of copper vaporizes into 1.44 cubic yards of vapor creating a rapid expansion of the air resulting in the blast or explosion (OSHA, 1991).

OSHA states, "The pressures developed by high-energy arcs can damage equipment causing fragmented metal to fly in all directions. In atmospheres, which contain explosive gases or vapors or combustible dusts, even low-energy arcs can cause violent explosions" (OSHA, 1990).

In *Pressures Developed by Arcs*, Lee (1987) discusses methods that can be used to determine the amount of damage that a short circuit can cause in switchgear and the buildings where the gear is located (OSHA, 1991).

### NFPA 70E OVERVIEW

NFPA 70E is the most comprehensive electrical safety standard available that addresses protection for employees from these electricity hazards. Other electrical safety standards, as well as regulations, include the National Electrical Code (NFPA 70), National Electrical Safety Code (ANSI/IEEE C2), OSHA 29 CFR 1910.331-.335, and 1910.269, but NFPA 70E is the only one that addresses electrical safe work practices, electrical hazard analysis, electrically safe work conditions, energized electrical work permits, electrical maintenance safety and special electrical equipment safety in one standard.



*Various studies on the causes of electrical injuries show that many serious electrical injuries involve burns from electrical arcs.*

Serious consideration must be given to complying with NFPA 70E's requirements, not only because it assures compliance with OSHA's electrical requirements, but also because it addresses how to perform an electrical hazard analysis to determine the necessary work practices and protection from electrical hazards for employees and others who work on or near or operate electrical equipment.

A question often asked is, "Does OSHA enforce NFPA 70E?" The answer to this is no, not directly. NFPA 70E is not incorporated by reference in 29 CFR 1910.6. It is, however, listed as a reference in OSHA Instruction STD 1-16.7, Directorate of Compliance Programs, Electrical Safety-Related Work Practices—Inspection Procedures and Interpretive Guidelines, which OSHA compliance officers use when performing inspections or investigations (OSHA, 1991). However, OSHA has several comparable requirements that are directly enforceable, e.g., 1910.132, .331-.335 and .269.

Several terms apply to NFPA 70E that relate to the hazards of electricity and hazards analysis that must be understood. Quoted here are the definitions of these terms as found in NFPA 70E-2009, Article 100 (NFPA, 2009):

**Limited approach boundary.** "An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists."

**Restricted approach boundary.** "An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part."

**Prohibited approach boundary.** "An approach limit at a distance from an exposed energized electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part."

**Flash protection boundary.** "When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur."

NFPA 70E addresses the requirements for conducting an electrical hazard analysis with emphasis on the shock hazard analysis and the flash hazard analysis to establish these boundaries. NFPA 70E states that if circuits operating at 50 volts or more are not deenergized (placed in an electrically safe work condition), then other electrical safety-related work practices must be used. These work practices must protect employees from an arc flash, as well as inadvertent contact with energized parts operating at 50 volts or more.

Each analysis must be performed before employees approach exposed energized conductors or circuits parts, within the limited approach boundary. NFPA 70E, Paragraph 130.2(B) FPN, provides a reminder that the arc flash protection boundary may be a greater distance from the exposed energized conductors or circuits parts than the limited approach boundary in some instances (NFPA, 2009). Whichever boundary is the greater distance establishes the protection boundary where safety signs or tags, barricades and/or attendants must be posted to protect employees not engaged in the work.

NFPA 70E requires equipment to be placed in an "electrically safe work condition" before employees work within the limited approach boundary, or within the arc flash protection boundary, of exposed energized conductors or circuits parts. Equipment, therefore, should be deenergized, locked out/tagged out and isolated or grounded before any work is done that may result in inadvertent contact with energized parts or where an electrical arc flash might occur.

Putting the equipment or system in an electrically safe work condition should be the primary or first choice when performing work on electrical equipment, circuit parts or conductors where contact might be made or where arcing might occur. Performing energized work, using proper procedures and PPE should be the last choice when all other options have been considered.

However, in some cases, work cannot be performed on deenergized equipment or systems. OSHA states that work may be performed on energized equipment and systems if it is "infeasible" to deenergize. Infeasible must not be confused with inconvenient. OSHA's reference to infeasible is clearly spelled out in 29 CFR 1910.333(a)(1), which states, "Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them, unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations" (OSHA, 1990).

OSHA continues by providing examples of "additional or increased hazards" and "infeasible" work as follows: "Examples of increased or additional hazards include interruption of life support equipment, deactiva-

tion of emergency alarm systems, shutdown of hazardous location ventilation equipment, or removal of illumination for an area. Examples of work that may be performed on or near energized circuit parts because of infeasibility due to equipment design or operational limitations include testing of electric circuits that can only be performed with the circuit energized work on circuits that form an integral part of a continuous industrial process in a chemical plant that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment” (OSHA, 1990).

In these cases, the electrical hazard analysis must be done to determine the type and level of electrical hazard(s), the safe work practices and PPE that would be required to be used to protect “qualified” employees performing the work. Also in these cases OSHA requires a “written procedure that is strictly enforced” (OSHA, 1990). To provide the best protection from an incident occurring, the equipment must be shut down and all energy sources controlled or in other words be placed in an electrically safe work condition.

NFPA 70E requires several specific steps to ensure that an electrically safe working condition exists:

- Determine all possible sources of electrical supply by checking applicable up-to-date one-line diagrams and all applicable drawings and identification tags.

- Stop or interrupt all loads, then open the disconnecting device for each source.

- If possible, visually verify that all blades of the disconnecting devices open or that draw-out-type circuit breakers are withdrawn.

- Apply lockout/tagout devices in accordance with the energy control policy and procedures.

- Use a rated voltage detector to test the circuit or equipment part for the presences of both phase-to-phase and phase-to-ground voltage. The voltage detector operation must be verified before and after each test to validate the test.

- Where induced or stored energy may exist, ground each phase conductor or circuit part before contact is made. Grounding also applies where the deenergized conductor or circuit part may come into contact with exposed energized conductors or circuit parts. The grounding device must be rated for the available fault current and clearing time.

- Establishing these safety protection procedures should be part of every electrical safety program and should be in effect for each facility (NFPA, 2009).

When work is performed on energized or deenergized equipment and systems, programs and procedures must be developed.

- Employers must develop and implement electrical safety procedures and practices, such as the use of qualified persons only, for work in areas where electrical hazards exist or may exist.

- Where energized work must be performed, an ener-

gized electrical work permit, authorized by management, must be used.

- Employers must provide training for employees in the skills and techniques needed to work with electrical equipment, PPE, job planning and emergency procedures.

- Employees must implement the practices according to policies and procedures and their training.

- Companies must perform an electrical hazard analysis, which includes shock hazard analysis and flash hazard analysis before any work is done on any energized equipment.

### ELECTRICAL SAFETY PROGRAM

Establishing an effective electrical safety program is vital to employees. The employer is required to develop and implement an electrical safety program that addresses employee exposure to each specific hazard that exists. This program and the related training must be appropriate for all existing conditions and is required to be written, published and available to all employees who might be exposed to the hazards.

OSHA established the mandate for an electrical safety program in 29 CFR 1910.333(a), which states:

“Safety related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits, which are or may be energized. The specific safety related work practices shall be consistent with the nature and extent of the associated electrical hazards.

“Such work practices shall protect employees against contact with energized circuit parts directly with any part of their body or indirectly through some other conductive object. The work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the exposed electric conductors or circuit parts.” (OSHA, 1990)

With regard to this requirement, the OSHA directorate of compliance states, “If the employer does not deenergize then suitable safe work practices for the conditions under which the work is to be performed shall be included in the written procedure and strictly enforced” (OSHA, 1991).

As can be seen in this OSHA requirement, there must be a written procedure. The intent of this is to establish a written electrical safety program, which must include the safe work procedures required (OSHA, 1991).

NFPA 70E, Section 110.7, Electrical Safety Program, provides seven topics that must be included in the electrical safety program. Following are these seven topics along with brief explanations of each. References

*To provide the best protection from an incident occurring, the equipment must be shut down and all energy sources controlled or in other words be placed in an electrically safe work condition.*



*Employers must develop and implement electrical safety procedures and practices, such as the use of qualified persons only, for work in areas where electrical hazards exist or may exist.*

will be made to several annexes, which provide excellent guidance for developing the electrical safety program (NFPA, 2009).

**1) Awareness and self-discipline.** For workers to avoid exposure to hazards, s/he must be aware of the work environment. The electrical safety program along with required training must emphasize this as well as self-discipline. The supervisor must also discuss all safety aspects of the tasks performed along with examples of incidents and injuries for similar tasks to help increase employee awareness (NFPA, 2009).

**2) Electrical safety program principles.** The electrical safety program is required to identify the principles upon which it is based.

Essentially, an assessment of the electrical equipment and systems, along with a job/task and hazards analysis, is needed.

Annex E, Section E.1, Typical Electrical Safety Program Principles, although not part of NFPA 70E's requirements, provides a list of principles that can be used to establish the electrical safety program. These principles amount to a job/task and hazard analysis, planning and procedures (NFPA, 2009).

**3) Electrical safety program controls.** An electrical safety program is also required to identify the controls by which it is measured and monitored.

In Annex E, Section E.2, Typical Electrical Safety Program Controls, provides a list of controls that can be used in developing the electrical safety program.

The equipment assessment and job/task and hazard analysis would also be needed to accomplish this requirement (NFPA, 2009).

**4) Electrical safety program procedures.** All tasks that involve exposure to electrical hazards must have a procedure. The procedures also define requirements and provide guidance for workers to accomplish the job safely.

Annex E again provides additional guidance for developing these procedures as found in Section E.3, Typical Electrical Safety Procedures (NFPA, 2009).

**5) Hazard/risk evaluation procedure.** The electrical safety program must have a procedure that employees can use to assess the hazards and risks associated with each task.

Annex F, Hazard/Risk Evaluation Procedure, provides information to assist in developing this procedure.

Written authorization to execute work on or near live parts must also be obtained. The energized electrical work permit required by Section 130.1(A) provides the means to accomplish this. An example permit is found in Annex J, Energized Electrical Work Permit (NFPA, 2009).

**6) Job briefings.** Another important element of the electrical safety program is a job briefing, which is a discussion of the work tasks and is required before the start of each job. The employee in charge conducts this briefing with all employees involved in the job. The job briefing should cover:

- hazards associated with the job;
- work procedures involved;
- special precautions;
- energy source controls;
- PPE.

This briefing should also address other work in the immediate area, as well as other work associated with the same electrical circuits and equipment (NFPA, 2009).

If a task is routine and will be repeated several times during the day, a single job briefing would be required before the task is performed the first time. However, if significant changes occur that may affect employee safety, then a new job briefing would be required before employees are exposed to any additional hazards.

A job briefing should be as extensive as necessary to ensure that employees understand their exposure to electrical hazards. If the job is routine and if employees are well trained and experienced and can recognize and avoid the hazards involved, then only a brief discussion would be required.

However, if the tasks are unfamiliar to the employee or complex, a more complete briefing would be required. This would also apply for outside employees and for those who are new to the area where the work is to be performed.

Annex I, Job Briefing and Planning Checklist, of NFPA 70E, illustrates considerations for a job briefing, as well as a planning checklist, that can be helpful in conducting job briefings (NFPA, 2009).

**7) Electrical safety auditing.** The electrical safety program is required to be audited to help ensure that its program and procedures are followed. The frequency of this audit is determined by the employer and is determined by the type of work performed and by the complexity of the procedures. If the audit reveals that the program is not followed, then revisions must take place (NFPA, 2009).

## **SELECTION OF ELECTRICAL PROTECTIVE EQUIPMENT**

Most employers, operators and electricians are knowledgeable in the selection and inspection requirements for electrical PPE used for the prevention of electrical shock hazards, as well as PPE used for head, eyes and face, hands and foot protection. All of these requirements are readily found in OSHA 1910, Subpart I, Personal Protective Equipment. Although not addressed in OSHA 1910, Subpart I, body protection would also be required as addressed in NFPA 70E.

OSHA 1910.137, Electrical Protective Equipment, provides the requirements for the in-service care and use of electrical protective equipment. Unfortunately, many

employers, operators, electricians and engineers have limited knowledge or experience with regard to arc flash and arc blast hazards that may be associated with the maintenance and operation of energized electrical equipment and the necessary PPE required.

OSHA requirements for the hazard analysis and selection of protective clothing must first be defined. OSHA 1910.132, General Requirements for Personal Protective Equipment, Paragraph (d) states, “The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitates the use of PPE. If such hazards are present, or likely to be present, the employer shall select and have each employee use the type of PPE that will protect the affected employee from the hazards identified in the hazard assessment” (OSHA 29 CFR 1910.132).

The three hazards of electricity—shock, arc flash and arc blast—must be included in the hazard assessment. OSHA 1910.137 identifies the selection, inspection and use requirements for electrical PPE. OSHA does not currently identify specific clothing and PPE that should be worn to protect the employee from the arc flash hazards, but OSHA specifies what type of clothing is prohibited (OSHA 29 CFR 1910.137).

OSHA 1910.269(l)(6)(ii) requires that “the employer shall train each employee who is exposed to the hazards of flames or electric arcs in the hazards involved.” Additionally, 1910.269(l)(6)(iii) states, “the employer shall ensure that each employee who is exposed to the hazards of flames or electric arcs does not wear clothing that, when exposed to flames or electric arcs, could increase the extent of injury that would be sustained by the employee” (OSHA, 1994).

**“Note:** Clothing made from the following types of fabrics, either alone or in blends, is prohibited by this paragraph, unless the employer can demonstrate that the fabric has been treated to withstand the conditions that may be encountered or that the clothing is worn in such a manner as to eliminate the hazard involved: acetate, nylon, polyester, rayon.”

However, OSHA requires protection from the hazards of electricity in 1910.335, Safeguards for Personnel Protection, as follows:

“(a) Use of protective equipment. (1) PPE. (i) Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

“(iv) Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts.

“(v) Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.

“(2) General protective equipment and tools. (i) When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts.

“(ii) Protective shields, protective barriers, or insulating materials shall be used to protect each employee from shock, burns, or other electrically related injuries while that employee is working near exposed energized parts which might be accidentally contacted or where dangerous electric heating or arcing might occur.” (OSHA, 1990).

The consensus standard for determining the necessary protective clothing and training is NFPA 70E. To properly select rated PPE to provide this protection, the employer has but two options. The employer must calculate the incident energy (in cal/cm<sup>2</sup>) available at the work location and the protective clothing/equipment required for the specific task, or as an alternative, use NFPA 70E Table 130.7(C)(9), Hazard/Risk Category Classifications, to identify the clothing required for the hazards associated with the specific task the employee is to accomplish (NFPA, 2009).

Caution must be used if applying Table 130.7(C)(9) because the short-circuit current and protective device clearing time must be known as stated in the notes at the end of the table. The values of short-circuit current and protective device clearing times used in the development of this table are “assumed” values (NFPA, 2009).

**Note:** The employer must also determine the arc flash protection boundary in accordance with Paragraph 130.3(A) of NFPA 70E for all energized work. The arc flash protection boundary establishes the approach limit to exposed live parts where a person could receive a second-degree burn (NFPA, 2009).

Once it has been determined that arc-rated protective clothing and PPE are necessary to perform the specific task, the necessary protective clothing and PPE must be procured and the employees must be trained to wear it properly.

## TRAINING

One of the most important aspects of electrical safety is to ensure that all employees who are or may be exposed to energized electrical conductors or circuit parts are properly trained and qualified. First identify the qualified person. This has always been a point of debate throughout industry, but it is clearly defined by the National Electrical Code (NEC), NFPA 70E and OSHA.

NEC defines a qualified person as “one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.” This definition also has a fine print note that refers to NFPA 70E for electrical safety training requirements.

The OSHA 29 CFR 1910.339 definition of a qualified

***Each of the three hazards of electricity (electrical shock, electrical arc flash and electrical arc blast) has its own unique characteristics that require special protective measures.***

person must also be quoted since it has an additional element that is important to understand: “Qualified person. One who has received training in and has demonstrated skills and knowledge in the construction and operation of electric equipment and installations and the hazards involved.” Note the requirement to “demonstrate skills and knowledge.” To accomplish this requirement, the employer must provide hands-on skills training for all qualified persons.

In addition to the requirements stated in the NEC and OSHA definitions, NFPA 70E, Section 110.6, Training Requirements, states that employees are required to be “trained to understand the specific hazards associated with electrical energy,” “the safety-related work practices” and procedural requirements. These training requirements are necessary to help protect employees from the “electrical hazards associated with their respective job or task assignments” as well as to “identify and understand the relationship between electrical hazards and possible injury.” Training in emergency procedures is also required when employees are working “on or near exposed energized electrical conductors or circuit parts” (NFPA, 2009).

In addition to these requirements, NFPA 70E states that qualified persons must be familiar with:

- special precautionary techniques;
- PPE, including arc-flash;
- insulating and shielding materials; and
- insulated tools and test equipment.

OSHA 1910.399, Definitions, states the following additional information concerning qualified persons:

“Whether an employee is considered to be a ‘qualified person’ will depend upon various circumstances in the workplace. It is possible and, in fact, likely for an individual to be considered ‘qualified’ with regard to certain equipment in the workplace but ‘unqualified’ as to other equipment.

“An employee who is undergoing on the job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his/her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.” (OSHA 29 CFR 1910.399)

With regard to PPE training, OSHA states in 1910.132(f)—Training (1), “The employer shall provide training to each employee who is required by this section to use PPE. Each such employee shall be trained to know at least the following:

- when PPE is necessary;
- what PPE is necessary;

- how to properly don, doff, adjust and wear PPE;
- the limitations of PPE; and
- the proper care, maintenance, useful life and disposal of PPE.” (OSHA 29 CFR 1910.132).

## **CONCLUSION**

Each of the three hazards of electricity (electrical shock, electrical arc flash and electrical arc blast) has its own unique characteristics that require special protective measures. Once again, the best way to avoid exposure to these hazards is to stay out of the circuit or to keep as far away as possible from electrical equipment and systems that have exposed live parts or where the electrical equipment is operated.

NFPA 70E-2009 states that if circuits, operating at 50 volts or more, are not deenergized (placed in an electrically safe work condition) then other electrical safety-related work practices must be used. These work practices must protect the employee from inadvertent contact with live parts operating at 50 volts or more, as well as from an arc-flash. These analyses must also be performed before an employee approaches exposed live parts within the limited approach boundary (NFPA, 2009).

Again referring to OSHA 1910.132, Subpart I, Personal Protective Equipment, Paragraph (d) requires employers to perform a hazard assessment of the workplace to determine if PPE is necessary. The hazard assessment is an important part of the process to help ensure that the PPE selected is appropriate for the hazards that are or may be present in the workplace (OSHA 29 CFR 1910.132). NFPA 70E addresses the requirements for PPE as determined from the shock hazard analysis and the arc-rated FR clothing and PPE requirements as determined by the arc flash hazard analysis (NFPA, 2009).

Using only qualified persons to perform work within the limited approach and arc flash protection boundaries of energized electrical conductors and circuit parts is vital to any electrical safety program. The goal of any training program is to develop and maintain an effective and safe workforce.

OSHA and NFPA 70E have provided the industry with several good reasons for the training and qualification of employees. There are also many benefits to having well trained and qualified employees. One of the major benefits expressed by industry is the reduction of unscheduled downtime. Another major benefit is the safety of employees. The more in-depth the training program, the better qualified the employee. It has been proven that the most effective training programs include a combination of lecture and hands-on instruction.

Electrical power systems today are often complex. Protective devices, controls, instrumentation and interlock systems demand that technicians be trained and qualified at a high technical skill level. Safety and operating procedures used in working on these systems are



equally as complex requiring technicians to be expertly trained in all safety practices and procedures. ☛

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# EnviroMentor

VOLUME 10 • NUMBER 2



## What Oil!?

BY JUDY LYN FREEMAN

**As oil resources become ever more scarce,  
we are drilling in places that are  
ever more difficult, expensive and risky to drill.**

**L**ike the rest of the world, I watched the Deepwater Horizon explosion with my family and friends, emergency response and then the release into the Gulf of Mexico as spectators. We stared, riveted at video feed in real time of an alarming volume of oil spewing out of a geyser off the Louisiana coast. We have the perspective of interested professionals, but our view is just as distant as anyone watching disaster

*Environmental risks can have monumental and long-term consequences. Some are slow, silent and unseen, such as leaks that have occurred in the Gulf floor throughout time.*

unfold on television. We wanted to see the impact of the oil spill in the Gulf up close. The rig is sunk, the hole in the bottom of the sea is plugged and tapped so is there anything left to see? Our group of Chicago-based environmental professionals, a lawyer and an engineer contacted colleagues in Louisiana to find out.

“Nothing to see on shore,” they tell us. To see the damage, we will  
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**COMPLIANCE**  
Ecological  
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**What Oil?***continued from page 1*

need to go out into the Gulf. There is a water conference in Alabama during our visit, and many of our colleagues will be out of town. We contact the Louisiana Environmental Action Network who is also short of boat captains, short of help, generally still overwhelmed with dealing with the release. However, they still graciously make arrangements for us to go out on our schedule. We call our contact, Chief Chuckie, who turns us over to Russell who, despite some serious language barriers, quickly and graciously agrees to take us all out on his boat.

Instructions to their place are somewhat circuitous. It is south of Houma, depends on which way you come. Our destination is the Point Au Chien Bayou Nation. Just about the southern-most point in the state west of the peninsula that juts out southeast of New Orleans.

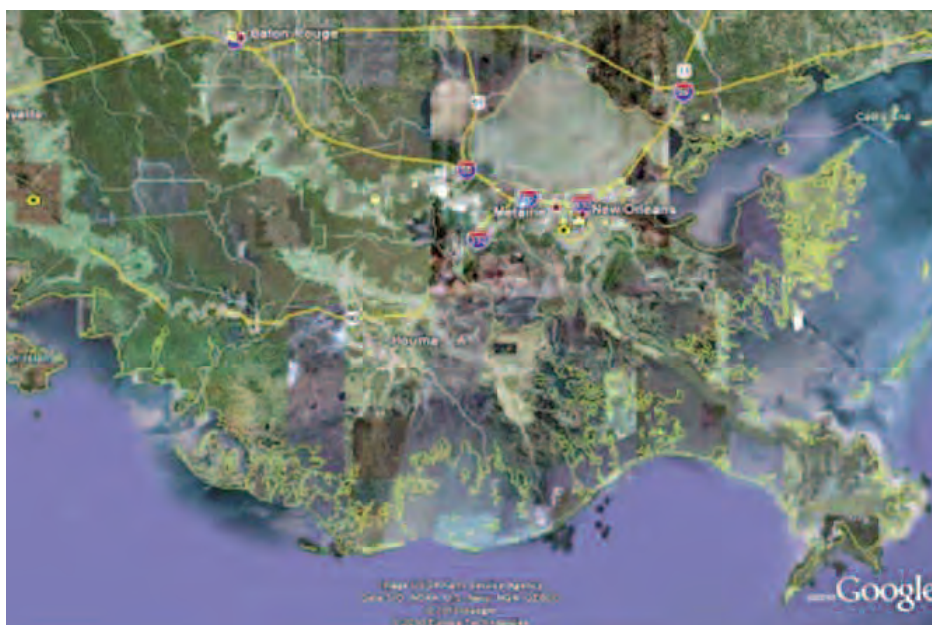
Let's just say that it is beyond where most of us Midwesterners know you can go in Louisiana by car. Remote hardly describes it. Our GPS says there are no more streets, no more houses. We use logic, instinct and dumb luck to find the place.

Homes and shelters dot the sides of the bayou, many of them still showing signs of hurricane damage from Rita. But the overwhelming life here is on the water. Boats line the bayou on either side.

Everyone in town is on the water, many hanging out in shelters that look like movie sets. It is a lovely autumn day, but I can imagine it at night, the music and lights during Mardi Gras. One of our hosts is wearing a t-shirt that reads, upside down, "If you can read this, please get me back in my boat." He lays on the helm as we move out into the water. I cringe and ignore years of safety training and remind myself that we are guests and in someone else's boat. I am relieved to see sufficient life preservers in our boat.

Russell has decided we are to take two boats because they also want to know what the long-term damage is to the Gulf from the release of raw crude from April 20 to Sept. 19 when the well was officially declared "dead." They want to know why we have come so far and worked so hard to find them. They suspect that the damage to the Gulf is worse than they are being told. They are looking to us to either confirm or deny that. We are looking for the same from them.

Josh is the pilot of our skiff. He is the brother of the guy on the helm of the other boat, Curt. "Out too late last night," he mumbles.

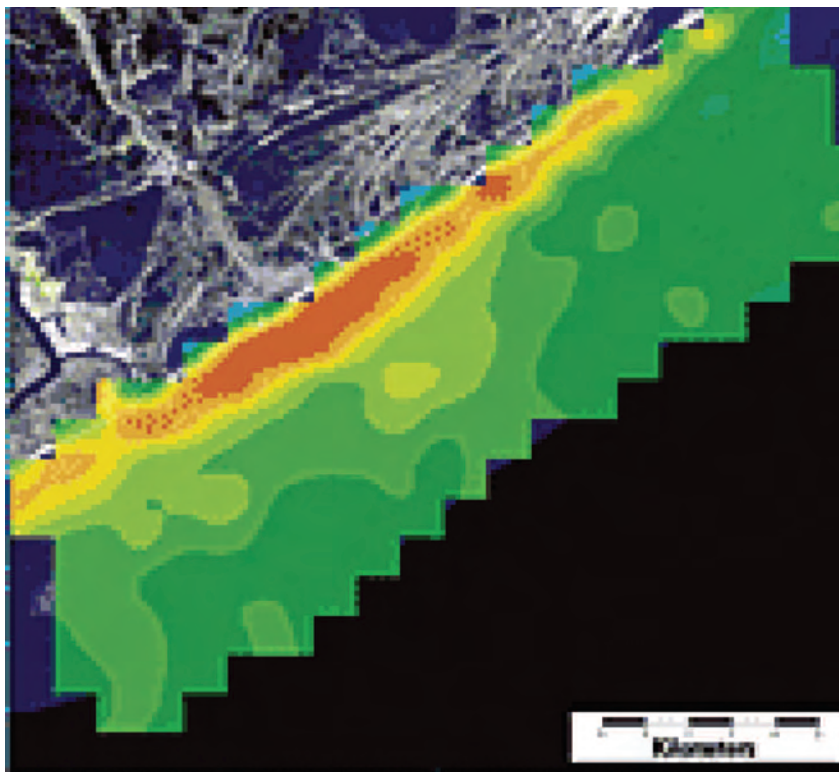


**Photo 1:** Satellite image of Point Au Chien Bayou Nation south of Houma, LA.



**Photo 2:** Satellite image of Point Au Chien Bayou Nation south of Houma, LA.





**Photo 3: Estimated vertical seafloor erosion, ranging from 1.0 m to 4.5 m, along part of the Caminada-Moreau headland between 1989 and 2005 (pre-Hurricane Katrina), from U.S. Geological Survey data. Warmer colors indicate greater erosion.**

His wife Casey tells me early on that it is her dream to go to Louisiana State University and to be a biologist. “I should have already done it,” she admits, looking out over the water to the oil platforms on the horizon.

We are told that BP has just pulled out; they are to do no more cleanup. Curt and Josh have just been laid off. “There were BP officials here last week, and we showed them the oil that is left. They said it was algae. We do not think it is algae.”

We are stunned that BP is pulling out. Just as we were leaving Chicago for New Orleans, we saw BP commercials assuring us that they will be there until it is cleaned up. “Perhaps,” I thought, “the stuff they have seen really is algae and they are just a little paranoid.”

On its current website, BP promises, “The completion of the relief well operation in the Gulf of Mexico is an important milestone in our continued efforts to restore the Gulf Coast. However, our work is not finished. BP remains committed to remedying the harm that the spill caused to the Gulf of Mexico, the Gulf Coast environment and to the livelihoods of the people across the region.”

It is a tall order. According to its website, a \$1.45 billion commitment is being

made to Louisiana alone. Is it enough? Many people are looking for that answer.

Casey and Josh have a new boat. They get teased about their Cadillac engine as we slowly leave the bayou. They are justifiably proud; the boat is comfortable and fast. “It is nice to have a Cadillac,” Casey smiles. But they are worried. Their livelihood is fishing, not pumping oil. Russell scoops his hand into the water. “Any other year, this time of year, I could pull up dozens of little crabs in my hand when I scoop the water up like that. Now, I get one, maybe two. And they act lethargic.”

We pass coastline lined with egrets and great blue herons. It is the season for migrating birds. Russell remarks, “They will not stay so long this year, their food source is diminished.”

We speed up as we move out into open water. For a time, it is too noisy to talk and we can almost forget why we have come. Coastal Louisiana is lovely. A paradise.

It is six months after the Deep Water Horizon explosion and the beginning of the release into the Gulf. A little more than five years after Katrina and Rita wrecked the lives of those in coastal Louisiana the last time. We want to see the progress of rebuilding New Orleans, and we want to know the long-term impact of the release.

Engines power down as we approach our first stop. We see it before we get there. Is that black layer on the surface normal? No. We can smell it, but then the Gulf air smells clean. Are our noses playing tricks on us? We climb out of the boat, the ground squishes below our feet. It is black, brown and grey. Some glistens and shines. The smell of decaying vegetation? No, some-

Following BP’s response to EPA’s directive—and to ensure that decisions about ongoing dispersant use in the Gulf of Mexico are grounded in the best available science—EPA began its own scientific testing of eight dispersant products on the National Contingency Plan Product Schedule. Those dispersant products are Dispersit SPC 1000, Nokomis 3-F4, Nokomis 3-AA, ZI-400, SAF-RON GOLD, Sea Brat #4, Corexit 9500 A and JD-2000. On June 30, 2010, EPA released peer-reviewed results from the first round of its own independent toxicity testing on eight oil dispersants.

EPA’s results indicated that none of the eight dispersants tested, including the product in use in the Gulf, displayed bio-

logically significant endocrine-disrupting activity. While the dispersant products alone—not mixed with oil—have roughly the same impact on aquatic life, JD-2000 and Corexit 9500 were generally less toxic to small fish and JD-2000 and SAF-RON GOLD were least toxic to mysid shrimp. While this is important information to have, additional testing is needed to further inform the use of dispersants.

The next phase of EPA’s testing will assess at the acute toxicity of multiple concentrations of Louisiana Sweet Crude Oil alone and combinations of Louisiana Sweet Crude Oil with each of the eight dispersants for two test species.

For more information, [Click Here](#).

thing deeper. We scoop up samples of the black ooze into sample jars. Russell writes the coordinates of our location and the date on the jar. We note our position on our map. Russell has kept a log of his trips to the islands—dates, times, coordinates and conditions.

Russell shows us where the black ooze has worked its way into the island. We can see, below the watery surface, where the black ooze stops and the clean marsh starts. “It just keeps coming up,” he tells us, “this line keeps moving further inland, and everything outside of that line is dying.” I recall concerns that coastal island erosion is destroying one of the area’s natural measures to mitigate hurricane damage and shudder.

We visit four islands total, each worse than the last. We find an oyster shell deeply embedded with a crusty layer of black tar. Then a crab trap, rendered useless by layers of the same black tar. We carry the shell back to the boat in a plastic bag.

When we return to land, we review what we have seen with our hosts. We have decided to run the samples for semivolatile content on the assumption that those constituents are likely what remain in the original release. Running the samples for semivolatiles also solves the problem of how to preserve the sample for the length of time it will take us to get it back to the lab.

Back at the hotel, we face a problem we had not previously anticipated. Would a jar of petroleum ooze violate the 3-oz liquids rule in our carry-on luggage? We would need to check the jar in our luggage and hope it did not break or that we were not picked for a random search of checked luggage.

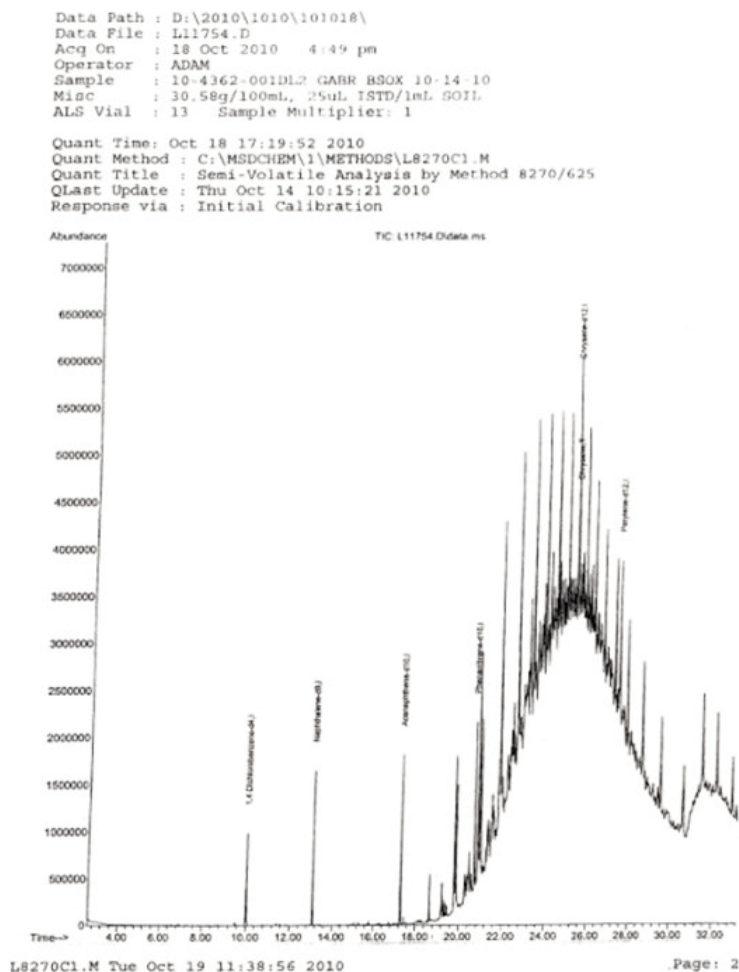
When we return to Chicago, Gabriel Environmental Services and First Environmental provide laboratory and professional services. Figure 1 is the chromatograph from the 8270 scan of the Gulf sample.

We are aware that we are only getting a snapshot—one day, one sample, a few coastal islands. We do not know what lies on the bottom of the Gulf. We do not know how Gulf currents and weather patterns have affected this area. We do not know what volatiles were dispersed, their volume or their ultimate disposition.

Our quick trip to the Gulf does nothing to further examine the dispersants used in the response to the emergency. We do not know the dispersion patterns of the dispersants, their final disposition or their long-term impact on the ecosystem. Our excursion only comes closer to whatever has settled to the bottom of the Gulf in distance, not in depth of knowledge or understanding. We must have faith that our professional colleagues in the oil and gas business are making it their personal responsibility to learn as much as can be learned from this disaster and thinking at all hours of the day and night on how to make sure it never happens again.

As oil resources become ever more scarce, we are drilling in places that are ever more difficult, expensive and risky to drill. Deepwater drilling in the Gulf is not just drilling in the Gulf. Deepwater Horizon’s demise has

**Figure 1**  
**Chromatograph From**  
**the 8270 Scan of the Gulf Sample**



clearly shown that much more attention needs to be paid to the specific risks of deepwater drilling and a new commitment to doing it safely.

We must depend upon our Louisiana-based colleagues in the unique aspects of its coastal biology. We must hope that sufficient resources are being applied to wetlands remediation. It is now up to those individuals who have long been concerned with the quality of the ecosystem of the Gulf for whom this commitment is a career.

We have a professional interest in what treatment technologies are being applied to the cleanup and whether anaerobic digestion technologies might be useful to reduce toxicity and rebuild wetland islands. This is a time for serious research into how these technologies might be useful in such situations. Our short stay on unnamed Gulf islands has only whetted our curiosity about this.

Indeed we have only satisfied our own curiosity as to whether one of the worst environmental catastrophes of





Photo 4: Oil on North Chandeleur Islands. (Source: NOAA).



Photo 5: NRDA team checks for oil in marsh. (Source: NOAA).

our lifetime is as bad as it appeared to be during the months of daily and nightly news reports and the relentless footage of the geyser. In our professional opinion, based on only a brief peek into the maelstrom, we believe much more work must be done to understand what has happened in the Gulf, how to fix it and how to make sure that it never happens again.

We have come with a professional interest, but we have left with the responsibility to be an honest witness to what we have seen. We have gained insights because of the generosity of the people who have lost the most. We continue to struggle with how to best address what we have

seen. Our hosts are not politically powerful. "Politically, we are not part of Louisiana," Russell tells us. "Our representative? I do not know, who is our representative?"

The Deepwater Horizon accident raises important regulatory questions. At what point in a catastrophe is the command of the situation beyond the mandatory spill plans and emergency response plans of the Oil Pollution Act? When should the federal government take command of the situation? Who has jurisdiction for which aspects of the emergency response activity? The health and prosperity of the region and, indeed, the nation, depend upon a healthy Gulf of Mexico. Federal agencies also continue to monitor the region and to analyze the data.

BP's website shows slides of BP Shoreline Cleanup Assessment Team members taking marsh samples on Nov. 11, 2010. These people are clearly not on vacation; this assessment is serious business. Still questions arise.

What markers are used? What protocols are followed? What do we know? What do we not know? What will be addressed and fixed? For example, the website does not address remediation options for the deterioration of marsh grass islands.

We have seen what we came all this way to see, but it was more than we thought it would be. As environmental professionals in ASSE, we must frequently remind other Society members that our jobs as environmental health and safety professionals touch the public as well as our fellow workers. But here we have been reminded that our responsibility also extends to the livelihood of other workers. How can the fishermen of the Louisiana coast be compensated for declines in fish populations that might not occur until next year? What will the impact be 3, 5, 7, 10 years out? These assessments are being made along with settlements.

It is ASSE's mission to provide the tools for environmental health and safety professionals to protect people, property and the environment. All phases of this mission were challenged on April 20, 2010 when the Deepwater Horizon oil rig in the Gulf of Mexico exploded, killing 11, sinking the rig and causing long-term environmental damage to the Gulf. For the eleven men lost, the story ended that night tragically, although not for their families. And that floating oil rig city has likely all but disappeared in the murky bottoms. We can only hope that the lessons learned from this disaster are employed in the future. Property can be replaced, environments may heal, but people are not replaceable.

The hole is plugged, the rig sank and the beaches, if not pristine, will still be welcoming vacationers with memories by next summer. Now that the immediate crisis is over, it is assumed that accident analysis continues among the parties. Environmental health and safety engineers with specialized knowledge of petroleum must continue for some time to collect data, recreate the accident and analyze the results. This may ultimately be the most important part of taking responsibility for such a monumental disaster; a true commitment to never allowing it to repeat itself.

Like comparable disasters—9/11; Katrina; Chernoble; Bhopal, India—details of the Deepwater Horizon disaster will be written about and considered and reconsidered for years to come.

What of the dispersants? The *Wall Street Journal* reports that the National Oceanic and Atmospheric Administration (NOAA) (Department of Commerce) has just released another report updating its estimates on oil cleanup efforts in the Gulf. It is now estimated that 77% of the oil release was removed after the spill (rather than the 74% previously reported). Further, NOAA scientists now estimate that 16% of the oil was "chemically dispersed," up 100% from the previous estimate of 8% last August.

According to a *Wall Street Journal* article, NOAA Administrator Jane Lubchenco said, "Additional data and





studies over the past few months have led scientists to change initial, more conservative assumptions about the effectiveness of dispersants.” Lubchenco said the government would continue to study the environmental impacts of the oil spill on the Gulf, along with the long-term fate of the oil that escaped collection or dispersal. That research will take time, she said, “It is a big Gulf out there.”

What about the strategy to let it burn? One of the lessons learned from the Exxon Valdez release into Prudhoe Bay in Alaska’s Prince William Sound was the understanding that as toxic as an oil burn might be, it is likely less toxic than the long-term effects of the release of the

same material into the water. The fire following the explosion in the Gulf was allowed to burn. Further, controlled burns were undertaken several times subsequently to burn off oil on the surface. The circumstances of the BP disaster were different than Valdez where the release was limited to the cargo capacity and there was no fire. The fire that accompanied the explosion on the Deepwater Horizon made the decision for the emergency response team. Lives were saved on the platform because trained personnel carried out a planned response. Those parties with firsthand knowledge of emergency response activities are most qualified to answer questions about how the response went and whether changes would be made if catastrophe strikes again.

Environmental risks can have monumental and long-term consequences. Some are slow, silent and unseen, such as leaks that have occurred in the Gulf floor throughout time. Others are dramatic and riveting like an explosion and underground geyser. As the response to the Gulf crisis powers down, we must not lose sight of what we have yet to learn. ☺

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# The Concept of Universal Design

In the study of ergonomics, we commonly focus our awareness primarily on the needs of a normal, healthy adult. However, a large and increasing number of people fall into categories outside of the norm. The aging population, permanently or temporarily disabled, larger and smaller people, expectant mothers, and children and teenagers all have their own unique demands that need to be considered when designing products or environments. So how can we be inclusive of all people, including those outside the confines of a normal, healthy adult, in our ergonomic approach? The answer is universal design.

## WHAT IS UNIVERSAL DESIGN?

Universal design is the “design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design” (Connell, et al., 1997). Commonly, this approach allows for special provisions for those with permanent disabilities but still excludes other individuals falling outside of the normal adult stereotype, defined as a healthy individual aged 20 to 40 (Kroemer, Kroemer & Kroemer-Elbert, 2003). Although the universal design concepts of today evolved from the disabled community, a more diverse approach goes beyond providing special feature for only permanent disabilities. The National Endowment for the Arts recognizes universal design as emphasizing products and environments that are aesthetically pleasing as well as functional, not just for those with permanent disabilities, but for those who may have temporary disabilities and those whose abilities may change with age (Barreto, 2000).

