

Disney's Safety by Design

**Gail House, CSP
Mario Scarabino, P.E.**

Introduction

Currently NIOSH has developed a "Prevention through Design" document that has been developed as a Plan for the National Initiative. One of the objectives of the document is to "prevent or reduce occupationally related injuries, illnesses, fatalities and exposures by including prevention considerations in all designs that affect individuals in the occupational environment". There has been considerable opinion that the effort to prevent injuries through design also needed to be extended to the redesign process.

As a result, the definition for Prevention through Design (PtD) was expanded to "Addressing occupational safety and health needs by eliminated hazards and minimizing risks to worker in the design and redesign processes throughout the life cycle of work premises, tools, equipment, machinery, substances and work processes including their construction, manufacture, use and maintenance and ultimate disposal or re-use".

While a national initiative is greatly needed, there are many processes that a company can use to develop their own strategy for "prevention by design". How this design process occurs varies greatly depending on the scope of the project and the cultural environment of the company itself. One of the critical factors to any design or redesign factors however is the integration of the Safety professional with the design and engineering team. The language and processes used by each team will need to be reciprocal for a truly integrated design process.

In this session, we'll be discussing the Walt Disney Parks & Resorts "Disney's Safety by Design" process from concept to operation. A case study on the development of a new attraction will be featured and the participants will learn how to apply this design methodology for their company. We will also highlight a few projects where "design lessons learned" apply and how the design process changed. This paper concentrates on new design projects although the process can applied to a redesign project as well.

With design being a complex process, it is important to have the right team of technical experts to include architects, software designers, maintenance and operations personnel, safety & health professionals and engineering disciples such as mechanical, civil, structural and electrical. For safety and health professionals, understanding how these stages affect the potential safety and health of your employees is a critical step to reducing injuries through design.

The "Create it to Experience" Process

Within the Walt Disney Parks & Resorts, ride attractions and facilities go through a vigorous "create to experience" process. The diagram below outlines the two major aspects of work and the details within each aspect.

The focus for this process is two-fold in that it ensures our millions of guests who visit our parks and resorts are safe, and it ensures that our Cast Members (employees) are safe while operating the parks and resorts.



Figure 1. Safety by Design Process

The backbone of the entire design process includes a strong auditing program. It is not called out as a separate component within each phase but rather is incorporated into phases two through seven and briefly mentioned in these phases.

The importance of having solid engineering and productions teams in these stages is obvious so they can build a solid product. However, it is just as critical to involve safety & health professionals in these stages as well. Far too often, safety professionals are asked for their input too late to affect any design flaws since the product is well under production. By involving the Safety professional throughout the process

“Create It”

1. The Conceptual “Blue Sky” phase

The Walt Disney “Imagineers” are the team that develops the concept of a new attraction – it’s called the “Blue Sky” creative process. This starts with an earliest of spark of an idea that with artistic and creative people who understand engineering principles. There are many aspects in the blue sky process that are considered from financial return on investment decisions to how the concept will theme into a park or resort.

At this first phase, the main team will consist of creative, financial and engineering teams that will determine what technology can be used, how does it theme into the area, what is the financial return and how will the attraction fit into the landscape. As an example, the team must consider why a new attraction (or facility) needs to be created. The “why” can be a large list of reasons from an operating necessity for a new facility to a park enhancement to building something new or to redesign an existing area to update it. Beyond the why of building or redesigning an attraction or facility, the team must have capital funding which often involves many layers of approval since these are generally involve investments of multi-million dollars. The team must also justify how it can value to the park as a return on investment. The process to develop the conceptual process for funding and justification of a project probably varies from company to company, but the end result will likely require the financial and engineering teams to propose their idea.

Once the rough concept has been decided, Walt Disney Imagineers will use “story boards” to develop many different variations on an attraction. The end result is a thrill ride which matches the theme of the park. In your company, you may not necessarily need this level of a creative process, but using story boards or visuals to conceptual your product, facility or process is an essential first step in the concept phase.

