A thought provoking safety article. Read it. It introduces **Haddon's Matrix** - an Accident Investigation and Review Matrix which takes a single crash and divides it into pre-crash, crash and post-crash phases.

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AN ALTERNATE VIEW

BOB WEIEN
(from "SOARING")

We have a problem with soaring safety, I think we'll all agree. And we are contributing to the problem by our single-minded insistence that better flight training is the cure to the problem.

"Wait a minute." most of you are saying. "What kind of heresy is this? The pilot is the one responsible for aircraft accidents, so better flight training will prevent accidents by getting to the source of the problem. Right? And all these wimps that want crash-survivable cockpits should just realize that if they don't have the crash in the first place they don't need a crash survivable cockpit. So, just train them better!"

As you may have guessed, I don't agree with this philosophy, and will try to show you why in the course of this article. But before I leap into this any farther, I want to make one thing very clear. I am in favor of improved flight instruction. I am a CFIG and am very aware of the benefits of good flight instruction. This must continue but we must not put all our safety eggs into any one basket. Whether it be labeled "flight instruction" or "crash-survivable aircraft".

How did I get interested in all this? I had the good fortune to be able to attend a CFI Revalidation course given last February by one of the leading instructors in our sport. I would recommend it to anyone. It was a full twenty-four hours of classroom instruction, and was uniformly superb, with the exception of about two minutes.

Early on the first day, the instructor reviewed the accident data for the previous couple of years, making occasional comments along the way about how specific accidents occurred and could have been prevented. When he finished, he sat back and said something to the effect that better flight training was the only way to reduce the accident rate in soaring, and that we as instructors, need to work harder to make sure our students were better pilots.

The rest of the class murmured assent, but I raised my hand and made a comment to the effect that flight instruction wasn't enough, and that perhaps we need to consider doing other things. I specifically mentioned launches and landing areas as areas that could be improved. The instructor gave me a paternalistic smile, and asked me if I didn't think that we wouldn't need safer launches and landing areas, if only we had safer pilots.

I responded in a less-than-organized fashion, I'm afraid. He had caught me off guard, because I thought that some of the ideas I am about to explain to you were self-evident, and required no defense. Consequently, I was not well prepared to defend those ideas to one of our sport's leading flight instructors. I made a few statements about the three phases of the crash sequence, and how there are things which can be done in each to reduce the injury burden, but my classmates did not appear to be very interested, so I let the issue drop.

What I had assumed to be the common wisdom about aviation safety was not acknowledged as such in at least part of the soaring community. Many in our sport, I now believe, have not considered some of the ideas which I am presenting here.

What is it we're really trying to do with soaring safety programs? If I went to a soaring convention and asked 100 people that question, I'd be willing to bet that at least 90 would say "prevent accidents".

I do not believe that all accidents are preventable. People are just too different from each other and too difficult to communicate with to make sure everybody gets the message about how to prevent accidents. Even if you could get the message to everyone, there are some people who'll try something simply because they've been told not to. We all know people like that.

I will submit to you that what we are really trying to do is prevent injuries. (For the purpose of this article, "injuries" will also include fatalities) I would much rather see a glider destroyed than to see someone injured, even a little bit, or killed. I would not want to share a thermal with someone who cares more about his ship than either himself of me. Dr. Whitehead summed it up will in his October, 1987 letter to SOARING, when he quoted "Good judgment is based upon experience, and experience is the result of bad judgments." Our goal should be to protect people while they're gathering that experience.

Public health professionals who work in the safety field are now using the term "injury control" to describe what they do, instead of the previously popular "accident prevention" This term more accurately describes the objectives that I believe are the true goals of soaring safety.

Why do I say that more and more flight instruction is not the answer to the problem? Economists have a concept that they call The Law of Diminishing Marginal Returns. Simply put, it says that for each additional unit of any given input (read "flight instruction") the amount of output it generates (read "soaring safety") gets smaller. In the soaring environment it can be assumed to mean that the first hour of flight instruction is much more effective than the tenth which is much more effective than the thirtieth, and so on. At some point the return on the effort expended by the instructor is zero. If at this point the pilot remains one with poor judgment or is unsafe in any other way, further flight instruction is not going to help. If your goal is to protect him from injury, you must do so some other way.

ANECDOTE When I was flying gliders out of Jack Frost's strip in Robert Louisiana there was a middle-aged gentleman who flew there. He had lots of flight instruction, had his commercial rating, and was talking about getting his CFI-G. He was also sponsoring the flight instruction of a young boy who had just turned fourteen. The man seemed to be something of a father figure to the boy, at least at the gliderport. This boy had been flying with an instructor for about two years and actually had been ready to solo for months. On his birthday, of course, he was soloed and rapidly transitioned into the 1-26.