The universal design concept accommodates the needs of all members of society, regardless of age, body size, disability and pregnancy. The 2000 U.S. census shows that of the more than 281 million people living in the U.S., approximately 29% are people under age 20 and another 34% are over age 40. Combined, this equals more than one-half of our population, some 149 million people, falling outside of our scope based on age alone (Kroemer, 2006; Census, 2000). Factor in people with permanent or temporary disabilities, different body shapes and expectant mothers, and we have a strong need for universal design.

The need for universal design may have always been present but has definitely increased in recent years.

Average human life expectancy has increased from 47 at the beginning of the 20th century to 76 in the latter part, due largely to advances in medicine, sanitation, healthier lifestyles and vaccines eradicating deadly diseases (Connell, et al., 1997).

Another rising need for universal design, the need that shaped much of our approach today, comes from increasing numbers of individuals with total or partial physical disabilities. Disabilities that were once extremely rare are becoming more common, again due largely to medical advancements. According to Story, Mueller and Mace (1998), “two world wars created a huge population of veterans with disabilities.” At the beginning of the 20th century people, who had a spinal cord injury “had only a 10% chance of survival” but “antibiotics and other medical advances enabled people to survive accidents and illnesses, which were previously fatal” (Story, et al., 1998).

During the 1950s, the U.S., Europe and Japan, in response to pressure from veterans’ rights groups and activists for the disabled, started to pay special attention to designing for people with disabilities by creating barrier-free environments and by moving people with disabilities away from institutional settings and into their communities (Adaptive Environments, 2003). The first accessibility standard was published by the then-named American National Standards Association.

“The Civil Rights Movement of the 1960s inspired the subsequent Disability Rights Movement” and by 1966, 30 states had accessibility legislation, following the lead of the American National Standards Association (Story, et al., 1998). In 1968, the Architectural Barriers Act enacted by the federal government mandated the removal of physical barriers but only in buildings that received any funding from the federal government.

During the 1970s and 1980s, additional federal mandates made advancing provisions to protect people with disabilities in housing and employment. The Rehabilitation Act of 1973 made it illegal to discriminate on the basis of disability but still only applied to institutions and activities receiving funds from the government. “The Fair Housing Act of 1988 expanded the coverage of the Civil Rights Act of 1968 to include families with children and people with disabilities” and required that all new multifamily housing with four or more units in both public and private sectors be made accessible (Story, et al., 1998). During the 1980s, the term *accessible design* became synonymous with “making environments usable, primarily by people with disabilities” (Walsh, 2002-04).

During the 1990s, the idea of accessible design was replaced with the concept of universal design. The biggest advancements for the disabled community, which

*Applying the principles of universal design, we can evaluate existing conditions in terms of people falling outside of the “norm” and find ways to make products and environments more usable by all.*



helped shaped the concept of universal design, came when the federal government passed the Americans with Disabilities Act (ADA) of 1990. It was the first legislation to comprehensively protect disabled Americans in both the public and private sectors, regardless of federal funding. It granted the right to legal action for discrimination against the disabled in terms of employment, public transportation and access to public accommodations. (U.S. Department of Justice, 2004)

The new ADA laws, combined with the rising need, inspired a group of universal design advocates to draft a set of principles by which existing products and environments, as well as new designs, could be evaluated. With funding from U.S. Department of Education's National Institute on Disability and Rehabilitation Research, this group drafted seven principles, that became known as the "Principles of Universal Design." Those principles are: 1) equitable use; 2) flexibility in use; 3) simple, intuitive use; 4) perceptible information; 5) tolerance for error; 6) low physical effort; and 7) size and space for approach and use.

Applying the principles of universal design, we can evaluate existing conditions in terms of people falling outside the "norm" and find ways to make products and environments more usable by all. But, the needs of the aging population, permanently or temporarily disabled, larger and smaller people, expectant mothers, and children and teenagers vary and need to be understood to make the most of universal design concepts.

### AGING POPULATION

As people live longer, we can expect people to work longer. In 2002, it was estimated that nearly 34 million people over age 65 were still working. With aging, we can expect that older people will have several physiological changes, including a decline in hearing and vision, reduced efficiency in respiration and circulation, diminished sensation and perception of stimuli, problems with balance and decreased strength, endurance and dexterity. (Kroemer, et al., 2003; Kroemer, 2006).

To help accommodate for hearing loss of the aging, we can make several minor changes in work and public environments. Important audible signals should be "easily distinguishable and of sufficient intensity" (Kroemer, 2006). Providing quieter environments will allow people with hearing loss to better distinguish audible signals without interference. The concept of masking background noise is frequently used but can prove distracting, especially for people with hearing aids, which amplify all sounds, including the noises used for masking. For pertinent information, a combination of visual and audible clues can be used, such as elevators having verbal announcements in addition to illuminated or flashing numbers indicating the next floor.

Corrective lens are important to help compensate for vision deterioration with age, but they cannot guarantee legibility of certain fonts and colors in different lighting sit-

uations. To help with these issues, it is important to consider signage, instructions and product labels with font styles, sizes and colors that are easy to read, with simple styles, large sizes and contrasting colors being the easiest. Graphic representations can be used to simplify comprehension, which is also a benefit when a language barrier is present. Lastly, we can appeal to a variety of senses, including hearing, and, in the case of Braille, touch.

Physiological degradation can also affect a person's balance. Affected balance combined with decreased mobility brought on by changing body size and shape and decreased reaction times can require the use of external means of providing balance. One external aid can be as simple as providing handrails or other surfaces, such as counters and tables, for one to hold on to. Other aids include canes, walkers and, in extreme cases, wheelchairs. However, these present other problems of access. People using walkers or wheelchairs may find it difficult to access certain facilities and modes of transportation. Canes typically do not pose these problems.

When it comes to decreased effectiveness of the circulatory and respiratory systems, we can expect that the aging population will fatigue earlier, have less endurance for prolonged physical effort and have longer recovery times. A comprehensive work program encompassing the aging workforce could allow for frequent or longer break periods and a period of controlled exercise prior to the start of the work shift.

### PERMANENTLY & TEMPORARILY DISABLED

People described as disabled may suffer from any number of a wide range of ailments. ADA defines disabled as "a physical or mental impairment that substantially limits one or more major life activities, a person who has a history or record of such an impairment or a person who is perceived by others as having such an impairment" but does not go so far as to specifically name all of the impairments covered (U.S. Department of Justice, 2004). If we try to name all of the conditions within the broad spectrum of the term *disability*, we have a list that includes permanent or partial blindness, permanent or partial deafness, wheelchair-bound or needing a walk aid, and any number of neurological or mental disorders. It may seem difficult to accommodate every need, but simple considerations can make an environment more usable by people with disabilities.

People using wheelchairs and walkers benefit from ramps, wider access points and passages and space enough to move around in a room or cubicle, all of which should be considered during the initial design phase to prevent later retrofits and modifications. ADA defines minimum requirements for accessibility.

People with vision or hearing impairments may require information to be conveyed using various senses simultaneously, as in those used for aiding the aging population. Computers can provide visual and audible messages or commands. Crosswalks can flash a walk



signal while playing an appropriate auditory cue. Tactile senses can also be used as in that of a stove knob that clicks at each heat level.

People with neurological disorders may find it difficult to accomplish simple tasks we take for granted. Something as easy as opening a door can be a challenge. A wider range of individuals can more easily use door levers, instead of knobs. If typing is difficult, computers can easily be converted to receive verbal commands with inexpensive software and hardware.

### LARGER & SMALLER PEOPLE

Variability should be expected in any population. Although designing for a percentile group is a common practice, some may not fall into that category. Height and weight are common varying factors. Although larger individuals may require more space to move around, perhaps the best accommodation for varying body size is user-defined adjustability. Allowing a user to select the height of a work surface and chair and the distance from the work will ensure the user's comfort. The height of chairs, desks, workbenches and even some sinks can be adjusted. The distance from controls can also be adjusted, as in a car or airplane cockpit.

### EXPECTANT MOTHERS

An expectant mother's weight and size will increase during her pregnancy. On average, a woman's weight will increase by 17% and waist circumference by 27%. This added size and weight causes expectant mothers to fatigue easier and makes it difficult for them to bend forward and to get close to their work, especially during the latter phase of pregnancy. Here again, it is recommended to provide frequent, self-selected breaks and an environment with enough space for an expectant mother to comfortably move around. Expectant mothers also benefit from adjustable-height work surfaces and chairs that they can set to a position comfortable to them. Chairs should be sturdy, provide firm support, have a high back and, if possible, a footrest to slightly elevate the legs (Kroemer, 2006).

### CHILDREN & TEENAGERS

During the first 20 years of life, humans undergo major changes in body size. Length can increase up to four times and weight more than 20 times. The times of rapid changes, or growth spurts, vary by gender and by individual, which makes it impossible to identify and design for a typical boy and/or girl at a given age.

Adjustability, again, is fundamental when designing for the young. For example, the seat height of a bicycle can be adjusted within a set range. Desks in schools should not only be adjustable, but should also support the natural shape of the body, especially the curves of the back. Too often, chairs in schools are flat and do not support the spine.

Another area of concern when designing with the younger population in mind is head, neck and hand entrapments. Playground equipment, reclining furniture,

banister and handrail spindles and even child safety gates designed to keep children from harm have been known to cause entrapment hazards for young children. If a product or environment is designed to prevent entrapment of the smallest individual, generally a female infant in this case, all children can be protected.

### CONCLUSION

Although we can take these concerns into consideration, a truly universal design, designing for an entire population, may be "impractical and expensive or not even thought of" (Kroemer, 2006). Designing for an aging population, permanently or temporarily disabled individuals, larger or smaller people, expectant mothers, or children and teenagers in addition to the normal population may not be possible due to the variety of demands of the different groups and individuals.

However, principles of universal design can be applied to everyone's benefit. The important thing is to keep in mind targeted users of a product or environment during the design phase to avoid costly alterations after the fact. If a retrofit becomes necessary, do so with the interests of all people who may benefit. Some simple design practices can make a difference. ☉

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# Fireline

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FIRE PROTECTION PRACTICE SPECIALTY

VOLUME 3 • NUMBER 1



## Partners in Fire Risk Management

Part 1 of 2

The Building Owner & Fire Service as partners in fire risk management reduce unnecessary exposure to serious injury or death to the public and firefighters.

By Frank J. Baker, CSP, CFPS, ALCM

**T**he risk assessment factors, commonly abbreviated in the insurance industry as COPE, include building construction, occupancy, protection systems and exposures. These factors are reviewed and described in detail in the loss control or engineering survey reports used by insurance underwriters.

Underwriters rely on these internal confidential reports to accurately

*The first arriving fire officer, in the course of conducting the initial on scene size-up, should attempt to identify the scope of the fire problem, predict its behavior and make initial decisions.*

describe what is there, what is not and what needs to be improved. The same terminology may also be found in many fire and building codes defining prescriptive standards as to how a property should be constructed, how it is used, fire and life safety protection features and allowable exposures.

A less commonly recognized factor that can also affect the outcome of fire events is the Rules of Engage-  
*continued on page 20*



**PAGE 4**  
**FIRE PROTECTION**  
Operations at Sprinklered Properties



**PAGE 9**  
**SMOKE ALARMS**  
Fire Prevention Week 2010



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Electrical Distribution Safety & Reliability



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**CSB**  
New Safety Recommendations

**For a complete Table of Contents, see page 3**

The board heard from two witness panels, including:

- Professor Paul Amyotte, Dalhousie University (Canada);
- Ervin Patterson, Commissioning Management Services, Inc.;
- Larry Danner, GE Energy;
- Representative Matthew Lesser, Connecticut House of Representatives;
- Professor Glenn Corbett, John Jay College of Criminal Justice (New York);
- Michael Rosario, Local 777, United Association of Plumbers and Pipefitters;
- Steven Schrag, Connecticut Council for Occupational Safety and Health.

Bresland told the House committee, “We believe that the 18 urgent recommendations proposed—together with the two urgent recommendations issued on Feb. 4—address all of the principal root causes of these two tragic accidents. If adopted by the recipients, I have no doubt that future accidents will be avoided and lives will be saved as a result.” ☺

For more information, **click here**.

To view CSB’s urgent recommendations **click here**. ☺

## Partners in Fire Risk Management

*continued from page 1*

ment for the fire service. As building construction changes and fire loading increases, these Rules of Engagement are evolving as well in an ongoing effort to improve firefighter safety. The impact is a calculated reduction in the risks they are willing to take to save property from the peril of fire and reduce unnecessary exposure to serious injury or death to the public and firefighters.

If the fire department is summoned to your facility as a result of a fire, something has gone terribly wrong. At that point, the property owner or occupant will either remain part of the problem or has already become part of the solution. What happens next is the culmination of what has happened in the previous years, months and days leading up to this day. Your role has already been defined and you must now live with the consequences of your action or inaction.

### FIREFIGHTING RULES OF ENGAGEMENT

The first arriving fire officer, in the course of conducting the initial on scene size-up, should attempt to identify the scope of the fire problem, predict its behavior and make initial decisions on how to apply the available or needed resources to the problem. Questions that need to be answered include “Where is the fire now? Where is the fire going? Who or what is in its way?” to determine if confinement and extinguishment are possible (FEMA, USFA, NFA, 2004). If it is determined that there is reasonable likelihood of success with the resources that can be mustered, then a risk/benefit evaluation must be conducted. Questions asked during this process include “Are the risks taken worth the benefits gained?” and “If it is worth the risk, for how long?” (FEMA, USFA, NFA, 1991).

Alan Brunacini, fire chief of the Phoenix, AZ Fire Department, is credited with development of an early risk-based decision policy that has long since been integrated into their standard operating procedures. It defines the extent of risk that is acceptable in a given situation as follows:

- Each emergency response is begun with the assumption that “they can protect lives and property.”
- They will “risk their lives a lot to save savable lives.”
- They will “risk their lives a little, and in a calculated manner, to save savable property.”
- They will “not risk their lives at all to save lives and property that have already been lost.” (Goodson & Sneed, 1998)

Many fire departments have used this basic tenant to develop more detailed guidelines or internal practices known as standard operating procedures or guidelines (SOPs or SOGs) to assist in the decision-making process of how a fire event will be managed. Use of these basic guidelines has allowed progressive departments to develop strategies that provide for best firefighter safety when



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**Table 1**  
**ISO Building Classification Systems**

Common Name/Construction Details	ISO Classification	NFPA Classification
<b>Wood Frame:</b> Combustible wood framing members for roof and sidewalls, combustible floor and roof decking, with or without nonbearing masonry veneers, includes wood pole structures.	Class 1	Type V
<b>Ordinary (Joisted Masonry):</b> Bearing masonry walls, usually of brick or block, supporting floor and roof structural members of combustible wood construction.	Class 2 Includes heavy timber or mill	Type IV Includes heavy timber or mill Type III Ordinary
<b>Light Noncombustible:</b> Unprotected steel frame structure with metal or noncombustible exterior cladding.	Class 3	N/A
<b>Masonry Noncombustible:</b> Fully or partially bearing masonry walls combined with unprotected structural steel and unprotected noncombustible floor and roof decking.	Class 4	Type II
<b>Modified Fire-Resistive:</b> Structural steel with at least 1-hour rated fire protection coatings or encased in concrete with reinforced concrete floors and roof decking at least 4" thick.	Class 5	Type II
<b>Fire-Resistive:</b> Reinforced concrete structural members, floor of at least 2-hour rated material, roof at least 1-hour fire-rated material (often misnamed "fireproof").	Class 6	Type I

While these two systems describe the same buildings, they are polar opposites in how the buildings are identified by numerical classification.

The ISO building classification system uses six categories and is based more on the use of specific types of materials with commonly known fire resistance ratings or durability. The NFPA system and each of the model building codes classify building construction in different terms but essentially divide them into five classifications and are generally based on prescriptive requirements of fire resistance of the construction elements and less so on the particular materials used (Hall & Adams, 1998).

#### **WOOD FRAME CONSTRUCTION: ISO CLASS 1**

Wood frame construction is characterized by the use of lightweight wood or steel framing members in the common sizes of dimensional lumber. This includes 2" x 4", 2" x 6", 2" x 8", 2" x 10" and 2" x 12" members referred to as dimensional lumber. The floors that are not supported directly by the ground (poured concrete slab) are

usually wood decking on either a large dimensional lumber system or engineered lightweight truss.

Roof supporting structures are either conventional rafters using a ridge beam to connect each side or a lightweight engineered truss connected with metal fastener plates or gussets. Some newer construction will use the metal studs for interior and exterior wall framing. Although the use of the lightweight metal studs within the walls offers a reduced fire load, there is no appreciable gain in the structures' ability to withstand fire conditions, as these members are only stable as long as the entire wall system remains intact.

Limited fire resistance is often provided to the structural members. Any fire separations are either of limited

using a risk-based decision-making process. Some of these specific areas include ensuring that firefighters effectively manage their self-contained breathing apparatus (SCBA) air supply, limiting the distance to which they will stretch hose lines inside a large structure or ultimately deciding certain property is not worth the risk to personnel.

#### **CONSTRUCTION OF THE BUILDING**

Construction of the building relates to the types of materials used and how they are assembled or held together to keep the structure from falling down by forces of gravity or wind pressure. Two major building classification systems exist. One was developed by Insurance Services Organization and the other by NFPA.



**Highly combustible interior hazards.**

resistance rating or must be constructed of nonwood frame materials, such as masonry, to effectively divide the structure into two or more freestanding compartments. Most wood frame structures are far smaller in size than those of other construction types. A large wood frame structure would be 10,000 sq ft per floor or less and usually not greater than 3 floors in height. Pole frame construction also falls into this classification. While originally limited to farm buildings, they are now found in a wide variety of uses including commercial, recreational and storage facilities (ISO, 2007).

Older wood frame construction is generally considered to be more inherently stable than the newer configurations that include a large degree of engineered components and subsystems to provide structural integrity. Older systems relied on the mass of individual members and the method of construction used to provide resistance to movement, flex and direct flame impingement.

The framing of an older structure using only dimensional lumber held together with common nails will usually have a greater ability to resist the damaging effects of direct flame impingement than one of lightweight engineered members. The primary reason for this is the mass of the members. Direct impingement on these members by fire creates an insulating char on the surface, thus slowing the rate at which the member is consumed and providing longer structural integrity. The common nails of 10d (penny) and 16d (penny) that are commonly used in conventional framing applications penetrate along their entire length and still provide a solid grip on the lumber even after development of char on the surface.

Lightweight engineered “T” joists now used for floor and roof systems do not have enough mass, especially through the center web of the truss, which may only be ½ in or less in total thickness, to resist the effects of fire. It is important to understand when these have become

directly exposed to fire, as their resistance to degradation is very limited.

Other styles of engineered lightweight trusses employ an open web design using a top and bottom chord and the vertical compression members are held together with stamped metal plates often called a gang nail. These plates generally only penetrate the truss chords by about ½ in, thus not giving any support once the surface has begun to char to any degree. This is the same type of fastener used in roof truss construction that is pressed into place at the connection points of the members. Many fire codes enforced for one- and two-family dwellings will require periodic draftstopping to limit the size of each concealed space in an effort to control the unchecked spread of fire. Studies have shown that lightweight construction using engineered wood products can fail in as little as five minutes after fire impingement on the assembly (FEMA, USFA, NFA, 2005).

Flame spread as a result of the unchecked concealed spaces can permit the fire to run through the structure at a rapid pace. This often occurs in case of fires in concealed attic spaces without any firestopping. Fires in the concealed space of an attic or the space between original and later roof structures can move so fast that the fire department has extreme difficulty in getting ahead of the flame spread. Controlling the advance of the fire can only be done by opening up a large enough ventilation hole ahead of the flame front that the fire will be drawn upward and stop its horizontal advance. This radical procedure, called a trench cut, creates an opening that traverses the entire width of the building so the fire will vent vertically and not progress past the opening horizontally.

A 2005 NIOSH Alert warns of increasing hazards due to the presence of truss construction and unpredictability with collapse. It recommends that work above a truss-supported structure or under any truss roof be suspended and the area evacuated immediately when it becomes apparent the structural members have become exposed to fire (NIOSH, 2005). This may become apparent by visual observation of direct flame impingement or a change in smoke color from white, grey or black to a brown color. Due to the nature of engineered systems, they are only stable when all structural elements are intact. Unfortunately, once that integrity is compromised, the collapse will be imminent and often total in nature.

## **ORDINARY MASONRY CONSTRUCTION: ISO CLASS 2**

This category is characterized by load-bearing masonry walls and combustible roof and floor structures spanning between them. The masonry materials used for the walls can include solid brick laid in multiple courses interlocked together, hollow concrete block or a combination. However, precast or poured-in-place reinforced concrete can also be found as wall materials.

The roof and floor assemblies will be primarily of wood and can utilize either dimensional lumber framing or engineered lumber products. This type of construction



is well suited for single and low-rise structures, although it can and has been used for much taller buildings.

The wall material is a noncombustible material with great compressive strength for withstanding the vertical down force created by the weight of the roof, upper floors and the walls themselves. This is a more labor- and material-intensive construction method than wood frame. It is usually afforded cheaper insurance rates than wood frame because of the limited combustibility of the wall material even though the effects of fire on the most common wall materials will vary greatly (ISO, 2007).

A subclassification of this type is known as heavy timber or mill construction. This group is categorized by very large dimensional wooden support members referred to as timbers due to the size. Minimum sizes include 8" x 8" wooden columns and 6" x 6" horizontal beams. It is commonly found in older industrial buildings with solid brick walls using straight timbers of even larger dimensions. In modern buildings, the members are usually comprised of laminated beams like those found in churches to create large open areas. The large mass of these timbers allow them to char to a limited depth while most of the cross-sectional area remains unaffected by the initial fire exposure.

Advantages of this construction method include its ability to withstand relatively high wind, even if the roof is compromised as long as all the exterior walls remain intact. In cases where solid brick has been used, the thickness of the walls will increase as the height of the structure increases, to a point where they may reach several feet thick for a multiple-story structure. The enormous mass of a solid brick wall of a foot or more in thickness using interlocked courses of brick enables it to absorb great quantities of heat from a fire without sustaining significant damage. In fact, a unique construction

**Narrow access behind building partially blocked by vehicle.**

detail called a fire cut, where the floor beams or joists enter pockets in the exterior walls, is designed to permit a beam to pull away when it collapses without pulling down the walls.

Due to the labor-intensive nature of constructing a solid brick wall, this method of building is usually only found in older buildings. What may appear to be solid brick on the exterior may be a brick face with a hollow concrete block backup.

The greatest disadvantage of this type of construction is found in those structures built with hollow concrete block as the supporting wall material. This lightweight material has great compressive strength to resist the vertical down force created by the weight of the structure above but has little mass to absorb thermal energy unless it has been slushed or filled with concrete during construction. This inability to absorb thermal energy is compounded by the thin webs that connect the inner and outer faces that do not allow the energy to transfer efficiently from one face to another.

When one side is heated by fire exposure and the other is cooled by water, the block often cracks at the web, making the structure prone to sudden collapse. Because of the cracking due to thermal imbalance and separation that can be induced by wind forces, water streams or pulling toward the interior by collapsing roof and floor members, the wall can separate and fall both inward and outward.

From a firefighting standpoint, it is widely recognized that while solid brick tends to endure heat exposure for longer periods, it is not immune from its detrimental effects. In older buildings, it is common to see reinforcing steel rods that connect the outer walls characterized by decorative "stars" or plates with large threaded nuts on the exterior. Also, thickened wall segments known as pilasters are also used to help stabilize the wall. Given enough exposure to intense heat and lateral forces caused by collapse of interior floors from fire damage and absorbed water weight into the contents, this structure will still fail. The key is that if a fire cannot be controlled with offensive strategies, even this type of structure can be damaged beyond repair.

One particularly infamous type of

***When one side is heated by fire exposure and the other is cooled by water, the block often cracks at the web, making the structure prone to sudden collapse.***







*Sofa Super Store front view supply lines, Phase 2 (p. 127 Charleston Post & Courier).*

construction that falls within this category is the ordinary masonry building with a “bow string” wooden truss roof. This is easily recognizable by the arched roof that extends from one end of the building to the other. As with any truss assembly, its strength lies in the system as a whole, not in the strength of the individual component members. Once any single part fails, the entire assembly will ultimately fail.

#### **LIGHT NONCOMBUSTIBLE: ISO CLASS 3**

This type of building is characterized by materials that are classified as noncombustible or slow-burning supported by an engineered steel framework. The roof and sidewalls are usually of metal siding attached to metal girts and purlins that are attached to the unprotected structural steel frame. This type of building will usually not have any supporting columns except at the exterior walls.

Often used as commercial and industrial occupancies, this is a structure that can be erected quickly at a relatively low cost. It can be finished on the exterior with a wide variety of materials, including brick or stone veneers to enhance its appearance (ISO, 2007).

The tradeoff for the low cost and speed of erecting the framework is that it is highly susceptible to fire damage, as the structural steel frame is commonly not protected with any sort of fire-rated protection. Steel will fail to support even its own weight when heated to temperatures of 1,000°F or higher and thus will result in collapse of the structure. However, several factors can affect this process, including size of the member, the load placed on it, type of steel and geometry of the member. Large dimensional structural I beams will tend to withstand this heat somewhat longer than a lightweight open web steel bar joist, which does not have nearly the same mass (Hall & Adams, 1998).

#### **MASONRY NONCOMBUSTIBLE: ISO CLASS 4**

Masonry noncombustible construction is characterized by the combination of masonry and steel materials that make up the supporting structure. Roof is of noncombustible or slow-burning material, usually a metal decking supported by various configurations of steel joists and beams. This roof structure is supported by bearing masonry walls and unprotected steel vertical columns. Commonly, this is a single-story industrial building, but can reach several stories in height (ISO, 2007).

The most common roof supporting structure in this classification is the open web steel bar joist system, which employs the use of a lightweight parallel chord truss design. This can have many different materials making up the assembly, but the basic design is the same. The open web steel bar joist is effectively a truss comprised of a top and bottom chord, held together by vertical and/or angled members. The lightweight feature of these bar joists/trusses is also detrimental to their ability to withstand exposure to fire. The smaller dimensions of the members in a metal truss cannot absorb nearly as much heat as large dimension steel I beam. When exposed to fire, open web steel bar joists have been known to collapse in as little as 9 minutes (FEMA, USFA, NFA, 2005). The infamous June 2006 Sofa Super Store fire that occurred in Charleston, SC, where 9 firefighters were tragically killed in a sudden and catastrophic building collapse, involved a building of ISO Class 4 construction.

This type of construction can have a single building divided into several fire divisions by strategically located freestanding masonry walls that extend through the roof. The fact that these walls do not support the roof on either side allows one side to collapse without compromising the wall and exposing the unburned side to fire.

#### **MODIFIED FIRE RESISTIVE: ISO CLASS 5**

This classification of construction is characterized by the lack of unprotected steel that is used to support the building. A minimum of 1-hour fire resistance rating is required on any exposed steel either by spray on insulation, metal lathe and plaster or being encased in concrete. Floor and roof decking are of a masonry product, usually precast panels. Any exterior walls are also of masonry of concrete panel construction but are not load-bearing as the framework actually supports the building (ISO, 2007).

Although this type of construction generally lasts longer when exposed to fire due to the fire resistance of the protective coverings on the steel, any compromise of this protective system will leave weak points that can cause a premature failure because of weakening at that point. It is not uncommon to see where contractors have compromised these protective systems to install cable clamps or in the course of fishing wire through concealed ceiling spaces and along supporting columns.

### FIRE-RESISTIVE: ISO CLASS 6

This classification is characterized by the use of cast-in-place, steel-reinforced concrete beams and columns to support the building. The floors and roof are either reinforced precast panels or poured-in-place reinforced concrete. Floors must have a 2-hour fire resistance rating and the roof structure at least a 1-hour rating. Exterior building skin materials can be of almost any type, as they have no load bearing capability. This is the most expensive type of building to construct, but it offers the greatest resistance to fire exposure. This type of construction was once identified as fireproof, but this identifier has long since been dropped since no such type of building exists.

Every building will fail in time with sufficient fire exposure—fire-resistive construction only provides the most exposure time before that failure would occur (ISO, 2007). Unique features of this classification's ability to resist the effects for fire due to the thermal mass created by the use of heavy masonry and concrete materials for the structure and floors also provide it extra strength.

This allows a structure to withstand more collateral loading caused by the extra weight of water soaked contents. Although not unlimited, this provides for a longer safe working period inside during extended firefighting operations.

Compartmentalization provided by the fire-resistive nature of the floors helps slow fire spread from one floor to another, unless it finds penetrations, such as improperly protected vertical shafts, or leap frogs through the exterior openings from one floor to the next. On the flip side, vertical fire control ventilation operations on this type of structure are nearly impossible and thus limited to horizontal methods.

### SPECIAL CONSTRUCTION CONSIDERATIONS

The Big Box is a fairly recent term in firefighting practice. It is not uncommon to find single fire division buildings exceeding 100,000 sq ft with high ceilings equaling two stories in height. Usually, this is of the ISO Masonry Noncombustible Class 4 construction due to current construction technology. This is now commonly known as the Big Box when it comes to retailing operations, but manufacturing facilities can be 5 or 10 times larger. This amounts to a building that is too large to reach much of the interior under the new Rules of Engagement.

These new rules on how fires will be fought have resulted in limitations on the amount of hose that can or will be stretched into a building from the nearest doorway. Many departments have adopted the rule that no hose lines longer than 150 ft in total length will be



*(Above) Well marked access doors & protected post indicator valve.*



*(Left) Well marked building.*

extended past the outermost door opening, so this will greatly limit the effective reach of suppression activities. For this reason, placement of additional exit/egress doors must be strategically located to provide access with less interior travel distance to reach the seat of the fire or to access critical systems, such as the sprinkler controls, electrical and natural gas disconnects.

Another driving factor in restricting the entry distances for firefighters involves management of their SCBA air supply. Due to the number of firefighters dying as a result of running out of air when they become disoriented or trapped while waiting on the rapid intervention team to rescue them, the concept of shortening work cycles within the structure has come of age. Although most departments are moving toward higher-capacity (high pressure and/or high volume) cylinders for SCBA, the actual working times inside the building



**Wide driveway  
provides good  
clearance for  
FD apparatus.**



are shortening due to better practices of managing their air. Instead of waiting for the low air alarm to sound on SCBA before beginning to retreat, the use of the heads-up display (HUD) located in the face piece has now made it easier to monitor the air supply so exiting can begin with a substantial reserve air supply in case of emergency.

***Goods and containers  
that can withstand  
the detrimental  
effects of fire or  
water saturation and  
remain stable for pil-  
ing to heights of 20 ft  
or more are rare  
unless constructed of  
wood, metal or rein-  
forced plastics.***

properly draft stopped, fire can spread unchecked throughout this space, consuming the structural members without ever breaking through the surface materials, such as floors or ceilings. Controlling fires that are located in these concealed spaces is often difficult, as they are difficult to find without the aid of a thermal imaging camera. Once located, they require a great amount of manpower to open up the space and to suppress the fire at the same time. Therefore draft stopping is required when these concealed spaces reach specific square footages depending on the occupancy of the building and local codes.

NFPA 1404, Standard for Fire Service Respiratory Protection, now requires implementation of an air management policy with the intent that the reserve air is not used for entry, interior work or exiting the structure but only to preserve the firefighters' lives while they are being rescued. Current guidelines are to use not more than 75% of the air for entering, working and exiting, leaving a 25% reserve air component. The impact is that actual interior work cycles could be reduced to as little as 12 minutes or less if the firefighter is not in top aerobic condition.

Combustible concealed spaces are commonly found in those buildings of ISO Class 1: Wood Frame construction. If these spaces are not prop-

When the floor support system is made up of dimensional lumber and the concealed space runs only in one direction, draft stopping may not be required unless unusually large spans occur. However, when an open web truss of wood construction is used to support the building, fire can spread in any or all directions without draft stopping. Although the draft stopping in a wood frame structure is not usually a fire-rated material, it helps significantly slow the progress of the fire through the confined space.

Multiple roofs are common on older buildings where the structure was originally built

with a flat roof, and through age or neglect, has fallen into a state of disrepair and has been replaced with a second structure above it that is often sloped or pitched. This modification creates a significant problem for trying to ventilate directly above a fire inside. The outermost roof can be breached effectively, but the one below cannot be reached to open it up and allow the products of combustion to rise upward. This modification can include any combination of wooden and metal structures to form the first and second roofs. In any scenario, the interior cannot usually be effectively breached, as it cannot be reached with power ventilation saws from the upper deck. Without vertical ventilation, the fire will spread laterally throughout the structure until stopped by firewalls. Not only is effective vertical ventilation nearly impossible in this situation, it also creates a confined space that, depending on the materials, can enable the fire to run unchecked from one length of the building inside the space.

Compromised fire protective materials and fire stopping occur during renovations, remodeling, building additions and updating of utility or wiring services in a building. This leaves critical structural members exposed to the effects of fire. In some cases, this damage to the fire-resistive materials, commonly spray-on fire retardants, plaster and metal lathe or concrete, cannot be avoided to do the work necessary. However, it is crucial that the protective features be restored immediately upon completion of the work. Some occupancies, such as JCAHO-accredited healthcare facilities, are required to conduct regular inspections of all fire-rated partitions and walls within the facility for integrity of the fire stopping materials at all penetrations.

Collateral loading of building structures is very common. One of the most common situations involving collateral loading is that of the roof structure by equipment, such as HVAC units, dust collection systems, etc. If



installed when the building was originally constructed, the building design should have accounted for this additional loading. However, if later modifications are made, their impact on the roof design and safety factors of loading may not have been contemplated.

Another area is that caused by weather situations. In northern climates, extreme snowfall may increase roof loads beyond design parameters. If a fire erupts inside the structure and causes heating under the roof, this can rapidly melt the snow, causing water to mix with it and form slush, which is much heavier and cannot escape through the normal roof drainage system.

### OCCUPANCY

The occupancy of the building as used by NFPA can mean two different things. One is related to the occupancy fire load and is based on normal expectations of fire loading as “low, moderate and high hazard” that would be encountered with a particular type of operation (NFPA, 1997). The other is how the building is occupied as related to its use. This classification system breaks down the building use into categories, such as business, residential, educational, mercantile, industrial, place of assembly, healthcare, etc. when used in reference to life safety issues. However, in the insurance industry, it is defined as how the building is used and specifically describes the operations within it, including the type of business and its relative hazards.

### OFFICES

The typical office building has a known set of hazards that would commonly be present. This would include the used of electronic machines for communications and data, paper file storage and potentially combustible office furniture. Fire services would grade this to be a relatively low hazard, although the fire loading of this hazard group has increased significantly in the last 20 to 25 years.

In the early 1980s, it was not uncommon to find primarily metal desks, a telephone and typewriter at most workstations spread throughout a large relatively open office setting. As time has passed, that has evolved into cubicle partitions covered in fabric and multiple electrical devices, including computers, monitors, printers, copiers, fax machines, adding machines, telephones, clocks, radios, compact disc players, personal fans, heaters, PDAs and cell phone chargers. Combined with the fact that most businesses have yet to go completely paperless, there is still the preponderance of papers and files scattered throughout the office areas that previously existed.

This increased fire load of synthetic materials and plastic-cased devices (made primarily of petroleum) in the last 20 to 25 years has significantly increased the fire loading to the point where the Btu output of a fire in the same space has grown exponentially. As fire service safety advocate Deputy Chief Billy Goldfeder has espoused many times when speaking on the subject,

“This is not your father’s fire.” Strategies and tactics for all fire need to change with the times.

This increased thermal output has resulted in better PPE for the firefighters and mandated use of SCBAs on all fires due to the respiratory hazards from the toxins off-gased in the products of combustion. With the presence of more vertical partitions to form cubicles, firefighters can easily become disoriented and lost in a maze consisting of rows and rows spreading out on large floors of a building, also making it difficult to advance hose lines through this labyrinth. Therefore, a greater emphasis has been placed on municipal mandates for fire sprinkler protection.

### MANUFACTURING

Producing a finished good or a component part of that finished good is considered to be manufacturing. Whether that product is liquid, solid or gaseous, made from naturally occurring raw materials or from synthetic products made from raw materials does not matter. All manufacturing operations have inherent hazards associated with their processes. The major difference from an occupancy standpoint is how severe the hazards caused by the operation are and how well they can be controlled.

From a firefighting standpoint, it is important for the local fire department to be aware of what hazards are present at all phases of the operation, as well as specific actions to take or not take that may worsen an emergency. Such instances would include the presence of water-reactive products since their primary extinguishing agent is water, large open-top pits that crews could fall into, chemical operations that if not shut down properly will cause runaway reactions, etc. At least annually the local department should be invited into the facility to either initially develop or update their quick action prefire plan.

### WAREHOUSING

All operations will have some degree of storage, whether raw materials, materials in process or finished goods. Common methods include use of solid piles of stackable items or use of tiered storage racks, both with aisles between them to facilitate handling of the goods with forklifts. Solid piling of goods requires a natural shape or container that inherently stable.

From a storage standpoint, there is a tradeoff on the amount of building square footage required to house a given amount of product (ongoing cost) versus the initial cost to purchase and install rack storage systems.

Where high ceilings are not available to accommodate racking systems and the packaging can withstand its own weight as well as that of several layers of goods above it, this type of storage method can become more cost-effective.

*Combined with the fact that most businesses have yet to go completely paperless, there is still the preponderance of papers and files scattered throughout the office areas that previously existed.*

**From a fire propagation standpoint, the rack systems cause problems with fire suppression, as each pallet load of product is a separate unit with flue (both horizontal and vertical air flow) spaces created between it and the adjacent unit to each side as well as above and below.**

tive. If properly arranged, it can lessen the fire load properties with some commodities by eliminating some vertical and most of the horizontal flue spaces that often exist in racking systems. This has the capability to provide nearly as effective use of the floor space as a racking system provided the containers are stable. Goods and containers that can withstand the detrimental effects of fire or water saturation and remain stable for piling to heights of 20 ft or more are rare unless constructed of wood, metal or reinforced plastics. Corrugated cardboard containers stacked

directly atop one another can be damaged in a very short period of time when involved directly in the fire or when they become saturated with fire suppression water and can collapse in any direction. Therefore, in most applications where the contents have any significant weight, the storage height should be restricted to two units, or in some cases, single layers only.

Rack storage is usually a more expensive method initially of arranging goods in a warehouse, first by the cost of the engineered racking systems themselves and secondly by the limitations of height by ceilings or by the vertical reach of the forklifts on hand. From a fire propagation standpoint, the rack systems cause problems with fire suppression, as each pallet load of product is a separate unit with flue (both horizontal and vertical air flow) spaces created between it and the adjacent unit to each side as well as above and below.

This helps to provide more combustion air to all sides of the product involved in the fire within the racking system as well as radiation feedback between the goods adjacent to each other within the rack to accelerate the fire growth.

Although there is less danger of immediate collapse since each pallet of commodity is individually supported, it is still present should the fire burn with enough intensity to weaken the racking system. The use of in-rack automatic fire sprinklers can be very beneficial in controlling fires that may develop within the system.

Forklifts used can be electric running on rechargeable lead acid batteries but are more often powered with liquefied petroleum (LP) gas. As no one ever wants to have a situation where you run out, extra cylinders are always on hand. Ideally, these should be stored outside the building in a secure location that is well marked and protected. However, OSHA standards permit storage of up to 300 pounds of LP, which equates to 8 of the 33.5 lb or 6 of the 43.5 lb typical cylinders. LP cylinders, when directly exposed to flame impingement, can undergo a phenomenon known as a boiling liquid expanding vapor

explosion (BLEVE) with catastrophic results. The effects of larger quantities will be discussed later under the topic of exposures.

Pallets, particularly those considered idle pallets, are a great concern since fire can grow involving a stack of pallets with alarming speed and intensity. A stack of idle pallets presents basically a perfect fire setup since the individual members of the pallet are combustible, have a relatively low in comparison to the surface area and also possess the previously mentioned horizontal and vertical flue spaces that permit rapid flame propagation.

Although they present a significant fire hazard in any building, strict requirements are outlined in NFPA 13, Standard for Installation of Automatic Sprinkler Systems in an attempt to keep from overwhelming the suppression capabilities of the sprinkler system. These guidelines generally require that not more than four stacks of pallets of not more than 6 ft in height be assembled into a single pile and that piles be separated by at least 8 ft of clear space or 25 ft of other commodity. If delivery densities of the sprinkler system are greater than that required by Ordinary Hazard, Group 1, additional storage heights can be achieved as specified in the standard (NFPA 13, 1999, 2002). ☉

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## ***New Safety Recommendations Considered at CSB Public Meeting in CT***

**A**ccording to U.S. Chemical Safety Board (CSB) investigators, the practice of using flammable natural gas to clean power plant piping, which led to the fatal explosion at Connecticut-based Kleen Energy on Feb. 7, 2010, has been commonly used across the gas-fired power-generating industry.

The explosion, which killed six workers and injured at least 50 others, occurred during a gas blow—a planned effort to clean out new fuel-gas piping leading to combustion turbines by directing high-pressure natural gas through the pipes and out of vents located near ground level, adjacent to the power generation building. The gas accumulated above the lower explosive limit and ignited, causing massive damage to the new billion-dollar facility, which was nearing completion.

The ignition source for the blast has not been determined. CSB investigators say the construction site had many possible ignition sources and that gas blows could also self-ignite if debris ejected from piping impacted other objects nearby, creating sparks and adding to the risk of the practice.

The plant was designed to use a combined cycle to efficiently generate electricity. In this type of facility, natural gas is combusted to drive massive turbines and then residual heat is recovered from the exhaust gases to produce additional power through the use of steam turbines. Newly constructed pipes frequently have debris and other contaminants that can damage gas turbine blades, necessitating some form of pipe cleaning prior to startup.