In general, Safety professionals are not involved in the concept phase since there is no design criterion to review. The feasibility and technology of a new ride or facility at the first spark of the conceptual phase is not generally dependent on the Safety professional. Although technology has been available, Safety professionals will be brought into the next stage with a few exceptions.

2 . The Design Phase

When the conceptual part of your new ride (or new machine, process or facility) is developed and financially supported, there will be at some point a “green light” to proceed with the actual building of your product. This phase is the most critical step in developing a successful project by reducing risk, lowering future costs and providing the most return on investment for the Safety professional.

There are many considerations that need to occur along parallel paths including vendor considerations, systems safety analysis, visual concept development, design review of blueprints and architectural drawings and other facets. The most successful team includes engineers, safety professionals, system safety experts, architects, manufacturing experts and procurement professionals.

As you move into “design and engineering” stage this is where you apply a systematic approach to safety by incorporating standards for your industry. This is where the Safety professional needs to be brought into the process, along with the engineering team. Standards such as ANSI, OSHA, ASTM, ISO, AWS, NFPA, etc. should all be consulted as well as any internal standards your company may have. It is also critical to begin to involve your operations team – it doesn’t help to design something that operations can’t operate!

For the Safety professional, one of the critical skills is to be able to speak the language of the diverse design team. Some of the skills needed include:

- Know mechanical and electrical engineering terms - hydraulic, pneumatic and electrical energy; solenoids, electrical circuitry, capacitors and transformers. This will be important to discuss not only how something is built, but how is it maintained. How will lockout/tagout be designed? How will fall protection be addressed especially for maintenance? Can a space be reconfigured so it is not a permit-required confined space? Risk management principles are applied at this stage as well. For example, it may be possible to reduce certain hazards such as designing electrical circuitry for a lower hazard category rating. This common language allows the engineering team and the Safety professional to clearly understand what each group is trying to accomplish and balance what each group needs.
- Understand basic system safety terms – What-If analysis, Failure Mode and Effects Analysis (FMEA), Hazard and Operability Analysis (HAZOP) and other system safety methodology are important to know. It is unlikely the Safety professional is the expert to apply system safety, but they are often asked to provide input into the process so they need to understand the benefits and problems associated with each analysis.
- Know how to read blueprints and other design documents – complex line drawings, blueprints, 3-D models and other documents. Safety professionals need advanced skills to read blueprints and other documents to provide their opinion on the operating mode of equipment. This is often the primary method to understanding how standards and regulations apply when the attraction or facility are fully operational.

- Know basic human factors terms – anthropometric tables, cognitive understanding and other human factor issues must be considered at this stage. Very often, this is an overlooked process and the Safety professional needs to be savvy enough to engage the team in these considerations. Blueprints or other modeling can assist ergonomic issues as well so the safety professional must thoroughly review blueprints at this stage. A vendor can also provide assistance when products are being considered for purchase.
- Understand financial terms and procurement processes – capital funding, operations & expense money, and stages of bidding and acceptance are all important during this stage. It helps the Safety professional to know how monies and budgets affect the project. This is also where Safety professionals can state their case to spend money now to reduce risk later. As an example, building in a fall protection system (if it can't be designed out) is a lower cost alternative rather than building the fall protection system when the project is complete (and often no one wants to pay for it when the project is completed). Also know what signage or markings will be required for the attraction or facility so the design team is prepared to have them purchased and installed during the building stage.
- Verify the information you provide – OSHA, ANSI, NFPA and other standards. Safety professionals are often asked to interpret a standard or provide the language in a standard. Even if you are seasoned Safety professional, verify the information you provide the design team – this is not the time to rely on your memory.

For Walt Disney Parks & Resorts, the design process often involves 3-D scale model so the teams can visualize the attraction. It is here that the theme of the attraction will be designed. As an example, if a new ride is being designed at Disney's Animal Kingdom Theme Park, it would have the feel of conservation, learning, an animal aspect and similar themes.

We also develop complex computer-generated modeling with many algorithms on how to maximize the ride for the electrical, mechanical and operations systems. And just as important is the need for the engineering team to understand the language of the Safety professional. If you design and engineer correctly at this point, you will be well on your way to a successful project.

