Amusement ride safety through Human Factors analysis

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It is important to look at human factors in the amusement industry because it is common to find a high human involvement in the causation of injuries. This is unsurprising, because there would not be an injury if no humans were involved. In addition to the patron, there are operators and attendants, mechanics and inspectors, and designers and manufacturers who are also all humans.

Human factors is not a description of the specific ways that people are disappointing us this time. It's also not a magic spell that eliminates all the ways people fail when they try to cope with the environments we throw them into. Human factors (HF) aims to make human performance more reliable. Just as good engineering does not mean machines will never fail – inspection and maintenance are still required – good human factors does not mean people will become perfect; we still need to monitor human performance so that the system as a whole is protected from human failure.

Human factors is a scientific discipline concerned with designing products, systems, or processes to take proper account of the interaction between them and the people who use them.

Starting point: Violations

A violation is simply an action that is not permitted. We cannot treat all violations as if they are deviance. Some violations could be appropriate or even necessary, like breaking a rule to save a life. Others violations are errors made while pursuing legitimate goals.

In the amusement setting, having fun is a legitimate goal. Ideally, the mechanical actions of the ride will provide all the fun the guest expects. When the ride itself does not meet their social or sensory expectations, patrons may feel the need to "complete the design".

Patrons' goals are to have fun: social, enhance enjoyable sensations and reduce discomfort, conserve effort, protect their valuables.

However, their knowledge of what is safe vs. hazardous may be inadequate, and the actions they choose may be errors. The errors may be violations. However, the goal to have fun is not deviant.

HF would look at the nature of their errors and how design may have contributed. If errors are due to misunderstanding, design would aim to make situations and appropriate actions more obvious. If errors are due to clumsy and inaccurate performance of appropriate actions, HF would look for design adjustments to make those actions easier to do.

Intentionally deviant actions are not performance failures in the HF context. The person *succeeded* at their goal; the *system* failed to resist. HF can be used to support the performance of people defending the system, rather than expecting to change the deviant goals.

Goals, and not actions, are most meaningful in considering a behaviour to be deviant.

Errors may be wrong and undesirable, but are not the same as violations in pursuit of deviant goals. We need to help them achieve their goal without the actions we do not want.

Common sense: Affordances

We expect people to be responsible and prudent, and even when rules are communicated, some things require people to use common sense. Affordances are what people use to figure out what is sensible. These are not recommendations or intended design principles. These are the intuitive perceptions people have. We cannot simply counteract them with rules.

Affordances are the perceived or actual properties of a thing that communicate what you can do with it.

Some examples are:

- If it is open, it is close-able
- If it is raised, it is lower-able
- If you can reach it, it is okay to touch it
- If it is a slot, things can be inserted into it
- If there is no opening, you are meant to go around it
- If it is horizontal, flat, smooth, and dry, it can be stepped or sat upon
- If it is a button, it is push-able
- If it is a knob or a wheel, it is turn-able
- If it is slippery, sharp, delicate, or liquid, you are not meant to stand, sit, or place objects on it
- If there is resistance, you are meant to leave it alone or apply force elsewhere
- If unexpected results occur, a different action is required

Operators have a duty to warn and inform, but the **affordances** in the patron's environment have more credibility to the patron at the time of their decision: they will trust their eyes and ears more than what they read on a sign or heard in a spiel, if they can even remember those.

Trying to improve human performance by communicating rules with signs and warnings requires the patron to understand and remember all of that information, and recognize when to use it, and that process has to repeat for *every single patron*. Getting the affordances right requires less explanation, memory, and recall, and benefits everyone.

If the affordances suggest that an action is possible, then any time that action would serve the patron's goals, there is a chance they will take that action. HF offers several strategies to counteract this, some of which might work in a particular situation:

1) remove the affordance by making the action possibility invisible, concealing it from their perception, perhaps by redirecting the patron's attention elsewhere, or actually making the action not possible.
2) understand the patron's goal, and provide an obvious and appealing action that enables them to achieve their goal more easily and effectively.
3) make the action seem undesirable by altering the affordances, making the action seem likely to be ineffective or making the action seem more dangerous than it is.

Common sense is made of affordances. Louder rules will not counteract affordances that shout possibility.