CSB investigators presented the new findings, derived from a survey of 62 representatives from the combined-cycle gas power industry, at professional society meetings in Maryland and Connecticut. Thirty-nine survey respondents (63%) indicated their companies had at some time used flammable natural gas to blow out piping. Only one of those 39 respondents said a flare was used to safely combust the gas prior to venting to the atmosphere.

According to the survey, using natural gas to clean pipes remains the most common single





# Fireline

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## Building Owner & Fire Service

### *Partners in Fire Risk Management*

BY FRANK J. BAKER, CSP, CFPS, ALCM

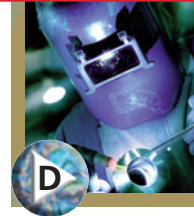
**P**rotection under the terms discussed focuses primarily on how the peril of fire can be avoided or controlled. This article examines the common fire control methods of portable fire extinguishers, hose stations, standpipes and automatic fire sprinkler systems. Specialized systems, such as for commercial cooking or clean agent systems used for high-value assets, are not addressed.

*Fire exposures include anything that could either permit fire to communicate to the subject building or that could be endangered by a fire extending from the subject building.*

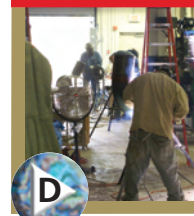
#### **PORTABLE FIRE EXTINGUISHERS**

Portable fire extinguishers are considered to be the front-line defense when dealing with incipient-stage fires. These are commonly not intended for use on larger fires, but larger units are available, up to a size that requires them to be equipped with wheels to facilitate moving when needed. NFPA 10, Standard for

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## Building Owner & Fire Service

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Portable Fire Extinguishers, contains guidelines for selection, installation and maintenance of these.

Proper portable fire extinguisher selection is critical to how effective it will be in controlling an incipient-stage fire. Classifications are based on the ability of the agent used on particular types of fires.

Five basic classifications are in use today to identify the proper type for a given situation and can range in size from 1 pound in agent lasting only about 10 seconds to those carrying more than 300 lb capable of discharging agent for more than 100 seconds. The size needed will vary based on the fire hazard, type of unit, area to be protected and capabilities of the personnel who will use them.

### PRIMARY HAZARD EXAMPLES

- Class A Ordinary Combustibles:** Natural fibers, paper, wood, cloth, plastics, etc.;
- Class B Flammable & Combustible Liquids:** Oils, grease, alcohols, ethers, gasoline, solvents, etc.;
- Class C Energized Electrical Equipment (including Class A):** Any electrically powered equipment requiring a nonconductive extinguishing agent to reduce shock hazard potential;
- Class D Combustible Metals:** Aluminum, magnesium, sodium, potassium, lithium, etc.;
- Class K Commercial Cooking Exposures:** Commercial kitchen exposures protected by foam agents systems.

In no instance is the maximum travel distance ever greater than 75 ft to the nearest portable fire extinguisher, and in some cases, as little as 30 ft depending on the hazard involved. Ensuring that the maximum square footage per unit and total travel distances are not exceeded when locating these throughout a facility can take some creativity and mapping skills.

In addition to the strategic locations to meet the mini-

mum requirements, many recommend locating them near exits and fire alarm pull stations for convenience during an emergency.

In all cases, proper signage or marking of the locations is necessary to ensure they can be located when needed. Whatever method is chosen to indicate the location, it should be visible from all directions taking into account adequate height to clear any visual obstructions caused by stock, storage or partition walls that may otherwise obstruct signage at the 7 to 8 ft level.

### HOSE STATIONS & STANDPIPES

A hose station is a remote point on an internal water main that either has hose preconnected to it or has fittings for the fire department to connect its hose packs. For occupant use, the hose lines that are attached are only 1.5 in. in diameter, nozzle pressure is restricted to about 50 psi and hose length is limited to 100 ft or less as it is felt that untrained personnel cannot easily handle anything greater (NFPA, 1997).

Standpipes are preplumbed vertical water mains, usually located in a stair tower, but can be located anywhere based on need. They provide a readily accessible location for connecting hose packs carried into the building. A standpipe or hose station significantly cuts the amount of time and effort required to bring supply hose to a remote location. High rises and large buildings can benefit from such systems as they will limit the amount of hose each firefighter must carry into the structure for at least the primary attack line, conserving valuable energy and time.

However, backup hose lines will also be taken into the building from a secondary source, such as the next nearest engine/pumper that is not supplying the building standpipe system. Central control valves for these systems also need to be locked in the open position and remotely supervised to monitor them for tampering. (FEMA, 2004).

The presence of occupant-use hose stations has declined in many occupancies for several reasons: lack of knowledge about the advantages in incipient stage firefighting; inability or lack of funding to properly train occupants in their use; and local authorities permitting or in some cases mandating their removal. Maintenance of these devices can be quite involved because of the need for regular testing and inspection. This includes reracking annually with a different fold pattern and pressure testing of the hose as specified in NFPA 1962, Standard for the Care, Use and Service Testing of Fire Hose every 3 years (after the first testing within 5 years).

### AUTOMATIC FIRE SPRINKLER SYSTEMS

Automatic fire sprinkler systems are designed to be essentially a self-operating fire control method. These systems use a system of piping and automatic operating sprinkler heads to deliver water to the immediate area of a fire. They are designed to control, not necessarily completely extinguish the fire, although this often occurs.

Several different types of systems meet various occupancy needs. The variations to meet these specific needs

*Photo 1: Good arrangement of hydrants and FDCs away from the building provides adequate working clearance and removes firefighters from the potential collapse zone of the exterior walls.*







**Photo 2:** Well marked building makes for easy identification of both the structure and access points for specific occupancies.



**Photo 3:** Wide driveways provide good clearance for FD apparatus, allowing them to move even multiple vehicles outside the potential collapse zone of the exterior walls.

can be accomplished by use of different types of heads, operating controls and layout of the piping systems.

The two most common types of systems are wet and dry pipe variations. Different hazards can be controlled by what sprinkler heads are used, how frequently they occur on the piping system, the size of the piping members and the available water supply. Extremely high-hazard situations can be addressed with combinations of special early suppression fast response (ESFR) heads, piping arrangements and fire pumps to provide the needed pressure and volume of water.

Fire records show that nearly 70% of all fires in sprin-

kler-protected buildings are extinguished with five or fewer heads operating. A common misconception about sprinkler systems is that they operate as seen in motion pictures. Very few systems, known as deluge systems, are designed to function where water will automatically flow from every head in the system when activated (NFPA, 1997).

In systems with conventional sprinkler heads, each head operates on an individual basis as it is exposed to sufficient heat. Most commonly, the heat melts a fusible metal solder holding two parts of a plug together or heats a liquid-filled capsule to the point of bursting. Each design has a predetermined activating temperature, response time and ability to flow water through its discharge opening. Heads have other design characteristics specific to their use, such as the type of deflector to control the water spray and how they must be positioned on the piping or next to adjacent structures.

Matching the sprinkler system design to the hazard classification is critical to proper operation and control of a fire. If the system is not capable of delivering adequate water to the fire, it cannot be expected to control let alone extinguish the fire. Ceiling sprinklers alone may not control hazards in areas with high rack storage. Some common hazard scenarios even exceed the capabilities of the schemes prescribed in the NFPA standards. One example is the high rack storage of combustible foam materials, such as upholstered furniture and bedding as was found in the Charleston Sofa Super Store, which was involved in a fire that resulted in the deaths of nine firefighters.

Maintaining the system is critical to reliable operation. NFPA 25, Standard for Maintenance and Inspection of Sprinkler Systems outlines specifics about testing and maintenance. Years of data indicate that about 96% of all fires are controlled or extinguished by an automatic sprinkler system if the building is properly equipped. The remaining 4% are usually the result of water being shut off before the fire or prematurely during the fire, only partial sprinkler protection, inadequate water supplies, faulty building construction, obstructed piping, disrupted flow from heads, hazards of the occupancy, outdated equipment and/or inadequate maintenance (FEMA, 2004).

All systems with more than 20 sprinkler heads must have at least a local water flow alarm but should be supervised off premises. All control valves should either be supervised through electronic monitoring or be locked in the open position to deter tampering that can disable the system.

Fire department support of the automatic sprinkler system can boost system performance by providing more water through any heads that have already opened, allowing them to work more efficiently at discharging water directly onto the fire. All systems should be fitted with a fire department connection to provide a method for direct connection to the system. It is to be located on



the building exterior or in a freestanding configuration away from the structure. This inlet can either be a 3-in. Siamese or a 5-in. Storz connection depending on what the local authority having jurisdiction or local fire codes mandate. Even if the main control valve is closed preventing water from flowing into the system from the public main, the proper location of this connection should still permit the fire department to supply water to the sprinkler system. Removable covers should be in place to prevent debris from being placed into the piping system that can obstruct the flow of water.

### **PUBLIC PROTECTION** ***The Fire Department***

Municipal fire departments are rated by the Insurance Services Organization (ISO) using a complex matrix

known as the fire suppression rating schedule that is based on three major categories of data: fire alarms, engine companies and water supplies. Within each of these broad categories, many individual criteria are evaluated to arrive at the final rating. Each department is assigned a numerical rating that defines their public protection classification (PPC); one being the best protection to 10 representing no recognized protection or protection that does not

meet minimum ISO standards (ISO, 2005).

As a general rule, the lower the numerical PPC rating number, the better the protection afforded to the community and, consequently, lower fire insurance rates for those property owners. ISO research clearly shows the impact of better public fire protection on both commercial and homeowners insurance fire losses.

A PPC rating of 1 indicates exemplary fire protection. Maximum travel distances and response times cannot be exceeded with penalty on the scoring. Less than 1% of the U.S. fire departments carry a PPC of 1 or 2. ISO data show just under half (21,848) would be Class 6 PPC or better. This indicates respectable protection to address most of the needs for the community, but some split classifications, such as 5/9, are given. For example, the local fire department has a rating of Class 5, but your building carries a Class 9 for fire insurance rating purposes. This would usually be the result of your proximity to the nearest fire station and access to public water. The farther the travel distance and proximity to a public hydrant or reliable water supply, the higher the protection class rating at a given location, regardless of the department rating. Anything more than 5 miles from the nearest fire station and in excess of 1,000 ft to the nearest hydrant will be assigned a Class 10 rating (ISO, 2005).

PPC is merely an indication of the response capabilities for typical fire suppression emergencies. It may not be truly reflective of the fire department's ability to

address your particular hazards during a fire event caused by storage or use of products that are not compatible with water, those requiring high volumes of special firefighting foams or involve hazardous materials for which their protective gear would provide little or no protection.

ISO rating criteria are undergoing a major overhaul to reflect modern occupancy hazards, technology and practices in firefighting. The system was criticized after the 2007 Charleston Sofa Super Store fire in which nine firefighters from a PPC 1 department died in a fire due primarily to the department's ineffectiveness to manage and control the fire. If a facility is located in a jurisdiction with a high PPC rating, it will need to rely more on its own resources to effectively control a fire or to at least supplement the resources of the responding department.

### **WATER SUPPLIES**

Water supply for the fire protection systems is a vital element in protecting property. Water can be available from several sources. These include municipal systems, static sources and portable or mobile sources. In most cases, a fire response within a city or town will involve use of the local municipal water delivery system, whether for the sprinkler system or for firefighting. The prevalence of sprinkler-protected properties in rural areas is small due to the challenges with reliable water supply. If the fire building is located in a rural area with no municipal system, the water available to fight the fire will be limited to what can be delivered from static sources (lakes, ponds, etc.) in the area and on portable delivery systems (tanker/tenders).

A municipal water system is the most desirable but can still have significant limitations in the event of a major fire. Municipalities with large-diameter (12 in. and larger) looped main systems can expect water flows of 1,200 to 1,500 gallons per minute from a single hydrant. In older communities, the water mains may be as small as 4 in. in diameter and arranged in a dead-end layout. If the fire is in a building located at the end of a long dead-end water main of small diameter, the amount of water might well be less than what can be delivered by an effective rural fire department adept at tanker shuttle operations.

Other municipal water system problems include depleting the reserves in the water storage system or causing unusually low pressure in the city mains. The size and condition of these mains is a significant factor in the sustainable water flow. If a main is ruptured due to surges or pressure drops, water supply may be completely cut off, causing the fire building to become a total loss and endangering nearby exposures (FEMA, 2004).

One main challenge to firefighting in the rural setting is how to deliver the necessary volumes of water on a sustainable basis. Static sources, such as lakes and ponds, can be suitable water sources, provided they are easily accessible at all times during the year. Fire apparatus is not designed for off-road use due to its weight and

***ISO rating criteria are undergoing a major overhaul to reflect modern occupancy hazards, technology and practices in firefighting.***



**Photo 4: Poor placement of irrigation equipment restricts access to FDC and fire pump test header.**

will quickly sink in soft soil or may roll over if parked on too steep an incline. Therefore, it has become popular to install dry hydrants so drafting of water from these naturally occurring supplies can be performed without placing the fire apparatus at risk.

The dry hydrant is a large-diameter piping system leading into the lake or pond with a compatible fire apparatus connection at the roadside, driveway or parking lot. This enables them to draft water out of the source regardless of the weather conditions. If a dry hydrant connected to a natural water reservoir or a municipal hydrant is not located in close proximity to the fire building, tanker/tender operations may be needed to shuttle water to the fire scene.

### STAFFING/MANPOWER

On average, the number of personnel needed to carry out fire ground operations is one firefighter for each 25 to 50 gpm of required fire flow. This takes into account the other operations, such as search and rescue, ventilation, RIT, relief crews, etc. Average responses will require a minimum of 20 to as many as 40 firefighters for each 1,000 gallons of required fire flow order to adequately staff all required functions to make a successful attack and extinguish the fire. Extra alarms on fires are often struck or called to bring additional manpower to the scene, not necessarily the equipment they arrive on (MCTO, 1991).

OSHA does not require a specific number of personnel on an individual apparatus (for those states where municipal employees are covered) but requires a minimum number on scene before interior fire attack can be initiated per 29 CFR 1910.134 (g) (4), the OSHA Respiratory Protection Program Standard (Two in/Two out Rule).

However, NFPA 1710 addresses staffing for career fire departments and recommends a minimum of four persons on each apparatus. NFPA 1720, the counterpart

standard to NFPA 1710 for volunteer departments, recommends four persons on the scene before interior fire attack can begin, much like the wording in the OSHA respiratory protection standard.

### EXPOSURES

Although building fire exposures from a protection standpoint can be either internal or external, most arise from outside the structure involved in the fire event. Fire exposures include anything that could either permit fire to communicate to the subject building or that could be endangered by a fire extending from the subject building. Depending on which structure is involved in the fire event, the other is considered its exposure. Examples of exposures include adjacent buildings, chemical and fuel tanks that normally accompany manufacturing operations, material yards containing combustible goods and even open fields subject to wildfire if not maintained.

The fire department, as part of its strategic plan to stabilize the incident, is responsible for protecting exposures that may be damaged by the fire as well as extinguishing the fire itself. Protecting exposures can demand valuable resources be diverted from normal fire suppression activities. This can result in situations where insufficient manpower or water remains to effectively control the situation at hand.

Radiant heat and flying brands are the two most common methods of fire communicating from one structure to another. Generally, a building less than 40 ft from the fire building is most likely an exposure. If it is located 40 to 100 ft away, it will probably be an exposure depending on the radiant heat produced by the initial fire. A building more than 100 ft would not generally be considered an exposure, unless severe environmental conditions exist that can spread the fire.

To combat radiant heat exposure, water must be applied to the surface of an adjacent structure to absorb the radiant heat energy that was transmitted through the air from the fire. Water curtains are ineffective at preventing transmission of radiant heat. Flying brands can create significant problems when high winds are present causing them to travel great distances, setting fire to building hundreds of feet away (FEMA, 2005).

Exposures that must be protected affect the required fire flow needed by the fire department and never in a positive way. Each side of the structure with an adjacent exposure, regardless of size, requires a surcharge to the required fire flow of at least 25%, before any reductions for percentage of fire involvement are made. Therefore, the more potential exposures there are to a fire building, the greater the anticipated water demand will be to protect them as well as the additional fire crews to man those hose lines.

### ACCESS LIMITATIONS

For the fire department to operate effectively and safely at a fire, a structure needs to have paved access around all





**Photo 5: Remains of a dumpster after the contents exploded when water was applied to extinguish the fire, resulting in a firefighter fatality, Dec. 2009. (Photo courtesy of FirefighterCloseCalls.com).**

**Any type of construction introduces its own set of issues when it comes to how well it can withstand the damaging effects of fire. Regardless of the specific type of construction, protective measures can improve the survival of the structure and reduce the overall loss.**

sides. This is to permit positioning fire apparatus as needed to reduce the distance of hose stretches to the building for interior fire attack and for placement of aerial ladders for roof or upper-floor access. Since fire apparatus cannot be

taken off a hard surface, this access must be paved or at least compacted gravel that is not subject to seasonal softening due to subsurface frost.

Fire apparatus or personnel should not be positioned closer than 1.5 times the height of the building as there is always the risk of collapse as fire continues to weaken the structure. Also, there is the potential for exposure to radiant heat on the fire apparatus just as with adjacent buildings. Once fire apparatus are placed, pumps are engaged and hose is on the ground, it is difficult to move them without great effort and time.

Accessibility for fire apparatus to all sides of the building from a level paved surface extending at least three to four times the height of the structure would be recommended. This would provide enough space to position multiple pieces of apparatus in close proximity to each other if needed, but far enough away to be outside the potential collapse zone. If the paved surface and the building are separated by too much grass area or due to physical barriers, it can limit the reach of aerial ladders to upper floors or the rooftop. This might result in a 100-ft aerial only being able to reach the second or third floor instead of the eighth floor.

#### **IMPROVING THE OUTCOME OF THE FIRE EMERGENCY**

The issues of how building construction, occupancy,

protection and exposures impact the firefighting rules of engagement as related to how any fire emergency is handled are not absolute but can greatly affect the situation. Remember to seek the advice of your insurance loss prevention/control experts and the local fire service to determine exactly what a facility's risk factors are and how they can best be controlled in your particular situation. Also, implementation of a program compliant with NFPA 1600, Standard on Disaster/Emergency Management Business Continuity Programs or similar business recovery plan can be beneficial for managing those issues outside the scope of this article. While there are many different business continuity and recovery models, the most recent 2007 edition is available free from [NFPA](http://NFPA).

#### **CONSTRUCTION**

Any type of construction introduces its own set of issues when it comes to how well it can withstand the damaging effects of fire. Regardless of the specific type of construction, protective measures can improve the survival of the structure and reduce the overall loss.

- Design for fire safety when considering new construction or renovations.

- Fire walls & partitions. Where possible use these to separate high-hazard areas from lower-hazard areas or to separate large areas into smaller exposure units when constructing new buildings.

- Fire stopping. Inspect fire walls and partitions for penetrations that may allow fire to communicate from one side to another. This includes draft-stopping in large concealed spaces to slow fire spread.

- Opening protection. Properly rated opening protection in place in fire walls and partitions to limit the spread of fire through the wall.

- Protective coverings. Ensure that any missing or damaged protective materials are repaired, such as spray-on coatings over exposed steel or plaster, drywall or concrete coatings over structural columns and beams.

- Provide additional exterior doors that can not serve only as emergency exits, but also can provide improved access by the fire department to locate the seat of the fire and conduct extinguishing operations or manage utility services due to the limited interior travel distances for firefighters caused by air management policies and limited hose lengths.

- Avoid multiple roof scenarios that create concealed spaces that if not properly draft-stopped, can permit fire to spread the facility's entire length as well as make vertical ventilation of the fire area nearly impossible.

#### **OCCUPANCY**

The primary factors related to occupancy involve the materials and processes that are part of the normal day-to-day operations:

- Reduce operational hazards by complying with local and state safety codes as well as with OSHA and NFPA standards.



- Replace highly hazardous operations with less hazardous alternatives.

- Occupancy hazards should not exceed the protection capabilities of either the private or public fire protection.

- Ensure that all personnel can evacuate safely and be accounted for quickly

- Provide wide, clear aisles through the facility that will not be compromised by storage collapse.

- Prequalify contractors who will perform work in your facility to ensure that they follow proper safety guidelines and pose a manageable risk.

### PROTECTION

Since the protection component consists of both private and public elements, some are within the control of the building owner and others are not. However, for those situations where circumstances are out of the owner's control, knowledge is power for advance planning.

#### Private Protection

- Install automatic fire sprinklers (new construction or retrofit) as a first line of defense to prevent small fires from becoming large fires.

- Fire detection systems should be installed to provide early warning for employees and response by the fire department.

- Ensure 24/7 supervision of all fire detection and control systems.

- Maintain all fire protection equipment and systems according to NFPA standards to ensure reliability. This includes not only the fire extinguishers and sprinkler systems, but also fire doors, smoke and heat venting and early detection capabilities.

- Employees should be trained in handling incipient-stage fire control, even if response is optional for most.

- If the local fire department(s) will not be able to handle your anticipated fire emergency, serious consideration should be given to establishing an industrial fire brigade.

- If municipal water supplies will be inadequate, serious consideration should be given to alternative water sources, such as elevated tanks, ponds or underground cisterns, that will be accessible during a fire emergency.

#### Public Protection

- Work with the local responding fire department(s) in establishing a quick access prefire plan. Understand their capabilities and limitations, such as equipment available, staffing and the ISO public protection classification.

- Evaluate public and private water supplies for adequacy.

#### Exposures

- Use sound principles of layout for buildings on your property to limit how they expose one another.

- Control outdoor storage of fuels, combustible materials and natural exposures that can cause fire to be communicated to the buildings.

- Provide large paved driveways that can support fire apparatus weights as far around the structure as possible,

taking into account the potential collapse zone and additional traffic for extended fire operations. ☺

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# HealthBeat

VOLUME 9 • NUMBER 3



## Safe Patient Mobilization & Six Sigma

If looking for a solution to the challenges of safe patient handling that will address employee injuries, patient safety and engage patient care staff in an objective blame-free process, the six sigma process may be an answer.

BY PATTY KELLY, HEM, CPDM, CEAS

**S**H&E professionals working in the healthcare field know the challenges of trying to reduce employee injuries from patient mobilization tasks. Many have learned that a one-size-fits-all approach will not produce lasting results and if done in a method that does not include staff input will sooner or later fail. An additional lesson learned is that throwing equipment and training on the problem does not

*Hospitals not only have the challenges of nursing safety, they also have the increasing requirements to address patient safety initiatives, all while struggling to remain in the black amid ever-changing reimbursement rules and regulations.*

address the underlying issues and only adds to nursing staff's perception that safety does not understand the complexities of providing patient care in the age of electronic medical records, shorter stays and a patient population that is physically larger and presents multiple health issues.

Hospitals not only have the challenges of nursing safety, they also have the increasing requirements to address patient safety initiatives,

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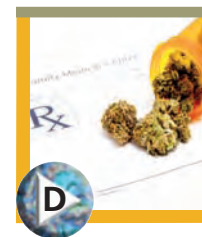
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such as reduced patient falls and hospital-acquired pressure ulcers, all while struggling to remain in the black amid ever-changing reimbursement rules and regulations. A successful six sigma project outcome will help improve a hospital's bottom line by decreasing waste and inefficiencies. In addition, proposed solutions from a project are more likely to be implemented by staff as they have been validated by data gathering and analysis.

If looking for a solution to the challenges of safe patient handling that will address employee injuries, patient safety and engage patient care staff in an objective blame-free process, the six sigma process may be an answer.

**Six Sigma**

Features of six sigma improvement initiatives include:

- a clear focus on achieving measurable and quantifiable financial returns;
- an increased emphasis on strong and passionate management leadership and support;
- a clear commitment to making decisions on the basis of verifiable data, rather than assumptions and guesswork.

Six sigma project methodology has five phases (DMAIC):

- 1) Define the project/problem, the customers, the voice of the customer and the project goals, specifically.
- 2) Measure key aspects of the current process and collect all relevant data.

3) Analyze data to investigate and verify cause-and-effect relationships. Determine what the relationships are and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.

4) Improve or optimize the current process based on data analysis

using various techniques, such as setting up pilot runs to establish process capability.

5) Control the future state process to ensure that any deviations from target are corrected before they result in defects. This includes the use of measures and strategies that support holding gains in improved performance

Based on the nursing process outlined in the Lippincott Manual of Nursing Practice, nursing staff follows general six sigma principles when providing patient care (Nettina, 2005). For example, consider the process outlined below for obtaining patient history.

1) "The first step in caring for a patient and in soliciting active cooperation is to gather a careful and complete history.

a) "In all patient concerns and problems, an accurate history is the foundation on which data collection and the process of assessment are based.

b) "The comprehensiveness of the history elicited will depend on the information available in the patient's record and the reliability of the patient.

2) "Time spent early in the nurse-patient relationship gathering detailed information about what the patient knows, thinks and feels about the problems will prevent time-consuming errors and misunderstandings later (Nettina, 2005)."

By comparing the six sigma process with the nursing process example, one could conclude that the basics of nursing practice as outlined for something as simple as obtaining patient history are similar to six sigma processes.

•Define: Develop the patient's history and learn why s/he is in the hospital, thus defining the project of making the patient well.

•Measure: Nursing gathers data, such as input/output, test results, etc., to obtain a baseline of the patient's health status or condition.

•Analyze: Nursing and the physician analyze the patient's data to determine next steps toward making the patient well.

•Improvement: Accomplished by administering medication to the patient to make the patient well.

•Control: Control measures for a successful patient outcome are implemented by nursing staff throughout the patient's stay. These control measures follow standard practices of care recommended by nursing protocols to ensure that the hoped-for standard results in the patient being successfully treated and discharged.

**SIX SIGMA STEP BY STEP**

Two hospitals significantly improved their employee injury rates from patient mobilization tasks by using the six sigma process.

**Define**

This first step in the six sigma process assists in laying the foundation for anticipated successful outcomes of the project. Within six sigma, the project charter is developed, the project scope is identified, team members are recruited, high-level work-level processes are mapped, customers are defined and what is critical to satisfying them is outlined. This six sigma process is an early step toward gaining the buy-in of staff toward developing a workable solution they are willing to own and implement.

In one project, team members were identified and asked to join based on their roles within the patient care model and anticipated project goals. Among those identified to be on our team were nurse managers, staff nurses, rehab services, transport, environmental services (laundry), nursing leadership (usually the nursing executive for the hospital), employee safety and nursing employees who reported a work-related injury from performing a patient mobilization task.

The team first completed a supplier, input, process, out-

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put and customer (SIPOC), which identifies all relevant elements of the process improvement project before work begins. Both projects identified the following in SIPOC:

- Supplier: patient, physician, nursing team, transporter, rehab services, etc.;
- Input: diagnosis, care plan, diagnostic testing, nurse observations, turning/repositioning schedule, rehab plan, surgical procedure, etc.;
- Process: turning the patient, patient ambulation, etc.;
- Output: test completed, skin integrity, pain and comfort of patient addressed, nurse/patient care provider not injured, etc.;
- Customer: patient, patient's family, physicians, patient care team, administration, etc.

This was an exciting start to the process for the team as everyone became involved and could easily see how important their role was to solving the challenge of keeping both employee and patient safe during patient mobilization tasks. Within these various areas, critical to quality items were identified, which flowed into developing a voice of the customer (VOC) questionnaire.

To gather data that are useful, easy to analyze and objective, keep VOC questions short and easy to answer. With a slight change in wording, the same questions were asked of physicians, patient care staff and patients. Similar answers were received, all from a different perspective. Two important questions asked included if the interviewee had noted and could identify challenges in the patient mobilization process and if s/he had suggestions for improving the process.

As a group, current state workflows were mapped out for the various patient mobilization tasks.

### **Measure**

VOC results were reviewed to determine key issues and to identify items critical to a successful outcome of the patient being discharged healthy and the nursing staff not sustaining an injury in caring for the patient. Within the workers' compensation data, injury frequency for day of the week, employee job class, type of patient mobilization task, body part, years of service, employee age at time of injury, etc. were measured. Additional data points measured included patient falls, hospital-acquired pressure ulcers, transporter logs outlining how many patients were moved throughout the hospital in a day and where they went. The number of times patients are repositioned, transferred, toileted, etc., within a day presents many opportunities for employee injury.

Process variation was throughout the hospital and not concentrated in one area. Key issues for staff safety included resources, communication, training, time and environment. The team completed a Pareto chart or fishbone diagram that identified the challenges within those identified key issues. There was significant variability in how patients were assessed and mobilized from nurse to nurse, within a department, across shifts and across departments.

### **Analyze**

The team analyzed and reviewed safe patient mobilization studies, clinical best practices for reducing patient falls and hospital-acquired pressure ulcers, overhead lift versus floor lift studies and training program studies to determine could be authenticated from external sources. These studies would assist in validating theories/recommendations to reduce employee injuries and to improve patient safety initiatives. They provided the team the opportunity to test various solutions to see if they would address the critical to quality issues previously identified.

For example, could there be one method of assessing a patient to eliminate variability in moving the patient thus reducing employee injuries? Would having patient mobilization equipment that was easy to use and quick to obtain reduce employee injuries and improve patient outcomes?

### **Improve**

In this stage, the team had the opportunity to think out of the box to generate process improvement alternatives to existing processes. Items that both teams identified as improvement to the current processes and critical to the success of injury reduction and patient safety goals included:

- 1) Development of a safe patient mobilization policy to guide implementation and to establish accountability.
- 2) Development of safe patient mobilization algorithms and communication protocols to reduce variability in the mobilization process and to ensure that appropriate processes are consistently followed.
- 3) Providing appropriate equipment to eliminate or reduce physical effort needed to mobilize patients.
- 4) Development of an assessment protocol that ensures patient mobility status is identified so that the appropriate algorithm and equipment is used.
- 5) Mandatory training of all staff involved in the patient mobilization process to ensure effective use of equipment, assessment protocols, communication procedures and algorithms.

Both hospitals have implemented these steps. At one hospital, physical therapy and nursing worked together to develop the safe patient mobilization algorithms using common definitions for the various patient mobility levels based on the reimbursement guidelines. Now documentation is appropriate in the patient plan of care in regards to reimbursement guidelines and patient care staff has one language to describe the patient's mobility level. This in turn led to revising the patient care forms and hand-off documents to encourage staff communication on the mobility levels across all shifts and disciplines.

Each hospital's team recommended the installation of

***Two hospitals significantly improved their employee injury rates from patient mobilization tasks by using the six sigma process.***

**Table 1 Patient Mobilization Rate & Actual Number of Injuries: Facilities A & B**

	<b>YE 2007 Patient Mobilization Rate Actual Number of Injuries</b>	<b>YE 2009 Patient Mobilization Rate Actual Number of Injuries</b>
<b>Facility A</b>	4.2/100 FTEs; 17 injuries	1.1/100 FTEs; 4 injuries*
<b>Facility B</b>	2.2/100 FTEs; 6 injuries	0.7/100 FTEs; 2 injuries

*Note: Year-end 2009 data injury rate includes 3 patient mobilization injuries from transporting patients on gurneys. This loss cause was out of scope of the project. Absent those 3 injuries, the rate would have been 0.3/100 FTEs.*

overhead lifts in all patient care rooms. The teams said the overhead lift would be easy to use, readily available, reduce the amount of staff required to safely mobilize a patient, increase the ability of staff to implement appropriate turning/repositioning schedules for patients identified as at risk of developing pressure ulcers and by using a variety of slings would meet the needs of all patient mobilization tasks, including repositioning, transfers, toileting, skin checks/cleaning and ambulation.

### **Control**

The team developed the control plan for the project based on data that were measured and analyzed and by reviewing successful safe patient program studies completed at other hospitals. Items the team recommended for the control plan included:

- 1) 100% of staff in each unit to be trained at the time of equipment installation and all new hires trained at orientation.
- 2) Unit managers held accountable for staff adherence to policy in their job performance evaluations.
- 3) The nurse executive and/or our staff nurse champion (from the project) to conduct periodic walkthroughs focusing on staff adherence to patient mobilization policy, such as documentation in charts, updating whiteboards and observation of mobilization procedures.
- 4) Chart audits to measure compliance with assessment protocol and whiteboard communication.
- 5) Measure hospital-acquired pressure ulcers and patient falls data for each unit as implemented.
- 6) Measure workers' compensation injuries for each unit as implemented.
  - a) Root-cause analysis for all patient mobilization injuries to focus on identifying root causes and correcting problems.
- 7) Measure patient satisfaction for each unit as implemented.
- 8) Measure employee experience of work satisfaction.

Throughout the project, the also team identified project communication as key to the success of reaching goals. Meeting minutes were published as soon as possible after each meeting and frequent communication to all staff regarding the project, its team members, project

steps and anticipated goals were provided in monthly employee newsletters.

Table 1 shows how the two facilities reduced employee injuries through safe patient mobilization.

Facility A installed a third of their overhead lifts by year-end 2009 with the remainder expected to be installed by year-end 2010. Within the recommended control plan outlined, items 1 through 4 have been implemented. Currently, physical therapy and an RN III who has taken on the safe patient handling project for her certification project are working together with nursing education to develop an ongoing nursing orientation training for all staff performing patient mobilization tasks who want a refresher, are new to the facility, registry or returning from leave. The six sigma task force for this facility now meets on a monthly basis to provide program oversight. A smaller group meets regularly to address all patient mobilization challenges as they arise and revise the training/ orientation program to meet those identified challenges.

Facility B is awaiting funding for overhead lifts but has continued the project in developing the policy, assessment/communication plan and staff training.

Safe patient mobilization and the six sigma process can assist the healthcare organization in achieving a winning solution to reduce staff injuries. ➕

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# Functional Capacity Evaluations & Return to Work

**F**unctional capacity evaluations (FCEs) in their modern form have existed since the 1980s. According to the American Physical Therapy Association (2010), “The purpose of an FCE is to provide an objective measure of a patient’s/client’s safe functional abilities compared to the physical demands of work.”

*FCE begins with one-on-one discussion. The interview includes discussion of the relevant history of existing physical limitations and residual symptoms, general medical history and perceived activity limitations.*

FCEs have been used as the standard tool in determining work readiness in workers’ compensation cases for the last 30 years. They have been adapted for other uses, such as in selecting new hires for strenuous jobs or to test an existing employee’s ability to remain fit for duty after an illness or injury. However, federal guidelines and case law have narrowed the scope by which these evaluations may be administered. A recent notable example of a court decision on this issue is *Indergard v. Georgia Pacific*, 582 F.3d 1049 (9th Cir. 2009). This article attempts to clarify the role that FCE and variants of FCE can play in work evaluation.

## FCE BACKGROUND

FCEs have many names depending on the provider or a protocol’s copyright. They can also be known as functional capacity assessments (FCAs), physical capacity assessments or evaluations (PCAs or PCEs) or work capacity assessments or evaluations (WCAs or WCEs). In peer-reviewed medical literature, accepted standards of practice (Matheson, 2003), professional performance guidelines and validity/reliability studies exist (Gross, 2002; 2003; 2004; 2006; Lechner, 2008). These items are beyond the scope of this article.

In general, certain generally accepted practices are related to FCEs regarding the manner in which they are provided. FCEs are typically performed by occupational or physical therapists in outpatient clinics and use standard clinical evaluation instruments as well as a variety of simple to computerized assessment tools. FCE is either a job-specific test (established job target) or a generic test (no job target) depending on the reason for which the subject was referred.

Ideally, in the case of a job-specific FCE, the provider

has at its disposal an established set of job requirements obtained from the employer and/or FCE subject, and these are used as requirements to be met during FCE. But in the case of a generic FCE, the subject is tested against general guidelines to identify the type of work s/he can safely perform relative to any existing physical limitations s/he may possess. All FCE protocols contain the same general components, including an interview, vital sign screening, musculoskeletal screen, cardiovascular assessment, material handling tests and nonmaterial handling tests.

FCE begins with one-on-one discussion. The interview includes discussion of the relevant history of existing physical limitations and residual symptoms, general medical history and perceived activity limitations. Vital signs are taken to establish a baseline and to assess whether the subject is safe to proceed with testing. The evaluation subject is screened for musculoskeletal status generically or for an area that has been treated for injury or illness. Some examples of tests in this screen include range of motion, strength, joint integrity, sensation or postural alignment. The physical tests most often performed are material handling tasks (lifting, carrying, pushing, pulling) and nonmaterial handling tasks (sitting, standing, walking, reaching, gripping, fine motor function, bending, squatting, kneeling, crawling, and climbing). During assessment of these tasks, the subject is monitored for kinesio-physical signs or substitution, quality of effort via heart rate, perceived exertion, symptomatic response and consistency of performance. These data points are collected to assess the subject’s safety, effort and perception of pain/disability.

## EMPLOYMENT TESTS

With the passage of the Americans with Disabilities Act (ADA) of 1990, employers began to see the value in using FCEs as employment tests for employee selection and retention. Approximately 130 million people are employed in the U.S. (Green-McKenzie, 2004). The estimated cost of employee health and productivity loss as a result of work-related injury is \$1.2 trillion annually. This is equivalent to approximately 14% of the gross domestic product (Fisher, 2003). Because of rising costs associated with occupational injuries, employers became increasingly concerned with worker safety and injury prevention (Leigh, 2004). Employers found that modified FCEs referred to as functional employment tests are among several effective ways to prevent work-related



*The provider should have a basic knowledge of federal and state law and where it fits as a helping agent in the hiring and return-to-work process.*

injuries (Littleton, 2003; Scott, 2002; Harbin, 2005). Accordingly, providers began developing assessment protocols and marketed these products aggressively to occupational and physical therapists eager to generate direct revenue independent of insurance companies and their repricing networks.

Employment tests are paid for directly by the employer on a fee-for-service basis, and an employer should have specific guidelines in their policies and procedures to ensure that their hiring and retention practices are consistent and fair and are in line with state and federal law. The employer's policies should be developed by legal counsel. Healthcare providers should not develop hiring and retention policies for employers.

FCEs in their original form should not be used as employment tests, and the FCE provider should not assume that just because it is a service provider it is immune to legal repercussions in the event that its evaluation results in a denial of employment to a new hire or in a termination of an existing employee's employment. The provider should have a basic knowledge of federal and state law and where it fits as a helping agent in the hiring and return-to-work process. Specifically, these laws are ADA, the Family Medical Leave Act (FMLA) and state workers' compensation laws.

## ADA

In general, ADA prohibits discrimination against an applicant or employee based on a "disability," which is a physical or mental impairment that substantially limits one or more major life activities [42 U.S.C. § 12102(1)]. Someone who has a record of a disability or is perceived to have a disability is also protected by ADA. ADA also requires employers to provide reasonable accommodations to applicants and employees in certain circumstances [42 U.S.C. § 12112(b)(5)].

While ADA does not prohibit employers from subjecting applicants and employees to physical agility and physical fitness tests (or place restrictions on those tools), employers cannot require employees to submit to a medical examination unless such examination or inquiry is shown to be job-related and consistent with business necessity [42 U.S.C. § 12112(d)]. Applicants can be subjected to medical examinations only after they are first given a conditional offer of employment, which cannot be revoked unless the examination demonstrates the applicant currently cannot safely perform all of the essential job functions for the position.

## MEDICAL EXAMS VS. PHYSICAL AGILITY TESTS

The difference between medical examinations and physical agility tests was recently discussed by the court in *Indergard* (and the *Indergard* case). A physical agility test determines an individual's ability to perform physical job tasks or functions, and a physical fitness test requires the performance of physical tasks, such as running or lifting. However, medical examinations go one step further and actually measure, monitor or test bodily functions and biological reactions.

The court in *Indergard* applied the Equal Employment Opportunity Commission's enforcement guidance factors for determining whether a medical examination existed. One or more of the following characteristics could indicate a test is a medical examination for purposes of ADA:

- 1) whether the test is administered by a healthcare professional;
- 2) whether the test is interpreted by a healthcare professional;
- 3) whether the test is designed to reveal an impairment of physical or mental health;
- 4) whether the test is invasive;
- 5) whether the test measures an employee's performance of a task or measures his/her physiological responses to performing the task;
- 6) whether the test normally is given in a medical setting;
- 7) whether medical equipment is used.

When balancing all of these factors (no one factor is dispositive), the test to which Georgia-Pacific subjected *Indergard* was deemed to be a medical examination because it included range of motion and muscle strength tests; it measured *Indergard*'s heart rate and breathing both before and after a treadmill test; and it involved observations and documentation by the physical therapist regarding *Indergard*'s heart rate, aerobic fitness, current pain level, use of medication and assistive devices, communication, cognitive ability, attitude and behavior. The court noted that there was no reason to limit the term "healthcare professional" to only doctors—physical therapists and nurses should fall into that category when conducting these types of tests and exams.

Therefore, the appeals court sent the case back to the trial court for a determination whether the examination

was “job-related and consistent with business necessity.” If the examination had merely been a physical agility or physical fitness test, then Georgia-Pacific would not have been so restricted by ADA, and the “job-related and consistent with business necessity” requirement would not have been imposed.

It is not yet known whether Georgia-Pacific violated ADA by requiring Indergard to submit to the medical examination in question. Perhaps the trial court will find that Georgia-Pacific correctly required the medical examination before allowing Indergard to return to work and that it was “job-related and consistent with business necessity.” However, it seems that a physical agility and/or physical fitness test may have sufficed in Indergard’s situation. Georgia-Pacific may not have intended to subject her to a “medical examination” as defined by ADA. In the future, Georgia-Pacific and other employers will surely be more careful when determining what type of test or exam they want or need with regard to a particular employee or situation.