3 . The Build It Phase

Moving into the build stage of manufacturing and production is a very complex process and faces many unique challenges. The engineering team will usually take the lead on the overseeing the manufacturing and production processes as there are many "test and accept" procedures that need to be completed. The phase may also be dramatically different depending if your company is constructing the facility or attraction or if you are using an outside contractor – and if you're building it on your site or at a vendor's site. The Safety professional will need to understand the various differences of manufacturing and contract responsibility.

The Safety professional at this point will have more interest in the safety of the manufacturing and construction workers, especially if the attraction, facility or machinery is being built on-site. Typical issues that need to be addressed may include fall protection, electrical safety, material handling, ergonomic considerations and construction issues.

It is crucial that a plan for manufacturing and construction safety is developed prior to starting the work. Safety professionals will often be most comfortable for this stage of work and are well-versed on the applicable standards. This is the where they can help educate the other team members particularly the management team that oversees the work and the engineers who are testing materials.

An auditing process must also be in place during this work to include regular observations of employees “on the shop floor” which can be done by a combination of the local management team and the safety & health team. The work done on various shifts must be accounted for in the auditing process. There are many different auditing processes that can be employed at this phase and will not be detailed in this paper.

4. The Test Phase

The next phase of test and adjust sometimes will be concurrent with the manufacturing process. Testing of vendor and as-built components, weld inspections and other issues are generally done by a dedicated team of engineers. As such, the Safety professional is not usually a part of the test team but can be asked for input. The role of the Safety professional during the test phase is focusing on the testing being done to provide a safety & health plan for their work similar to the manufacturing safety plan. Vendors and contractors may be part of the test acceptance phase along with procurement professionals so the Safety professional needs to make sure all of these people are included with the safety & health plan.

For a typical attraction, the test and adjust phase is extraordinarily complex - component testing, required manufacturing requirements, system testing and many other factors are managed by the engineering staff. Registered Professional Engineers are often required to approve the attraction or facility prior to opening to the public.

Experience It

5. The Training Stage

The experience phase can often be done concurrently with the create it phase, particularly as you move from manufacturing into the training stage. As Safety professionals know, excellent training guides and operating procedures are not only essential to the employees’ knowledge of correct operation, but also to help prevent injuries by learning the skills to do the tasks correctly and safely. The engineer team may still have some involvement at this stage but generally the operations and training teams will drive this process with Safety involved primarily with regulatory requirements.

There are several layers of training that might be required particularly for a new attraction or facility. The training can include: various OSHA-required training classes; safe operations of the new attraction or facility; theory of operations; maintenance requirements and other operational aspects. For Walt Disney Parks & Resorts, other training may include guest service guidelines, emergency procedures, and food safety requirements depending on the attraction or facility.

The training requirements should be a blend of classroom education to understand knowledge and theory, and field experience to demonstrate the practical and operational aspect. There are training experts who can assist with knowledge assessments, delivery methods and content development. Safety professionals may also assist in this stage depending on whether a company has a dedicated training team. Occasionally Safety professionals may be developing the training on their own particularly for regulatory requirements or for a company with a smaller staff.

Typically Cast Members (employees) who are learning a new attraction will spend up to several days in the classroom learning the theory and operation of the ride. From there, they will spend several days at the attraction learning the various roles from a greeter, to load zone, to unload zone. Once they have completed their training, a local trainer will take them through a skills assessment with a check list to ensure they have complete knowledge and skills to safely operate the ride. A skills assessment is a more valid tool for typical operating roles as opposed to a knowledge assessment. Periodic audits of the classroom and field teachings can be done by the training and safety professionals.

6. The Operations Stage

The operations stage includes both how the attraction or facility is operated and the sustainment of the operation through an audit process. Safety professionals should have provided and verified safe operation during the training phase which includes development of operational guidelines. They will have a role in this phase along with the operations team. Audits during the operation stage can be a combined effort of operations management conducting their own audits to validate written procedures are followed; Safety professionals can also conduct their own audit looking at risk factors and adherence to written procedures.

