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Prevention through Design (PtD)

Tom Zarges *, Bradley Giles

Washington Group International

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Tom Zarges: We believe that the Prevention through Design (PtD) initiative is an extremely worthwhile endeavor. Putting safety into design practices is the natural next step in the construction business, as well as all other industries. As our profession is one of the oldest (e.g., the Great Pyramids and Stonehenge), it is set in its ways and is slow to change.

We would like to tell you what kinds of projects our company works on. We participated in the construction of the Washington Metropolitan Transit Authority (WMATA) project, the Trans-Alaska Pipeline, the Hoover Dam, and the San Francisco Bay Bridge. It is important to remember that many of these projects were completed in a different era. Construction has always been a macho profession, where taking risks has been part of the culture. While building the Hoover Dam, over 120 men were killed. In today's environment this is unthinkable. The only way to get more work done on the Hoover Dam was to bring additional men in and work them harder, which meant taking more risks and doing the work using unproven methods to hurry it along. Even though the standards of construction used on the Hoover Dam don't apply today, construction employs 7% of the workers, but accounts for 21% of the injuries.

Aerial View of the Hoover Dam

Everything that we can do as an industry to provide a safe environment for our workers is critical. From the standpoint of a large-scale engineer and construction company, with contracts around the globe, the key is to apply your standards no matter the geography and politics of the area. The same standards have to apply everywhere you work.

PtD is part of our Continuous Improvement Program. This also embodies a social improvement aspect, which includes the welfare of the workforce, and green construction and design elements. These efforts are driven not only by social responsibility, but also by commodities costs, which are rising faster than anyone expected. The expense of having an inefficient or unsafe environment is enormous.

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The social impact of our efforts is changing. Clients with large, continuous capital programs, such as large industries and governments, are beginning to get on board with this. They will start to look for safety in design when they evaluate awards, which will set some strong standards in the industry.

We are a consumer of our own design products. As builders, we share the benefits and consequences of our designs in the field. So we ask ourselves, how will it get assembled? How can our design help it be built more efficiently and effectively? We used to spend many hours with plastic models of the whole anticipated construction project. Now we use 3-dimensional designs, and elements of artificial intelligence, which will query you about your protocols and make sure you're taking the right things into account during each step of the process. It's important that engineers, procurement people, safety officials, etc., all participate in this design loop.

The entire company needs to be up to speed on safety practices and protocols. To ensure this, we have a whole series of programs at every level. For employees, we have Voluntary Protection Program Behavior-Based Safety. The managers/supervisors have a Safety Trained Supervisor (STS) certification program. For the executives, we have leading indicators. Some of the questions we ask are: how is the quality of your training? How quickly are you receiving your training? How often are you going out to look at the sites? It's up to us to know and look into what the industry offers, and make the products available that are appropriate for our use.

As far as I know very few engineering curricula include safety course work. This is the crucial piece that is missing. We don't just expect technical proficiency from our engineers; we expect some understanding of practical issues of safety. Companies must take the initiative to train engineering staff in safety and health procedures.

Here's a quick outline of what we do to train the bulk of our engineers, designers, schedulers, estimators, procurement agents, and contract administrators:

- Formal training: Safer Design Principles for Construction—a 4-hour class on practical issues of potential hazards involved with Design in Construction. It includes many examples where we could have done a better job in the design phase. A matrix that allows engineering staff to identify the hazards and implement methods to remove them from the design, are included. There are a number of resources that allow the attendees to get immediate answers to their questions on types of hazards and the means of eliminating them.
- Formal training: the Safety Qualified Supervisor program—this class is more advanced. The attendees take the Occupational Safety and Health Administration (OSHA) 10-hour class, then additional modules in the economics of safety, job hazard analysis, hazard recognition, control of hazardous energy, and accident investigation.
- We have standardized the process through the development of a Project Execution Plan (PEP) for implementation and management control of a task. Generally, there's a crunch in the front-end of a project, because you're already behind when it is awarded. The plan should be no less than 1% of the cost of services, and it may go to 3–5%, but this pays off. The full team is completely involved, the design consequences are known, and re-work is eliminated. Having this type of plan is a critical part of design discipline.
- Participation with OSHA Alliance workgroup on Safety in Design.

Over the last 2 years, we have trained over 1,000 United States and Romanian engineers. This is beginning to show results. We're adamant about taking this through our entire company.

One of the obvious returns on investment (ROI) is workers' compensation costs. Our Days Away Case rate (DAC) is less than 0.1 and our Total Recordable Rate (TRR) is less than 1.0. Workers' compensation costs are around $.04 per hour.

Not quantified yet are savings in time not lost. Safe performance and overall results are directly related, and should be part of an overall project management discipline. All of these things must be in alignment: safety, cost, and scheduling performance.