ADA imposes these restrictions no matter whether the employee is returning to work from a leave of absence or injury or whether the employee is currently working but with apparent difficulty or pain. When an employee is returning from a leave of absence that is protected by FMLA (an employee must both be eligible for FMLA protected leave and have a qualifying “serious health condition”), s/he can be required to provide a fitness-for-duty certification prior to returning to work (29 CFR § 825.312). FMLA regulations were revised in January 2009 to allow this. Prior to 2009, FMLA prohibited any type of examination or certification beyond a simple statement by the employee’s healthcare provider that s/he could return to work. To take advantage of this new FMLA return-to-work tool, an employer must provide the employee with a list of those essential job functions at the beginning of the leave and must specify that the fitness-for-duty certification is required to address the employee’s ability to perform those essential functions. That list of essential job functions should be used by the provider or therapist to certify that the employee can safely perform each and every essential job function.

### RECOMMENDATIONS

The good news for providers and therapists is that these employment laws primarily govern and impose liability on employers. However, it is theoretically possible for providers and therapists to be liable for violation of these laws. Especially when addressing parallel state laws, an employee can claim that the provider or therapist “aided and abetted” a violation by an employer and, thereby, violated the discrimination laws, too. Providers and therapists would be best served to protect themselves by asking important questions of the employers ordering the test or examination. A little bit of knowledge regarding these employment laws will help providers and therapists spot red flags and avoid obvious misuse/abuse of tests and

exams by employers. This article is not intended to serve as legal advice, but the FCE provider and employer can take basic steps to protect themselves from potential liability. These steps do not constitute an all-inclusive list, and these suggestions will evolve with new case law.

The first general recommendation is for the provider to use a protocol that adheres to the generally accepted “standards of practice” for FCEs (Matheson, 2003):

- Safety.** Given the known characteristics of the subject, proper administration of the FCE measure should not be expected to lead to injury.

- Reliability.** The score derived from the FCE measure should be dependable within the test trial and across evaluators, patients and the date or time of test administration.

- Validity.** The decision based on interpretation of the score derived from the FCE measure should reflect the subject’s true ability.

- Practicality.** The cost of administration, interpretation and reporting of FCE should be reasonable.

- Utility.** The overall value of FCE to its users.

The second general recommendation is for the provider to acquire a job description that outlines not only the essential job functions, but also the physical tasks making up those functions if there is an established job target. If the document contains insufficient information, contact the employer for clarification or preferably go on site to conduct an analysis.

The third general recommendation is for the provider to ensure that its informed consent policies include a section which states that certain musculoskeletal and physiological measurements shall be screened and monitored to ensure that the test subject is safe to test and continues to be safe throughout the testing process. This informed consent should also include consent for release of information to the employer and other relevant parties. A recent webinar held by Roy Matheson recommends this policy to be written as an “authorization to evaluate, collect, and disseminate medical information.” In effect, this terminology would provide some protection when testing existing employees.

The fourth general recommendation is for the provider to understand the situation in which it will be evaluating a subject and adjust the FCE content accordingly. Again, the following are general recommendations for the therapist/provider and employer and in no way constitute legal advice.

Return to work in a workers’ compensation case:

- Focus the musculoskeletal examination on the area of injury only.

- Physiological measurements, such as heart rate and blood pressure, can be taken and monitored to assess safety and effort.

*The good news for providers and therapists is that these employment laws primarily govern and impose liability on employers.*



***Whenever testing an existing employee, standard medical/physiological measures should be taken to ensure test safety and not as a criterion to determine the employee's ability to return to work.***

- Restrict the tasks tested to the physical demands outlined in the essential functions.

- Unlike the therapist in the Indergard case, refrain from recommending the employee “stay off work.” Rather, craft recommendations as a statement of what the employee can do. It is the employer’s responsibility to engage in dialogue with the employee regarding his/her specific return-to-work disposition relative to the physical and functional limitations identified by the therapist/provider.

- Offer specific opinions related to the area of injury and its effect on those job-specific functions.

- Minimize the risk of unlawful retaliation against an employee by returning him/her to work if able to safely do so given physical restrictions.

- Most FCE providers’ standard evaluation reports are acceptable to release to relevant parties in these cases, such as the referring physician, the payor for the evaluation and a nurse case manager, if involved.

Return to work after an FMLA leave of absence:

- Require a fitness-for-duty certification only if the employee was advised at the beginning of the leave that the certification would be required.

- Make sure the provider/therapist is using a valid list of essential job functions provided by the employer.

- Test and certify only with regard to the particular health condition that caused the employee’s need for FMLA leave in the first place (as opposed to other medical conditions or disabilities).

- No other restrictions or requirements may be imposed or required of employees returning from an FMLA leave of absence unless or until an employee exhibits problems with or inability to perform the job after his/her return.

Existing employee demonstrating difficulty performing the job:

- The employer has the right to test an employee who has been working but is complaining of difficulty or demonstrating difficulty performing one or more essential job functions.

- In this case, the evaluation would not be FCE but would be a fit-for-duty evaluation.

- It is recommended that the test simulate the job as closely as possible with respect to the loads lifted, carried, pushed, and pulled, and with respect to the positions and movements required to perform the essential functions of the job.

- The therapist/provider may take and monitor vital signs for safety only. These measures should not be used as pass or fail criteria.

- The provider should only disseminate information

to the employer that addresses only the employee’s ability to safely meet or not meet the physical tasks associated with the job’s essential functions. Do not release any information specific to the employee’s medical condition.

Existing employee being tested for transfer to a different job with the same employer:

- The test should not include any medical components; rather it should be restricted to the essential functions of the job. In this case, the evaluation would not be FCE but would be a fit-for-duty evaluation and include only physical agility or physical fitness testing.

- The therapist/provider may take and monitor vital signs for safety only. These measures should not be used as pass or fail criteria.

- The provider should only disseminate information to the employer that addresses only the employee’s ability to safely meet or not meet the physical tasks associated with the job’s essential functions. Do not release any information specific to the employee’s medical condition.

New-hire candidate being tested for a job with a new employer:

- This is done when a contingent offer of hire has already been proffered to the employee candidate, otherwise known as a post-offer evaluation.

- In this case, a general medical history and examination are appropriate, as well as an evaluation of the candidate’s ability to safely perform the essential functions of the job.

- The therapist/provider may take and monitor vital signs for safety only. These measures should not be used as pass or fail criteria.

- As stated, help protect the employer by providing only the result, (i.e., pass, fail or need more information), rather than divulging medical and disability information to the employer.

- The candidate’s offer can only be lawfully revoked if s/he is physically disqualified from the job due to an inability to safely perform all of the essential job functions.

## **CONCLUSION**

FCEs can be useful, valid and reliable tools to determine readiness for work. However, they must be adapted to the specific situation in which the subject is testing for a job. If the reason for the test is to evaluate the ability of an employee to perform a specific job, the test should replicate the job’s essential functions as closely as possible. Whenever testing an existing employee, standard medical/physiological measures should be taken to ensure test safety and not as a criterion to determine the employee’s ability to return to work. It is advisable that the FCE provider have a relationship with the employer allowing familiarity with the jobs tested. Finally, it is recommended that the employer have an established policy for new hires and for employees returning to work that has been developed with the assistance of legal counsel. ☉

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## Safety: Then & Now

As ASSE's 100th anniversary rapidly approaches, we would like to highlight our practice specialties, branches and common interest groups by providing members with a "Then and Now" view of professions in a variety of fields.

If you would like to partici-

pate, please choose an area within industrial hygiene and provide a view of what that job was like in 1911 (or for newer fields, what that was like when it first emerged) and how that job has changed/what it is like today. For example, one could

describe what industrial hygiene was like in 1911 and compare it to present-day, including advances in technology and the differences in rules and regulations.

Send all materials to Krista Sonneson, ASSE practice specialties manager. ☺

# WORLD FOCUS

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## Corporate Social Responsibility

An International Perspective

BY NORM KEITH, B.A., LLB., CRSP

Over the past decade, interest has increased in the concept of corporate social responsibility (CSR) and the proposition that corporations should take into account the interests of stakeholders other than their shareholders (Crook, 2005). Support for this idea has come not only from corporations themselves, but from national governments, extranational organizations, such as the United Nations, and nongovernmental organizations.

*Private citizens have increasingly come to question the role of corporations in society and the manner in which they operate*

As a result, recent years have seen legislative efforts to encourage or even mandate some form of CSR, with the reporting of CSR activities recently enshrined in Danish law, and proposed legislation in Canada, which seeks to regulate the activities of Canadian mining companies in developing nations. However, questions have arisen as to whether CSR advances a consistent set of interests

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**CSR: An International Perspective***continued from page 1*

and principles and whether it effectively serves the societal interests it purports to advance (The Economist, 2005).

This article considers the varying definitions, that have been advanced for CSR, and canvasses the varying interests that it has been used to promote. It identifies the organizations and forces that have been termed the drivers of the CSR movement and considers some criticisms leveled against it.

**The commission argues that corporations should adopt CSR, as it offers a direct benefit to productivity by encouraging the well being of employees and stimulating the development of new skills and technologies.**

Finally, it considers the efforts that varying governments and international actors have taken to encourage CSR and identifies trends, which may be expected to play an increasing role in the CSR movement internationally.

**CSR DEFINED**

At some level, it might be suggested that the idea of CSR is self-defining; corporations are encouraged to behave in a manner that is socially responsible. However, any such simplistic clarity is illusory. While various definitions for CSR have been advanced by different governments and organizations, common themes may be seen in their overarching concern for human rights, labor rights, safety standards and occupational

health and safety and issues relating to environmental responsibility.

**DEFINITIONS OF CSR ADOPTED BY GOVERNMENTS, COMMISSIONS & NGOS**

CSR may be viewed as the principle that corporations should respond to interests apart from and in addition to those of their shareholders (Canadian Democracy and Corporate Accountability Commission, 2002). However, the definitions of CSR advanced by governments and international organizations have tended to focus on corporate efforts to balance their economic activities with broader stakeholder interests.

For example, the Government of Canada takes the position that “CSR is generally understood to be the way a company achieves a balance or integration of economic, environmental and social imperatives while at the same time addressing shareholder and stakeholder expectations.” However, it also suggests that CSR is “an evolving term that does not have a standard definition or a fully recognized set of specific criteria.”

In 2006, the European Commission adopted a similar definition as part of its most recent policy communication on CSR, which defined it as “a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with

their stakeholders on a voluntary basis” (The European Commission, 2006).

The United Kingdom defines CSR as “how business takes account of its economic, social and environmental impacts in the way it operates—maximizing the benefits and minimizing the downsides” (U.K. Department of Trade and Industry, 2004). Finally, what may be the broadest definition is offered by the United Nations (2007): “CSR can be defined as the overall contribution of business to sustainable development.”

The World Business Council for Sustainable Development (WBCSD) provides that “CSR is the commitment of business to contribute to sustainable economic development, working with employees, their families, the local community and society at large to improve their quality of life” (WBCSD, 2002). Amnesty International advocates for mandatory “global standards on business and human rights that will apply across borders to all companies . . . (which) . . . will provide governments with clear, common guidelines on how to address corporate behavior on human rights” (Khan, 2007). A more specific call for action is made by the Corporate Responsibility Coalition (CORE), which argues that voluntary CSR efforts are insufficient and calls for “mandatory social and environmental reporting, enhanced directors’ duties and access to justice for affected communities” (Doane & Holder, 2007).

Despite this apparent diversity of definitions, some authors have identified underlying themes, which they suggest may define the concept (Kerr, Janda & Pitts, 2009). They suggest that CSR may be viewed as an effort to integrate economic considerations with environmental and social needs, as well as corporate efforts to balance the interests of diverse stakeholders. As such, it may be viewed as a diverse set of practices, which include “stakeholder engagement, company-wide commitments and strategies, measurable targets for improvement, training, CSR management practices and public reporting.”

It might be noted that each definition is wide-ranging and provides little information regarding the policies and practices that CSR advocates may be expected to advance. However, it has been suggested that this need not be seen as problematic, as what is socially responsible must be evaluated in the context of current issues and needs. Thus, the broad scope of most conceptions and definitions of CSR may permit it to adapt to novel or evolving social needs. As such, CSR may emerge as a constantly evolving concept, rather than as a fixed set of goals or practices.

**COMMON OBJECTIVES FOR CSR**

A single definition for CSR may be elusive or even undesirable. Clear themes emerge when one considers corporate efforts to behave in a socially responsible manner. In particular, CSR activities appear to focus on four common ends: human rights, labor standards, safety

standards and occupational health and safety, and issues relating to environmental responsibility.

The concern over human rights expressed by CSR advocates appears to have taken two primary forms. First, corporations are encouraged not to engage themselves in human rights abuses in the course of their operations. Additionally, while they may be compelled to comply with the national laws of the countries in which they operate, corporations are encouraged not to be complicit in encouraging or enabling human rights abuses carried out by governmental actors. In cases where compliance with national law would require human rights violations, corporations have been encouraged to withdraw their operations from those nations.

CSR has been used to advocate increased labor standards in the international context. This has included support for the right to representation by trade unions, the abolition of child labor and compulsory labor and the abolition of discrimination based on grounds, such as religion, race and gender. As with the promotion of human rights, these labor standards may require corporations that practice CSR to adhere to a higher standard than that imposed by the prevailing national laws.

This concern for labor standards has also included calls for enhanced safety standards and increased focus on occupational health and safety (OHS). In particular, the exploitation of workers in the developing world has been tied to “devastating consequences on the health and safety of the workers involved.” Some organizations, including WBCSD, have indicated that OHS should form a central part of any corporation’s involvement in CSR initiatives.

WBCSD suggests that like labor standards, OHS forms a core part of a business operation, and as such, they may be expected to exert a high degree of control over them in practicing CSR. In contrast, any one business may have only a very attenuated influence over the legal regime in place at the national level. Recognizing this, support for OHS has been explicitly included in the CSR strategies of several nations, including the U.K., France and Germany (European Commission, 2007).

Finally, CSR has also been used to encourage increased corporate consideration of environmental issues. Many aspects of corporate activity may be identified that have a large impact on the environment, including manufacturing, transport, resource usage and the generation of polluting emissions or byproducts. In attempting to minimize these impacts, the environmental aspects of CSR have been related to the sustainable development movement, in part due to the observation that the environmental issues targeted by that movement are frequently seen as resulting from corporate action. However, it has also been argued that, antagonism aside, this is a relationship of necessity, as the goal of environmental sustainability may be out of reach without the resources and innovation of the international corporate sector (Kerr & Cordonier Segger, 2005).

## **CSR DRIVERS**

It has been reported that most companies currently publicly report their efforts on environmental and social issues, with approximately 90% of European companies and 59% of American companies including such information in their annual reports or separate companion reports. In Canada, such activities appear to have increased dramatically over the past decade, where the reporting rate for companies listed on the Toronto Stock Exchange was 35% in 2001 but had risen to 60% in 2003 and stands at 80% as of 2007. Meanwhile, even critics of CSR note that it has “won the battle of ideas.” The impetus behind this dramatic rise in participation in CSR comes from several sources, including public demand, NGO activities, government encouragement or legislation, as well as voluntary action stemming from a corporation’s own business interests.

## **THE GENERAL COMMUNITY & NGOS**

Private citizens have increasingly come to question the role of corporations in society and the manner in which they operate (Broadbent, 2002). In part, this may be traced to the rise of transnational corporations and the perception that such bodies may be effectively able to evade traditional forms of legal control. This in turn has led to increased public pressure for corporations to behave in a socially responsible manner. Some corporations have responded to this social pressure by adopting CSR practices.

In Canada, growing public concern over the role of corporations led to the establishment of the Canadian Democracy and Corporate Accountability Commission (CDCAC), a privately funded body, which studied how to encourage greater CSR on the part of Canadian corporations. CDCAC conducted public opinion polls and found that “72% believe that corporate executives should take social responsibility concerns (impacts on communities, employees, the environment and charitable activity) into account in pursuing profits.” In contrast, only 20% believed that the only responsibility of a corporation was to enhance its competitiveness and profits.

Concern over corporate activity among the general public is reflected in the establishment of NGOs to advocate particular policy positions. These bodies have grown in number from the 1960s onwards, with some achieving considerable influence, including consultative status at the UN. Many major international NGOs, including Greenpeace, the World Wildlife Federation and Oxfam, have specifically targeted the corporate sector to encourage action in areas as diverse as human rights, the environment, labor and other externalities, areas frequently advanced as a component of CSR.

## **GOVERNMENT**

Governments have responded to the public pressure regarding the effects of corporate conduct on both the environment and the community at large with legislation and support for voluntary CSR initiatives. These efforts

may be illustrated by observing that many countries, including Canada, the United Kingdom (<http://web.archive.nationalarchives.gov.uk> and <http://www.berr.gov.uk/whatwedo/sectors/sustainability/corp-responsibility/page45192.html>), Germany, France and the European Commission, have departments that have specifically undertaken CSR considerations.

### THE BUSINESS CASE FOR CSR

Many studies have supported the argument that corporate involvement in CSR activities may serve to enhance profitability. As early as 2001, the *Financial Times* noted that “even on a sector-by-sector basis, shares of companies with a superior environmental or human rights record appear to outperform. Clean chemical companies will outperform dirty ones, clean oil companies will outperform dirty oil companies” (Heal, 2001).

Similar observations have been made in respect of the mutual funds industry, with socially responsible investing growing at a rate markedly faster than the industry as a whole. Several possible explanations for these results suggest themselves.

First, the support for corporate accountability found among the population at large is also reflected in the ranks of investors. CDCAC studies on attitudes toward corporate responsibility found that 72% of Canadians felt that corporations should have accountability which extends beyond their profit margins. However, an even larger number of shareholders, 74%, accepted the same principle. In contrast, only 20% of the shareholders surveyed felt that the only responsibility of the corporation was to operate competitively and to generate profits.

These beliefs are reflected in the practice of socially responsible investing (SRI), which has taken hold among some investors and encourages the consideration of the “social and environmental consequences of investments.” In the U.S., SRI has been observed to be growing at a faster rate than all other investment assets under professional management, with the total value of SRI assets estimated at \$2.71 trillion in 2007 (Social Investment Forum, 2007). Thus, the adoption of a corporate position on CSR may be seen in part as a response to shareholder demand.

In addition to this, it may be argued that the adoption of a CSR program has the effect of improving a corporation’s image, with potential attendant business upsides. Again referring to CDCAC studies, 75% of Canadians (and a full 78% of Canadian shareholders) thought that the government should not make purchases from companies with a poor history of social responsibility. As the Canadian federal government already ties procurement contracts to the employment-equity performance of bidders for contracts of more than \$200,000, there is no reason in principle why this policy could not be extended to consider other matters falling under the CSR rubric (<http://www.servicecanada.gc.ca/cgi-bin/search/eforms/index.cgi?app=prfl&frm=lab1168&ln=eng>).

Apart from responding to the desires of individual investors, or acting out of concern for their public image and profits, corporations may also be encouraged to adopt CSR by other sources of corporate capitalization, including lending bodies and insurers. To encourage this, the United Nations Environment Program (UNEP) has created the UNEP Statement by Financial Institutions on the Environment and Sustainable Investment (the UNEP Financial Initiative), which requires signatories to “. . . regard compliance with applicable environmental regulations and the use of sound environmental practices as important factors in demonstrating effective corporate management”. As of 2009, more than 180 financial institutions have signed the UNEP Financial Initiative, including some of the largest banks in the U.S., such as Citigroup, JP Morgan Chase and Bank of America. Likewise, both the World Bank and the International Financial Corporation (IFC) make their loans conditional on compliance with environmental and social standards.

UNEP has also issued a statement in respect of the insurance industry, the UNEP Statement of Environmental Commitment by the Insurance Industry (the UNEP Insurance Statement). This statement commits signatories to “reinforce the attention given to environmental risks in our core activities. These activities include risk management, loss prevention, product design, claims handling and asset management.” As such, signatory insurance agencies may be expected to consider a company’s practices in relation to CSR in the provision insurance policies.

### CRITICISMS OF CSR

While CSR has attained both widespread attention and acceptance in recent years, its principles and assumptions have not gone without criticism (The Economist, 2005). These criticisms have tended to fall broadly into three categories, arguments that corporate responsibility directed solely to shareholder is socially beneficial; observations that in certain situations CSR may create new problems apart from addressing existing ones; and, finally, the suggestion that some CSR initiatives may amount to little more than corporate promotion efforts, while distracting public attention from more effective means of addressing social issues.

### CAPITALISM WITHOUT CSR

The suggestion that corporate actors need to engage in activities loosely classed under the practice of CSR to benefit society has been criticized by those who believe that companies run solely to profit their shareholders not only provide a social good but will naturally seek to accommodate their stakeholders. That the pursuit of profit may serve a social purpose has been recognized from the emergence of free market systems in the 18th century. As Smith (1776) says in *The Wealth of Nations*:

It is not from the benevolence of the butcher, the brewer or the baker that we expect our dinner, but



from their regard to their own interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages.

In the modern context, it has been suggested that profit may be viewed as a measure of the value that a corporation creates for society, if the price that people are willing to pay for goods reflects the value that people attach to them, and the costs associated with production reflects the cost incurred by society in their production (*The Economist*, 2005). Such a company run solely for profit would further benefit the public by supplying its employees with wages, its customers with a product they desire and may in turn act as a customer to companies, which supply it with the goods and materials it needs to conduct its own business. Further, if the company is to persist, all of these groups must be satisfied in their transactions with it. Thus, the company's self-interest provides a powerful incentive to benefit groups with a direct interest in the corporation's actions, provided that it is properly situated in a competitive market.

#### **EXAMPLES WHERE CSR MAY CREATE NEW PROBLEMS OR DEFLECT ATTENTION FROM EXISTING ONES**

Some applications of CSR principles have attracted criticism when carried to their logical extreme. For example, while the promotion of Western ideals of human rights and labor standards in developing nations may appear to be laudatory, a refusal to deal with nations that do not meet these high standards may have adverse consequences. Such a refusal may not result in an improvement in the lives of the affected people and may cause harm.

It has been observed even in the absence of Western labor standards, the citizens of such a nation may benefit from continued wages and employment, conditions that may not be otherwise available to them. Further, direct foreign investment may serve to stimulate economic development (*The Economist*, 2005). As such, withdrawal from nations that do not meet international labor standards may result in reduced investment, with a loss of its attendant benefits, in some developing nations.

In some cases, a corporate withdrawal from developing nations may occur in response to public scrutiny of their labor practices and an attendant backlash that harms the corporation's image. In such instances, withdrawal would be motivated by the corporation's financial interests, rather than a consideration of the actual best interests of the developing nation's citizens. Problematically, some voluntary or mandatory codes may encourage such corporate behavior. An example of this may be viewed in the CDCAC Final Report, which suggested that where a corporation's activities in a country may result in violations of human rights standards, and protests to the government regarding this are ineffective, the company should be obliged to withdraw from that jurisdiction.

However, CDCAC continued to explicitly state that it

was not calling for Canadian minimum-wage standards to be applied to corporations acting in the developing world, noting that such calls would "remove a legitimate competitive advantage from an economically less developed part of the world."

In other instances, corporations have trumpeted their withdrawal from nations with poor labor standards. Such actions may not adequately weigh the interests of stakeholders in developing nations, effectively keeping them in poverty, where they might otherwise have made an income well above the standards of their nation.

While it may be difficult to find fault with the donation of funds to what may be admittedly worthy causes, it has been suggested that the equation is less clear when the money you choose to give is not your own. In the case of corporate executives, the donation of corporate funds represents an outlay of money ultimately owned by shareholders, rather than the individual executive. In turn, this may have the effect of simply shifting the source of money given to charity; shareholders, who might have expected to give money to charity on their own behalf, may now find the company in which they invest making these decisions for them.

Questions have also been raised regarding whether executive officers are the persons most suited to deciding which social initiatives are most deserving of funding. While a corporation's profits, or lack thereof, may be easily measured, concepts such as social justice or environmental sustainability may be less susceptible to evaluation (*The Economist*, 2005). Further, questions may arise as to which objectives are most worthy of the finite pool of resources dedicated to CSR and whether a particular proposal may work to those ends more efficiently than another. It is uncertain that corporate executives are better placed to answer these questions than government officials, or indeed, private citizens, and whether numerous corporations, acting separately, can produce an optimal or even effective policy to address global problems.

Concerns such as this may be exacerbated by the observation that almost all attempts to institute CSR would involve some initial costs, namely, the costs the corporation incurs to undertake their chosen initiative. In cases where these initial costs are not outweighed by a net social benefit, or worse, where they create unintended social costs themselves, society would have been better off in the absence of such well meaning but ill-executed CSR endeavors. The accountability of such corporate decision makers in respect to their CSR practices has also been questioned. Unlike politicians who may be expected to face public scrutiny come election time, the mechanisms of accountability for corporate charitable contributions are primarily internal.

Well meaning encouragement of CSR on the part of government or NGOs may also be perverted in instances where they act as a barrier to the entry of new firms into the marketplace. In such cases, established corporations may support even initiatives, which will result in costs to them as they may benefit over time from reduced com-

petition. However, such anticompetitive effects do not act in the public interest.

### **CSR AS AN INEFFECTUAL PR EXERCISE**

Some CSR practices have the potential to benefit both the community, and increase the corporation's profitability, through enhanced public goodwill or access to diversified sources of funding. While this may present opportunities for scenarios in which both corporations and external stakeholders benefit from CSR practices, it may also encourage corporations to engage in token CSR to gain public goodwill without placing too much of a burden on their finances. As a result this token CSR may fail to create the lasting benefits that CSR advocates would hope for and may serve to prevent actions that would effectively regulate corporate behavior.

It has been suggested that CSR undertaken as a public relations exercise may serve to distract attention from issues relating to business ethics or practices while doing little to alleviate the underlying problems. Further, by focusing attention on the corporation's relations with the environment and social stakeholders at large, some CSR may offer little to address problems with corporate management, which focus their harms on corporate shareholders, such as misleading financial disclosure or excessive executive compensation (Kazanjian, 2002).

In some instances, the public impression of action created by CSR initiatives may serve as a substitution for or an argument against legislation or regulatory control, which may have served as a more effective control of corporate behavior. This potential has led some organizations that create voluntary standards, such as UNEP, to caution that "Voluntary initiatives must be seen as part of an integrated policy and regulatory framework" and should not be used as a replacement for substitutions for regulation (UNEP, 2000).

### **VOLUNTARY & MANDATORY CSR CONTRASTED**

Many factors drive CSR, including the corporation's self-interest, public pressure, NGOs, lender and insurer requirements and government regulation or legislation. It may be observed that some of these drivers, such as public pressure or nonbinding covenants, act to constrain corporate behavior only as far as the corporation decides to regulate its own behavior. In this sense, they may be termed voluntary CSR. In contrast, compliance with legislation is typically mandatory and as such may create hard requirements for corporations to engage in specified CSR practices.

Apart from the apparent bright line division between the voluntary nature of some covenants, and the binding nature of legislation, other forces may operate to mandate CSR practices without the requirement for governmental action.

For example, requirements for the adoption of CSR practices may become effectively mandatory when they are adopted by large lending agencies or insurers as a condition of doing business. Likewise, socially responsi-

ble investing may exert strong pressures to engage in CSR where it is adopted by institutional investors or perhaps by stock exchanges as a condition for listing (Social Investment Forum, 2007).

In such cases, there may be an overwhelming business argument for adopting at least some CSR practices. A similar effect may be imagined if CSR requirements were to be implemented by professional regulatory bodies, such as the Ontario College of Pharmacists or the College of Physicians and Surgeons of Ontario. In such a scenario, compliance with the specified practices would become a nonlegislated requirement for practicing in a given profession.

Corporations may also bind themselves to selected CSR practices through the contracts they choose to sign with suppliers, financial institutions or other corporations. Such contractual provisions may find their origin in the internal codes of conduct adopted by one party to the contract.

For example, some corporations, such as Bombardier Inc., have included provisions in their code of ethics, which require their suppliers and partners to also adhere to its standards, which include provisions for OHS as a component of CSR.

While such CSR initiatives may have been agreed to by the corporation as a part of the contract negotiation after the execution of the contract, they would be binding in their effect on the parties to the contract. Further, some situations may present a corporation with little choice other than to agree to bind themselves to the CSR initiatives required by a business partner.

For example, small- or medium-sized businesses may have little negotiating power in regards to standard procurement contracts offered by major suppliers.

Finally, corporations may be bound to standards of behavior similar to CSR through court decisions, which find contrary practices to be tortious. For example, in the U.S., the tort of public nuisance may be invoked where a public right is interfered with by the defendant's unreasonable conduct, and the defendant failed to take reasonable precautions to prevent, control or minimize the harm resulting from their conduct.

Such claims have frequently been brought against corporations accused of engaging in environmentally irresponsible practices. While these claims have frequently been rejected on the ground that they raise nonjusticiable political questions, a recent decision of the Second Circuit overturned such a dismissal, allowing a claim from eight state attorney generals to proceed against a collection of American electric power companies on the premise of their greenhouse gas emissions (American Electric Power, 2009). Should this claim, or others based on similar principles, ultimately result in a finding that the corporation was liable and result in an award of damages, the threat of similar litigation may act as a potent, preventative constraint on corporate behavior.

## **BENEFITS & LIMITATIONS OF VOLUNTARY INITIATIVES**

The number of voluntary initiatives promoting compliance with numerous CSR standards has expanded in recent years so that they now number in the thousands. As they are created without the need for a legislative process, such initiatives may be implemented more quickly than a legislative response. As such, they may offer a means to address sudden or rapidly developing issues. Further, as such standards are privately adopted and implemented, they do not require administrative or financial support from the government in order to operate.

The lack of a legislative process also provides a greater ability for voluntary initiatives to be tailored to the needs of the industries they are targeted at. This stems in part from the fact that they may be drafted and implemented by the very corporations or industry groups to which they are ultimately intended to apply. In turn, this adaptability to corporate needs may encourage greater compliance or more rapid adoption. The process of drafting, adopting and implementing voluntary CSR programs may also encourage cultural changes within the corporation, promoting proactive actions by the management responsible for adopting the standard.

However, while voluntary initiatives thus have several advantages, they have been criticized, particularly with regard to their nonbinding nature, which has led to questions regarding their effectiveness in practice. In fact, a 2003 study by the Organization for Economic Cooperation and Development suggested that few voluntary initiatives in respect of the environment resulted in improvements significantly above the outcome, which might have been expected without them.

Several explanations may be offered for this lack of effectiveness. First, due to their voluntary adoption, voluntary CSR initiatives inevitably fail to capture all industry members. This problem may be particularly acute where those corporations that resist the adoption of voluntary standards are also those with the worst records in the field the standards address. Further, in the absence of effective enforcement measures, even those companies that adopt a voluntary code may be able to disregard it where they are motivated to do so by other business interests.

Problems may also arise where voluntary standards are drafted by industry members and fail to adequately address social or environmental concerns. However, such an insufficient standard may still be used to create a show of action to garner public support, possibly all they were intended to do in the first place. A particular damaging instance of this has been termed regulatory capture and occurs where the existence of voluntary standards are used to argue against the adoption of mandatory regulations or legislation. In such cases, meaningful action may be prevented by ineffective voluntary actions.

## **BENEFITS & LIMITATIONS OF MANDATORY INITIATIVES**

While several organizations, such as the European

Commission, have defined CSR to encompass only voluntary initiatives, others, such as the government of Denmark, have passed legislation, which mandates some minimum forms of CSR. Legislative measures are also contemplated in Canada, where the current Bill C-300 would regulate the behavior of Canadian mining companies in developing countries. Such mandatory initiatives, whether they arise from legislation or other sources, have many benefits that are missing in voluntary initiatives.

The clearest difference between mandatory CSR initiatives and voluntary initiatives is the enforceability of the former. Where mandatory CSR requirements emerge from legislation, the specific mode of enforceability may be provided by that legislative document and may include specific penalties, which transgressors will be subject to, often through access to the courts.

The penalization of those who contravene mandatory CSR requirements might be expected to encourage higher levels of compliance with mandatory requirements.

For example, the threat of a sufficiently substantial monetary penalty would be expected to engage the self-interest of the corporation so as to encourage it to proactively comply with the standard. This ability may be particularly important in situations where it is necessary to force corporate compliance with a CSR standard that is unlikely to be adopted voluntarily. Such situations may arise where the CSR initiative will require dramatic corporate outlays to achieve or will require the drastic alteration of normal business practices to achieve a pressing social or environmental need. Further, as this enforceability applies equally to all corporate actors who are subject to the CSR requirement, mandatory requirements avoid to some extent the problem of the refusal of some corporations to sign on to voluntary initiatives.

Several drawbacks are associated with mandatory methods of imposing CSR, particularly when they emerge from legislative efforts. In contrast to the speed of adoption that may be achieved through voluntary measures, the time-consuming nature of legislative undertakings may make regulatory solutions less responsive to quickly evolving situations. Further, it has also been observed that legislation tends to be less tailored to industry needs, an issue that may be important where the regulation will apply to corporations in different sectors and of different sizes.

While the potential for enforcement action and penalties have already been noted as benefits of mandatory CSR, these same attributes also create downsides.

For example, with regard to regulation, the costs of enforcement are placed on the government, and limited enforcement resources may lead to increased evasive activity. Further, some commentators have noted that monetary penalties may be insufficient to encourage compliance in all cases and may come to be seen as merely another cost associated with the business (Bakan, 2004). In such instances, even mandatory regulations may be insufficient to regulate corporate behavior.



While both voluntary and mandatory CSR have advantages and disadvantages, the debate as to whether CSR is best pursued through voluntary or mandatory means has been ongoing for some time. Some governments, such as the European Commission, have defined CSR to include only corporate actions that are made on a “voluntary basis”. Likewise, as early as 1992, the United Nations supported the use of private voluntary initiatives to address both environmental and social issues.

In contrast, some governments, such as that of Denmark, have introduced mandatory CSR reporting requirements, while NGOs have cautioned that “voluntary initiatives should not be proposed and adopted as substitutes for regulation.”

Some commentators have suggested that the debate between voluntary measures and mandatory measures is largely futile, noting that while both approaches have advantages and drawbacks, they are not mutually exclusive, and voluntary initiatives may evolve into legal requirements. Thus, both mandatory and voluntary initiatives may play a “complementary role in promoting CSR.”

This approach of supporting voluntary measures with mandatory requirements has been supported by NGOs, such as CORE and Save the Children, which have stated “specific regulatory actions can, and should, strengthen voluntary CSR commitments.” Further, in some cases, mandatory initiatives have attracted widespread corporate support.

An example of this may be seen in the Bali Communiqué, which was supported by many international businesses prior to the 2007 UN Climate Change Conference. The communiqué called for an “ambitious” and “legally binding” agreement, arguing that it was necessary to promote investment in low-carbon technologies. This observation suggests that the debate between voluntary and mandatory CSR measures need not always be painted as a war between corporate interests and social needs.

#### **INTERNATIONAL PERSPECTIVE ON CSR**

CSR initiatives have developed along different routes in different jurisdictions, varying from the encouragement of voluntary initiatives by the European Commission, to the adoption of mandatory reporting of CSR activities by Denmark. This section considers the status of efforts to implement CSR in the U.S., Canada, Denmark and the European Union.

##### **U.S.**

CSR in the U.S. has primarily been approached through the initiatives of its corporations, rather than through the legal developments or government actions seen in other jurisdictions. Currently, approximately 59% of American companies report information relating to their actions regarding the environment and social policies publicly. Further, major American corporations have actively promoted both voluntary CSR initiatives and have called for the adoption of mandatory standards. An example of this

may be seen in the U.S. Climate Action Partnership, which counts corporations, such as Ford Motor Company, Chrysler, Shell and General Electric, as members and calls for “strong national legislation to require significant reductions of greenhouse gas emissions.”

Apart from the initiatives of individual corporations, and participation in voluntary CSR initiatives, requirements exist for the reporting of corporate activities pertaining to the environment in the U.S. as part of securities regulation. These requirements emerge from Regulation S-K of the U.S. Securities and Exchange Commission (SEC), which specifies that listed companies must report any material effects that environmental laws may have upon their earnings or competitive position (Standard Instructions for Filing Forms Under the Securities Act of 1933, Securities Exchange Act of 1934 and Energy Policy and Conservation Act of 1975, Regulation S-K). Companies are also required to report any legal proceedings they are involved in regarding these laws, where the potential penalty exceeds a certain threshold. These reporting requirements may serve as valuable sources of information regarding a company’s environmental activities for individuals or institutional investors wishing to undertake SRI, as well as third parties, such as lenders or insurance agencies wishing to confirm compliance with contractual CSR obligations.

Additionally, it has been suggested that the SEC requirement to report any “unusual or infrequent events,” which may materially affect reported income, may encompass the reporting of consumer boycotts or campaigns targeting their poor environmental or social performance. Should this interpretation be correct, this reporting requirement could also serve as a source of information regarding the corporation’s compliance with CSR principles.

Recent legal developments in the U.S. also have implications for CSR. These include the Court of Appeal for the Second Circuit’s decision, which permitted a lawsuit to proceed against a collection of energy companies on account of their greenhouse gas emissions. This decision may have implications for companies whose environmental actions might constitute public nuisances.

An earlier decision of the Supreme Court of California also has implications for companies who voluntarily choose to declare their CSR-related activities. In *Kasky v. Nike*, Nike was the subject of a lawsuit over its claim that its products were produced without the use of sweatshop labor (while the court found that Nike’s statements constituted commercial speech, the case settled before a determination was made on the facts). The court found Nike’s statements to constitute commercial speech, as they were made by “a commercial speaker to a commercial audience” and contained representations regarding the speaker’s business conduct. As a result, the company’s representations were subject to California’s unfair competition legislation, which prevents such statements from being false or misleading. As a result, American companies that

make claims in respect of their CSR activities should be cautious that their claims are true.

### **Canada Bill C-300**

As in the U.S., the corporate law of Canada has a tradition of shareholder primacy. However, it also has a greater tendency to recognize stakeholder interests to a greater degree through the regulatory actions of the federal government (Kuras, 2002). Exemplary of this is legislation, which has recently been introduced in the Canadian Parliament, which if passed will specifically regulate the behavior of corporations in the mining and gas industries when they operate in developing countries (Canada Bill C-300, 2009).

Bill C-300 would require the Ministers of Foreign Affairs and International Trade to issue guidelines to corporations involved in these sectors. The ministers would be empowered to investigate complaints that companies in that sector had violated the guidelines and, if a complaint was found to be substantiated, to take action that would prevent that company from gaining access to government support from Export Development Canada for its foreign activities.

While a set of potential guidelines under Bill C-300 has not been released, the bill specifies that they will incorporate the IFC's Policy on Social and Environmental Sustainability, the Performance Standards on Social and Environmental Sustainability and the Environmental, Health and Safety General Guidelines. As such they would include requirements to provide workers with a "safe and healthy work environment" and to mitigate the conversion or degradation of natural habitats (IFC, 2006). By adopting standards initially adopted by another organization, Bill C-300 provides an example of the use of legislation to both expand the application of and provide enforcement means for existing CSR standards.

Bill C-300 has received support from NGOs, such as Amnesty International, which declared that it both supported the Bill and called for the Canadian government to "adopt stronger legal and policy frameworks to hold corporations to account for their abuse of human rights." However, whether this bill will become law remains uncertain.

To date, it has passed both first and second reading in the House of Commons and was referred to the Standing Committee on Foreign Affairs and International Development. While the committee is not currently sitting due to the prorogation of Parliament on Dec. 30, 2009, it appears that it has heard criticism of Bill C-300 from both industry members and Export Development Canada (Kovin, 2009). As such, it is not possible to state whether the bill will pass as currently drafted, will face amendments or will die on the order table.

### **Denmark: The Mandatory Reporting of CSR**

In 2008, the Danish Parliament adopted the act amending the Danish Financial Statements Act (account-

ing for CSR in large businesses). The act defines CSR to include the manner in which "businesses voluntarily include considerations for human rights, societal, environmental and climate conditions as well as combating corruption in their business strategies and corporate activities" (Danish Commerce and Companies Agency, "Reporting on corporate social responsibility—an introduction for supervisory and executive boards," 2009).

However, the act does not mandate that any specific activities must be undertaken by corporations in respect of CSR, instead leaving it "up to the businesses to decide how it makes sense for them to work on corporate social responsibility."

Where a corporation chooses to undertake such activities, there is a mandatory requirement to report them. This requirement applies only to a subset of larger Danish corporations, which have assets of over DKK 143 million (approximately USD 25 million), net revenues of more than DKK 286 million (approximately USD 51 million) or an average of 250 employees. The reporting requirements placed on such companies include the need to report information on their CSR policies, how these policies are translated into action, an evaluation of the results achieved by these actions and their expectations on future work. Businesses that do not have CSR policies are required to state this in their report.

The Danish Government has also adopted an action plan for CSR, of which the legislation of mandatory reporting for CSR formed a part. The action plan identified four key goals for CSR: 1) propagating business-driven CSR, 2) the promotion of CSR through state action, 3) climate responsibility and 4) responsible growth. Currently, the action plan is promoted by the Danish Government Center for CSR, which operates under the Ministry for Economic and Business Affairs.

### **The European Union**

The European Commission, the executive body of the European Union, has stated that the incorporation of social and environmental concerns into a corporation's operations is "fundamentally about voluntary business behavior." As such, it has suggested that approaches involving increased regulation may be "counterproductive." Instead, in its most recent communication in respect of CSR issued in 2006, it proposed a series of actions for the promotion of CSR practices. These proposals include raising awareness about CSR through the promotion of voluntary environmental initiatives and increased involvement for stakeholders and NGOs.

Most recently, the commission has issued a memorandum reiterating its support for the voluntary implementation of CSR. The commission stresses that the role of the European Union in CSR is primarily in raising awareness and organizing discussion to "further debate and action."