Soon the boy began to be slightly overconfident of his abilities as many post-solo students will be. One Saturday he landed quite long and brought the aircraft to a rapid, but not spectacular halt just short of the barbed-wire fence at the end of the roll out area. He seemed quite pleased with his ability to control the aircraft so well. The middle-aged gentleman took him aside and counseled him about showing off. He explained that we should all set good examples for each other. It was a very reasonable discussion demonstrating good judgment on the part of the middle-aged gentleman clearly setting a good example for the boy.

I'll bet you can guess what happened next. The middle-aged gentleman took the same 1-26 for a flight and when he landed, had to make a screeching nose-skid-in-the-dirt stop in order to avoid running into the same barbed-wire fence. When he got out, he was not embarrassed by the series of bad decisions he had made to get himself into that situation, but was proud of his ability to bring it off so masterfully. He seemed particularly proud that he thought of doing a deliberate ground loop, then realized it wasn't necessary. The middle-aged gentleman obviously knew what proper judgment was, he had just explained it to the boy. Whenever he flew with an instructor, he did an excellent job and demonstrated good judgment. So would more training have resulted in increased safety? I think not.

THE MORAL If you want to protect this pilot from injury, you would have to do it with something other than more training. More rides with an instructor just wouldn't have much effect on someone like him.

We are today in soaring where the automotive safety movement was about thirty years ago. During the 50's, virtually all auto accidents were assumed to be "driver error". In fact, the California Highway Patrol accident reports of that era listed 18 possible causes for accidents 16 of which were some variation on "driver error". So how did the improved automotive safety situation come about? Where did collapsible steering columns, breakaway sign posts, guard rails that work properly, and airbag technology come from?

During the 50's and 60's many people began to look at the problem and realized that a lot of people were being injured on the highways is spite of excellent education programs. They realized that no matter how well you train people, somebody will do something stupid and get into an accident. If you don't do something to protect them, then you're saying that if they're dumb enough to get into an accident, they deserve what they get.

Consequently, many of these people began to develop ways to limit the number of injuries resulting from vehicle accidents, other than by attempting to alter driver behavior. One of the tools they have found useful to organize their thinking about possible ways to intervene is to take a single crash and divide it into pre-crash, crash and post-crash phases. The questions asked then revolve around what can be done during each of those phases to reduce the injuries resulting from the crash.

They borrowed a concept from public Health: an epidemic of an infectious disease is often studied from the standpoint of the Agent (the bug), the Host (the Human with the disease) and the Environment (which often helps to transmit the disease). Aircraft accidents and the injuries associated with them can be considered a type of disease, and therefore can be approached in a similar manner. In this special case the three factors are called the Human (the persons on board the glider), the Vehicle (the glider itself) and the Environment (everything external to the other two)

Combining these two approaches results in **Haddon's Matrix**, named for the automotive injury specialist who devised the concept. On the vertical axis are pre-crash, crash and post-crash phases. On the horizontal axis are Human, Vehicle and Environmental factors (see Figure) This produces a matrix with cells numbered from one to nine. Each cell represents an approach to reducing the injury burden resulting from a glider accident.

	HUMAN	VEHICLE	ENVIRONMENT
PRE-CRASH	**1**	**4**	**7**
CRASH	**2**	**5**	**8**
POST-CRASH	**3**	**6**	**9**

Filling in the cells is an excellent exercise for glider clubs to perform at safety meetings, or for flight instructors to do with their students. Doing so will start people thinking about what can be done, and will allow the peculiarities of one's particular environment to be considered.

I'll give examples for each cell. These are not to be considered complete in any way, and should be augmented by all who read this article.

Most people's old favorite, improved flight instruction, would belong in **Cell on**e. This is because the goal of improved flight instruction is to alter human behavior (the pilot's) in the pre-crash phase. This leaves eight more areas in which the injury burden can be reduced, which is why I say we need to think about other ways of approaching soaring safety.

An example of something else that might be done in Cell One would be to ensure that we don't go flying unless we are physically prepared for it: no drinking, and no flying while sick.

Cell Two opens up possibilities for interventions relating to the human tolerance of crash forces. How might we intervene? Discourage unpadded harnesses? Require flack jacket material in the torso area of the harness? Demand harnesses with shoulder restraint lines to reduce head down crash impacts? How else?