Situational awareness

We may hear hazardous actions described as a loss or a lack of situational awareness. **Situational awareness is comprehension of the meaning of the environment we are in and the ability to make good choices to keep under control.** The concept properly refers to skilled professionals with experience to recognize patterns. The public are encountering unfamiliar situations and do not have the same practice and experience and underlying systems knowledge to recognize the patterns and understand the meaning.

The concept of situational awareness does not fit well to consumers in unfamiliar settings.

In addition to that, theme parks often involve *two concurrent, different situations*: the real physical world that has real physical hazards, and the world of illusions and immersive entertainment. Expecting patrons to maintain situational awareness of potential hazards in the real physical world may be good for safety, but the entertainment has failed.

Focussed attention

Patrons may see a warning sign right in front of them and still do something else. Patrons need to understand that the message is communicating a real danger. However, even when they understand a danger exists, they may still believe it does not pertain to their individual situation in that moment.

Humans are capable of focussed attention to deal with the most important threat to them. Prehistoric people needed this to avoid predators. The greatest hazards in the amusement park are so well controlled by regulations and operational procedures that patrons would be challenged to imagine them. The biggest threats they perceive are things like losing their valuables at the park, getting separated from their companions, or feeling ill or severe discomfort. When these issues get focussed attention, it outweighs any posted or spoken warnings. They may believe a posted warning in general, but they give more credit to their assessment of whether they can safely achieve their mission to get in, recover their valuables, and get out, or exit the ride at an unauthorized point and find their way outside. The one sign they remember is the one that says "the park is not responsible if you lose your valuables." They are making decisions in the context that they are on their own.

Focussed attention on the perceived greatest threat can hinder perception of other threats including much more serious threats.

Patron responsibility vs. foreseeable misuse

The standard ASTM F770-24 says this about patron responsibility in §11.1

> *There are inherent risks in the participation in or on any amusement ride, device, or attraction. Patrons of an amusement ride, device or attraction, by participation, accept the risks inherent in such participation of which the ordinary prudent person is or should be aware. Patrons have a duty to exercise good judgment and act in a responsible manner while using the amusement ride, device, or attraction and to obey all oral or written warnings, or both, prior to or during participation, or both.*

This clause appears to transfer responsibility to the patron that would otherwise be the duty of the designer and manager of the amusement ride or device, to consider foreseeable misuse.

In Canada, ASTM F24 core standards are adopted indirectly through standard ASTM F2783 *Standard Practice for Design, Manufacture, Operation, Maintenance, and Inspection of Amusement Rides and Devices, in Canada*. ASTM F2783 points to other ASTM Committee F24 standards and adds Canadian references such as electrical code, fire code, building code, welding standards and other considerations that differ between Canada and the USA. Relevant to this discussion, F2783-25 §7.3 specifically states that F770 Section 11 "shall not apply", as it would not be considered a reasonable standard in Canada.

Patron responsibility is not universally considered a reasonable standard. If applied, it must address how patrons should know the inherent risks and what constitutes a "reasonable" manner of action.

Patrons can be expected to take actions to pursue their goals related to fun. Some of the actions they may choose, given the affordances in their environment, will be actions that are not appropriate. Those actions would be foreseeable misuse. While foreseeable misuse is obviously a challenge to analyse, designers and owner-operators and regulators have more potential to identify foreseeable misuse than the patron has to do a risk assessment. They are also in a position to modify the affordances. To accept inherent risks, the patron would need to do a risk assessment in an unfamiliar environment with limited time, knowledge, and experience.

Warnings

Signs and spiels cannot overcome the cues in the environment but they are still necessary. Operators have a duty to warn. Warning signs, websites, apps, brochures, and spiels are parts of this. Merely posting or performing the warning will not truly inform the patrons. Warnings need to be designed organized effectively.

Information should be **presented at the right time**. Information provided too early creates a memory and attention demand that may be too much. It may be difficult to understand the meaning out of context, and difficult for the patron to recognize when it is meant to be used. Patrons need different information when deciding whether to queue for a ride than they need after they are queued and are anticipating to ride, and may need more information as they board, and even during the ride.