The commission argues that corporations should adopt CSR, as it offers a direct benefit to productivity by encour-

aging the well being of employees and stimulating the development of new skills and technologies. Further, CSR may provide a benefit to the corporation's public image and reputation and allow it to act in accordance with its corporate values. To achieve these aims, the commission has established a high-level group on CSR, that meets twice yearly to "facilitate the sharing of knowledge and information on new initiatives in the field of CSR between the member states and the commission."

### **CONCLUSION: THE FUTURE OF CSR**

CSR critics have observed that the stage has largely been ceded to those who advocate it. Few corporate leaders would be expected to stand up and argue in public against efforts to reign in what may be seen as harmful corporate practices. Thus, while there are still concerns as to the efficacy of CSR and debate over its implementation, it appears to be positioned to remain on public and corporate agendas for some time.

With this in mind, several trends for the future of CSR may be identified, including a trend toward stronger legislative measures, increased involvement by developing nations and the coming issuance of ISO 26000, a guidance standard from the International Standards Association on social responsibility.

### **THE TREND TOWARD STRONGER LEGISLATION**

Voluntary initiatives have been met with increasing skepticism in regards to their ability to effectively motivate changes to corporate behavior. To remedy this, calls have been made for such voluntary measures to be supported by binding regulatory measures. Such a policy appears to be widely popular with the public as well, with one survey finding that 80% of the Canadian population would support the government setting social responsibility standards (Davis, 2003).

However, some commentators have questioned the effectiveness of such strategies, noting that the increasing globalization of both the capital and products markets may weaken the ability of legislation at the national level to effectively govern corporate behavior (Strine, 2008). As a result, it has been suggested that increasing regulation from international bodies will be necessary for CSR to effectively protect human rights.

Despite these misgivings, some tendency toward the increased use of regulation at the national level has already been observed, such as in Canada where legislation has been introduced that would encourage the mining industry to conform to presently nonbinding initiatives, such as IFC's Policy on Social and Environmental Sustainability through the threat of losing access to government financial support for their overseas initiatives. Other countries, such as Denmark, have already adopted binding regulation, even though, as a member state of the European Union, it is encouraged by the European Commission to recall that CSR should be voluntary. It remains possible that the coming years will see

this trend continued, with further legislation introduced to encourage new CSR practices or to solidify compliance with existing voluntary standards.

### **AN INCREASING VOICE FROM THE DEVELOPING WORLD**

The developing influence of Brazil, Russia, India and China has been noted as a possible "historic shift" in the global distribution of power and wealth. As a result, these nations' standards and policies have been identified as an emerging influence on global standards, potentially including CSR practices.

This possibility has met with some trepidation, particularly due to the observation that while China has issued positive statements in respect of CSR, its human rights record remains of concern. Indeed, several international corporations have been implicated in complicity in human rights abuses occurring in China (Kahn, 2008). Nevertheless, it has been suggested that increased conformance to global CSR standards may emerge in China as a result of the increasing possibility that its companies may face either consumer backlash or exclusion from some SRI funds due to noncompliance. Indeed, one study has noted that the best predictor of whether Chinese corporations have a CSR policy is their ranking among the Fortune 500.

### **ISO 26000**

As a final future consideration, the International Organization for Standardization (ISO) is currently finalizing ISO 26000, a voluntary guidance document regarding social responsibility, which is intended to "distil a globally relevant understanding of what social responsibility is and what organizations need to do to operate in a socially responsible way." ISO 26000 has been released as a draft international standard (DIS), that provides an indication as to the shape the final text will take. Comments on the draft text were collected until Feb. 14, 2010, and the final text is expected to be published as an international standard in late 2010.

DIS posits that CSR has seven core elements, organizational governance, human rights, labor practices, the environment, fair operating practices, consumer issues and community involvement and development, and provides detailed guidance in respect of each. Additionally, DIS provides information regarding how these principles may be put into practice within an organization, including how to identify areas of action, which are relevant to the corporation's operation and how organizations may best exercise influence with others so as to promote social responsibility.

ISO 26000 is intended to apply widely to both private and public organizations, whether they operate in the profit or nonprofit sectors. However, it explicitly provides that it is not intended as a management system standard. As such, ISO does not intend it to be used for certification purposes or for regulatory or contractual use. Thus, ISO 26000 may be considered a voluntary guidance document on the practice of CSR. ☪



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## Practice Specialty Officers Reelected by Acclamation

**T**he International Practice Specialty (IPS) Nominating Committee nominated John J. Fearing, CPEA, as Administrator and Ashok Garlapati as Assistant Administrator.

As required by the Society Operations Guide, the Nominating Committee's decision was submitted to and approved by the current IPS administrator and assistant administrator and by the Society Nominating and Elections Committee. No other IPS member submitted a written petition for nomination by Feb. 15, 2010; therefore, the slate stands as submitted.

In accordance with Society Operations Guide 11.2, since the nominees were unopposed, John Fearing and Ashok Garlapati are hereby declared elected by acclamation. Congratulations to these two IPS officers. ☺

# The Compass

VOLUME 10 • NUMBER 2



## Transcendent Leadership

*Part I: How the right question can change everything*

BY DR. FRED LYBRAND

**Y**ou have before you strategic information about leadership—but leadership of a special nature. Anyone who asks a helpful question in a needful situation becomes the momentary leader. One good question can change everything.

Every crisis is only good leadership away from moving to a new place. This contribution of moving a crisis away from dead center is basi-

*"No problem can be solved from the same level of thinking that created it."*

cally the essential contribution of transcendent leadership.

Osama bin Laden was a transcendent leader, though clearly he is an evil one. He took his cause to a new level by "transcending" the current rules of operation in the world. He began thinking and asking questions, which could provide for transcendence. Somehow, in his thinking process, he devised a new way to create destruction as a terrorist.

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Transcendent Leadership: Part II

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Somehow his questions led to a conclusion: hijack commercial jets and fly them into skyscrapers.

Similar to most transcendent effects, there is now a need for transcendent countermeasure. The Minute Men of American Revolutionary War fame offered a transcendent strategy by hiding, rather than fighting fair in the British-gentleman fashion. Had the British had transcendent leadership, who might have changed the way they fought to match the American innovation, who knows how that war might have concluded?

True transcendent leadership is marked by words like honor, nobility and betterment. If you offer transcendence to your situation, it must offer direction to a better place.

Explaining the need for transcendent leadership is the first thing we must appreciate before moving on to the great tool of the True Ultimate Question, But why? The battle between good and evil is a continual theme of sweeping proportions. Not only in the military, but also in business, education, government and families; we need transcendent leadership everywhere.

Someone, we could argue, needs to step to the forefront and provide leadership to transcend the current, and often dire, circumstances we face in these difficult times. A transcendent leader in the military will realize the rules have changed since civilians are now used as weapons of destruction. A transcendent military leader could discover even more strategic and surprising countermeasures to rid the world of the ominous threat of terror perpetrated by individuals bent on destroying freedom and removing choice from the face of the earth. Motives are irrelevant since a good reason to do evil never changes the nature of any dark act. Business practices are no different in principle.

We could be accused of wasting a few minutes of your time by focusing on the need for transcendent leadership. The battle between good and evil rages on; however, it is not the current situation that calls for transcendent leadership. It is the nature of leadership itself that calls for transcendence. We need and have always needed leaders. Leaders by their very nature are transcendent or transcend due to the act of leading itself.

What is a leader? What is transcendence? Transcendence is defined as “exceeding usual limits,” which is just right for our purposes. Latin origins breaks the word into trans + scendere. Trans means *across* and scendere means *to climb across* as a literal, if not metaphorical, meaning of transcendence.

Leaders are transcendents by definition. A leader is one who climbs across a limit or a barrier to an entirely new place.

Robert Fritz, creator of structural dynamics, describes a leader as one who will go to a new place and will invite others to go along. The invitation itself largely sep-

arates the leader from the dictator or manager. When people are invited to go along, there is a natural and necessary camaraderie among the entire group. Force, manipulate, cajole—none of these belong to transcendent leaders. They have a clear sense or picture of where they are headed and invite others to join him. Perhaps we could say that leaders invite us to visit the future with them.

Can you begin to see how far pop-thinking on leadership has drifted from the truth? One glaring problem in today’s environment is the notion of buy in. Buy in is a management notion that employees and supporters have grown to expect from leaders, but it can unravel the very meaning of leadership. Essentially, decisions and overall direction depend on everyone in an organization agreeing or buying in to the plans, strategies and direction of the group. This easily empowers the followers such that a few can stymie progress because they do not buy in. Buy in or agreement is not actually a bad thing since we all appreciate agreement and like-mindedness in our organizations and work environment. The problem with buy in is what it does to leadership: buy in destroys leadership.

How can leaders be leaders when they must follow the followers? They cannot. Leaders who follow their followers are demagogues, giving an appearance of leading by taking their cues from the prejudices of the people, rather than from the compelling principles they follow and the better future they envision. Naturally, input from followers is both important and helpful, but input is information, not the decision.

Transcendent leadership builds support by casting the vision and inviting others to follow. Rather than engaging in constant therapy among the followers for all to feel good, the true leader builds agreement through providing focus on the immediate goals and objectives necessary to climb over to the new place in the group’s future.

When opinions are elevated broadly, where every voice is not only heard, but followed, the structure of the organization changes from a transcendence focus to a harmony focus. Harmony-focused groups are those that use therapy to operate the organization. Therapy-focused organizations spend time, energy and money on attempting to get everyone happy about their work and happy about the company.

This diminishes effective efforts for both the organization and its leadership. Idle chatter leads to poverty

***When opinions are elevated broadly, where every voice is not only heard, but followed, the structure of the organization changes from a transcendence focus to a harmony focus. Harmony-focused groups are those that use therapy to operate the organization.***



and much of the idle chatter stems from the influences of pop-psychology. It only stands to reason that a group can become entangled in idle chatter about feelings, rather than focus labor toward accomplishing together. However, feelings, due to their nature, can ebb and flow with the fluctuations in friendships, marriages, circumstances and hormones. No matter how much therapy or idle chatter, the whimsical harmony built on such shifting sands will rarely last.

Harmony built on mutually dependent labor toward a transcendent goal lasts. Despite all that confronts us as we circumnavigate the joys and horrors in this life, pulling together under the vision and invitation of a true leader can generate the most genuine kind of harmony.

Moreover, this harmony is productive and memorable as we see the group transcend and climb over to a truly new place, creating further opportunities to transcend again. Finally, note that just because you may not be the official leader in a particular situation, it has nothing to do with offering leadership of the transcendent kind.

#### **WHY QUESTIONS MAKE THE LEADERSHIP DIFFERENCE**

Selling snake oil was legendary in the U.S. during a certain time in our history. All snake oil salesmanship was built on the claim. The claim is a proposition concerning the benefits of the thing sold. You are offered the outlandish claim that questions can make the difference. Indeed questions can make the difference—the difference between success and failure, the difference between victory and defeat, the difference between things staying the same and things changing. Questions are indeed powerful. Perhaps we can substantiate the claim and move it from the domain of theory to fact.

#### **CONSIDER ATHENS**

Athens, Greece, around 500 B.C., was a city of about 100,000 people. Among that 100,000, over a period of a generation or so, Athens produced Socrates whose disciple was Plato, whose disciple was Aristotle, who tutored Alexander the Great, who conquered the then-known world.

The amazing thing about these individuals is that they were not kin. They were not genetically and immediately linked in terms of intelligence. Rather, they had what Wenger has described as the genius meme.

For a popular explanation, see *The Einstein Factor* (Wenger & Poe, 1996). The genius meme is based predominantly on the Socratic method. In recent years, the Socratic method is seeing a bit of a rebirth through many classical educational institutions, especially at the high-school level. Some schools have existed for a long time based on this Socratic method. For example, St. John's College, with campuses in Annapolis, MD, and Santa Fe, NM, has honored this method for more than 50 years.

The Socratic method is fundamentally a method based on questions or questioning. Loosely speaking, law schools use Socratic dynamics of questioning,

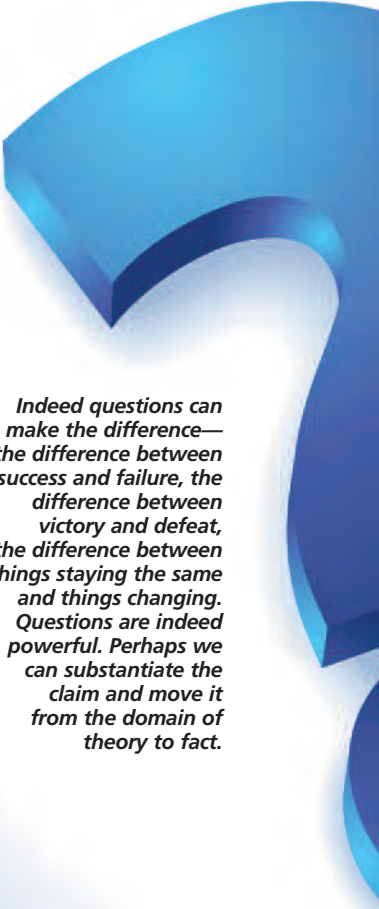
though in the strictest sense we would not think of a law school as a Socratic institution. Nonetheless, law schools effectively use questions to get results (usually in the case of getting a client out of legal trouble before a jury or a judge).

The Socratic method was probably not developed by Socrates; however, he popularized that approach, especially as immortalized in the writings of Plato concerning the exploits and final demise of his teacher, Socrates. The curious thing about the Socratic method is not that it was a questioning approach to learning, but rather that it was invented for the benefit of the teacher or tutor and not for the students.

Today it is common to think of everything being designed to benefit the student; however, the Socratic method found a curious relationship between questions and learning. Questions create a natural feedback loop such that there is an entire leap in learning that can occur as an individual or individuals continue to wrestle through a series of questions related to a topic. In other words, a topic might be expressed and a question is asked. The question generates answers to which more questions can be applied, which generate more answers, and that cycle continues until either the topic leads to something significant or the topic is exhausted as it is examined from every angle through a questioning process.

The Greeks, in fact, coined the word *education* to be something quite different than what we experience in our day and age. Many educators tend to promote the idea that students are a *tabula rasa*, which means *blank slate*. The idea is that the student arrives as a blank slate and the teacher must teach and write upon that blank slate the things that the student needs to know.

The Greek understanding of education is found in the word itself, which breaks down into “e” and “ducere.” Roughly translated, this means “to draw or lead out of.”



*Indeed questions can make the difference—the difference between success and failure, the difference between victory and defeat, the difference between things staying the same and things changing. Questions are indeed powerful. Perhaps we can substantiate the claim and move it from the domain of theory to fact.*



In other words, this questioning process was so effective that it appeared insight and understanding were drawn out of the student, which already existed within the student. Supposedly, a student was handed a hereditary connection to a cosmic understanding that humanity held in common. The leaps and insight were incredible and dramatic due to the Socratic Method, so it appeared the students just somehow already knew.

The way in which the Greeks thought about education assures us that

the method was developed for the teacher and not for the student. The teacher or tutor in Greece was a learned individual who wanted to learn more and, in the course of time, someone happened to notice that as he offered a topic and questions to his students, their responses would then help him generate more questions and more insights, such that he could refine his own thinking.

Not surprisingly, the students began to benefit from this interactive loop. You might think of the Socratic method as putting on the table with others a topic of discussion, which could be anything. The tutor, who is more committed to learning the truth and being right, would then begin with his students to examine the topic or the claim or the subject for discussion. The tutor was seeking to discover what he thought about what he thought. Often, as is the case with most humans, we discover that we do not really agree with ourselves and as we investigate something we think we believe, we come to greater clarity, cast it aside and embrace a new and normally more pristine understanding regarding the topic.

In a way, the Greeks understood what George Washington Carver understood in his own education. Carver, the wizard of peanuts who found that hundreds

of different products could be developed from a peanut, said, "Anything will yield its secrets if you love it enough." The Socratic Method was organized for individuals who loved truth and learning. And yet, that love for truth and learning would have been completely inadequate without the use of the question.

A further surprising thing about Athens, Greece and the power of this questioning process is that we only have some of the manuscripts that tell us the insights from very few of their thinkers. There is no telling what things in the coffee shops, restaurants, homes and street corners were etched in the dirt or written on a crude form of paper or discussed in day-to-day conversation that we have since lost.

As they discovered in Athens, and as they in large measure rebirthed in the Italian renaissance in Florence, the nature of tutors and mentors and the use of questions for learning have been borne out—proved beyond any doubt that questions make the difference.

### WHAT IS A QUESTION?

You may think it is funny to ask a question about questions; however, as you follow the logic of this article, you will find that the question actually helps you discover together the meaning and value of questions.

A question is a sentence or statement; however, the question has the unique feature of inviting anyone who hears the question to look beyond the words to an answer. In the way we write and read, we have statements and explanations and quotes, most of which make a point that we either agree to or do not agree to.

However, the question has a way of throwing a line and a hook into the dark. This line and hook thrown into the dark until now has been largely an unpredictable, though worthwhile, action. As you work your way through this article, you will see that you can make a far more educated guess about where the line and hook will land, into what new world or new answer it will connect and draw you through the darkness into the light and the beauty of that new place.

We believe a question is a blueprint of a map to an answer. In short, it is a predictive map. If you know anything about maps and mapmaking, you know that the map is designed to represent the territory. So if you are in a new city or new area or even the wilderness, you can take out a map and orient yourself to the map, face yourself north and face the map north and roughly begin, or perhaps exactly begin, to understand what is to your east, west and south. In this way, the map can be used to direct yourself to wherever you would like to go.

In most countries, the most common use of the map is to go from where you are to where you want to be; basically, we use a map to get from here to there. However, all of these things happen to be points of interest in the physical world. Having a map and directions allows you to guide yourself directly to a specific point in the physical world.

But what of questions? A question is a blueprint of a map to an answer. It is a predictive map. Blueprints are generally used to serve as a basis for construction. For example, a blueprint of a house is a way to outline and organize the materials such that when they are fastened together with nails, screws, concrete and trusses, what was first conceived in the imagination then comes to exist in reality.

Questions serve to bring these things together. They are a blueprint of a map to an answer. In other words, a question becomes a blueprint that, as you use the pieces together, develop in reality to a map that represents a place predictively you can go. In other words, it might be just as easy to think of questions as a way to create. Creation is always about something that does not exist that is then created and that then exists. Questions are a way in which to move from something not existing to something created.

If you were to become an ardent student of creativity and you began to study the greatest technological creations of the past 200 years, you would find that questions and questioning is at the heart or core of creating. Thomas Edison, for example, invented the incandescent light. In the process and struggle of discovering how to light the entire world with electricity, Edison needed to keep asking certain questions.

These questions led him to attempt to use the hair of a beard and a strip of bamboo to discover [in a vacuum tube] how to pass electricity through this element without combustion. In the course of time, with this question and many more, Edison followed this path to a new place. In our own day and age as individuals have asked questions related to calculation, computing and graphics, the personal computer grew to become something to increase the productivity of our lives.

However, in the course of time, individuals began to

ask questions about how to connect computers and so networks were developed. Beyond that, questions led the way to the Internet, a way in which to connect computers, and therefore people, around the world such that information can be relayed virtually at the speed of light.

## CONCLUSION

A question is a blueprint of a map to an answer. Think about where you are. Think about the dark beyond, which you cannot imagine and then think about what might be out there. How can we teach children to learn at twice the speed they currently learn? How could we begin to have management and labor instantly understand what really matters in the business? How can we give feedback to subordinates so they do not get upset but are helped? How could we generate genuine camaraderie between enemies rather than just a truce? How might we create a sales force out of our customers?

The questions you can ask are endless, and they are the very thing that can make the difference in moving you from where you are to where you would like to be. You have information that will offer you the opportunity to develop the skills necessary to generate questions in any area of endeavor that might cast that line and hook to connect to the next great answer in your field, team or daily life. No doubt, you are about to have a fresh way to provide transcendent leadership. ☉

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## ASSE Notes SH&E Profession Is Growing

**A**ccording to ASSE, the SH&E profession is growing. Not only did *Money* magazine's November issue feature "The 50 Best Jobs in America" list the "environmental, health and safety specialist" job as number 22, the "environmental engineer" job as number 5 and the "risk-management manager" job as number 14, but according to the U.S. Bureau of Labor Statistics, employment of SH&E practitioners is expected to increase 9% during the 2006-16 decade. Additionally, the University of California San Diego Extension listed the SH&E profession among a "dozen hot careers for college graduates."

The Money's ranking of the Top 50 Jobs in America was developed, as reported, based on pay for experienced workers, growth prospects and overall job satisfaction. The University of California-San Diego hot career options list for college graduates was devel-

oped by the continuing education academic directors based on enrollment trends, an analysis of national employment statistics and discussions with the school extension's more than 750 business, community and professional association curriculum advisors.

SH&E professionals' salaries range from about \$30,000 for safety inspectors to \$150,000+ for highly qualified individuals. Safety professionals are knowledgeable in "safety science," a 21st-century term for everything that goes into the prevention of incidents, illnesses and other events, that harm people, property and the environment. Key knowledge areas include chemistry and biology, physics, ergonomics, environmental sciences, psychology, physiology, biomechanics and medicine, engineering, business management, economics, sociology and geology. ☉



# Transcendent Leadership: Part II

## Designing Your Own Questions

**H**ow do you design the best question for the moment or need? Let me tell you a story about the value of training. I was an Eagle Scout, stemming from the values of my family and our small town of Anniston, AL. In those days, becoming an Eagle Scout meant a lot of swimming. Summer camp at Comer Scout Reservation always began with the same old test—you needed to prove you could swim. Once your skill level was decided upon, you would receive a color-coded tag for the week. The tag would put you in a beginner, intermediate or advanced group. Whenever you went swimming, and always with a buddy, you were required to swim in a designated area; only advanced swimmers were allowed into the deep water.

Even to this day, the training comes in handy. Every year we make it to the Gulf Coast of Alabama for about 2 weeks. My children have known about the buddy system since from the beginning. A loud shout of “buddy check” means to get to your swimming partner and raise your hands to be counted. The ocean is attractive, but it is not always friendly. Many years ago on the very first day at the beach, the undertow was pretty severe, but I did not check it. Tripp and Laura, my two oldest, set out for the waves as buddies. In a few minutes, Laura was yelling and pointing at Tripp who was beyond the point where the waves were cresting. Laura could not get to Tripp and Tripp had the panicked look of a helpless swimmer. Tripp also has mild cerebral palsy on his right side, which only added to the situation. He was fighting to get to shore, but the current was dragging him away.

Occasionally, old lessons make the difference. I took off my shirt, handed my wife my keys, wallet and all the other sundries from my pockets. Fortunately, I never entered the ocean. As I walked toward the water, I motioned to Tripp to swim along with the current. It probably felt like I was telling him to swim out to sea, but Tripp trusted me instead of his own feelings. As a result, he came to shore. I knew that all waves actually make it to shore, and if he worked with the current, we would have him safe and dry. In a moment or two, he was safely resting on the beach.

What does this have to do with designing powerful questions? Everything! First, when we are asking the wrong question, or even a weaker one, it is like swimming against the undertow. Second, you cannot learn to swim unless you actually get in the water. You cannot really understand the ocean until you have been in it. You will not learn to design questions until you start designing them. There is no way to learn without involvement. We can intellectualize and pretend, but

working with questions is the way you will learn to handle them.

### TENSION SEEKS RESOLUTION

Robert Fritz has developed the discipline of structural dynamics or understanding the underlying structures involved in human and organizational realities. Fritz emphasizes how one of the great structural principles governing the way our world has been designed is the fact that tension seeks resolution. Take a deep breath and try to hold it. What happens? In time, the breath must be exhaled and the feeling is one of relief. The pressure on the chest, the oxygen-to-CO<sub>2</sub> ratio in the lungs, the overall sense of normal breathing; all these combine to insist the air be exhaled and new air inhaled. You work on your finances but a deposit is missing; the house or office is turned upside down until it is found. You develop a tension headache (from looking for the deposit), and you take a pain reliever.

In these examples, we see the principle that tension seeks resolution. Well structured movies use this principle from start to finish. The nature of “what’s next” continues to draw us into the next scene and the next until we learn how everything turns out. When we understand this principle, we can understand exactly why questions work: questions establish a valuable tension, which is resolved only by a matching answer.

### IMPLICATIONS SUGGEST THE PATH

An implication is something that is logically suggested or extended from an event or a cause. Much like dominoes, if you set them up in a proper array, you can predictably expect how the domino chain will fall. Another example is the way in which evidence implicates someone in a crime. A person’s close association with the victim along with a motive and evidence all serve to implicate or suggest that the person committed a crime.

In working with questions, it is helpful to understand how implications work because the answer to one question often suggests a new question. This trail of questions and answers can be used to design a path of questions or predictably help us see where a question might take us. Our goal is not to become good guessers, but rather to have a pretty good idea about the direction a question will take us. Once we look at this likely direc-

*In working with questions, it is helpful to understand how implications work because the answer to one question often suggests a new question.*



*Our goal is not to become good guessers, but rather to have a pretty good idea about the direction a question will take us. Once we look at this likely direction, we can more easily decide if a particular question is useful to ask.*

tion, we can more easily decide if a particular question is useful to ask.

For example, if I ask, “Why is Bill such an incompetent jerk?” then by implication (or inference), I can safely expect an answer the question suggests: Bill is an incompetent jerk because of genetics, upbringing, alliance with the dark side of the force, his jealousy of me, etc. None of these answers really get us toward what we want from the question. What we want is to know how to get along with Bill. In this case, a question like, “How could I get on good working terms with Bill?” is far more useful because it looks to solutions rather than to a catalogue of problems.

### RESULTS ORIENT THE COMPASS

Another lesson from scouting comes from a skill known as orienteering. Orienteering involves the use of a map or directions combined with landmarks and the use of a compass. Usually, you are given a list of directions in terms of degrees and distance. From a starting point, you should be able to go a certain distance in a certain direction, take another reading to reorient yourself with a new direction and travel a certain distance again. It does not take long to find out that looking at a compass the whole time will not work well on land. Instead, you get a heading to a marker in the distance, such as a tree or rock, walk to the tree or rock, take another look at the compass and

repeat. This can keep you on course effectively.

What about questions? In designing useful questions, we need to practice principles of orienteering. Specifically, we need to use our compass properly to head in the right direction. To head in the right direction, you need two basic ingredients; you need to know 1) where you are and 2) where you are headed. A compass can tell you which direction to head from where you are, but it cannot tell you where you want to go. You, as a scout, pilot or ship’s captain, must decide where you want to go.

Where do you want to go? Said differently, where do you want to wind up? In both instances, the point is that you must supply an end result in order to decide on the direction to head. If you know land is approximately to the east, then head east. With questions, it is basically the same game. Where do you want to wind up? What is the result you want from your question? Do you want a list of reasons to do something? Do you want a new idea that

no one has considered? Do you want a different attitude among your employees, children or for yourself? Decide on what you want before you design the question—orient the compass.

### PUTTING IT ALL TOGETHER

Tension seeks resolution, implications suggest the path and results orient the compass all serve in combination to help us form strategic and effective questions. Although you can figure out your own way to make these principles work for you, a few templates are included here. The value of a template is that you can paint by numbers until you begin feeling comfortable with your own process. Basically, these approaches to designing questions have borne fruit, so we know they work. Additionally, they have a nice appeal to common sense.

Finally, using these templates does not require faith; instead, it just requires action. Walk through the steps/questions, answering them as fully as possible. Sleeping on your answers and revisiting the process the next day is also a valuable way to make use of these principles. Often, time is a great ally as we keep a question in mind. Tension seeks resolution, but usually there is a delay in finding the resolution or answer.

### ALPHA TEMPLATE (THE LONG VERSION)

- 1) What is the end result I want from the question?

- 2) What is the current and real situation or circumstances?
- 3) What needs to be asked last?
- 4) What needs to be asked before the last question?
- 5) What needs to be asked before that question (#4)?
- 6) What needs to be asked before that question (#5)?
- 7) Repeat as needed until a complete question path is created.

### **BETA TEMPLATE (THE SHORT VERSION)**

- 1) What do I want?
- 2) What could I ask?
- 3) If the above question (#2) were answered, where would it take me?
- 4) Repeat steps 1 through 3 until you design the question that will likely lead to the result you want if it is answered.

### **THE STRATEGIC QUESTION**

If I could only ask one question to get my result, what would it be? The strategic question creates a focus to find the most valuable question by limiting the possibilities. Limits create focus, and limiting your question to one-and-only-one can produce a wonderful and immediate result. The strategic question is a powerful way to find shortcuts, especially in a crisis.

### **THE TRUE ULTIMATE QUESTION What Is the Better Question?**

The True Ultimate Question (Trimtab Solutions, 2009) is in many respects the surest way to find the right question. Many people have talked about the ultimate question concerning everything from what the consumer wants to the meaning of life. The True Ultimate Question offers what May (1975) observed concerning the “elegance” of a solution to a problem and the resolution of creative tension. Elegance offers a bit of beauty and efficiency toward a creative solution or endeavor.

The True Ultimate Question allows you to use the incremental value of constant improvement to design a better question. If there is a better question, The True Ultimate Question is the best way we know to get there on your own. And naturally, with a better question, comes the best possibility for a better answer. Here are the steps to use with the Ultimate Question:

- 1) What is your topic or desired result?
- 2) Ask a relevant question.
- 3) Answer it (#2).
- 4) Ask The True Ultimate Question.
- 5) Answer it (#4).
- 6) Ask The True Ultimate Question again.
- 7) Keep repeating The True Ultimate Question until you find a question that will likely lead to the result you want if it is answered.

### **THE PATH: WHAT TO DO WITH A USEFUL QUESTION OR TWO**

We have used the phrase *question path* as a metaphor for your own thinking and understanding. The analogy of a

path is accurate and useful, but technically you are creating the path before you ever travel it. The path is a set of moves from one point to another. In this case, the path ends with the question you invent and begins with what you know related to your question. As in the alpha template, you may create a series of questions, which lead to your final result or answer, but there is another way to go.

Following our metaphor, think about the use of a path as a three-step event. First, you decide on which path to take (or create). Second, you start down the path. Finally, you stay on the path until you reach your destination. Here is how it looks when you create a question path.

### **Create the Path**

- 1) Get a useful question.
- 2) Think about what you know related to the question.
- 3) Think about the question.

### **Start Down the Path**

Think about what you know related to the question (again).

### **Stay on the Path**

- 1) List a few possible answers.
- 2) Hold the tension and wait for a resolution (answer).

In this last step, you hold the tension. In many ways, holding the tension is the most important part of the process. Profound answers often come from holding the tension when they will not come any other way. What is holding the tension? It is not accepting the first possible answer because it is first, which is often something like, “It is impossible.”

Holding the tension also means you do not prematurely quit. It literally means holding on to the tension. Sleep on it. Let it brew, percolate and steep until the mature taste of a full cup of an answer is ready. When we hold a question in our mind for an extended period of time, our mind tends to work in a powerful way to profoundly and elegantly resolve the tension between what we are asking and a final, workable answer.

### **EXAMPLE**

It might be helpful to play with an example. The situation is as follows: You are part of a team in charge of designing a marketing strategy for the 3D Wonder Widget, a new product that will revolutionize the burgeoning pasta industry. Unfortunately, all of the team members are also professional chefs so, as you can imagine, Ramou and Jean Pierre are in extreme conflict, which is dragging the team’s morale and focus down into the quagmire of a spoiled soup stock. You have been handed the chairperson’s whisk and all have agreed to let you try to help the circumstance with your questioning skills. So you begin:

### **What is the end result I want from the question?**

I want Ramou and Jean Pierre to work well together and to act professionally toward each other so we can accomplish our mission. The end result is a happy and productive team. Mostly, however, I want a brilliant marketing strategy for the 3-D Wonder Widget.



**Take these questions along with a notebook and play around. The Transcendent Question for your situation is probably just around the corner.**

**What is the current and real situation or circumstances?**

Ramou and Jean Pierre do not like each other and are very competitive. Both have received acclaim for their restaurant businesses and world-famous recipes. Each thinks the other is a show-boater and only thinks about himself.

**What needs to be asked last?**

The last thing to ask will be something like, “What is left on the marketing campaign that we have not yet agreed to?”

**What needs to be asked before the last question?**

What are the best solutions to our areas of disagreement?

**What needs to be asked before that question (#4)?**

What are the major areas of agreement and disagreement we have on this project?

**What needs to be asked before that question (#5)?**

Is everyone committed to reach this result?

Repeat as needed until a complete question path is created. After some reflection, you come up with one more question to begin with.

**What do we agree is the result we want for this project?**

Now with these questions on paper, we can put them in order, fill in any gaps and ask a simple question about this question path.

Here are the questions in order:

- 1) What do we agree is the result we want for this project?
- 2) Is everyone committed to reach this result?
- 3) What are the major areas of agreement and disagreement on this project?
- 4) What are the best solutions to our areas of disagreement?
- 5) What is left on the marketing campaign that we have not yet agreed to?
- 6) Do we agree? Ramou? Jean Pierre? (Add this question to fill in the gap between question #5 and the desired result that “both individuals are happy or are behaving professionally.”)

Now, if the team finds answers to these questions, will they lead them to the stated goal of the chairperson to have a happy and productive team? It sure looks that way. Naturally, there may be a little extra work on questions since some of these questions have subpoints. Question #4 could easily ask, “What are our areas of disagreement? What are the best solutions for each?”

In any event, you now have a path and can begin leading the team to your desired result by getting them to answer each question. This could take several meetings as you hold the tension, but basically you have a path to travel. Remember to:

**Create the Path**

- 1) Get a useful question.
- 2) Think about what you know related to the question.
- 3) Think about the question.

**Start Down the Path**

Think about what you know related to the question (again).

**Stay on the Path**

- 1) List a few possible answers.
- 2) Hold the tension and wait for a resolution (answer).

Here is a final example to underscore the power you have before you.

In *What a Great Idea?*, Charles Thompson relates an example of asking the right questions from Thomas MacAvoy, former president and chief operating officer of Corning Glass Works:

One day, while MacAvoy was a senior chemist in a lab at Corning, Corning’s president said to the head of research, “Glass breaks. Why don’t you do something about that?” The directive to the lab then became, “We will prevent glass from breaking.” The lab came up with 25 different ways of preventing glass from breaking; 18 of them worked and 5 made money.

The most interesting aspect of this exchange is not what the president asked but what he did not ask. He did not ask, “Why does glass break?” That question might have produced months of exhaustive research, resulting in some highly scientific reports that would collect dust on a shelf. Instead, the boss went straight for the desired solution: How can we make glass that does not break? The end result was the now-famous Corelle line of dinnerware (Lybrand, 1996).

Take these questions along with a notebook and play around. The transcendent question for your situation is probably just around the corner. Imagine walking into a meeting and bringing a powerful question to focus the challenge you and your team has before you. It really can be just that simple. ☺

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# Five Types of Human Error

**W**ho makes mistakes? The short answer is everyone. It has been reported that 70% to 80% of all aviation accidents are the result of human error. This could include errors by cockpit crew members, cabin crew, air traffic controllers, supervisors and aircraft designers.

Likewise, employees make mistakes in non-aviation settings. Examination of circumstances following an industrial accident shows that employees make mistakes; however, employees' mistakes are often a result of someone else's mistake. Designers also make mistakes, along with engineers, architects, supervisors and managers. A good incident analysis system will help employers get to the root cause of an incident and often will reveal the root cause as a human error of some type.

James Reason's Swiss Cheese Model of Human Error Causation is a good approach to identifying human errors that result in accidents (Shappell & Wiegmann, 2000). Other incident analysis systems can successfully recognize human error. But the ultimate goal is no incidents to investigate. Applying human error recognition

techniques will help employers identify the errors before the incident occurs.

There are already efforts to identify those not suited for a certain work. Not everyone gets into medical school or becomes a fighter pilot or NFL quarterback. Not every person possesses the skills and aptitudes required for many jobs. However, not every medical school graduate finishes at the top of the class. Someone has to be last in the class. Does that mean s/he will be a bad doctor? Not at all. The person who graduated at the top of the class will also make errors at some point.

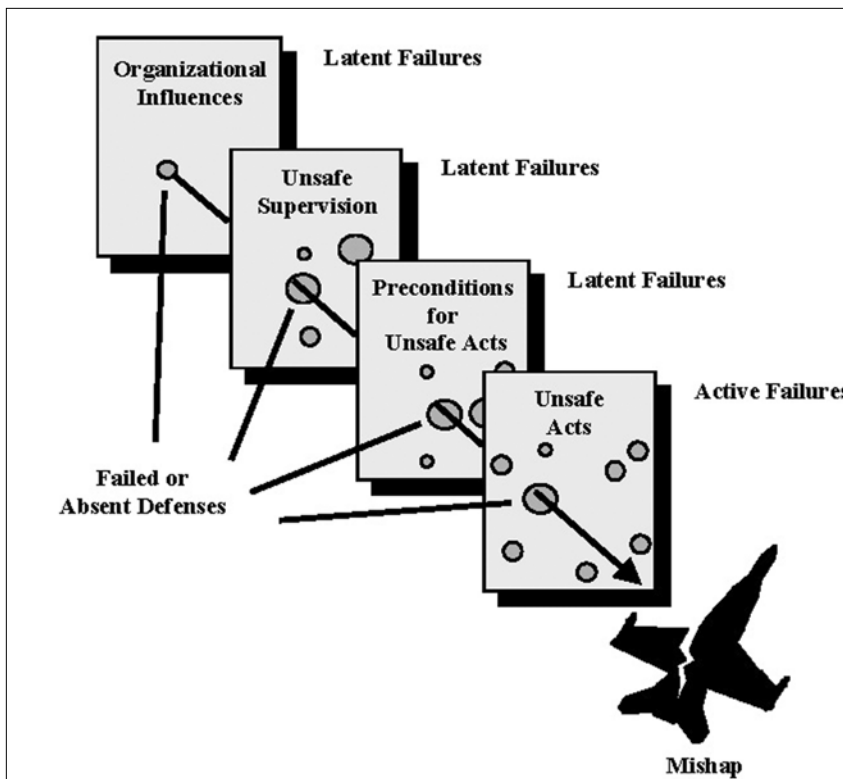
Historically, the response to incidents has been proportional to the anticipated cost in dollars and/or lives. In turn, this is usually based on the number of incidents that have occurred. For example, while passing through a railroad crossing, a car is struck by a train, killing the driver. The ensuing investigation reveals that the driver was in a hurry and tried to beat the train. The cause is classified as driver error. But did the investigation dig deep enough to assess why the driver was in such a hurry that he would risk his life to get through the crossing ahead of the train?

Furthermore, records show this is only the second such accident at this particular crossing within the past 10 years.

Local authorities decide to put up additional lighting or more signs, but the low number of incidents does not justify the expense of installing a gate at the crossing. Is one fatality every 10 years acceptable? The answer depends on whom you ask. If statistics indicate we can anticipate one fatality every 10 years, then our goal should be to find a way to eliminate that fatality. It is hoped the addition of lighting and signs will do that.

However, even if a crossing gate is installed, fatalities will still occur at the crossing because people will continue to make mistakes. Someone will decide to drive around the gate while it is down. In other words, only so much can be done to eliminate incidents. Despite best efforts, people will find ways around safeguards and make deadly mistakes. The frequency might be reduced, but it is unlikely the incidents will be totally eliminated using standard technology.

**Figure 1**  
**Swiss Cheese Model**  
**of Human Error Causation**



Source: Shappell's and Wiegmann's adaptation of James Reason's (1990) Model



***Most employers train workers to perform jobs safely. They also have detailed selection processes to match successful applicants with the job.***

In another example, an employer creates an outdoor employee break area by installing a picnic table located 44 in. above the adjacent sidewalk. Because the height is less than the minimum OSHA requirement for fall protection of 48 in., the employer does not install railing around the walled area because it would detract from the aesthetics.

Rather than ask whether the height is OSHA-compliant, we should ask whether someone could get hurt. If answer is yes, someone could even be killed, then we should

ask whether we would make changes in the situation should such a tragedy occur. If so, then why wait? Why not make the changes now and prevent the potential fatality (Coble, 2005)?

Should an employee fall over the edge and die, the investigation may identify the decision to forego fall protection as a design error. If we employ hazard recognition or human error recognition techniques in advance, then we can easily identify the need to make needed changes.

#### **REASONS PEOPLE ERR**

Why do people make mistakes? The reasons seem endless but can be classified into three major categories:

- 1) People are unaware.
- 2) People are unable.
- 3) People make the wrong choice.

#### ***People Are Unaware***

Often, a person will make a mistake simply because s/he is unaware a hazard exists. Perhaps the individual

has had no training, or the training s/he received was inadequate. That is why we teach children at an early age not to go into the street or to look both ways before crossing the street.

In addition, a person may not perceive a hazard because s/he has little or no experience. Until a person learns the job, adjusts to new surroundings and becomes familiar with equipment, routines, etc., s/he is more prone to error than an experienced worker.

An employee's state of alertness may be low due to working long hours, taking medication or thinking of other issues, such as personal problems, when s/he should be focused on the task at hand.

For example, an employee injured on the job is prescribed medication by his personal physician. To prevent the case from becoming a lost workday case, the employee was encouraged to report to the medical department where he would spend the day filing. While walking to the break room, and under the effects of his medication, he steps in front of a forklift and is seriously injured. The medication dulled his senses and he was unaware of oncoming traffic while walking through the plant.

#### ***People Are Unable***

On average, people are taller, wider and heavier than their grandparents and great-grandparents. Yet, the design for many items used in daily life is based on measurements taken 50 or more years ago. As a result, larger or smaller employees may find some activities difficult, if not impossible, simply because they are too small or too large to perform the task or to operate the equipment. In an effort to accomplish the task, they may put themselves and others at risk since they are unable to perform it safely.