Bradley Giles: The following is a case study developed by the Washington Group and OSHA that illustrates PtD concepts. The project was an Advanced Mixed Waste Processing Facility that was 105,000 square feet. Because radioactive waste management is very complex, this was a sophisticated engineering and construction program. The project was a privatized job with the Department of Energy (DOE), but worked on OSHA standards rather than DOE's. We looked at constructability and the end user safety.

The first thing we did was put together a safety review team led by the Project General Manager, who facilitated all activities. Because 80% of our injuries involved re-work, we wanted to try to minimize that this go-around. A formal process to capture input and ideas was created, and a variety of people were polled. We focused on overcoming the misconception that designing for safety costs more. Design managers were encouraged to include Design for Safety input and ideas early into the process. Accepted ideas were documented and incorporated into the designs, which were then reviewed and followed-up to ensure that safety was integrated from the beginning.

An example of incorporating design for safety is the operator's window where hazardous waste is sorted. Originally, operators opened waste containers and sorted contents from behind a railing. Now the operators stand behind finished windows, using remote arms and power manipulators to sort the waste, reducing the risk of splash hazards. We developed this design from a list of suggestions and concerns about how to minimize or eliminate hazards. We reviewed a "lessons learned" database for relevant

candidates and incorporated our findings into the list of suggestions. Some of the tools we used to design the new operator's window included a Design for Construction Safety "Toolbox" from the Construction Industry Institute (CII), and a 3-dimensional design software to create an intelligent model.

Advanced Mixed Waste Processing Facility Project, January 1, 2002 (Operators' windows): Operators will open waste containers and sort the contents standing behind these finished windows, using remote BROKK robotic arms and overhead power manipulators.

The result was that in 3.3 million hours over 4 years, there was not a single DAC. We received a $1 million bonus for safety, and the project was completed ahead of schedule. This was especially noteworthy, as the weather we had to contend with at the site was very hazardous. The severe temperatures and wind conditions had to be factored in during the design and the work. All-in-all, we had a great ROI.

Tom Zarges: It is important for us and our clients to remember that all of these things are bundled. We've been incorporating safety in design because it's the next step in our industry and in our continuous improvement process to meet the goal of zero injuries. (The discussions about whether or not we should set zero injuries as a goal are priceless. Some argue that it should not be the goal because it can't be achieved, but having the conversation is a very important element.)

In the future, our efforts will include more elements of green design, cost effectiveness, and efficiency. Using fewer precious materials and commodities is important and part of a general improvement process. Our client base is becoming more aware of the benefits. The United States Army Corp of Engineers, the Navy, DOE, and some organizations in private industry, are forward-thinking clients with sustained capital in projects. They are making sure that candidate firms are looking at these issues of design safety and are committed to addressing them.

Some barriers to implementing PtD:

- Engineers do not graduate with formal training in safety standards and best practices.
- Engineering curricula do not include industrial safety.
- Engineers/architects avoid the potential for liability and do not include safety considerations. (It's important to remember that we're all liable anyway. The idea you can avoid it by not being responsible is an anachronism. We need to be responsible and take charge of this issue.)
- Perceived increase costs for engineering. Individual elements might cost more, but you have to look at the program as a whole. As a total philosophy, the costs will be lower, and savings will be obvious.
- Engineers, academics, safety professionals, and designers work solo. We have to create teams that work together to address these issues. It's not just what you do on a job, but what equipment managers, procurement specialists, subcontractors, everyone involved in the job, does.
- Contracts, procurement, and scheduling do not include safety reviews.

Some of the great sources we've used:

- OSHA Alliance Program Construction Roundtable Design for Safety Workgroup
- Hazard Information Foundation, Inc., funded by the Center to Protect Workers Rights
- A book entitled *Construction Safety Engineering Principles Designing and Managing Safer Job Sites*, by David MacCollum, PE, CSP
- A book entitled *Safety and Health for Engineers, Second Edition*, by Roger L. Brauer.

A few quick examples of design criteria that could save a lot of money: integrated fall prevention (anchor points built into columns and supports from the beginning), external tank indicators, grates/bars around skylights or any hole more than 6 feet high, external light bulbs that can be changed from inside the building instead of by the use of scaffolding. These simple ideas can save lives.

This is a high calling — an important calling. The availability of craftsmen at all skill levels are hard to come by. Do whatever you can to make it easier (routine helps). When you think about improvements in your business, consider a social responsibility policy. Each part must move in concert. For nonbelievers, make the economic argument — safe means more savings overall. Efficiency. Effectiveness. We should all assist the universities in incorporating safe design curricula. Those discussions and training sessions should include different disciplines working together to solve the same problem. Think about how we can create client demand for safety, and then we'll see contract requirements for it. Teach others that ignoring safety in design does not relieve them of liability. Use your successful execution of these practices as an example of how they have given you a competitive advantage. Thank you.