The actual presentation needs to be **organized for comprehension**, aligned to the information needs the patron has. Many signs are difficult for patrons to absorb because they combine statements of different kinds, such as:

- who cannot ride at all
- patron conditions that would be prohibited or recommended not to ride
- what riders must do before they ride
- what riders must do when they board the ride
- what riders must do after the ride starts
- things that will be present in the environment
- other information patrons may obtain elsewhere
- accommodations the attraction offers for patrons who would want them
- statements making the rider responsible in general

Are all the directions **clear**, or are they vague (e.g., to do something "properly") or inaccurate (e.g., hold on "at all times" rather than "until the ride is over".) When a thing is mentioned, such as things that will be present, is it clear what that means? Why has it been mentioned? If patrons are told other information is available elsewhere, are they told who should want it, and why?

The text must at minimum be **readable**. In the body text containing information, text in all upper-case letters, and full-justified text (both margins smooth) is more difficult to read than sentence case and left-justified text. The language(s) used and the difficulty of the vocabulary should be considered in relation to who should be reading the signs.

There are **four elements** of effective warnings:

- A signal word ("caution", "warning", etc.)
- A statement of the hazard (e.g., sharp edges, not "danger")
- A statement of the consequences (e.g., laceration, not "serious injury")
- Directions that will avoid the hazard (e.g., "do not open while in motion")

Many attraction warning signs skip the middle two points, which effectively demand the patrons simply comply without understanding the reason. This hinders them from incorporating that into their "common sense" as they interpret the affordances

Warnings are needed but will not automatically be informative.

Disabled patrons and the determination of eligibility

It would be ideal if everyone could safely access every attraction, but the things that some patrons need would be barriers to others. Even if everyone could access everything, patrons would still need to choose, because everyone does not enjoy the same things.

Patrons will be most satisfied if they can access everything they would like to experience. The next most satisfactory option is for patrons to be able to decide for themselves that they cannot participate. Not only does this give them agency but ride attendants cannot assess the health of every patron. Many conditions are not visible, and many visible conditions are not relevant.

Ride attendants cannot identify every disability or condition that may be relevant to eligibility to participate.

To make an appropriate decision, the patron needs to know what participation will require them to tolerate and do, in terms of physical demands for tolerance for forces, ability to hold a position and fill an adequate amount

of space within the restraint system, physical action and reaction, and psychological and sensory tolerance. Many ride experiences are completely unfamiliar to the patron before they ride it for the first time. They cannot be aware of the unnamed “inherent risks” to make responsible decisions, even though they know very well what they can do and tolerate.

Patron directions like “diabetic people may not ride” or “patron must have two hands” do not help patrons agree that they could not ride without risk of harm. They can merely determine whether they are diabetic or have two hands. If the rule does not make sense to them (how would the ride affect a diabetic person, differently than a non-diabetic person?), they may consider the rule illegitimate and ignore it. The ride attendant is unlikely to be able to intercept a diabetic person boarding.

The principles of effective warnings apply to patrons’ self-selection decisions. Without explanation of the hazard and consequences, some directions may be inadequate. For example, a person may be able to brace or stabilize without two hands, but a person who has two hands might not be able to use their hands as assumed by the writer of the rule. Rather than listing the requirement for “two hands”, it is safer to communicate what the patron needs to do.

Effective warning characteristics also apply to patron advisory messages about eligibility.

Of course, the ride attendant should any patron whose body shape would not fit and be retained by the restraint devices, and would be at risk of ejection. Requirements related to comfort will be more satisfactory to patrons if they understand the nature of the experience and can decide for themselves if they want to be uncomfortable in order to ride.

The preference for self-selection does not override interception of clear hazards. Body shapes that are incompatible with the restraints and present risk of ejection should be intercepted by ride attendants when seen.

Although there should be team members who can answer patrons’ specific questions, requiring disabled patrons to consult a “disabled patron office” is impractical, given the large percentage of the population that is disabled in one or more ways. Equally important, all patrons who should be advised not ride specific attractions are not considered “disabled”. Clear advisory messages benefit all patrons to help them select attractions they will enjoy.

Summary

Designers and managers often expect team members and patrons to perform exactly as directed, and attribute all failure to so as intentional non-compliance. Human factors takes a different perspective. This brief presentation discussed the difference between actions to pursue deviant goals and errors made in pursuit of valid goals. Options to improve action choices by modifying the environment and providing informative warning messages were discussed. These principles were applied to unsuitable action choices and choice of unsuitable rides, in the context of eligibility.

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