An individual may not possess the motor skills needed to perform certain tasks and, makes frequent mistakes. Or, the motor skills may be diminished because of fatigue or stress. For example, an employee who is required to assemble small parts may have difficulty grasping parts and putting them together as s/he approaches the end of a 10-hour shift. Although the shift began at 8:00 a.m., the day began 3 hours earlier by making breakfast and getting kids off to school.

Or, perhaps an employee does not have the cognitive abilities to perform the job safely. For example, not everyone can understand the process involved in driving a forklift safely. It seems simple enough: Start the engine, lift the forks, put it in gear and drive. But beyond pointing it in the right direction and pressing a pedal, a good driver must also know whether s/he is driving too fast to make a turn since the forklift has a narrow wheel base and overturns easily.

#### ***People Make the Wrong Choice***

Most employers train workers to perform jobs safely. They also have detailed selection processes to match successful applicants with the job. While many mistakes



may be the result of an employee being unaware or unable to perform safely, most human error is a result of choices made by workers (unsafe acts).

Drivers who drive through the railroad crossing in an effort to beat the oncoming train or who drive around the crossing gate because they are in a hurry have made a decision that could cost them their life. In the same way, a worker who opts not to lock out equipment because it would take another 3 minutes to walk to the shop and get a lock has made a decision that could be deadly. S/he has made the same decision many times in the past without incident, so it feels safe taking the shortcut again.

Like the supervisor's decision to permit the action, this is known as a latent failure. It is a mistake that may linger unnoticed until one day, in conjunction with other errors, something goes wrong and the employee is pulled into the machine, started by another employee who is unaware that anyone is inside.

An employee may make the wrong choice because of a potential monetary gain. Have we set up workers to make mistakes by offering some type of personal reward? And do not forget youth. Young men, in particular, sometimes commit errors out of a desire to impress their peers.

### **FIVE TYPES OF HUMAN ERROR**

The five types of errors are:

- 1) errors of omission;
- 2) errors of commission;
- 3) design errors;
- 4) sequence errors;
- 5) timing errors.

Of these, the most common are errors of omission, commission and design.

#### ***Errors of Omission***

An error of omission is when an individual fails to do something. Such an error occurs when an action is needed to ensure, or at least maximize, the safety of the task, yet the worker fails to take the needed action. Examples: an employee who fails to lockout equipment; a driver who fails to buckle his/her seatbelt; or the entry supervisor who fails to verify that rescue service is available before allowing entry into a confined space.

#### ***Errors of Commission***

An error of commission is when someone does something that is either the wrong action or the action done wrong. For example, an employee who reaches into the guard to clear a jammed machine or who uses an overhead crane for confined space rescue, has committed an error of commission. The supervisor who tells the employee to jump into the tank, even though the employee has not been trained and confined space procedures have not been followed, has committed an error of commission.

#### ***Design Errors***

A design error is just as it sounds. This would be

when equipment, processes, procedures, etc., are poorly designed and may lead to someone making an error.

An example can be found in most every shop. Most bench or pedestal grinders are designed with the switch located at front-center. As a result, it is natural that the user stand in front of the grinder (the operating position) when s/he flips the switch. Yet, if a grinding wheel will disintegrate because of a crack or fault, it is likely to occur when the grinder is first turned on. Therefore, until manufacturers redesign grinders, employers should either relocate the switch (preferred) or train workers to stand to the side when turning on the switch.

As technology has advanced, we have learned and implemented ways to overcome human error—some-what. Three design approaches are employed to minimize the likelihood of an incident occurring due to human error.

### **EXCLUSION DESIGN**

Exclusion design is designing an item in such a way that human error becomes impossible. The pull-back restraint worn by press operators is a good example. As long as the device is properly adjusted and not damaged, the wearer cannot reach into the press's point of operation during cycle since the wearer's hands are physically pulled away from the machine.

### **PREVENTION DESIGN**

When prevention design is used, error is difficult, but not impossible. A rotating shaft that is higher than 7 ft above the floor does not require a guard, according to OSHA 29 CFR 1910.219(c). Instead, it is considered guarded by location. However, if an employee sets up a ladder underneath the shaft and climbs high enough to where s/he is now within reach of the shaft, a hazard exists.

In prevention design, several techniques may be used, such as color coding, positioning the worker, or hazard or shape coding. Many examples of these techniques exist. For example, a red button or switch on a machine usually indicates the button is for emergencies—an emergency stop or fire protection. Providing a length of air hose with a clip-on chuck and standoff gauge allows someone to inflate a tire, a dangerous procedure, yet take a position out of the path of trajectory.

Shape coding has been used for years in the aviation industry. This involves using different shaped knobs, for example, for different controls, enabling the flier to identify the control in total darkness.

### **FAIL-SAFE DESIGN**

The final technique, fail-safe design, does not reduce the likelihood for error to occur, but it reduces the consequences. An employee who wears fall protection may still fall, but if it is the proper gear worn in the proper manner, the fall should be arrested and the employee's life saved. Another example is someone who leaves

his/her house key at work, yet has a hidden a key in a fake rock in the garden.

### **SEQUENCE ERRORS**

A sequence error is actually a form of error of commission in which someone performs a task or function out of sequence. An example is when someone changes the order of checking for atmospheric hazards inside a permit-required confined space. Oxygen sensors of some atmospheric monitoring equipment may be affected by some contaminants; therefore, if oxygen is not checked first, the sensor could be rendered ineffective by other contaminants, unbeknown to the tester, resulting in an inaccurate oxygen reading. If instead of checking oxygen, flammables, then toxics, the tester checks oxygen last, a sequential error that could kill confined space entrants has occurred. Or, suppose someone enters the space and smells something like rotten eggs. If s/he then decides to check the atmosphere for the presence of hydrogen sulfide, this sequential error may not allow the worker to survive the exposure that has already occurred.

### **TIMING ERRORS**

Also a form of errors of commission, timing errors occur whenever someone fails to perform the task within the allotted time—either too fast or too slow. If a skydiver waits too long to pull the ripcord, then the chute might not deploy in time to allow the skydiver to drift slowly and safely to the ground. If a predischARGE alarm sounds in the computer room and occupants do not evacuate immediately, they will likely still be inside when the fire protection system dumps.

### **HUMAN ERROR REDUCTION STRATEGIES**

How do we reduce human error or mitigate its consequences? The first step is recognition. Only when a problem or potential problem has been recognized can it be evaluated so control measures can be implemented. This is Safety 101. Figure 2 presents an accident sequence model created by Ramsey (1978) and adapted by Sanders and McCormick (1987); it represents various stages in the occurrence or avoidance of accidents in a hazardous situation.

#### ***Perception***

We must make every reasonable effort to enable workers to perceive the hazard. When an employee is unable to recognize a hazard because s/he lacks the sensory or perceptual skills or is not alert, there is an increased potential for an unsafe behavior resulting in an incident to occur.

#### ***Cognition***

If the employee lacks experience or proper training or does not possess the mental or memory capacity to recognize the hazard, again, there will likely be an unsafe behavior.

#### ***Decision***

If no barriers prevent recognition of the hazard, then

any hazards or potential hazards should be recognized by the worker, and the employee can then make an informed decision on the next course of action. If the employee is a risk-taker, s/he will likely commit an unsafe act. If not, then s/he may choose the safe behavior. The decision is often influenced by past experience, training, attitude, motivation or personality.

### ***Ability***

Does something prevent the employee from performing the task safely? Does workstation, equipment or process design force the worker into a position or action that leads to an unsafe behavior? Or is the worker unable to act safely because s/he lacks the motor skills or other necessary attributes?

A fiberglass insulation manufacturer had a belt conveying insulation. A rotating, circular blade would move laterally across the conveyor to cut the insulation. A guard was built to enclose the blade. The guard was 7 ft high and had a gate to allow workers to enter the area of the blade; however, a sign instructed employees not to enter whenever the blade was in operation. When an employee was observed standing inside the guarded area, just behind the rotating blade, she was asked why she violated the rule. Her response was that she was required to make frequent adjustments to the blade during operation, but the guard prohibited her from getting close enough to do so. Therefore, she had to enter the guard in order to do her job.

To reduce the potential for human error or its effects, the following steps should be taken.

### **ESTABLISH A BUSINESS CULTURE**

First, establish a business culture. A business culture is simply managing all aspects of the business, including worker safety, in the same way and with equal emphasis. If a plant manager wants to hire a new production manager, s/he will look for someone with strong managerial skills. While the plant manager expects the production manager to ensure good production, s/he must also insist on having top quality, low cost and good human relations. But s/he does not want anyone getting injured either so this person must ensure that safety rules are enforced.

In other words, this new manager must apply good managerial skills to everything for which s/he is responsible, not just production. S/he must ensure that employees do the job right, including doing it safely. Safety cannot be separated from doing the job right. It is as much a part of the job as production or quality, and if the new manager fails to enforce or manage safety with the same emphasis as production or quality, s/he is not doing her job right and the plant does not have the business culture desired.

Establishing a business culture means developing safety policies and procedures in the same effective way and with the same purpose as other policies and procedures and ensuring that policies and procedures are followed. Managers should establish procedures that will

enable them to run the organization effectively with maximum production, best quality, at the lowest cost and with no injuries. Safety policies are often less effective than other policies, developed only to satisfy an OSHA mandate and are not taken seriously by management.

### TRAINING

Clearly, we must ensure that employees are properly trained. However, too many employees lack the skills to work safely because the employer has failed to provide the training or the trainer(s) do a poor job. Good training costs money; like anything else, you get what you pay for. It may be necessary to pay for top-shelf training. Plenty of companies can provide good training. Do not cut corners when it comes to training. Take a look at the [OSHA training requirements](#).

In addition to specific task training that may be required by OSHA, an employer should provide training in hazard recognition, enabling workers to identify and be aware of hazards in the workplace. We are not born with an inherent ability to recognize hazards. Until we are told what the rattlesnake can do to us, we may not have a fear of approaching it. It takes very little to enlighten someone about the danger of getting too close to a rattlesnake.

Likewise, it takes very little training to bring someone to the point where s/he can easily and instinctively recognize workplace hazards. To drive this ability even deeper into workers' minds, get them involved in the safety and health process. Participation is an excellent teacher, and this can be achieved in many ways.

### EMPLOYEE SELECTION

Most employers do a good job of selecting employees based on skill and experience. Occasionally, someone who is not qualified to perform the job s/he has been hired to do will slip through the cracks. Review selection practices to ensure that they are current and that the company is selecting only qualified applicants. This can be a problem because for some jobs it may be hard to get qualified applicants to apply. Settling for someone less than qualified with the intention of bringing that individual along can be risky.

### EFFECTIVE DESIGN

Only qualified people must be hired for critical jobs, such as forklift drivers, electricians, welders and other hazardous crafts. It is equally important to hire qualified engineers and designers. Ensure that they are provided with adequate resources appropriate for what they are asked to design. Designers must employ sound engineering practices. They should also be trained in OSHA standards and how to use them as well as appropriate consensus standards.

While inspecting a new water treatment plant, the author noted numerous obvious OSHA violations. The design company had been designing such facilities for

nearly 100 years, yet one of their newest facilities had no eyewash in the chemical room, substandard railing, improperly designed ladders and more. It is not only vital to provide designers with proper resources, either the SH&E department or an outside contractor with OSHA regulatory knowledge should be involved in the design process; at a minimum, have preliminary blueprints reviewed by someone with such knowledge and experience.

### CONCLUSION

By applying sound management principles to all aspects of business operations, we can develop the business culture and, in the process, minimize human error and related injuries. By managing the following principles, we help protect our most important resource—people.

- Establish a business culture.
- Develop and implement effective safety rules, policies, programs and procedures.
- Enforce safety rules in the same way all other rules are enforced.
- Effective training.
- Proper employee selection and placement.
- Effective design.
- Holding everyone accountable.
- Effective management.

To view a sample human error and culture evaluation checklist courtesy of CTJ Safety Associates, LLC, [click here](#). ☺

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# Inside Global MINING

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## Zero Is the Goal

An empty slogan without required resources

BY JAMES E. LEEMANN, PH.D.

**F**or the better part of the last two decades, most corporations have fallen prey to obsessively using zero to define virtually every safety and health goal, not to mention the plethora of environmental goals—waste, emissions, GHG, carbon footprints, spills, leaks and on and on.

To those in senior management positions, “Zero is the Goal” is a simple, easy-to-remember catch-

*Safety and health goals must appeal to the achievement motive of employees. Achievement-motivated employees stray away from very hard goals for fear they will not achieve the goal.*

phrase. Safety and health professionals welcome senior management’s support but still struggle to convince management that human, material and financial resources are necessary to reach this laudable goal of zero. Too often senior managers arbitrarily set goals and have no clue as to what it will take to meet the goals.

For many at the worker level (where most injuries occur), “Zero is the Goal” is contemptible. Factory-

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## Zero Is the Goal

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floor operators and mechanics are cognizant of the fact that they do not work or live in a “risk-free world.” These people can live with the high-probability, low-consequence injuries many encounter during their career. It is the low-probability, high-consequence events they lose sleep over.

Slogans like “Zero is the Goal” are fine as long as management is willing to provide the resources to do the more difficult and expensive safety and health program activities. Otherwise, workers who face the hazards on the factory floor will view these slogans as nothing more than corporate poppycock.

### SETTING SAFETY & HEALTH GOALS

For more than four decades, researchers have focused on the benefits of using goal-setting to enhance business performance. In fact, goal-setting is so ingrained in today’s business cultures that it would be hard to imagine a business being successful without some form of goals.

Locke’s (1968) research revealed that a direct relationship exists between the difficulty of a specific goal and an individual’s performance to accomplish the goal. In particular, Locke found that hard goals produced a higher level of performance than easy goals; specific hard goals produced a higher level of output than a “do your best” goal, and behavioral intentions regulated choice behavior.

### GOAL-SETTING PRINCIPLES

In 1990, Edwin Locke and Gary Latham collaborated on their seminal work in the field of goal-setting, publishing their book, *A Theory of Goal-Setting and Task Performance*. Using their goal-setting principles, consider this when setting next year’s safety and health goals.

First, consider the clarity principle. Safety and health goals must be clearly measurable, unambiguous and behavioral with a definite timeframe for completion. Although admirable, “Zero is the Goal” does not clearly convey what one must specifically do or change in order to achieve zero. As a vision, “Zero is the Goal” is what all companies strive for, but operators and mechanics are more receptive to specific goals with allocated time and resources that directly relate to their work environment (e.g., reduce process risk exposures by 75% from the 2005 base year by 2012).

Then consider the principle of challenge. Safety and health goals must appeal to the achievement motive of employees. Achievement-motivated employees stray away from very hard goals for fear they will not achieve the goal. Additionally, these same employees will tend to ignore easily achievable goals because they think they do not offer genuine challenge. Assigning difficult goals is fine as long as they are realistic and attainable.

Next, consider the commitment principle. Safety and



health goals created in a vacuum will lack the necessary buy-in from those who are expected to deliver the goal. Make a solid effort to encourage employees to be involved in developing not only their personal goals, but also those of the corporation.

Incorporate the feedback principle. Safety and health goals, especially ones that take a long time to accomplish, need a built-in and routine feedback mechanism to allow employees to know how they are doing and whether they are going in the right direction or need to make adjustments. Consider breaking down more complex safety and health goals into reasonable pieces with specific milestones that can be tracked.

Finally, consider the task complexity principle. Safety and health goals must have a realistic timeframe based on the difficulty to achieve the goal. Allowances need to be taken into account if the employee tasked with the goal requires additional training and practice to master new skills to deliver the goal. In this case, consider including a learning goal that compliments the performance goal.

### GOAL-SETTING PITFALLS

In 2006, Latham and Locke identified 10 pitfalls they associated with goal setting. In 2009, controversy erupted in the goal-setting community when Ordóñez, et al. published their “Goals Gone Wild” article criticizing the lack of research attention given to the downsides of goal-setting. Locke and Latham responded to Ordóñez, et al. with both barrels blazing.

Academic jousting aside, the authors raise many goal-setting downsides worth paying attention to when setting safety and health goals. A sampling of some include adverse effect on risk-taking, elevated stress levels, feelings of failure, ignoring nongoal performance areas, dishonesty and cheating, lack of skill or knowledge, being overwhelmed by too many goals, setting unattainable

*Most corporations have fallen prey to obsessively using zero to define virtually every safety and health goal, not to mention the plethora of environmental goals—waste, emissions, GHG, carbon footprints, spills, leaks and on and on.*

goals, eroding cooperation within groups due to competitive personal goals, decreased intrinsic motivation, unfair monetary rewards and inhibited learning.

The keys in setting safety and health goals to ensure success are to encourage participation in the development of the goals and to ensure that adequate time and resources are provided to accomplish the goals, while being mindful of the potential pitfalls. ☺

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## MSHA to Launch Safety & Health Conferencing Pilot Program

**M**SHA has announced it will launch a 90-day pilot program aimed at addressing the backlog of contested citations and the agency's conferencing procedures. According to 30 CFR §100, mine operators may request a conference with MSHA officials to dispute citations issued by federal mine inspectors. The pilot program will allow the mine operator and the miners' representative to hear MSHA's interpretation of regulations and to discuss and resolve issues relating to violations prior to the civil penalty assessment and litigation. Under the current system, conferencing takes place after penalty assessment and a timely contest.

Joseph Main, assistant secretary of labor for mine safety and health, renewed the pledge he made before the Senate Committee on Health, Education, Labor and Pensions last April to improve the conferencing system.

"It is clear that the current conferencing structure is not working," said Main. "By resolving factual disputes before a violation is contested, these citations will not be added to the enormous backlog of cases that have bogged down the judicial system. This process should also improve consistency in MSHA's enforcement of the Mine Act."

Three MSHA district offices will participate in the pilot: Coal District 2 in Mt. Pleasant, PA; Coal District 6 in Pikeville, KY; and Metal/Nonmetal Southeast District in Birmingham, AL. These three



*By resolving factual disputes before a violation is contested, these citations will not be added to the enormous backlog of cases that have bogged down the judicial system. This process should also improve consistency in MSHA's enforcement of the Mine Act.*

locations were selected so that pilot efforts could include a wide range of mine operators and different MSHA personnel to determine what will work and if the program goals can realistically be met. The pilot began on Aug. 31, 2010.

Currently, approximately 89,000 violations are in contest. Congress recently appropriated \$18,200,000 to the Labor Department and \$3,800,000 to the Federal Mine Safety and Health Review Commission for the purpose of reducing the existing backlog of cases. ☺



# Managing Generation X

In 1991, Canadian novelist Douglas Coupland coined the term “Generation X” to describe people born between 1966 and 1980. He portrayed them as whiny, self-centered slackers, dissatisfied with their lots in life. A year later, Mike Myers and Dana Carvey painted Gen Xers as dimwitted goofballs in the movie *Wayne’s World*.

Today, most have grown out of those descriptions, which were dubious to begin with, and are now living productive adult lives.

But, as generations go, they were unique. Gen Xers were shaped by the events of the mid-1960s to the mid-1990s. They grew up in a different environment than did their Baby Boomer parents—one in which having children was not as fashionable, staying at home to raise them not as common and staying together as a family not a given. They were young children during the stagflation of the 1970s and young adults when the grownups around them were laid off in the early 1990s.

So they ended up fairly wary, independent and adamant about what they wanted out of work and life. Those who successfully manage Gen Xers today will recognize these characteristics and act to support them. Here are some suggestions on how to do it.

## GIVE THEM INDIVIDUAL RECOGNITION

In addition to team recognition, make sure that Gen Xers are spotlighted individually for jobs well done. To the degree you can, put them in working situations where they can shine.

A Baby Boomer we know who leads a marketing team tells us that she makes it a point to reward her Gen X teammates in a way that is significant to them.

“It is very simple. Whenever one of the members has a good idea or

has helped us out of a jam, I send a brief e-mail to everyone outlining what the Gen Xer has done. The team is stronger for the efforts of the Gen Xer and the Gen Xer is happier for being recognized. Besides, I am not foolish. That Gen Xer could be my boss next year.”

## ESTABLISH A MERITOCRACY

Meritocracy is defined as “a system in which the talented are chosen and moved ahead on the basis of their achievement.” Notice that there is no mention of who they know, how they schmooze or how long they have been with the company.

Gen Xers have little patience with organizational politics, especially patronage. Nothing will turn a Gen Xer off faster than to see someone receive a promotion that is not based on merit but on whom the person knows. The old saying, “It is who you know, not what you know, that counts,” drives Gen X cynicism. The better course is to award promotions, raises and other discretionary perks on merit alone.

## APPLY DONALD TRUMP-STYLE TRAINING

Preferring to work alone, Gen Xers expect to be trusted to do their jobs without having to run to their managers for decisions or permission to use their judgment to solve problems.

The owner of a small manufacturing company we know is looking forward to retirement next year. He is grooming a Gen Xer to take over. To facilitate this process, he uses what he calls the “Donald Trump Apprentice” approach, based on Trump’s television show *The Apprentice*, where he assigns apprentices tasks and then lets them sink or swim. He meets with this protégé every Friday to discuss the upcoming week, then heads for the golf course and does not come back until the next Friday. The Gen Xer is to call



him only if the place burns down or someone dies. Otherwise, she is on her own.

Every Friday, he applauds her for the things she did well and holds her brutally accountable for her mistakes. In a speech we attended years ago, business guru Tom Peters called this the “white knuckle” approach to leadership training. He said, “You do not really have a grasp of what leadership is like until you experience the white-knuckled terror of being totally responsible for what you are leading.” Our experience has shown that Gen Xers embrace this approach to their own development with gusto.

By the way, the last time we checked, this project was going so well that our friend was planning to extend his golfing hiatuses to a month.

## GET RID OF STUPID RULES

In spending lots of time alone as children, Gen Xers were forced to create their own rules. As a result, they have little tolerance for rules that make no sense to them. We

know a manager who pulled his team of Gen Xers into a room, put a copy of the 3-in.-thick policy and procedure manual on the table and ordered them to figure out how to cut its weight and volume by half. Four hours later, they had trimmed the book by 60%. He said his team was delighted and one member told him, "This is the most fun I have had at work since I started here."

### KEEP THINGS MOVING

Ready. Lights. Action. Gen Xers tend to like a fast pace and will become frustrated when they feel things are lagging. They often turn their noses up at team meetings because they consider them bottlenecks that delay, rather than accelerate, decision making. One client put a big red action button on the conference table. If it looks like a meeting is starting to drag and go off course, anyone can hit the action button, which rings a loud bell, getting everyone back on task.

To make meetings more productive and more inviting to fast-paced Gen Xers, consider the following eight-step meeting strategy:

**1) Determine the purpose.** Gen Xers are quick to judge something as stupid if it wastes their time. Holding a meeting every Friday afternoon just because it is Friday is stupid to a Gen Xer. Having a clear purpose for the meeting that contributes to his or her success on the job is smart.

**2) Consider alternatives to meetings.** Can the purpose be accomplished equally well through a less-time-consuming method, such as e-mail, Twitter or Facebook, or through audio- or videoconferencing? If the purpose is simply to keep everyone informed, maybe so. If it is to discuss a complicated matter, generate enthusiasm for a new plan or brainstorm solutions to a problem, maybe not. The bottom line is not to hold meetings just for the sake of holding meetings. It will drive your Gen Xers crazy.

**3) Create an agenda.** Be sure to identify who, what and when. In

other words, each item on the agenda should describe who is responsible for presenting the issue, what they expect to accomplish (e.g., decision, solution, information dissemination) and how long they expect to take (e.g., 2:00-2:15 pm).

**4) Start on time.** How often have you arrived at a meeting at the scheduled time only to have it start 15 minutes late? The problem with starting meetings late is that they then tend to run late. It also insults the people who made an effort to get there on time and rewards the people who were tardy. Finally, it teaches those who are concerned about their time (like many Gen Xers) to arrive late on purpose.

If you want your meetings to start on time, start them on time, even if people are missing. As people learn that a 2:00 pm meeting really starts at 2:00 pm, they will begin to get there on time. Either way, proceed without them.

**5) End on time.** How often have you attended a meeting that was scheduled to end at 3:00 pm, only to have it drag on to 4:00 pm, 5:00 pm or later? The only reason meetings do not end on time is because they do not end on time. If you want your meetings to end on time, end them on time.

If you stick to the ending time, a magic thing will begin to occur. As the ending time approaches, people start talking faster. They come to the point quicker and they digress less. It follows the famous Parkinson's Law, which says, "Work expands so as to fill the time available for its completion."

**6) Stick to the agenda.** This will help keep the meeting from getting off track.

**7) Assign responsibilities.** Gen Xers like to know what they are responsible for. If a meeting ends and there is no clarity about who will do what by when, Gen Xers will often assume it is someone else's responsibility. When they are asked later why they did not produce, they

will blame you for not clarifying that they were supposed to do it.

Take notes and publish minutes with assigned responsibilities clearly defined. That way, when the Gen Xers get the e-mail with the minutes, they know what they are supposed to handle and they can act accordingly.

Remember, Gen Xers tend to be individual players who do not like to worry about what the other people on the team are doing.

**8) Beware of hovering.** No one likes to feel like they are being micromanaged, but given their signpost of latchkey independence, Gen Xers are especially sensitive to it.

### THE BOTTOM LINE

Generation Xers are not loyal for loyalty's sake, but they can be very loyal if the company meets their needs. They will not work long hours just because the company wants them to, but they will work long hours if they understand the need and can expect a balance of time off for their efforts. They prefer working on their own to working in a team, but they are team players if the other members of the team do their part to meet a goal. They will not schmooze their way to a better job, but they will seek better jobs on the basis of their abilities. They get bored easily, but they will be engaged if you challenge them, remain flexible, keep things moving and recognize their achievements. ☺

**Meagan Johnson and Larry Johnson**, a father-daughter team, are the Johnson Training Group whose clients include American Express, Harley-Davidson, Nordstrom, Dairy Queen and others. They are noted public speakers on the subjects of generations in the workplace and building productive corporate cultures and other management challenges. They may be reached at (800) 836-6599 or at <http://www.JohnsonTrainingGroup.com>.

This article is adapted from the Johnsons' book, *Generations Inc.—From Boomers To Linksters: Managing The Friction Between Generations at Work*.



# Managing Up the Age Ladder

**N**early all managers must oversee people older than they are. If you are a Gen Xer or Gen Yer with Baby Boomers to manage, your success, to a large degree, is tied to how well they perform. How does a manager in his/her 20s, 30s or 40s deal effectively with someone old enough to be his/her father or grandfather. Here are seven strategies:

## 1) RESPECT THEIR EXPERIENCE

Acknowledge older employees' experience by asking for advice. All of us like to think we have value. To a Boomer, much of that value comes from having decades of experience. Be careful, however, not to come across as pandering. Most people can tell when a manager is saying something she does not really mean. Focus on the work, and ask legitimate questions that acknowledge the older person's experience.

## 2) GIVE THEM ROOM WITHOUT ABANDONING THEM

Most Baby Boomers are at a point in their careers where they do not need much direct supervision.



*As a manager of people older than yourself, you want their perception of you to be that you are doing a great job for them. This is especially true when they observe how you deal with the "suits" upstairs. If you do this well and get them what they need to do their jobs well, their respect for you will climb.*

However, for the young manager/older employee relationship, it is important to have a frank conversation about boundaries and communication requirements early in the relationship because the potential for misunderstanding and hurt feelings is so much greater when the age difference is reversed.

For example, how often, and in what manner, do you expect the Boomer to inform you about day-to-day events? Through what communication vehicle? Phone? E-mail? Twitter? At what point do you expect Boomers to involve you in a problem? Make sure they know you will not micromanage or stand in the way of getting their job done.

## 3) PROVE YOURSELF THROUGH PERFORMANCE

Accept the reality that, for a while, you will be perceived as "just a kid." You will gain respect by your performance.

For example, a brilliant young software engineer we know was promoted to lead a team of senior scientists because the group was working with advanced systems in which he had expertise. When a disagreement would arise about how to handle a problem with the system, he made it a practice to ask for their opinions first. If their solutions seemed right to him, he would say something like, "Great. That makes sense to me." If he disagreed, he would often make a comment like, "I am the one with the least experience, but I have an idea. What do you think about. . . ? In your experience, do you think that would work?" He would then present his case. As the Boomers got to know him and trust that he really understood what he was talking about, he was able to drop the disqualifiers and to engage with them as equals.

## 4) PRACTICE RADAR O'REILLY MANAGEMENT

If you ever saw the television series *M\*A\*S\*H*, you probably remember Radar O'Reilly, the cute, naïve company clerk and bugler. His real job, however, was to get the surgeons and nurses what they needed to do their jobs well. If they needed scalpels, he tracked them down and delivered them. If they needed a generator but none was available, he would wheel and deal with clerks from other companies to score one.

As a manager of people older than yourself, you want their perception of you to be that you are doing a great job for them. This is especially true when they observe how you deal with the "suits" upstairs. If you do this well and get them what they need to do their jobs well, their respect for you will climb.

## 5) MOTIVATE THEM ON THEIR TERMS

What motivates people is highly individualistic, espe-





cially for Baby Boomers who have lived long enough to have a wealth of experience. In choosing special awards or incentives for them, you may consider increased contributions to a 401(k), flexible schedules so they can start developing postretirement interests and opportunities to be recognized and applauded for their achievements. However, this does not mean all

Boomers will want those things. The obvious step is to ask the Boomer, "How can I reward you for your terrific work?"

#### **6) ARRANGE FOR RECOGNITION AND CREDIT.**

Like any generation, Baby Boomers like to be recog-

nized for their achievements. To the degree you can make that happen, you will reap the rewards of their loyalty. You must be careful, however, not to sound fawning.

The chances of this happening are directly proportional to the difference in your ages. If you are more than 10 years younger than the Baby Boomer you are praising, see whether you can enlist the help of another Boomer from whom the praise will carry more meaning.

For example, during a team meeting, Judy, the Gen Y team leader, said to Jack, the Baby Boomer, "Bill was telling me about what you did on the Anderson account, right, Bill?" At that point, Bill made a comment supporting Jack's abilities. It gave Jack a double dose of praise, and it built Judy's credibility because she 1) did her homework and 2) proved she is willing to give credit where credit is due.

#### **7) FORGE ALLIANCES WITH YOUR VETERAN SERGEANTS**

All great leaders surround themselves with advisers who may have wisdom in areas they lack. Making an ally of a Baby Boomer who holds the respect of the team will do the same for you. It will enhance your credibility with the entire team and give you support when things get rough. Best of all, the Baby Boomer with whom you build this adviser/advisee relationship will tend to feel more vested in your success and in the success of the group. ☺

**Meagan Johnson and Larry Johnson**, a father-daughter team, are the Johnson Training Group located in Scottsdale, AZ. Their clients include American Express, Harley-Davidson, Nordstrom, Dairy Queen and others. They are the coauthors of *Generations Inc.: From Boomers to Linksters—Managing the Friction Between Generations at Work*, from which this article was excerpted. Larry can be reached at [larry@larryjohnson.com](mailto:larry@larryjohnson.com) and Meagan at [meagan@meaganjohnson.com](mailto:meagan@meaganjohnson.com). They may also be contacted via their website, <http://www.JohnsonTrainingGroup.com>.

## **Register for Safety 2011!**

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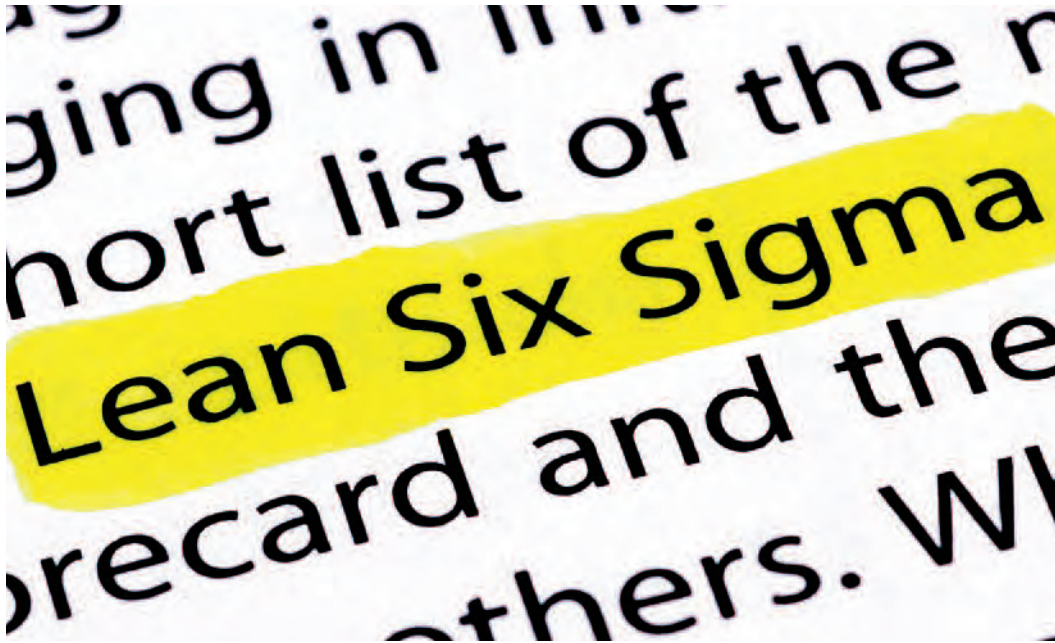
ASSE will commemorate its 100-year anniversary in 2011. The Society's 100th-year theme is "Your Safety Is Our Business. Your Future Is Our Mission." For the 2011 conference, the Society will deliver a technical program that reflects the breadth and depth of the profession and addresses the professional development needs of SH&E professionals.

For more information, visit <http://www.safety2011.org> ☺



# Perspectives

VOLUME 9 • NUMBER 3



## Safety V $\sigma$

### *Application of an Evolutionary Biological Generation Model Illustrating Lean Systems Engineering & Six Sigma Processes*

BY DR. JOHN F. HOUPPT II, PH.D.

**J**ean Houston said, “We are the people of the parenthesis—at the end of one era but not quite at the beginning of the next one. Maps no longer fit the new territories. In order to make sense of it all, we must cultivate a vision. No old formulas or stopgap solutions will work: Recreating and reeducating ourselves is our best preparation for the future” (Germer, 2007).

This article uses the biological

*The Safety V $\sigma$  theory validates the combined or integrated safety office structure illustrated in DP91 and provides a successful organizational practice and procedural model for other DOD of Defense safety offices to follow.*

generation model to illustrate the evolution of a U.S. Army installation occupational safety and health program from its origins within the U.S. Army safety program and OSHA standards though the influence of systems engineering practices, application of design for six sigma (DFSS) and quality function deployment (QFD) protocols with the development and accountability of individual system/ process indicators  
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## **Safety VIσ**

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in the analysis. The definition and creation of Safety VIσ is presented. Safety VIσ is the term used to distinguish this model and associated fundamentals from other published works related to six sigma safety.

Many illustrations are presented to demonstrate the accuracy and efficiency of the methods applied. The end result is an occupational safety and health plan that links both regulatory and customer needs into a no-nonsense practical safety system. Safety VIσ combines essential training and doctrine command (TRADOC), installation management command (IMCOM) and Department of Defense and Department of Labor (DOD/DOL) Voluntary Protection Programs (VPP) processes into a program using process metrics, eliminating elemental duplication (kaizen) without increasing the expenditure of limited resources beyond the current available level.

The Safety VIσ theory validates the combined or integrated safety office structure illustrated in DP91 and provides a successful organizational practice and procedural model for other DOD of Defense safety offices to follow.

### **BACKGROUND**

The Fort Gordon Installation Safety Office oversees the safety program of both a garrison industrial and TRADOC training base consisting of approximately 56,000 acres of training area, live-fire range complex, state-of-the-art information and communications technology, and more than 20,000 individuals comprised of service members from all four branches of the armed services, foreign national students, on-post dependents and a community-wide retiree base.

To facilitate and standardize the installation's occupational safety and health program, an in-depth analysis was conducted of the installation safety operation using fundamental systems and systems engineering protocols.

The resultant product is Safety VIσ. The reader is advised not to think this product is purely theoretical without proven structures for it is not. Theory was developed and defined. Once defined, it was tested immediately for validity and application. The component examined is treated implicitly during the substep in which it is examined, which guarantees positive definiteness, no matter how fast the utilization rate or how large the time step.

To illustrate how the practice evolved, the biological generation model format was selected. A biological generation model:

- can evolve a population in a quasievolutionary manner;
- can gradually improve the fitness of the population (process/system);
- is evaluated by an objective function, which measures multiple alignment quality (six sigma).

Services deploy to human tasks and information (not

*continued on page 20*



## **Safety VIØ**

*continued from page 17*

components), services cannot be stored as inventory because they are delivered at the moment of transaction, most often by people, and once delivered, services evolve.

Basing the processes on the biological generation model, the reader can visualize the evolution of the safety process from a single-focus, command-driven model with narrow metrics to a localized/commander-driven process of universally applied metrics.

To demonstrate the viability of the Safety VIØ process, parallel and most times, simultaneous metrics were developed using recognized six sigma process metrics. Of interest during the evolution were the definitions of opportunities.

The outcome of the Safety VIØ processes and metrics confirmed the Fort Gordon safety management processes were able to achieve an average 94% compliance with established TRADOC and IMCOM evaluation criteria for fiscal year 2008.

This level of compliance translated to a 3.66 sigma ranking of both the IMCOM operational readiness inspection (ORI) and the TRADOC command inspection program (CIP). This was validated by comparing current industrial safety programs, which average a rank of three to four sigma.

Fort Gordon experienced a 36% increase in program efficiencies and compliance when compared against the FY06 baseline evaluation of 59% compliance.

With the application of internal statistical process control (SPC) tools, processes that were previously unquantifiable and consisted of lagging or “after-the-fact” events (accidents, injuries) were able to be qualified and quantified.

## **THESIS**

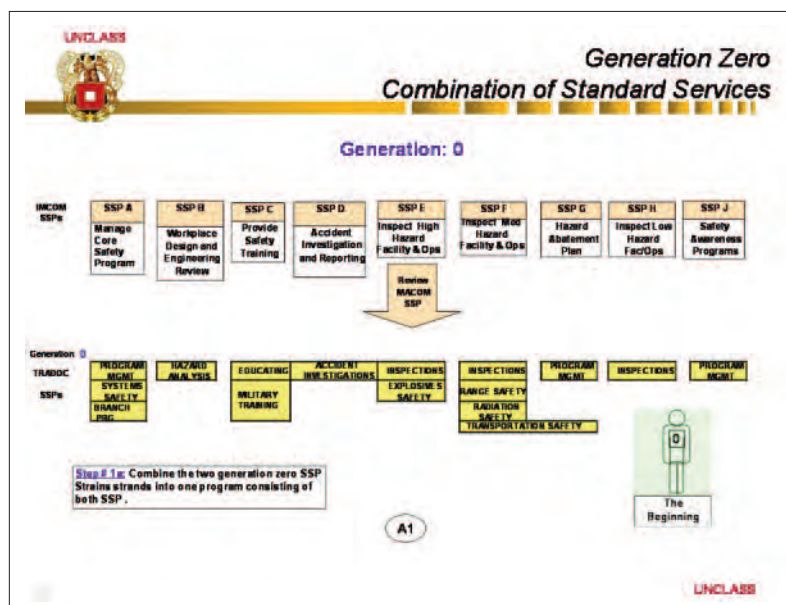
In fiscal year 2008, Fort Gordon published the first 5-year strategic plan for safety within IMCOM and TRADOC: Safety Assurance Plan, 2008-2013, Back to Basics and Renewing Safety Strategies.

To support the Fort Gordon safety assurance plan, the installation safety office isolated four key performance indicators (KPIs), which are published in the Key Performance Indicator Plan FY2008 and 2009. These indicators embody the four vital areas of the command safety process and those found within the voluntary protection program—hazard prevention and control, hazard assessment, professional development and policy and program.

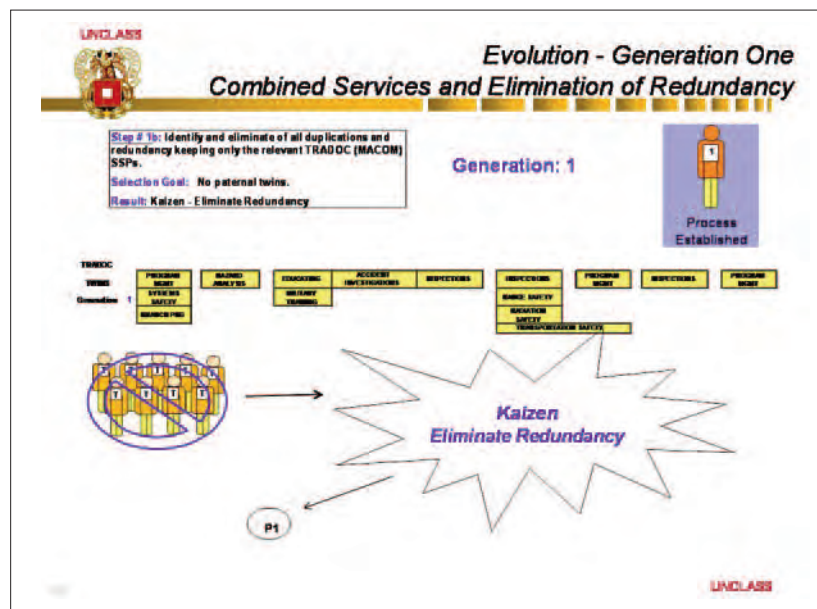
KPIs are comprised of the 12 service support programs (SSPs) consisting of 22 individual processes, which are supplemented by 35 statistical process controls.

Upon development of KPI and the supporting process indicators, research into and subsequent development of Safety VIØ were started.