This stage will provide the feedback as to whether you have successfully designed your attraction or facility – the operators will quickly find the faults or any design flaws. There should be a feedback method so that the front line operators can quickly convey information to the design team – from procedural changes, safety issues, downtimes, etc.

The design team should be able to quickly address any changes at this stage. A continuous feedback loop must be established to ensure future issues are addressed. There are many different process improvement plans that can be used and are not discussed in this paper.

7. The Maintenance Stage

The maintenance stage for an attraction, facility or new process can often be as complex as the operations. Development of the maintenance requirements can be complex with the engineering and maintenance teams the driver to determine requirements. Manufacturers and vendors will also have a role in developing the maintenance procedures.

The Safety professional does not usually identify the maintenance procedures but will have a key role in how they are executed. As with traditional industrial safety & health, many regulatory requirements will be incorporated into the maintenance procedures. This can include a long list of how the work is done such as: lockout/tagout, confined spaces, fall protection, electrical safety, powered industrial truck safety, respiratory protection and potentially a long list of requirements. In order for the maintenance procedures to be executed safely, the Safety professional needs in-depth knowledge of the work tasks, the environment and the potential hazards. This often requires a hands-on approach to work with the maintenance team to discuss the work then develop a plan. Observing the maintenance work in person is also invaluable to develop the maintenance procedures with appropriate safety procedures built into the maintenance requirements. The type of maintenance work may change on different shifts so understanding all aspects of the work is essential to assuring the safety & health of the maintenance team. A strong auditing program is essential at the maintenance stage, both for adherence to written maintenance procedures as well as safety procedures.

At Walt Disney theme parks, the night shift is where all preventative maintenance is performed. The maintenance program is managed through a computer system that tracks all maintenance requirements daily checks to annual inspections. Using all in-house maintenance staff and engineers allows us to ensure peak performance, troubleshoot systems and continue a quality assurance program. At the maintenance stage, it is often the engineers and operations team that drive the requirements for maintenance. The Safety professional has an equal role with ensuring the safety and health of the maintenance team that performs the work. Maintenance work often involves many different OSHA standards as well as material handling issues.

8. The Communications Stage

The final stage is determining how you communicate or inform the people who are affected by the new attraction or facility. For many companies, this is most likely an internal communication designed to

congratulate the team on a successful project. There may be some local publicity or press release as well as information on a company's website.

For the millions of Guests who visits our theme parks each year we use guide maps, signs, verbal instructions, audio messages, ground markings and more. We are also able to accommodate Guests with disabilities so they can have a safe and enjoyable visit. All the information is included in our "Wild About Safety" program where Guests can learn the many facets of our safety program. With the characters *Timon and Pumbaa*, children can learn as well.

References

"ASSE Position Paper on Designing for Safety" Approved by the Board of Directors in 1994. Des Plaines, IL: ASSE.

Christensen, W.C. and Manuele, F.A. 1999. *Safety Through Design*. Itasca, IL: National Safety Council.

Christensen, W.C. "Retrofitting for Safety: Career Implications for SH&E personnel. *Professional Safety*, May 2007.

Guidance Document for Incorporating Risk Concepts into NFPA Codes and Standards. Quincy, MA. The Fire Protection Research Foundation, 2007.

International Standards Organization (ISO). 2003. ISO 12100-1. *Safety of Machinery: Basic concepts, general principles for design, part 1. Basic terminology, methodology*. Geneva, Switzerland: International Organization for Standardization.

_____. ISO 14121. *Safety of Machinery: Principles for risk assessment*. Geneva, Switzerland: International Organization for Standardization, 1999.

Manuele, F.A. 2003. *On the Practice of Safety*, 3rd ed. Hoboken, NJ: John Wiley & Sons, 2003.

National Institute for Occupational Safety and Health (NIOSH). 2007. "Prevention through Design." (<http://www.cdc/niosh/programs/ptdesign>).

Stephans, R.A. 2004. *System Safety for the 21st Century*. Hoboken, NJ: John Wiley & Sons.