How about helmets? Many Army aviator's lives have been saved in low-speed crashes because they were wearing (impact) certified helmets. The motorcycle experience is well known to be an emotional issue with some but the evidence is clear: head injuries are less severe with helmets. Since typical glider speeds are similar to motorcycle speeds it follows that the forces involved are similar. Wearing (certified) helmets is an idea worth considering. (Note: Wearing helmets is mandatory under Transport Canada Regulations.)

In **Cell Three** the Crash is over so this one is concerned with how to reduce the degree of damage done by the injuries already sustained. First Aid training would be useful so a pilot could attempt to slow or stop his own bleeding, or know what to do if he suspects that his neck has been injured. Placing survival gear onboard the aircraft during preflight is an example of how to reduce injury in the post-crash phase.

Cell Four concerns itself with insuring that the glider is ready to fly. The preflight inspection is crucial to this as well as the annual inspection with a checklist, and an uninterrupted preflight, belong here.

In **Cell Five** would go all those things about the glider which could cause or worsen injuries during the crash phase. Knobby instrument panels and a non-crashworthy design are examples of points in this cell. Interventions could include rounded nonprotrusive insturments, airbags and energy absorbing keel extensions at the nose of the glider.

Cell Six relates to those aircraft factors which could make injuries worse after the dust settles. The ability to get out of the harness is important here. Are the edges of the fractured materials sharp? Have the oxygen fittings broken away in a safe manner (without leaks)? In a mid-air could the pilot clear the wreakage or would they have difficulty getting their reserve parachute out? Was the accident scene readily accessible to emergency vehicles?

Cell Seven concerns how the environment could be improved during the pre-crash phase. Weather awareness, proper use of Flight Service Station weather briefings are good examples. Airfield maintenance is important here. Did that last big thunderstorm leave an erosion ditch on the grass runway? Don't tell the tug pilot he should try to miss it on his landing: simply repair the damage. What about the obstacles on either end of the runway? Trimming back the trees or placing telephone lines underground could help make the approaches and takeoffs safer.

Cell eight refers to those aspects of the environment which endanger the pilot during the crash phase itself. If obstacles are not essential such as a fence, signs, or trees, why not remove them? Trees can be replanted in other areas to provide asthetic appeal to the landowner and still provide safe flight approaches.

Cell Nine is about how the environment responds during the post-crash phase. How prompt and competent is the emergency medical response system? Does anyone in the field have first aid training? Even if someone has training, are adequate first aid supplies available?

As I said before, I did not attempt to make this chart complete: that would be a good exercise for individual pilots, gliderport operators, students and instructors, club safety meetings, contest pilot meetings, convention seminars, and anywhere else people gather to discuss soaring safety and how to improve our safety efforts.

ANECDOTE When I began flying at Stennis International Airport, outside Bay St. Louis, Mississippi, we had a near-ideal field off of which to fly. There was an 8000 foot long, 200 foot wide concrete runway with a taxiway joining it at about the middle. There were wide, flat, smooth, grassy areas on either side of the runway which were used for the bulk of the soaring activity. Takeoffs, regardless of direction, began at the taxiway and had long, clear areas without obstruction for at least 4000 ft. Landings, by convention ,were ideally to end up near the taxiway, to make positioning easier for the next takeoff. All one had to do was to pull the aircraft across the taxiway and you were ready to go.

There were no signs, lights or other obstructions near the taxiway, so an inadvertently long landing merely involved rolling across the taxiway. Even if there was an aircraft present, waiting to takeoff, there was usually enough room to maneuver to one side without a problem. Since there was nothing to run into, this was highly unlikely to result in bodily injury (although you were guaranteed verbal injury from Andy Ewing, the airport operator, if he saw you roll across the taxiway.)

Shortly before I left that part of the country, airport expansion began. One of the first things the FAA required was a prominent sign on the taxiway announcing that you were about to enter the only runway on the airfield (or in the county, for that matter).

The specifications were rather rigid. Naturally, it had to be a certain distance from the runway. Also, of course, it had to withstand the hurricanes which frequent the area. This meant that it was firmly planted in concrete, with thick support beams. That sign wasn't going anywhere! The sign sat exactly in the middle of the roll out area for a south landing (naturally, the most frequently needed on the Gulf Coast) It was end-on to the landing gliders, sitting like a blunt knife waiting to crumple some fiberglass of aluminum, and the softer contents therein.

How did the glider operation respond to this threat? Surprisingly, few people questioned the safety aspects of the sign's installation. Those who did were told not to hit the sign, make sure your landings are short enough to avoid it. An alteration of pilot behavior was proposed as a cure for an environmental problem which could have been solved in other, better ways.