## Figure 1 Initial Comparative Analysis of TRADOC & IMCOM Programs



## Figure 2 Application of Kaizen Protocols



The premise was that Safety VIσ would combine essential TRADOC (or other senior mission commander), IMCOM and DOD/DOL voluntary protection program processes and associated industrial system metrics while eliminating process duplication (kaizen) and without increasing the expenditure of limited resources beyond the current or previous fiscal year level provided.

By applying the basic principles of lean six sigma and kaizen and by using design for six sigma techniques,

alignment of the competing safety processes into a cost-efficient management program and office structure was conducted.

### INFORMATION SOURCES

The first step was to analyze both programs for commonalities and dissimilarity. Once the combined program elements were identified, the next step was to apply kaizen protocols to the two safety program elements, eliminate paternal twins and combine the remaining services into the appropriate IMCOM SSPs.

Early on, the decision was made to create a predictive front end to the six sigma design package going beyond identifying and fixing problems. This system was to get upstream to the fundamental decision-making process and become more active than reactive.

This meant the standard DMAIC

process was not applicable and it was replaced with DFSS. By using DFSS, the design analysis ensued using the identify, design, optimize and validate (IDOV) process.

DFSS focuses on preventing problems instead of just fixing them. Using DFSS, the auditor is able to proceed further upstream to recognize design decisions that affect the quality and cost of all subsequent activities necessary to build and deliver the product or service.

Figures 1, 2 (left) and 3 (p. 22), illustrate the logic flow of the beginning (two variant DNA strains/

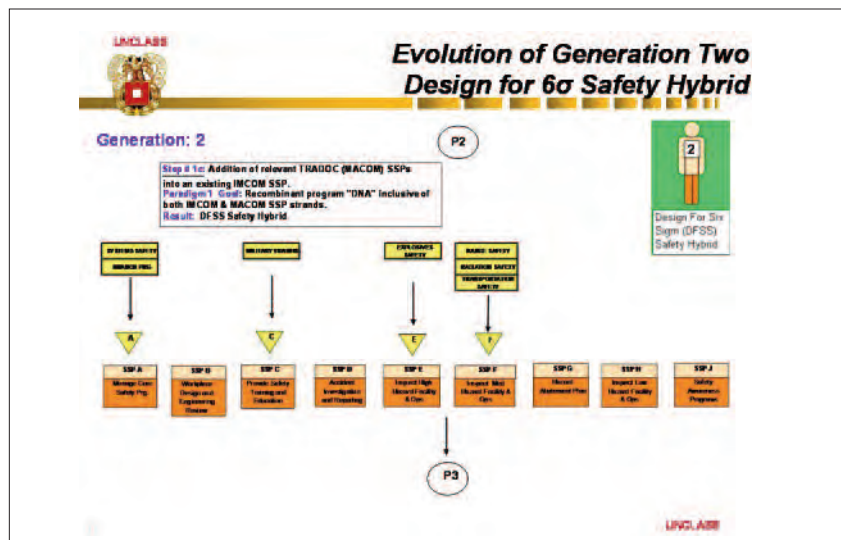
programs), the application of kaizen protocols and the end result of a hybrid program consisting of common and unique variant DNA strains.

Generation 3 (Figure 4, p. 22), illustrates the conversion of remaining TRADOC and IMCOM process/SSP into a hybrid system. The systems presented qualified and quantified processes blended with DOL/DOD VPP.

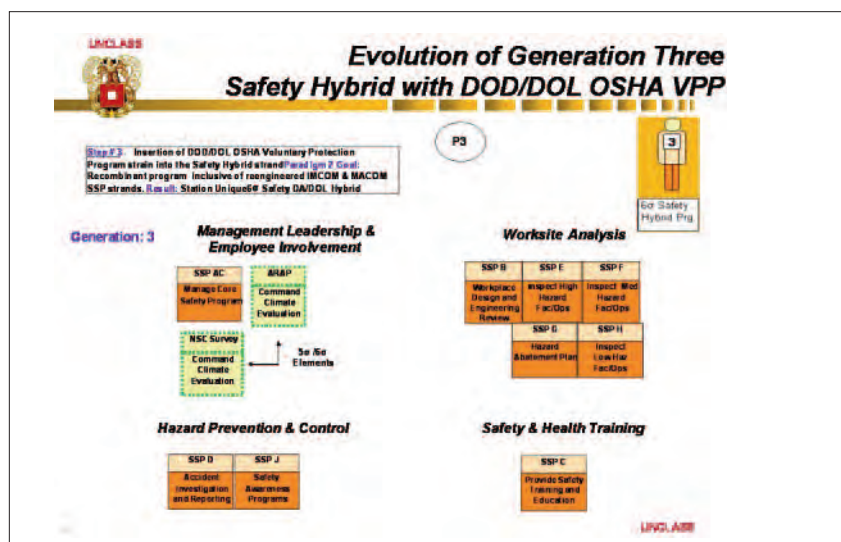
To quantify the system, processes were analyzed and various definitions and assumptions were documented.

*By applying the basic principles of lean six sigma and kaizen and by using design for six sigma techniques, alignment of the competing safety processes into a cost-efficient management program and office structure was conducted.*

## Figure 3 Merging of Program Common Elements



## Figure 4 Final Hybrid With DOD/DOL OSHA VPP DNA



The fundamental definition is that of defect—what constitutes a defect and does not.

A defect or process defect is defined as an ORI/CIP auditor finding or observation. A nondefect is defined as satisfactory or commendable annotation by the auditor. There is no reference to the quality of the annotation—it is either a defect or not.

Numerically, a defect is assigned a value of one. That is, there is a one-to-one association to ORI and CIP evaluation topic. (1 topic equals 1 defect or 1 nondefect opportunity). There are no weighted averages with the established processes.

### FINDINGS & DISCUSSION

Using the MACOM/activity CIP/ORI evaluation form

as the basis for identifying and quantifying process opportunities and the associated defect versus nondefect, a six sigma matrix was created illustrating the processes as a definitive data set comprising one safety system—the new hybrid system or division comparison. The matrix/table provides a six sigma ranking based on the delta between the sum of the possible process opportunities and the identified defects per subelement/process (Figure 5).

With the processes identified and metrics assigned, it is a matter of selecting those processes that support the individual SSP and illustrate opportunities and defects related to OIP/CIP and VPP audits. Additionally, the metrics must support the higher-level performance measure reviews established by HQIMCOM and other MACOMs. A process is defined as an SSP consisting of subprocesses/tasks while statistical process controls, defined as metrics, illustrate the variance of the activities/actions performing the process (subprocesses, tasks) IAW with established conditions and standards defined as opportunities.

Process (performance) indicators are standardized, assigned to and will represent the individual process throughout the analysis.

### HAZARD ASSESSMENT PROCESS (WORKPLACE ANALYSIS)

- planned high-/medium-risk evaluations completed vs. number of sites requiring evaluation;
- identified RAC I and II safety hazards corrected within 30 days;
- number of job safety analyses conducted vs. requirement;
- number of new operational changes that included hazard analysis and CRM;
- number of safety-related work orders completed in 2 business days.

### PROFESSIONAL DEVELOPMENT PROCESS (SAFETY & HEALTH EDUCATION)

- number of documented safety briefings conducted;
- number of army traffic safety training program students completed versus dropouts;
- number of new employees completing new employee safety orientation;
- number of commanders completing commander's certification training;
- number of additional duty safety officer/collateral duty safety officer completing certification training.

### POLICY/PROGRAM PROCESS (LEADERSHIP/MANAGEMENT)

- number of organizations' annual safety goals achieved;
- number of organizational army readiness assessment program (ARAP) and National Safety Council (NSC) surveys completed;
- number of ARAP/NSC corrective actions implemented;



**Figure 5**  
**Defect/sigma Data Set Matrix**

Inspection	Period	Units - Opportunities	Defects	DPMO	Defects %	Yield %	Sigma
Program - Baseline (FY06)	FY06	121	50	413,223	41.32	58.68	2.32
TRADOC - FY07	FY07	121	6	49,587	4.96	95.04	3.46
TRADOC - FY08 Prj	FY08 - Phase 10d	121	4	33,058	3.31	96.69	3.63
TRADOC - FY06 07 08	FY06 FY07 FY08	363	60	165,289	16.53	83.47	2.88
TRADOC - FY07 08	FY07 FY08	242	10	41,322	4.13	95.87	3.54
IMCOM - FY08	FY08	194	13	67,010	6.70	93.30	3.63
IMCOM - IG	FY08	97	6	61,856	6.19	93.81	3.66
IMCOM - CIP	FY08	97	7	72,165	7.22	92.78	3.60

**Figure 6**  
**KPI/Business Drivers**

Key Performance Indicators	
1.	Incident Frequency
2.	Hazard Assessment
3.	Policy/Program
4.	Professional Development Process
Key Business Drivers	
1.	Army Mission
2.	TRADOC Mission
3.	IMCOM Mission

**Figure 7**  
**Hazard Prevention & Control**

Quarter	IMCOM TCIR/DART	Contractor TCIR/DART	TRADOC TCIR/DART	TRADOC MILINJ Rate	Installation POV Rate	Installation POM Rate	+/- Army Goal
1 <sup>st</sup> Qtr							
2 <sup>nd</sup> Qtr							
3 <sup>rd</sup> Qtr							
4 <sup>th</sup> Qtr							
Total							

- number of organizational safety committee meetings conducted;
- number of organizational preventive maintenance events completed.

#### LEADING INDICATORS

Examples of program leading indicators include percent of reported injuries investigated by installation safety office division personnel, percentage of identified corrective actions completed for reported concerns/complaints, per-

centage of training completed for staff who require safety training, percentage of new employees who have completed new employee orientation, percentage of motorcycle owners who have completed the basic riders course/military sports riders course training, percent of planned high- and medium-risk safety evaluations completed, percentage of identified safety hazards corrected within a set period of time, percentage of new operational changes that included hazard analysis, percentage of safety behavior observations consistent with expectations, percentage of organizations' annual safety goals achieved and percentage of position descriptions that outline health and safety responsibilities

#### LAGGING INDICATORS

Examples of lagging indicators include percentage of Garrison (AF/NAF) SIGCEN Class A-D incidents reported, percentage of Garrison (AF/NAF) SIGCEN Class A-D injuries reported, percentage of Garrison (AF/NAF) SIGCEN Class A-D equipment damage reports, actual Garrison (AF/NAF) SIGCEN and contractor OSHA recordable incident rate (TCIR), actual Garrison (AF/NAF) SIGCEN and contractor OSHA days away from work (DART) and actual Garrison (AF/NAF) SIGCEN WC claim rate (OWCP).

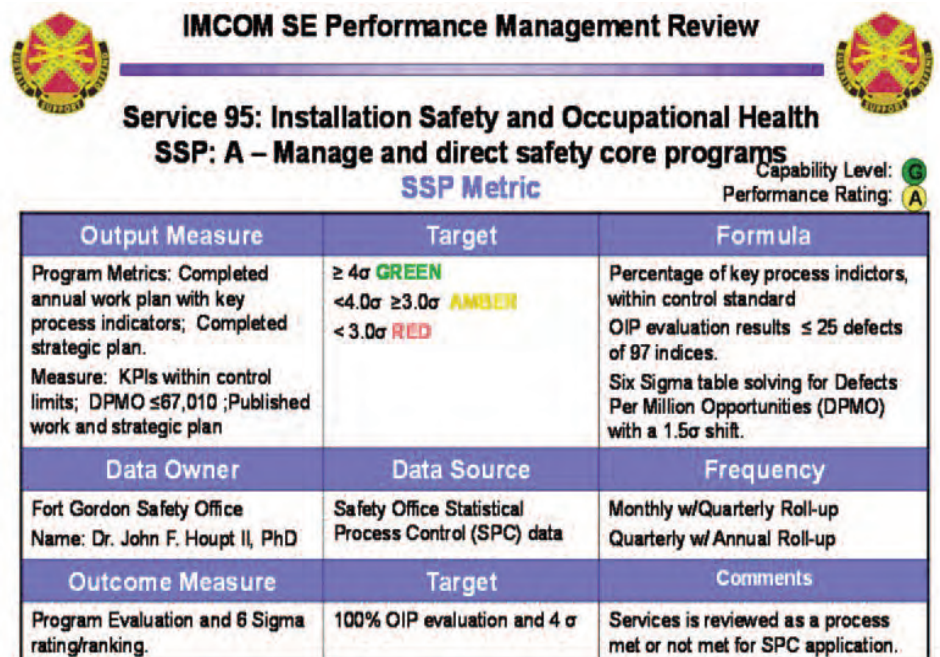
By using Safety VIσ, Fort Gordon safety management processes performed at an average 94% compliance with established TRADOC and IMCOM evaluation criteria for fiscal year 2008. This equates to a 3.66 sigma. Industrial programs average a rank between three and four sigma. Program efficiencies and compliance increased 36% when compared against the FY06 baseline evaluation

of 59% compliance.

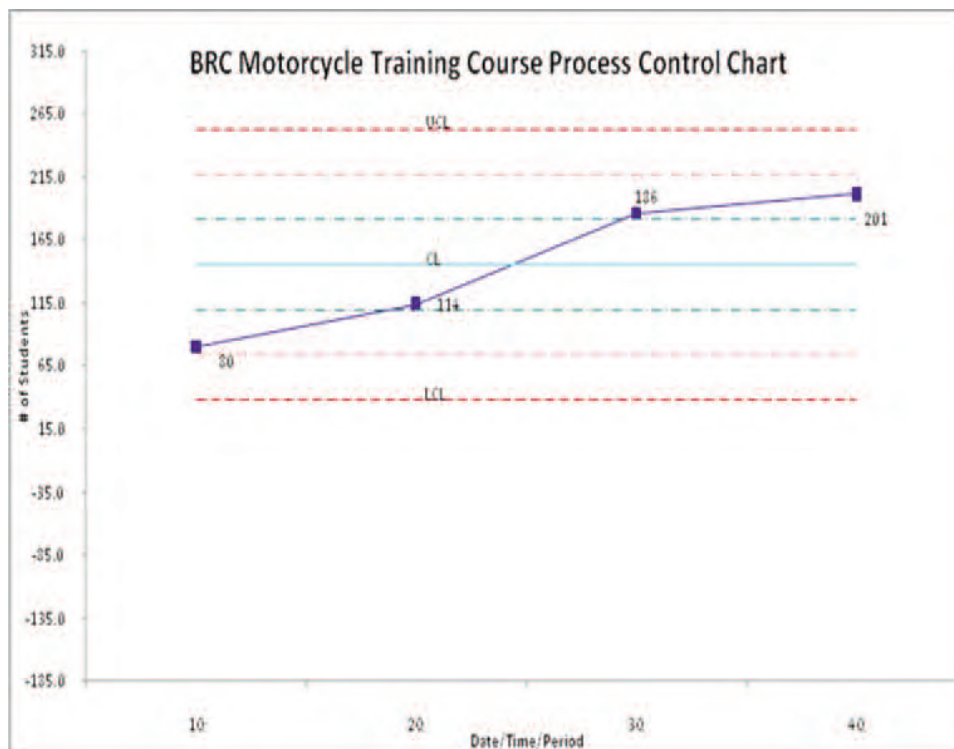
Applying statistical process controls (SPC) to areas that were previously unquantifiable or not even evaluated or consisted of lagging or "after-the-fact" events (accidents, injuries) were now balanced with real-time process leading indicators illustrating the health of the overall safety management process as a summation of the whole and not just a few topics of interest.

Safety VIσ has three levels of statistical process

**Figure 8**  
**Sample Performance Management Review**  
**SSP Metric Using KPI & Six Sigma**



**Figure 9**  
**Sample Basic Motorcycle Rider Course**  
**Statistical Process Control Chart, FY08**



importance. The statistical processes are directly tied into customer needs and are defined as command intent and provision of SSP.

The three levels of importance are process owner, division/office level and directorate/command level. The information provided within the levels is: Why is the information being provided? Who uses /reviews the information? What is the information telling?

The process owner level contains the detail of the process analysis. It shows not only the delta between opportunities and defects (basis for six sigma), but also the variation within the process (statistical process control data). Statistical process control data illustrate how the process is operating by tracking normal vs. variation and allows the process owner to correct to meet the target opportunity level. Variations are illustrated through the use of statistical process control charts (generally in the form of Cp/Ck charts).

In the division level, there is overall visibility of the composite of the target processes, which are rolled up into a subsystem series of charts and the individual processes are combined into and compared to the MACOM ORI/CIP checklist sections. This is a composite check of the processes performed within the MACOM division. Here variations are identified across the division subsystem and corrections are made.

In the directorate/command level, there is overall visibility of the division and the process owner composites compared to the MACOM OIR/CIP checklists. This is a composite check of the processes performed within the MACOM divisions compared to MACOM OIR/CIP and SC/GC guidance.

The data presented here are reduced to four vital areas comprising 15 KPIs and a frequency matrix, which is passed on to senior leadership in various forms, one of which is illustrated in Figure 8.

#### PERFORMANCE MEASUREMENTS

Performance measurements (PMs) illustrate the key process and process indicators supporting the formula associated with the IMCOM performance management review (PMR) SSP metric. KPI and PI are used to define the output



**Figure 10**  
**Program Evaluation, Six Sigma Data**

MACOM CIP DO-4	Goal	CIP FY08	IG FY08	Combined Defects	Aggregate Potential	CIP SIGMA	IG SIGMA	Zero Defects- CIP	Zero Defects- IG	Overall Zero Defects
A - Command Factors	6	5	6	1	12	3.23	6.00		X	
B - SOP	8	8	8	0	16	6.00	6.00	X	X	
C - Safety/Administration	6	5	6	1	12	3.23	6.00		X	
D - Surveys	9	9	8	1	18	6.00	3.42	X		
E - Hazard Analysis & Tracking	5	5	5	0	10	6.00	6.00	X	X	
F - Safety Council	10	10	7	3	20	6.00	2.94	X		
G - Safety Training	9	9	8	1	18	6.00	3.42	X		
H - Reports & Invest	10	10	9	1	20	6.00	3.48	X		
I - Safety Training/Education	4	3	3	2	8	3.03	3.03			
J - Explosive Safety	15	14	15	1	30	3.63	6.00		X	
K - Radiation	6	4	6	2	12	3.23	6.00		X	
L - Work Place Safety	5	5	5	0	10	6.00	6.00	X	X	
M - Special Interest	4	4	4	0	8	6.00	6.00	X	X	
Total Points	97	91	90	13	194	3.66	3.68	8	8	81.5%
Total Defects	0	6	7	13						
Program Evaluation Percentage	100%	94%	93%		93.30%	3.63				

TRADOC CIP DO-4	Goal	FY08	FY07	FY06	Combined Defects	Aggregate Potential	2 YR Combined Defects	2 YR Aggregate Potential	FY08 SIGMA	Overall Zero Defects
PROGRAMMING	13	10	11	7	11	39	5	26	3.87	
EDUCATING	7	6	7	3	5	21	1	14	3.38	
INSPECTIONS	4	4	4	2	2	12	0	8	6.00	
ACCIDENT INVESTIGATIONS	3	3	3	0	0	9	0	6	6.00	
HAZARD ANALYSIS	5	5	5	2	3	15	0	10	6.00	
BRANCH PRG	6	6	6	3	3	18	0	12	6.00	
MILITARY TRAINING	31	31	31	16	15	93	0	62	6.00	
SYSTEMS SAFETY	12	12	10	6	8	36	2	24	6.00	
EXPLOSIVES SAFETY	11	11	10	8	4	33	1	22	6.00	
RANGE SAFETY	12	12	12	10	2	36	0	24	6.00	
RADIATION SAFETY	12	12	12	8	4	36	0	24	6.00	
TRANSPORTATION SAFETY	5	5	4	3	3	15	1	10	6.00	
Defects		4	6	58	60		10			
Total Points	121	117	115	71		363		242	3.98	83.3%
Program Evaluation Percentage	100.00%	96.69%	95.04%	58.68%	83.47%		95.67%			

measure of the PM SSP metric using common derivatives—delta installation and the MACOM-established defects per million opportunities (DPMO).

Process indicators illustrate the variance of the individual process/SSP at the installation, division and process level supporting the results of the individual PMR SSP metric and answer the question, “Why?”

Process indicators are both textual and visual representations of the variance between the units of opportunities and the defects identified during a specific time period judged against the acceptable defects per million opportunities established by MACOM.

When compared to DPMO, process indicators provide a visual picture of the health of the individual performance measurement/system, which illustrates the

health of the underlying subsystems (MACOM Division) and individual processes.

DPMO delta is comparable across all MACOM/HQ elements regardless of ORI/CIP parameters. In creating defects per opportunity, opportunity is a part while defect is any nonconformance to the part specifications, regardless of how many processes are applied to each part. A part is defined as a process indicator. A defect is a defect, which is compared to the unit of opportunities for success. There are no weighted defects. All rankings are yes or no, successful or defective, go or no-go. For the purposes of this article, a part is defined as a process indicator (requirements driver).

An example is the comparisons between the Mission and Garrison Division of the Fort Gordon Installation



Safety Office. TRADOC ORI contains 121 units of opportunity while IMCOM CIP contains 97 units of opportunity with a defect per opportunity of 4. Effective FY08 CIP, the number of IMCOM opportunities has increased from 97 to 102.

The assumption is that DPO of 4 illustrates a “normal” curve of safety process outputs within the industry level of  $3\sigma$  and  $4\sigma$  using a 1.5 sigma shift. When taken separately as individual audits, each audit provides a series of distinct process indicators, defects, DPMO and DPO, ultimately yielding a six sigma ranking for the individual audit.

The auditor can now consider the data in many ways, each supporting a high (command) or operative (office, division, individual) level of data requirements.

One analysis is the delta between the two divisions and compares them to each other (director and SC/GC level); compare these to like audits within individual MACOMs (SC/GC and MACOM); average (bar over X) of the summation of both division sigma rankings equate to the overall sigma ranking of the installation program or even at the lowest level, compare the individual process deltas to themselves to identify the weaknesses and strengths of the processes. OSHA and HQDA accident frequencies are correlated to a six sigma ranking as well. Each accident is classified as a defect and the formula is adjusted accordingly.

#### CONCLUSION

The shift from general program representation using lagging indicators to a system orientation consisting of quantifiable processes with associated leading and lagging indicators provides a new corporate standard. This simplified standard represents the quality of providing the process supported by the quantity of the target occupational safety and health process offered, interpreted equally across command and service boundaries. (i.e.,  $4\sigma$  programs are  $4\sigma$  regardless of the evaluation criteria).

The primary goal for all safety program owners is to acquire a  $4\sigma$  ranking of their respective program. Only when  $4\sigma$  is realized across the full spectrum force will the U.S. Army and ultimately the Department of Defense begin to acquire the desired cultural change as represented by the 5th and 6th  $\sigma$  rankings.

By applying the outputs of Safety VI $\sigma$  performance evaluations, KPIs and PIs, quality evaluations, competitions and other audits requiring statistical representations are now quantifiable using accepted industrial statistical

processes. Senior leadership has one representation illustrating the health of the effected safety programs under their oversight without getting into the individual drivers.

It is the responsibility of the Department of the Army Safety Office in cooperation with subordinate organizations to 1) establish and publish the PIs along with KPIs defining the  $4\sigma$  safety program and 2) establish and publish the remaining indicators for senior leadership to implement the  $5\sigma$  and  $6\sigma$  levels of cultural change referred to by the Army chief of staff. ☛

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# Occupational Safety Hazards in the Assisted-Living Environment

**T**his article summarizes the occupational safety hazards of the assisted-living industry and defines a risk management safety model to help control the occupational safety hazards and their associated costs.

The assisted-living (AL) industry by definition provides people with a home-like residential living experience with staff who provide the resident with assistance with various activities of daily living (ADLs), which are feeding, bathing, dressing, grooming, homemaking and leisure.

*The greatest risks arise during the assistance of bathing, dressing, transferring and assisting to ambulate using or not using their assistive devices, such as walkers, scooters and wheelchairs, due to the postures.*

The industry provides housing largely for the private-pay customer more so than the Medicare/assistance customer. The AL model of care also has as a core belief of advocating to maximize the individual's autonomy and abilities, and to provide care in a building that does not feel institutional, providing an ambience of home, albeit with secured doors and 24-hour supervision. Varying degrees of privacy and levels of services exist for residents, ranging from private apartments, including private bathrooms, to shared living spaces commonly containing two single beds with family or non-family members, and a shared bathroom and communal eating two to three times per day.

According to the National Center for Assisted Living (NCAL), the typical length of stay for a resident in an AL environment ranges from 2.5 to 3 years (Wright, 2004). Residents commonly enter the AL community from their own home or apartment and come to the AL home with the help of someone else (90%), usually with the assistance of an adult child (Wright, 2004). NCAL statistics indicate medication assistance is a number one driver of care (Wright).

## AL RESIDENTS' NEEDS FOR ASSISTANCE

According to NCAL, AL residents need help with medications (86%), bathing (72%), dressing (57%), toileting (41%), transferring/moving (36%) and eating (23%).

When and if the resident leaves the AL setting, it is often because of the need for higher care. The AL indus-

try has filled the go-between step from one's home before entering a nursing home/skilled-care setting. A recent trend across the country in the AL marketplace is an aging-in-place business practice. With this practice, the resident often lives at the AL home through hospice care or leaves for skilled care only after deteriorating to a very high level of care.

## AGING IN PLACE

From the perspective of safety, this trend of aging in place is a leading cause of hazards in the AL workplace. Safety hazards arise for the resident as well as for AL employees when aging in place is practiced. Hazards are mostly experienced when residents become more dependent on the staff to help them with their ADLs due to their physical decline and increased inabilities and cognitive issues.

The greatest risks arise during the assistance of bathing, dressing, transferring and assisting to ambulate using or not using their assistive devices, such as walkers, scooters and wheelchairs, due to the postures. Risks also are present due to the AL home-like environment, which includes at times standard household tubs, showers, sinks, doorways and floor surfaces.

When direct care employees and family members provide care and assistance in these home-like settings they are exposed to frequent forward flexion of the spine to bend toward the now dependent residents/family members and aid them in their ADLs and to and from many surfaces multiple times per day. Staffing levels in the AL environment are not as high as skilled care, so a direct care employee may have more than 10 to 14 residents under his/her direct care during a shift, and now the added demands of more dependent residents compound the risks for occupational injury.

The AL industry home environment needs to be inspected for safety routinely to make safety an everyday practice versus a meeting held only once a month or occasionally once a quarter to help curb the impact of losses.

The AL industry, like its counterpart healthcare industry members (acute care, long-term care and home health services), also experiences a negative financial impact on its bottom line from the direct costs of claims, both liability and workers' compensation. Industry members pay for these events with after-the-fact dollars because of the lack of investing in prevention in engineering solutions. They pay in the form of workers' compensation, liability

and property claims occurring as a result of the physical demands of the work and the work environment.

These after-the-fact dollars are estimated to be three to 10 times greater than the initial investment that could have been made to prevent them. These costs are preventable but are driven by the strong core care beliefs of 1) “make it look like a home”; 2) resident rights are primary over employee rights; and 3) the emphasis on continuing residents’ independence, focusing on their abilities and never placing residents in or with equipment. Assistive devices in the AL industry are seen as too institutional and negatively aid in promoting a resident’s decline in abilities.

Currently, federal and state safety regulations apply to the AL industry for typical occupational safety hazards related to blood, needles and chemicals, driving, etc. But one leading cause of injuries to employees in this industry, musculoskeletal repetitive strain injuries, is not currently regulated. Injuries occur during the primary task of AL direct care employees’ work; the aiding of residents during the manual movement and assistance of getting from one surface to another, such as assisting them out of bed, helping them get from their bed to a wheelchair or scooter, lifting them from the floor if they have fallen, providing assistance getting dressed, etc. These tasks are usually performed by females, alone or with multiple employees if highly dependent, and with limited body mechanics training.

State resident handling legislation, which is in place in nine states in the U.S., is designed to begin regulating the employee safety aspect of the assisting tasks in healthcare, but none of these regulations include the AL industry. Therefore, no AL company in the U.S. is required to comply with any statutes for employee safety related to the safe movement of residents.

Although no legislation requires a safety program at this current time, many AL companies have implemented safe resident handling and movement programs in varying degrees. Many see the literature indicating safe patient handling programs can successfully drive down costs as they have experienced the high costs of claims and realize they need to change the way they provide care in a market where aging in place is practiced.

Resident-handling-related claims are a leading cause of injuries in this industry and often generate some of the most costly and long-term claims. Direct and indirect costs associated with back injuries in the healthcare industry, adjusted for inflation, were estimated to be \$7.4 billion annually in 2008 (Wachrer, et al., 2005). Home health industry costs are a part of this \$7.4 billion estimation and considering the explosive growth of this industry and future employment trends, this industry needs to start planning now to eliminate the risks. Many times, the AL industry feels it has little ability to control these resident handling-related injuries, that employees just need to control their movements better through body mechanics and it is too costly to buy any safety equipment to fix the problems.

During a review of job descriptions for direct care providers in the AL industry, it is common to find the physical demands section to include expectations of being able to manually lift 30 to 50 pounds frequently and be able to assist and support residents of weights ranging from 90 to 250 pounds. Few, if any, industries in the U.S. have job expectations with these physical demands. The safe lifting limit commonly followed in general industry is 51 pounds or lower. A recent revision of the NIOSH lifting limit, which took into consideration the complexities of resident handling, indicates the healthcare safe lifting limit should be 35 pounds (Waters, 2007).

The acceptance of manual resident handling along with the belief that safe resident handling hazards are difficult to control are the primary reasons why these safety concerns exist. From a root-cause analysis perspective, they are two opportunities for SH&E professionals and AL professionals to work on collaboratively to solve.

Three prominent occupational (and resident safety) hazards in the AL industry are created by 1) the resident; 2) the movement of the resident and his/her things in the home; and 3) the home itself and getting into and out of it. These are each summarized in greater detail. These are the reasons the AL industry needs a comprehensive safety review and assistance by a multidisciplinary team of safety and AL professionals to design the best risk management model possible to control the risks and their associated costs.

The scope of the problem and the leading safety issues in the AL industry are as follows.

**1) The resident is a hazard: Residents present hazards in and of themselves to the direct care employees.** From the perspective of risk and employee safety, this article lists some of the most common occupational hazards a resident presents to an employee.

**•Bloodborne pathogens and bodily fluid exposures and their associated diseases (HIV, AIDS and Hepatitis B, C, D, E and G).** These can all be contracted through contaminated needlestick incidents and/or bodily fluid exposures to open cuts/scrapes, eyes, nose or mouth of care providers. If proper PPE is not worn or supplied, employees are at risk for pathogen exposures and outcomes. A diligent process of assessing residents and properly educating direct care employees to practice universal precautions is important.

**•Complications of disease, treatment plans and pharmaceutical needs.** As noted by NCAL, assistance with medicine is a leading reason families seek AL services. Residents often have a long list of medical conditions, treatment plans, services they need to access and pharmaceuticals they need to take. In the AL industry, a registered nurse (RN) is in charge of all medicine distribution and management, which is positive for risk management reasons, but the outcome sometimes affects the direct care provider in forms of being attacked, kicked or scratched as medicines may be improper or not enough.



•**Residents with dementia.** These residents can be combative and can aggressively kick, scratch, hit and bite. Residents with dementia can be depressed, confused or have memory loss, which can lead to repeating instructions and answers over and over. Care providers' patience and empathy can be tested.

•**Elopement-wandering.** This requires extra security measures put in place by the care provider staff. AL homes need to diligently monitor entrances and exits, which can be hard to manage.

•**Needlestick/sharp(s).** A common incident/accident in the home to care providers are the many cut/puncture/scrape injuries associated with the management, use and disposal of needles, and various sharp objects in the AL home from personal care to kitchen activities.

•**Obesity epidemic.** CDC's behavioral risk factor surveillance system (BFRSS) has confirmed that the U.S. resident population from 1985 to 2008 has seen a dramatic increase in obesity. In 2008, only one state (Colorado) had a prevalence of obesity less than 20%. Thirty-two states had prevalence equal to or greater than 25%; six of these states (Alabama, Mississippi, Oklahoma, South Carolina, Tennessee and West Virginia) had a prevalence of obesity equal to or greater than 30%. The bariatric population lives in all AL communities across the U.S., and the increase in obesity is especially hard on staff (CDC, 2009). Science has confirmed that the amount of force on the spinal disk during the transfer by even two care providers of a 110-lb resident who has upper body strength, from a bed to a chair is beyond safe limits and thus is found to be a "high-risk task" (Marras, et al., 1999).

## **2) Safe resident handling and material handling: Tasks that cause employee (and resident) injury claims in the AL industry.**

•**Assistance with moving—things and people.** Assisting people to stand, sit, walk, exercise or get into or out of vehicles (residents can fall onto and into care providers, crushing, bruising or straining them) are often performed with no access to effective lifting equipment or friction-reducing or assistive devices (slide sheets, slide boards, pivot discs, etc). Moving residents who cannot assist themselves, also referred to as dead weight, places care providers in unsafe lifting levels.

•**Personal care.** Providing assistance during ADLs, such as bathing, exposes the care provider to showers, tubs and slippery surfaces. Bed-bathing can cause forward flexion when stooped in static postures due to nonheight-adjustable



beds. Applying or changing compression stockings or dressings produces static holding of limbs, with forward flexion postures, as does working on one's knees to apply compression stockings, perform foot care and assisting to dress/undress.

•**Confined work spaces.** AL homes in the U.S. market often have small personal bathrooms and do not allow for two employees to easily work in pairs when this is required. This contributes to direct care providers placing themselves in unsafe and awkward postures. These awkward postures get repeated multiple times per day, which results in various strain injuries. Elimination of awkward postures is a key factor for safe resident handling program success for the AL industry.

•**Housekeeping work and moving household furniture.**

Housekeeping work in the AL work environment encompasses vacuuming, sweeping and organizing individual or shared living spaces. The housekeeping tools used for this are oftentimes purchased in bulk with little hazard assessment performed prior to purchase or ergonomic evaluations completed to match equipment to the staff's heights/sizes. After incidents occur, then purchasing is evaluated and safer products are purchased. Use the organization's safety committee to help determine employees' needs and purchase based on safety and product utility. Broom, mops, buckets and vacuums now come with ergonomic handles and can be helpful in reducing strain injuries.

•**Motor vehicle incidents.** Work-related incidents in the course of driving to and from appointments, errands, visits, etc., and assisting residents into and out of their personal or public transportation vehicles are also common. Getting residents in and out of cars presents a hazard of stooping low to help lift feet out of

foot wells and then assisting to stand places great force on the spinal discs. If the resident falls during the assistance, many times the care provider is taken down in the incident or intervenes to lessen or stop the fall.

3) **The AL home is the hazard. The AL work environment is a hazard in and of itself.** The AL work environment(s) has a large variety of home settings, which present unique safety hazards. Some are styled after single-family homes, ramblers or multilevels. Each presents unique hazards and need to be evaluated from a risk perspective that takes into account, first and foremost, the employees. The following hazards should be part of a comprehensive risk assessment prior to an AL

home. A sample AL safety checklist can be obtained for free from the author.

•**Animal therapy.** A wide variety of pets exist in the AL home, the most common being cats, dogs and various birds. Establish a preferred vendor of these animals to ensure quality animals that will not contribute to employees or residents being bitten or scratched.

•**Indoor environmental hazards.** In the AL home, a master list of all chemicals, herbicides and/or pesticides should be maintained and updated as changes occur. An MSDS of each chemical should be on hand and readily available for all emergencies or inspections.

•**Outdoor environmental hazards.** Lighting, ice, snow, unclear paths to and from a property and poor physical access to AL homes result in numerous slip, trip and fall claims by employees, residents and family members. Due diligence of monitoring for any slip, trip or fall hazard is a must for AL homes. Document inspections and all actions completed to show good faith efforts to prevent such issues.

•**Weather hazards.** Severe weather onset in an AL home can alarm or upset residents, especially when the severe weather storm causes evacuations or movement to a shelter. Practicing is one way to help reduce the emotional stress of such events.

•**Working alone.** Many AL employees work alone, entering into private or shared residents' rooms and assist residents while working one-on-one. The time spent alone presents great risks for an employer. Solutions for helping reduce working alone risks include using pagers, walkie-talkies and requiring employees to make calls to check in and check out of resident rooms. If this is not addressed in an organization's current risk management plan, it should be reviewed and researched to implement appropriate solutions to reduce exposures to workers' compensation and/or other types of claims or lawsuits.

•**Workplace violence.** AL employees frequently work in moments of residents acting out due to medicine reactions or cognitive impairments, and this can cause the employee to face some form of violence from residents and/or family members. Have zero tolerance for violence and provide workplace violence prevention education for all staff. Have a written policy, offer training to all new employees upon hire, provide routine update training and document all sessions.

Added to these employee occupational safety issues in the AL industry are three compelling employment trends in the U.S.:

1) **Projections of a smaller employee base.** The home health services industry is a rapidly growing industry in the U.S., and the number of women age 25 to 54, the main labor pool from which these workers will be drawn, is projected to increase (2006-16) by less than 1% (PHI International, 2008).

2) **Projections of many residents.** During the baby boomer years (1946 to 1964), 78 million Americans were born. The biggest year of the boom was 1957,

*Getting residents in and out of cars presents a hazard of stooping low to help lift feet out of foot wells, then assisting to stand places great force on the spinal discs. If the resident falls during the assistance, many times the care provider is taken down in the incident or intervenes to lessen or stop the fall.*



when 4.3 million boomers were born. In 2011, the 1946 boomers turn 65 years old and will begin the uptick in service demands as they begin to retire. The Census Bureau predicts that 57.8 million boomers are expected to still be alive in 2030. Many of them will require some form of extended care, such as those services offered by the AL market.

**3) Aging workforce.** Some baby boomers may decide to work longer and delay retirement and look to the AL industry as a means of income and enjoyment. Employing the 55+ workforce will require AL employers to plan for business strategies to preserve the health of their senior workforce, while at the same time applying strategies to retain and motivate the workforce for employee safety.

This article presents the leading safety issues facing the AL industry. The items listed here are steps to implementing a comprehensive AL risk management safety model. This will assist AL employers in reducing the total cost of risk in their organizations for employee, resident and property safety.

**1) Have well-written job descriptions and clearly define the physical demands of the jobs.** To ensure that the best employees are hired to match the needs of the organization and to limit all liabilities, well-written job descriptions that also clearly define the physical demands of the jobs will help reduce turnover and their associated costs. It helps to have the physical demands defined by a physical therapist or job demands expert to ensure that ever-changing employment law requirements and safety laws/best practice standards are outlined. This also helps recruit and match the best staff possible. With well-defined physical demands, an employer can clearly ask if a candidate can safely perform the job as described. The employee can easily answer if s/he is capable of completing the job. The well-defined job description can later become a helpful tool for a treating physician who needs to understand if s/he can consider transitional alternate duty options with the organization for injured employees with workers' compensation work restrictions.

**2) Use preemployment screening tools to hire the best and to place them with the most complex clients.** Hire the best staff you can by using affordable employment screening tools available in the marketplace that establish the organization's needs with criteria that define the job demands and stay within employment laws. To reduce liability, match the best staff to service the organization's most complex residents. This along with the well-written job description and physical demand descriptions can help reduce turnover and the costs associated with restaffing.

**3) Develop management safety statements in-line with the organization's mission and value statements and exercise overt involvement of management in day-to-day safety.** Safety management statements set the tone for how employees will perceive the culture of safety and how they can or cannot behave toward safety

day-to-day. A successful safety program has safety statements that are developed by the management team and the safety committee members. It should be signed by the top leadership of the company. These statements act as the pillars of the organization. These safety statements need to be part of all employee communications, and there should be obvious and direct presence of leadership emphasizing the importance of safety to all employees at all times. The manager who expects safety and also acts out those safety requirements in front of his or her staff will get safe actions and behaviors in return.

**4) Create a safety/risk management committee for insurance program oversight.** Besides having written statements of safety, an effective risk management control is to have a multidisciplinary risk/safety management steering committee in the organization regularly reviewing, discussing and monitoring the organization's insurance programs. The purpose of this steering committee is to develop an open line of dialogue with the operations staff, risk management, human resources, clinical staff and front-line staff on matters related to all lines of insurance-employees-workers' compensation, residents-liability and property.

Collectively, the team needs to establish a set of metrics, such as claim frequency and severity, and claim trends for causes and costs. Based on the trends, develop multifaceted solutions for corrective action and follow up to ensure that they are implemented. Many times, insurance carriers, third-party administration companies and or brokers' loss control or claims consulting staffs can assist an employer in developing these oversight committees, help determine typical metrics and help benchmark an organization to their industry and peers in the state or country. Insurance professionals can also help establish who can generate the reports, the frequency of the reports and what format to document the monitoring of the corrective action plans.

**5) Emphasize a balanced culture of employee and resident safety.** Too often in healthcare-related industries, safety is all about the resident and the employee is secondary. It is imperative to equally balance the employee safety program so it is seen as an equal to the resident safety program. This will foster a culture of employee and resident safety, where one does not outweigh the other. Employees who feel they have employers who care for them are less likely to change jobs and less likely to file fraudulent claims.

**6) Require that safety be a measurement of job performance for all employees.** Establish a list of safety rules for all employees to follow and set these as job performance expectations for all job descriptions. During

*During the assessment, a care plan will be discussed and service options explained and residents (and their families) will be involved in determining how to carry out the care plan.*



annual performance reviews, have safety as a topic of performance and speak to each employee's part in the success or lack thereof. This sets the tone, that as individuals, we all are responsible for the success of our own performance and the organization's overall safety performance.

**7) Develop leading and lagging indicators for organizational safety performance, celebrate successes and set well-communicated corrective actions in place when goals are not met.** The organization's safety performance must be measured annually to ensure that progress is made toward safety and risk reduction. This can be measured by creating leading and lagging indicators for safety. Examples of leading indicators is establishing annual goals of holding a predetermined number of safety meetings with management and holding a certain type and number of annual safety training/communication meetings with all staff. Determine how many meetings were held and measure progress each year. Note trends and set corrective actions in place if the goals are not met. Report the results to all employees and the board if one is involved.