What could have been done? Mounting the sign on breakaway supports would have helped, but moving it a few feet farther from the main runway (off the glider runway entirely) would have been even better...

CONCLUSIONS When one is discussing how to make something safer, one has to consider the question of active versus passive safety measures. An active measure is one that the person being protected must take it upon himself to do, such as buckle a seat belt. You must actively do this, or you won't be protected. A passive measure is one which will operate whether you want it to or not, such as an automatically inflating airbag. It just sits there unnoticed until you have a car wreck, then if inflates and prevents injury. Obviously, a passive measure is better than an active one.

Let me draw an analogy which I hope will make this clear. Suppose your concern was to prevent people from getting sick from drinking contaminated water. If you go the active route of trying to alter the people's behavior, you could teach people what bad water looks and smells like, and give them test kits to check the water before they drink. I would guess that you would still have people drinking bad water, and getting sick because of it. It is simply human nature to do things like that.

On the other hand, you could take a passive approach to preventing this kind of illness. You could, as a municipality, provide a water treatment plant to purify the drinking water for your town. People don't have to know anything other than how to turn on the tap, and they'll be protected from the diseases associated with bad water.

The sign at Stennis Field is an example of this. The passive approach of altering the sign would have been better than the active approach of trying to alter the behavior of every pilot flying there. Only one pilot would have to make a mistake and a disaster would occur. Moving the sign would eliminate the problem, in a passive manner.

Soaring safety is a lot more than good flight instruction. It involves looking at the pilots, the aircraft we fly, and the environment in which we fly them. It involves reducing the risk in ways other than by saying, "Don't do this!" and "Don't do that!" It involves looking at our operations, and seeing if they can be altered in such a way so that it is impossible to do "this" or "that". It involves making sure that, if "this" or "that" happens anyway, nobody gets hurt as a result of it.

Changes in the environment have an effect on soaring safety, and we need to consider them when we evaluate the "big picture". Attempting to alter pilot behavior is a possible cure for an environmental problem, but it is not necessarily the best one. Mostly soaring safety involves the willingness to spend some time thinking about things from a safety standpoint, and then being willing to act on the ideas which are generated. Soaring safety is in our hands. Let's not botch the job, just because we're not looking at all the possibilities.

ABOUT THE AUTHOR Bob Weien first soloed a glider in 1975 but has done most of his soaring since he got back into the sport in 1981. He holds the ratings of Commercial Pilot, Helicopter and Glider, and is a CFI-G. He got his start flying helicopters for the US Army, and is now an Army Flight Surgeon. He is a graduate of the Aircraft Crash Survival Investigators School in Tempe, Arizona and well as USC's Aircraft Mishap Investigation Course. He has a Doctor of Medicine from LSU, and a Master of Public Health from Harvard University. Currently, he is a Resident in Aerospace Medicine at the US Air Force School of Aerospace Medicine at Brooks AFB, Texas.

Another proactive OCHS Matrixes (investigative techniques) which coincidently <u>also</u> completely ignores the accident in itself is the **Risk Matrix:**

Consequence							
	High	5			(9)		
		4					
		3			**Risk**		
		2					
	Low	1					
			5	4	3	2	1 **Probability**
			High				**Low**

This matrix is used to determine whether or not there is a need for an investigation (since it is not possible or practicable to investigate all incidents) or what depth that investigation needs to go to.

It is also a very useful tool for evaluating all factors leading up to an accident in order to determine root causes.

* **Scenario:** You are a happily married man. All of us at one time or another have faced the hissy fit when we leave the toilet seat up. A wife who stumbles into the bathroom in the middle of the night, only to sit on a dirty toilet bowl is not a happy camper.

The risk of that happening is not that high. We have all learned the concequences only too well. But the concequences of a memory lapse can be quite high.Correct? Lets say a "9" on our risk matrix - none of us relish the prospect of sleeping on the living room couch!

Now introduce a young boy into the family, and Junior, well, his aim during toilet training is not too good right now.

It is a fairly simple matter to explain to the wife that her quality of life is going to improve dramatically if we make a policy that the bathroom toilet seat is left up from now on... and just like that, the result is a complete turnover in our safety culture - and a delightful return to a male-dominated society.

This therefore was an incident that was worth while to investigate, and which obviously resulted in several benefits and reduced "costs" (in this case, marital.)

The benefit accrued from assessing the risk and issues from not one, not two - but three different vantage points. <u>That is the lesson, and the message of</u> Risk Assessment. Look at the hazard from all possilbe points of view.

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