An example of common lagging indicators may include a goal to reduce the organization's OSHA 300 log lost-time day incidents each year and/or frequency and severity

trends in claims going down 20% and measure the improvement or lack thereof of these parameters. Also, report the results to all employees and the board if one is involved. Simple goal setting and organizational communication also sets the tone for safety—it is important that management sets goals, measures it, expects it from all employees and celebrates when goals are achieved.

**8) For new resident assessments establish when to accept risk and**

**when to practice risk avoidance/risk transfer.** AL employers should determine in their business plans which level of resident care they will provide and through thorough resident assessments, make clinical business decisions whether services will allow them to do business or that the service requested will place them in too high a risk for an incident. The organization's clinicians will always need to use their professional judgment in the new business assessment and developing the optimal care plan for residents based on the new business assessments which reduces risks for all involved.

During the assessment, a care plan will be discussed and service options explained and residents (and their families) will be involved in determining how to carry out the care plan. At times, it may be optimal to practice risk avoidance for business continuity and to discuss discontinuing care activities for a period of time, or not engaging in a contract for service at all. The best assessment for resident care will also include a component of the occupational safety hazards and solutions noted in

this article besides resident safety. Establish a comprehensive assessment tool with criteria for establishing risks the resident presents to staff and risks inherent in the resident's home environment. The assessment is not only of the clinical issues the resident presents, it is a much broader scope of risk the employer must look at to know the total list of risks they are entering into prior to agreeing to provide services.

**9) Establish best practices of care: Use resources from other healthcare systems, such as those in Canada and Europe.** Establish best practices of care that define what are acceptable and unacceptable ways of providing services, which reduce risks to residents and employees. Comprehensive resources from the Canadian Interior of Health, British Columbia and Europe may be obtained from the author.

**10) Use job hazard analyses (JHAs) to establish best care practices, educate all staff and help hold employees accountable to follow the best practice standards.** The model of JHA is a practical format of defining the proper steps to a job, the hazards one may encounter in the steps and solutions for optimal resident and employee safety during each step of the job/task. Contact the author for specific home health job hazard analyses of bed making, bathing, etc.

**11) Develop a customized safe resident handling program.** The market in safe resident handling equipment now offers many solutions for the AL industry and functions well in the home-like AL environment. Implementing an AL safe resident handling program can be done by determining residents' dependency levels. AL homes in the U.S. have been outfitted with ceiling track, floor-based lifts and stands and assistive devices and incorporate therapeutic use of lift equipment successfully. Because incidents/injuries during handling of residents are one of the leading causes of injury in this employment sector, it will be imperative to have a creative and multidisciplinary team driving the initiative forward.

**12) Provide regular safety communications to staff and in various formats.** Safety toolkits are a recommended format of communication. After each resident and home environment assessment, have customized safety toolkits to address the hazards and risks identified in each AL home. The toolkits can then be placed in the care plan for employee and resident safety, which resides in the resident's room. This way it is an immediately accessible resource. The best safety toolkits should be developed by a multidisciplinary team of SH&E professionals from the carrier/third-party administrator/broker relationships, direct care staff, supervisors and management to create the excitement and buy-in necessary to bring new tools into the workplace.

Potential tools might include:

•**Assistive devices for residents.** Slide sheets to reduce friction during boosting, pivot discs to safely turn a resident on a seat or on the floor, slide boards to safely transition from one surface to another independently,

*Safety vendors will sometimes provide a free talk/in-service for employees when equipment is new or for annual updates.*

standing grab bars to help residents independently stand, bathing chairs, toilet seat stands, sit-to-stand lifts, full lifts and ceiling lifts.

•**Dress codes for employees.** Require staff to wear appropriate footwear and define what *appropriate* means (e.g., slip-resistant soled shoes, winter shoes for snow and ice). It is helpful if the employer helps staff purchase slip-resistant soled shoes or overshoes by providing vendor-supplied discount pricing or vendor-supplied discount coupon programs.

•**Safety briefs.** Send brief safety talks to supervisors/regions to review with and get to employees. These help educate staff on the most frequent type of injury causes and statistics and why it is important for an employee to act on safety hazards with urgency and with best practices established by the organization. The best practice care standards will be for employees who want to know “what is in it for them,” so tell them how safety improves the bottom line so they can get raises and equipment and give them motivation to use best practices. Constant reminders in all avenues of employee communication are helpful if they are relevant and tell adults why. Contact the author for sample safety briefs of best practice care standards.

•**Develop safety vendor partnerships.** The organization can obtain free safety training or services/products and low-cost safety supplies when they know their vendors. For example, when resident acuity levels are high, work with local durable medical equipment supply companies in your communities who offer more resident handling equipment, which can be financed by Medicaid and/or safety grants. Safety vendors will sometimes provide a free talk/in-service for employees when equipment is new or for annual updates.

•**Research and develop plans to apply for state safety grant programs.** Research states where safety grant dollars are available to help purchase all safety equipment and/or resident lift equipment. Pull together key team members to help the organization write the grants and seek assistance from safety consultants or loss control consultants with the insurance companies with which you work. Minnesota, New Jersey, Ohio, Washington and Texas all have some form of a safety grant program.

•**Transportation safety education and monitoring program.** The specific program will be based on the vehicles covered and the jobs completed in the line of work in personal and/or company vehicles. Specific monitoring will include driver's license reviews, insurance coverage expectations for personal vehicles and rules of the road for all vehicle use, including cell phones, pagers and three-way radios.

•**Winter car safety supplies.** For employers that operate in northern states, consider designing a list of suggested safety supplies that employees should have in the trunk of their cars to aid in the event their car stalls in a snowstorm. A typical winter survival kit may include things such as a sleeping bag, a bag of salt/sand, an

empty coffee can filled with energy bars, a candle, matches, tin cup, flashlight and batteries.

**13) Provide safety education and reeducate staff.** Well-trained staff in safety hazard recognition and control practices is a valuable asset to company profitability. The better staff is trained upon being hired and with constant safety reminders on the organization's best practices for care, the more staff will exhibit safer work habits. What they do not know they cannot practice. It is up to the employers to establish their standards and to teach their employees. Once effective safety training is in place, the organization should begin to see reductions in claim frequency and severity over time.

**14) Develop comprehensive claims cost containment practices and a written program with employee performance expectations.** Incidents and losses will occur. The best practice for employers after the fact is to have strong comprehensive claims cost containment programs, which include performance expectations for all employees in the organization. A successful program will have performance expectations for the executive director, the insurance administrative person(s) and all employees. True cost containment practices are measured through everyone taking an active role in managing incidents to closure. The basic steps to an effective program are:

a) Have well-defined job descriptions that include the physical demands of the job.

b) Have excellent incident analysis education and training in place for all new employees and ongoing for all staff.

c) Have a strong injury management program for all claims.

Establish best practice standards with all carriers/third-party administrators/brokers.

d) Hold all employees accountable for job performance standards under workers' compensation, leave of absence requests, and personal injury or property damage incidents.

e) Have a strong return-to-work, alternate and transitional duty program, and partner with occupational medicine clinics where employees can go for work-related injuries.

f) Have a customized predetermined list of alternate/transitional duty tasks ready to show treating physicians when alleged work-related injured staffs seek medical attention.

g) Remain in regular communication with all staff on work-related or personal leaves of absence.

*The better staff is trained upon being hired and with constant safety reminders on the organization's best practices for care, the more staff will exhibit safer work habits. What they do not know they cannot practice. It is up to the employers to establish their standards and to teach their employees.*

h) Conduct regular claim reviews to ensure that claims are monitored for costs and moving forward develop actions plans with carriers, third-party administrators and brokers to resolve issues.

### CONCLUSION

This article presents the reasons why the AL industry needs to develop a risk management model for reduction of risk, business continuity and market demands. By applying the program elements listed, this risk management model should reduce the negative impact on human and financial resources to this industry. Its purpose is to assist this industry in developing a multifaceted safety program, which each AL employer can customize.

A comprehensive list of general safety and safe resident handling equipment and assistive devices is available from the author to help AL industry employers identify solutions for their specific safety hazards. The list is not an endorsement of any of the vendors or the products. It serves as a resource and starting point for risk management teams to begin the process of considering new ways of providing care and creating lasting change, which positively impacts employees, residents and their care. This risk management model can provide a win-win-win solution for the AL industry.

If you wish to obtain a copy of the AL industry safety inspection checklist or safety resource listing or would like to provide comments on the risk management model, contact the author at [lori.severson@lockton.com](mailto:lori.severson@lockton.com). ☺

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# Transportation Ergonomics

The transportation industry has been researched extensively over the years to improve safety, but little focus has been placed on ergonomics and the ability to reduce musculoskeletal disorders (MSDs). A literature review reveals studies focusing on seatbelt use, fatigue, cognition, psychosocial factors, drugs and alcohol and work scheduling. The majority of these studies focus on safety, both for the drivers and for others on the road.

The Bureau of Labor Statistics (BLS) has published data on the frequency of MSDs that occurred in 2007. Figure 1 taken from this release, illustrates the top 12 industries with respect to MSDs based on the total number of incidents and MSD incidence rate. The top 5 job categories on the list involve tasks with heavy material-handling activities. Number 6 on the list (based on incidence rate), heavy and tractor-trailer truck drivers, has the third highest number of MSDs. This high frequency and incidence rate should clearly place ergonomics as a major concern for the transportation industry.

In addition to the incidence rate for MSDs, the severity of injuries, as demonstrated by lost workday rates, provides further indication of the ergonomics stress within the transportation sector. BLS reported that MSDs had the highest number of days away from work per incident. Looking at specific industries, transportation and warehousing had median days away from work of 14, double the national median. The highest median days

away from work for heavy and tractor-trailer truck drivers and light and delivery service truck drivers were 15 days each, followed by carpenters and construction laborers with 10 days. Therefore, while not a topic typically researched within the industry, ergonomics research and application should have a direct and significant impact on the financial performance of the industry.

To understand the potential impact that ergonomics factors may have on the commercial trucking industry, this article presents a review of more than 28,000 surveys of drivers collected between 2005 and 2008. Surveys were distributed to drivers at the beginning of a project that focused on improving driver postures in the cab, and follow-up surveys were administered biannually to track changes in health status. Survey content included employee demographic data, job-related information and discomfort ratings.

This article's primary objective is to review the demographic data provided by the drivers to identify any trends that can guide efforts to help the transportation industry. Through this review, a person in charge of a transportation safety and ergonomics process will be better prepared to:

- 1) prioritize efforts to meet the needs of high risk employees;
- 2) ensure that solutions are available for employees with special needs;
- 3) justify recommendations with the data provided.

## DATA COLLECTION

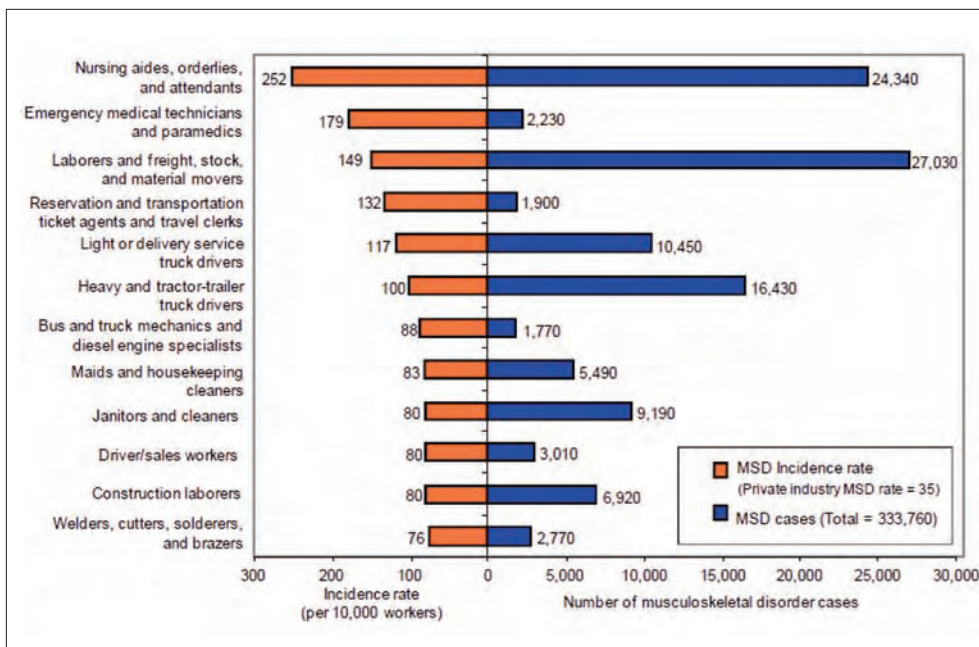
Data collection was completed using a paper-based transportation ergonomics survey. Prior to working with an employee to address any work-related concerns, a paper survey was provided to collect basic information to assist in classifying their demographics, measure his/her level of work-related discomfort and provide guidance for the selection of appropriate solutions.

Discomfort is assessed using a health index, which is a combination of frequency and severity of symptoms on a 5-point scale.

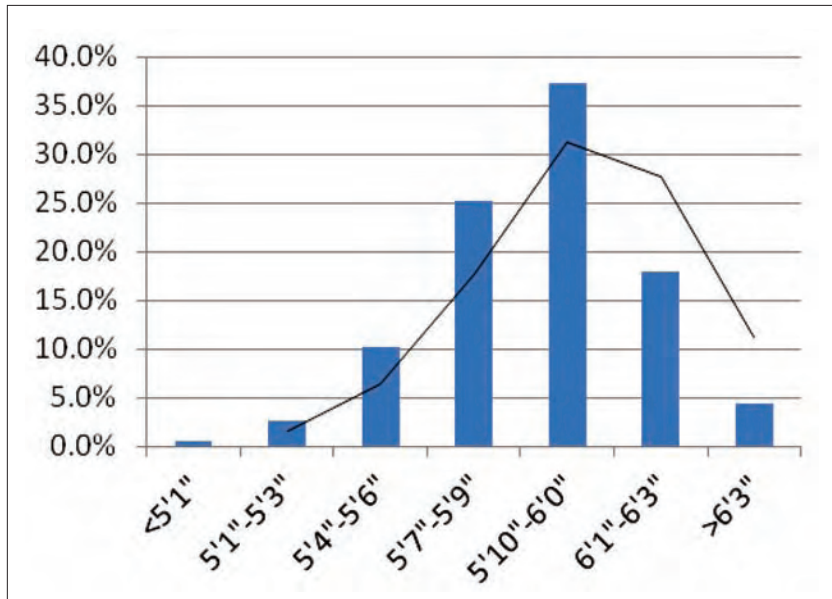
*A selection of figures is presented here. To view all other figures mentioned in this article*

[CLICK HERE](#)

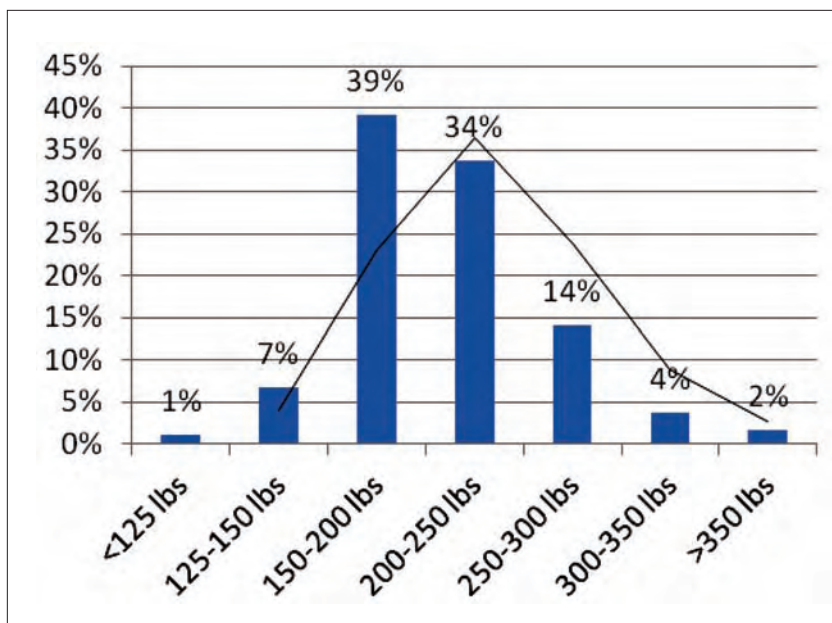
**Figure 1**  
**MSD Cases & Incidence Rate by Industry**



**Figure 3**  
**Distribution of Population by Height**



**Figure 4**  
**Distribution of Population by Weight**



The multiplicative value of these discomfort variables (frequency x severity) is rated as low (<6), moderate (6-10), high (10-12) and extreme (>12).

An online database may be used to record the paper assessments for tracking and evaluation purposes. Once recorded, the data are available to an analyst. Raw data can be downloaded into an MS Excel spreadsheet for detailed analysis and review.

## DEFINITIONS

To compare discomfort to various variables, it was necessary to process the discomfort data and to present it in formats that aided in viewing the potential relationships. Six key measures of discomfort were used to illustrate the interaction between demographics and discomfort:

**Discomfort prevalence.** At the time of the survey, employees are asked whether they are experiencing discomfort related to work activities. This yes/no question provides a measure of the percentage of employees who are experiencing discomfort at the time of the survey.

**Raw discomfort scores.** The frequency and severity scores are measured on a five-point scale. The answers the employee provides are multiplied together to provide a score termed the health index. This raw score provides a measure of the discomfort for a single body part.

**Total discomfort.** Adding all health indices for a single employee (i.e., scores for all body parts) provides a measure of the total discomfort for the employee.

**Average total discomfort.** For comparing differences between groups, an average of the total discomfort scores across all employees in the group is calculated.

**Maximum (Max) discomfort.** The maximum health index for a single employee (i.e., highest health index for all body parts) provides a measure of discomfort severity for the employee.

**Average max discomfort.** For comparing differences between groups, an average of the maximum discomfort scores across all employees in the group is calculated.

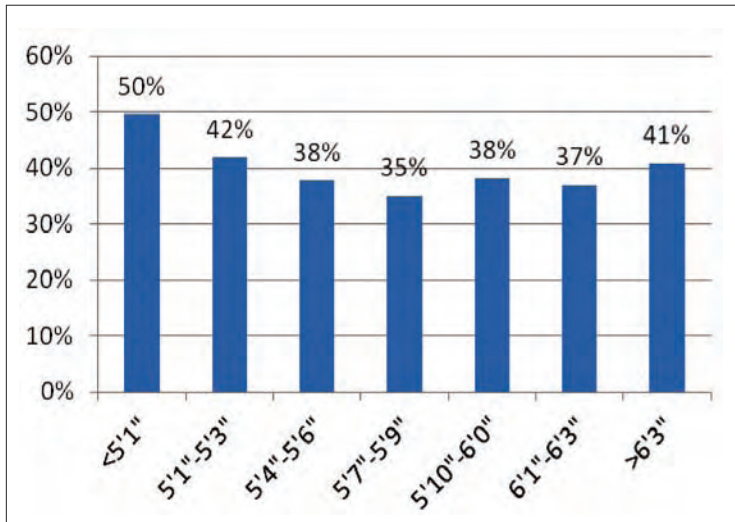
In addition to these measures of discomfort, the data within this article have been formatted to provide the most effective means of convey-

ing a message. Additional descriptions of the methods used to create the graphs and to format the data are described as necessary.

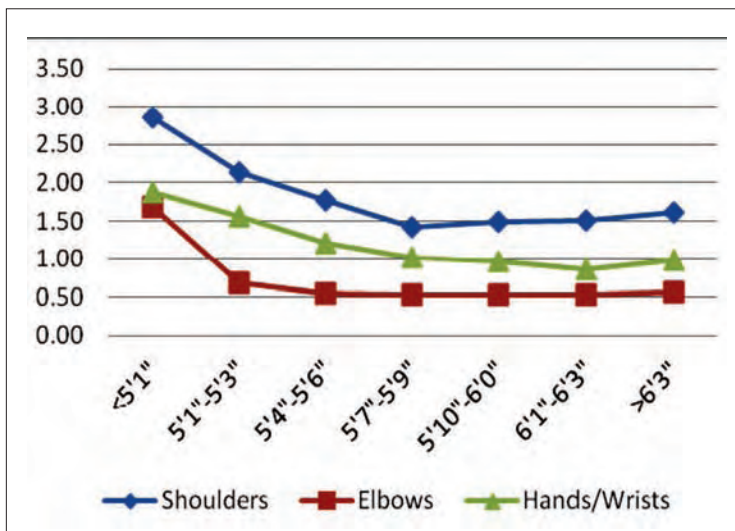
## PARTICIPANTS

This study included a population of 28,301 commercial truck drivers who had participated in the Atlas

**Figure 8**  
**Prevalence of**  
**Discomfort vs. Height**



**Figure 10**  
**Upper Limb**  
**Discomfort vs. Height**



process. The data were gathered over a 4-year period from 2005 to 2008. The type of work performed was largely long-haul operations, where drivers' primary tasks involved preinspection, driving the vehicle and dropping the loads off at new locations; approximately 90% involved no-touch load operations, and 10% involved unloading freight.

A standard makeup for height and weight within a population should follow a normal distribution, similar to the image presented in Figure 2.

The distribution of height within the truck driver population is skewed to the right, with a higher representa-

tion in the taller height categories (Figure 3). The distribution of weight is skewed slightly to the left, with the majority of the population between 150 to 250 lb, and 20% of the population >250 lb (Figure 4).

The body mass index (BMI) has been used extensively to approximate the body composition of an individual, using a calculation based on height and weight. The index has been categorized based on research to indicate when an individual is normal weight, under- or overweight or obese. The measure has known biases and can provide inaccurate measures for athletes (i.e., muscle mass) and elderly individuals. Overall, the measure provides a reasonable estimate of the fitness of an individual with respect to body composition.

The latest CDC estimates have indicated that nearly 31% of U.S. adults age 20 and older (approximately 59 million people) were obese, defined as having a BMI of 30 or more (Gallagher, et al., 2000; Flegal, et al., 2002; CDC, 2000). In this study, the population distribution indicated 46% of the population was obese, which represents a 48% increase in the level of obesity for the commercial driving population (Figure 5). Similarly, the CDC study indicated that 36% of the population is classified as normal weight; this study population has 18% of its population at normal weight—a 100% difference.

Figure 6 presents the age distribution for the study population, which is evenly distributed in the 30- to 60-year-old age ranges.

Figure 7 presents the distribution of seniority within the population, with the majority of the population in the 1- to 2-year and 3- to 5-year ranges. These seniority values represent the time that the driver has worked with the current employer and not the total time working as a commercial truck driver.

The truck driver population is predominantly male, with only 8% of the drivers being women.

## HEIGHT

In the tractor cab, an employee's height can significantly affect the ability to position him/herself correctly to safely and comfortably drive the vehicle. As illustrated in Figures 8 to 10 the cab design creates potential issues with a driver's ability to reach controls and the steering wheel and to easily work the pedals on the floor. Although not used heavily in highway driving, the clutch can present a biomechanical concern where smaller individuals may have difficulty generating the force required to activate the clutch (i.e., force requirements range from 62 to 72 lb). Conversely, the cab size can be constricting for larger



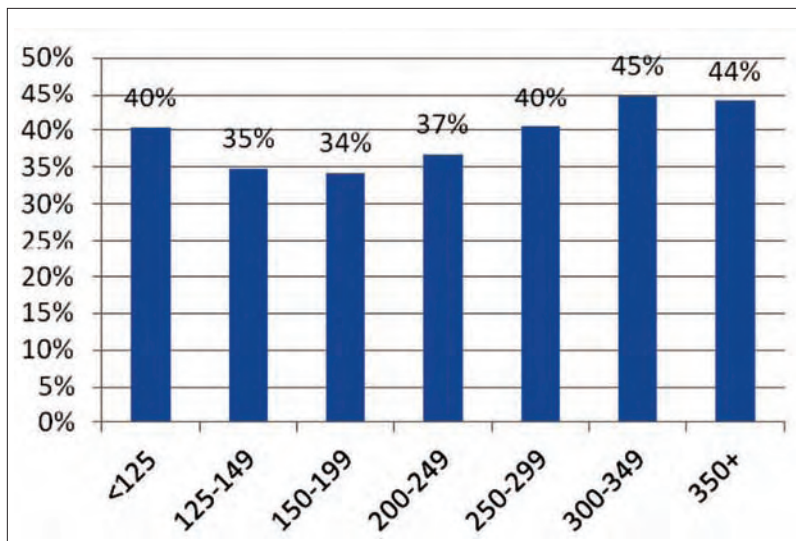
employees, creating challenges for leg clearance and maintaining a comfortable posture.

Figure 8 (p. 7) illustrates the prevalence of discomfort by height. The expected challenges for employees in the shorter and taller categories are seen in the slight U-shape of the bar graph. Drivers in the 5'1" to 5'3" and >6'3" height ranges demonstrated an 11% increase in prevalence versus the drivers in the 5'4" to 6'3" range. This is a noticeable, but not necessarily a significant, trend. For drivers <5'1", the 40% increase in prevalence should be considered significant and a factor that must be addressed.

The severity of the discomfort, as measured by the average total and maximum discomfort, illustrates an exaggerated trend in the data, with the shorter height ranges illustrating significantly higher average total discomfort values (Figure 9). The <5'1" and 5'1" to 5'3" height ranges are 81% and 32% higher, respectively, than the average for the remaining groups. The lesser trend in the average maximum discomfort indicates that drivers are not experiencing extreme ranges of discomfort between the height ranges but instead are experiencing systemically higher discomfort across all body parts.

A review of the trends in discomfort data across body ranges (i.e., upper limb, torso/spine and lower limb) provides further insight into how the discomfort varies within the height ranges. Figure 10 (p. 7) illustrates that the increased discomfort is seen in the upper limb for drivers <5'7". Shoulders and hands/wrists are most significantly affected, with the shoulders indicating a 93% increase in discomfort from the 5'7" to the <5'1" range. It appears that the reach requirements within the cab and the dimensions of the steering wheel result in challenges for shorter employees; the postural requirements appear to be causing increased strain on the upper extremity.

**Figure 13**  
**Weight vs. Prevalence**  
**of Discomfort**



A similar trend in the data is seen for the torso/spine region where the head/neck, upper back and low back all demonstrate higher levels of discomfort for the shorter height ranges (Figure 11). Additionally, a slight upward trend in discomfort is seen in the low back and upper back for drivers in the higher height ranges. The increase is not as dramatic as with the shorter drivers, but the trend is evident. Issues in torso/spine discomfort indicate potential concerns with seat design and/or adjustment.

The lower limb (Figure 12) indicated the largest U-shaped relationship, with shorter and taller drivers presenting higher levels of discomfort. The knees showed the greatest increase in discomfort for the extreme ranges of height; shorter drivers are likely affected by the compromise between supporting the lower limb, interacting with the pedals and maintaining a safe view of the road; taller drivers are likely affected by limited space to adjust seat height and depth and steering wheel height and angle. These challenging postural constraints result in the increased discomfort noted by the drivers.

### WEIGHT

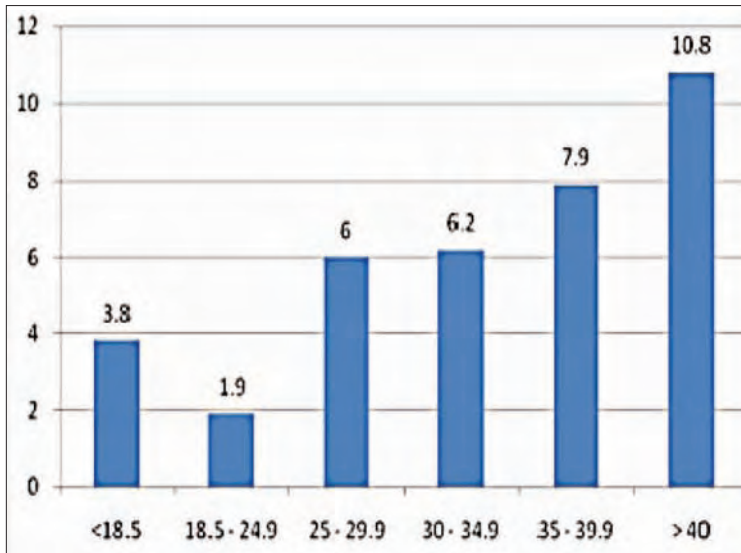
One major challenge for truck drivers is diet, exercise and weight control. The constant travel and sedentary nature of driving can result in weight-related issues. As noted in Figure 4 (p. 6) the study population has 20% of drivers >250 lb. A question to consider is whether weight is a factor that influences the discomfort drivers feel. Figure 13 presents the prevalence of discomfort by categories of weight. A skewed U-shape trend is seen in the data, with drivers <125 lbs and those >250 lbs experiencing a 14% to 28% higher prevalence of discomfort.

A similar trend is seen for the severity of discomfort (Figure 14). The wave-shaped line graphs illustrate a higher level of discomfort at the extreme ranges of weight. The increase in discomfort is approximately 30% to 40% when comparing the mid-range weights (125 to 199 lbs) versus the extreme ranges. The "bottoming out" of the discomfort values in the 150- to 199-lb range appears to indicate a potentially optimal weight range for drivers.

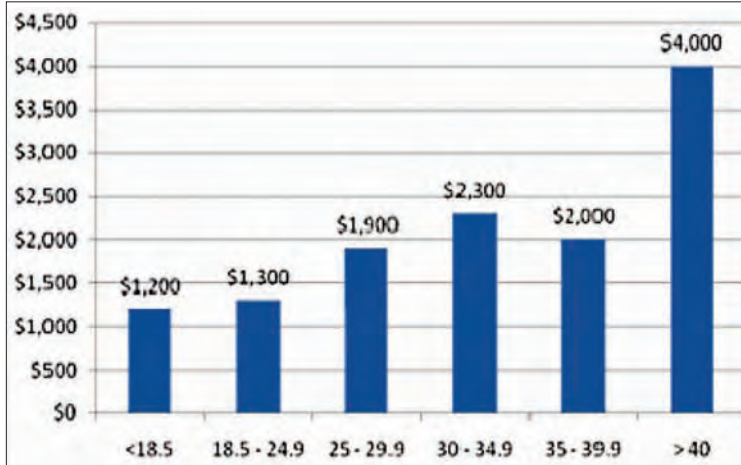
The primary region of the body where weight would be expected to affect discomfort for a professional driver is the torso/spine region. Increases in body mass for a driver would result in increased pressure placed on the spine from prolonged exposure to a vibrating, seated position. Figure 15 illustrates that a reduction in weight does not necessarily reduce discomfort in the torso/spine region. The higher levels of discomfort at extreme ranges of weight illustrate a combination of demographic factors. Employees in the lower weight categories are also in the lower height categories and therefore experience the issues of fitting the cab described in the previous section. Employees in the higher weight categories illustrate the effect of mass on discomfort during prolonged sitting.

Regarding fit within the cab, a review of drivers' heights within the different weight categories (Figure 16) shows an upward trend in height as weight increases. Given the previous discussion of height and the impact on

**Figure 21**  
**Lost Workdays per Incident vs. BMI**



**Figure 22**  
**Cost per Claim vs. BMI**



proper fit within the cab, there appears to be a strong interaction between these two physical factors when it comes to work-related discomfort. A measure that incorporates height and weight, while giving a sense of the driver's physical fitness, is the body mass index or BMI.

#### **BMI**

Figure 17 presents the prevalence of discomfort based on BMI. Drivers in the normal and overweight classifications (BMI = 19 to 29) showed the lowest prevalence of discomfort, with the underweight and obese classifications showing a steady increase in discomfort as a driver's BMI moves farther away from normal. This trend shows that 47% of the population has an elevated prevalence of discomfort that can be linked to BMI.

Figures 18 to 20 present the discomfort values for the upper limb, torso/spine and lower limb areas of the body. Each graph illustrates a similar trend—a slight increase in discomfort for underweight individuals and a steady increase in discomfort for overweight through obese individuals. The head/neck and upper back appear to be the only areas of the body that have a limited impact based on BMI.

Conversely, all three body parts for the lower limb (Figure 20 show the most dramatic upward trend in discomfort as BMI increases. It is clear from the data that fitness, as measured by the driver's body composition, is a factor that should be used to prioritize interventions.

Case studies and experience have shown that employees who experience higher levels of discomfort are more likely to require medical attention and/or become a workers' compensation case. Figures 21 and 22 present data from the Archives of Internal Medicine (2007) that illustrate a trend toward higher lost workdays and higher costs of injuries as BMI increases. These facts further emphasize the need to prioritize efforts to assist obese drivers.

#### **AGE**

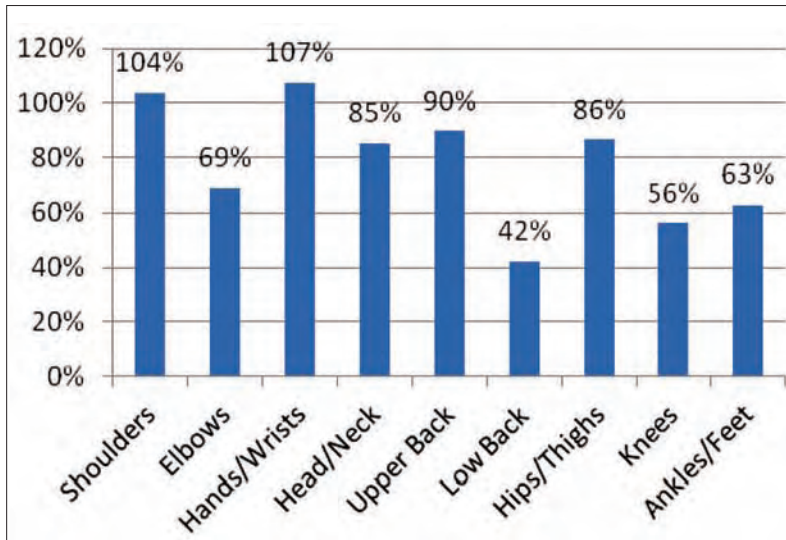
When looking at an employee's age, the question arises as to whether an older employee will experience higher levels of discomfort due to a longer duration of exposure to work activities. Figure 23 presents the prevalence of discomfort by age group, and it appears that there is a minimal increase in discomfort based on age. Any changes noted in this graph would likely be considered insignificant.

Figure 24 presents data on severity of discomfort, and a similar minor upward trend is seen as employees get older. A gradual 20% increase in average total discomfort is seen

from drivers in their 20s through to drivers in their 60s. This increase does not present a measure that would significantly affect the prioritization of an ergonomics process. The relatively stable values for the average maximum discomfort indicates that the relative strain on the drivers does not increase based on their age.

A review of discomfort for each of the body regions did not provide any significant trends that would influence an ergonomics process. The only discomfort measure that demonstrated a trend that could be related to aging is eye-strain (Figure 25). The size of this increase in conjunction with the relatively small discomfort values would lead to a simple explanation that this trend is more related to aging versus any work-related factors.

**Figure 32**  
**Increase in Discomfort**  
**for Women by Body Part**



#### SENIORITY

Age is only a measure of how long a person has been alive and a member of the working population. Seniority is a variable that provides a better measure of exposure to the actual work environment and specific lifestyle of a job, which is especially important when considering commercial truck drivers. Figure 26 presents the prevalence of discomfort for drivers with various levels of seniority. A significant increase in prevalence is noted when drivers reach a seniority of 3 to 5 years, and this level stabilizes for the remainder of employment. The increase in prevalence from 1 to 2 years to 3 to 5 years is 66%; the increase from the new hire point to the 3 to 5 years seniority level is 153%.

Figure 27 presents the severity of discomfort that is experienced versus the seniority of the driver. The exact same trend is evident in this data, where an 89% increase in average total discomfort is seen from 1 to 2 years to 3 to 5 years of seniority, and a 207% increase is seen from newly hired drivers to those drivers with 3 to 5 years of seniority. The average maximum discomfort line does not look as significant in the graph, but the trend is equally dramatic with a 63% and 163% increase in discomfort over the same time periods.

These trends in discomfort are seen across all of the body regions. Figure 28 illustrates a range of 153% to 325% increase in discomfort for drivers as one moves from new hires (<1 yr) to drivers with 3 to 5 years of seniority. With these significant increases in discomfort that occur early on in employment, it is important for an organization to look at its turnover rate and the average seniority of a driver when s/he leaves the company. As noted in Figure 7 only a small percentage of drivers have greater than 5 years' seniority (24%). A correlation in

these factors presents an additional opportunity to save costs by addressing the causes of the increased discomfort early in a driver's career with the company.

The dramatic increases in discomfort seen in the data, in conjunction with the stabilization of the prevalence and severity of these data after reaching the 3- to 5-year seniority level, indicate that the nature of commercial driving takes a toll on the body, but drivers appear to reach a point where they manage the demands of the job over the long term.

In addition to the physical toll, the commercial drivers' lifestyle appears to have long-term effects on health. Figure 29 illustrates that the average weight of a driver increases over time, not by age but by seniority. In other words, the study population does not gain weight as they get older, but they gain weight the longer they drive a truck. As discussed in the sections on weight and BMI, this increase in weight will only add to the discomfort that a driver experiences over time.

#### GENDER

When looking at potential trends in discomfort with respect to gender, the question is whether gender has an impact on how a person adapts to the physical demands of the task. Is the relevant difference gender itself, or are the physical differences between genders the real influence? The answer may have a significant impact on the approach to driver ergonomics. Figure 30 illustrates a distinct difference in the prevalence of discomfort between genders, with women showing a 31% increase in prevalence.

The severity of discomfort, as measured by average total and max discomfort, shows an even greater increase in discomfort for women (Figure 31); the average total discomfort is 74% higher and the average max discomfort is 55% higher. These values indicate a systematic impact of gender on discomfort.

Figure 32 shows the differences in discomfort levels between women and men by body part. Women consistently have significantly higher levels of discomfort. The upper limb region, which can include the head/neck and upper back, presents the most significant increases in discomfort. The low back was the area of the body with the lowest increase in discomfort. The important question to ask is what differences exist between genders that can be attributed to these differences in discomfort.

The demographic variables reviewed previously in this article include height, weight, BMI, age and seniority. Reviewing the details for these demographic variables, the following differences are seen based on gender:

##### 1) Weight & BMI

a) Women have an average weight that is lighter than men at 160 lb versus 213 lb.

b) Of the drivers in the overweight through obese classifications 6% to 10% were women.

c) This represents a low representation by women and likely has a minimal impact on the differences in discomfort. In fact, this trend should result in higher levels of discomfort for men.



## 2) Age & Seniority

a) The average age for women and men is relatively equal at 43.25 and 43.75 years, respectively.

b) Women had an average level of seniority of 3.7 years versus 4.8 for men.

c) These factors should be considered positive as lower levels of seniority were correlated with lower levels of discomfort.

## 3) Height

a) The average height for women is 5'4" and 5'10" for men.

b) Height is the lone demographic factor that has a significant difference between genders. Based on the data presented earlier in this article on height, it is clear that the design of the cab and seat creates a challenge for individuals of smaller stature, resulting in elevated levels of discomfort across all body parts.

A final factor not measured by the survey that may result in higher discomfort for women is muscular strength. Grip strength, upper body strength and lower body strength may influence the strain placed on drivers due to tasks, such as gripping and turning the steering wheel and depressing the clutch. These factors will need to be measured to determine the potential impact on drivers.

## CONCLUSION

Review of this significant database of driver demographics and discomfort provides valuable insight into the trends that must be acknowledged and therefore the solutions that must be considered for the future. These trends highlight how drivers interact with their job and their workstation (i.e., cab) and how differences in employee demographics may lead to approaches to improve an organization's safety:

**1) Population.** The commercial driving population is comprised predominately of men. The drivers are evenly distributed by age but tend to be taller in stature and heavier in weight; 20% of the population is >250 lb and 54% of the population is >200 lb.

**2) Height.** Stature appears to be a demographic variable with significant impact on driver discomfort. Smaller individuals seem to have concerns with reaching controls and accessing all cab features, while taller drivers seem to have issues with fitting into the available space. Optimization of fit and modifications to driver setup may be key factors to address this issue.

**3) Weight and BMI.** Weight is a measure that has a correlation with discomfort, but BMI appears to be a better indicator of risk. The driver population has an extremely high number of individuals in the overweight and obese classifications. Discomfort is distinctly higher for the obese population, which, therefore, prioritizes this group for intervention. The data illustrate a financial impact of obesity as noted by a higher frequency of lost workdays and a higher cost per claim. Research has further shown that BMI is linked to sleep apnea and short sleep cycles, which subsequently increases the health

and safety risk for drivers (Dagan et al., 2006).

**4) Age and seniority.** A recent BLS study found that median days away from work increase as age increases. Workers age 65 and older experienced the longest absences from work with a median of 16 days, compared to 4 days away from work for workers age 16 to 24. Age does not appear to be an indicator of risk within the driver population; insignificant trends were noted in the data. However, given the wide distribution of age within the population, this BLS finding may be an important factor to consider when looking at the potential costs of injury and the driver's age when they s/he is a new hire.

Seniority provided a significant indicator of risk, with drivers experiencing higher levels of discomfort as they approached 3 to 5 years of service. The low number of drivers with >5 years' seniority seems to indicate a potential opportunity to increase retention and to reduce turnover.

**5) Gender.** The differences in average height and strength seen between genders appear to result in elevated strain on the female population. Although a small number of women were in the study population (8%), their significantly higher discomfort levels presented a noticeable trend. Controls designed to improve the fit for drivers of smaller stature will have a positive impact on the female driver population. ☺

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