003. SAFETY IN GLIDING.

Tijl Schmelzer – aboutgliding.com

Is Gliding (too) Dangerous?

Danger and risk are inherent to all human actions. Every step you take, and every move you make, have a chance of terrible consequences. Of course, some activities are much more dangerous than others. But on the other hand, some experiences are much more valuable than other ones.

How should we decide if a certain activity is worth the associated risk?

Danger, risk and accidents have been part of gliding since the very beginning. After decades of observing birds, contemplation and experimenting, Otto Lilienthal made his first flight in mid-1891 from the Windmühlenberg near Berlin. In the years that followed he made over 2,000 flights. His well-documented progress enabled the advent of aviation. Sadly, after becoming the first glider pilot in history, he also became the first person who died in a glider accident. On the 9th of August 1896 he broke his neck after his glider stalled and crashed into the ground. He died in the hospital a day later. The picture in the banner shows the wreckage of his fateful last flight.

His sacrifice has been far from the last. After WWI, gliding boomed in Germany, especially on the now well-known Wasserkuppe. In the pioneer years of aviation, countless pilots died in accidents during their endeavors to push the flight envelope. To honor them a remembrance place, called Fliegerdenkmal, was opened in 1923 during the 4th annual Rhönwettbewerb gliding contest. According to the newspapers of that time 100,000 people attended the ceremony, amongst them several dignitaries such as the brother of the German Emperor.

A glider passing by the Fliegerdenkmal on the Wasserkuppe in the 1930s.

The ceremony did not mark the end of those perilous times. The day after the opening of the monument, another 3 serious glider accidents occurred on the Wasserkuppe, causing the death of one of the involved pilots.

As is often said: aviation regulations are written in blood. It is the sacrifices of men like these that made our beloved sport into what it is today. Now, what was acceptable in those pioneer years, is of course not acceptable anymore today. Luckily gliding has indisputably become a lot safer since the 1920s and 1930s. and even since the 50s and 60s. However, many have the feeling that safety records have stagnated for a long time now. And the leftover risk seems to be still high.

In 1993 Bruno Gantenbrink, World Champion 15m class 1989, held a highly controversial talk about safety in gliding, during which he proclaimed: “Gliding is bloody dangerous!”. Its premise is the same message as the one of this article: we should take safety considerations much more serious than we already do. I would urge you to look the transcript up and read it. It’s as relevant today, as it was 25 years ago: I just don’t have the feeling a lot has changed since that presentation.

11 people who I have been acquainted with, passed away in gliding accidents. I also know dozens upon dozens of pilots who had life changing accidents, in which they were lucky to survive. All of those in the last 20 years. And I don’t see a downward trend.

In the following chapters I would like to make an attempt to answer some important basic questions: How dangerous is gliding really? What is an acceptable risk? How do we decrease the accident rates further?

What is an acceptable risk and accident rate?

Long before the Challenger took off to the 25th Space Shuttle mission, NASA had made a thorough risk analysis of this space program. As is usual for projects like this, every single potential point of failure is measured, analyzed, estimated, and quantified. Those risks are then added up to get a global view of how risky the Endeavour is. In the case of the Space Shuttle program, that risk was expressed in the Probability Risk Assessment Number, or PRAN. This number expresses the chance of complete catastrophe of a mission from take-off to landing. The results of such a catastrophe would be hull loss, and loss of the lives of the crew. NASA internally calculated a PRAN of 1 in 7,000, which was deemed to be an acceptable risk. In fact, the Shuttle program was supposed to be extremely safe in comparison with earlier human space flight programs.

For most people, at NASA and beyond, the Challenger Disaster came completely unexpected. It was clear that the calculated PRAN was not correct. To investigate the disaster and clear things up, an impartial investigation commission was instigated. Amongst the members of that commission were astronauts and aviators with engineering backgrounds like Neil Armstrong, test-pilots like Chuck Yeager, but also Nobel prize-winning physicist Richard Feynman.

It was Feynman who came forward with the cause of the accident: a small rubber O-ring was not tested at low temperatures, and due to increased stiffness under such circumstances it did not properly seal a crucial joint in the solid rocket boosters. Another distressing fact he found out during his investigations, was that some engineers (Roger Boisjoly) did know about this O-ring issue before the disaster, and that they warned NASA management about it. Their concerns were unfortunately dismissed. Feynman also found cases in which the risk numbers that NASA used, differed by a factor of a 1,000 from the original engineering numbers. This led him to add an appendix to the final report of the investigation commission, in which he denounced the safety culture at NASA. He urged them to be more realistic in their assessments. He concluded: *“For a successful technology, reality must take precedence over public relations, for nature cannot be fooled.”*

Subsequently NASA went back to their risk analysis, now using realistic numbers. The new PRAN was revised to 1 in 78, meaning that 1.28% of all shuttle launches was to be expected to end in catastrophe.

The Shuttle program was halted in 2011 after 135 missions. With the Challenger Disaster and the Columbia breaking up during re-entry in 2003, 2 of those missions ended with complete loss of life of the crews. The final accident rate of 1.48% is remarkably close to the revised PRAN from 1986.

Now, the moral of the story, is not that a 1 in 78 risk of catastrophe is unacceptable per se, and thus that the Shuttle program should never have been greenlighted. It could very well have been deemed acceptable for such a pioneering project. The moral is, that it isn’t right when something is sold as being much safer than it truly is, just to quench opposition. US Congress, taxpayers, and astronauts were not in possession of the information they needed to make a balanced decision.

And, equally important, a false sense of security makes people less cautious and more dismissive of safety issues. Perhaps the engineers who warned for the problems with the O-rings before the Challenger took off, would have been taken more seriously if the PRAN was not artificially deflated.

This all shows how important risk assessments are. For gliding, some decent statistics do exist, and they are not censored nor manipulated. But they are not widely known amongst many pilots, and it is often poorly explained to how it relates to them personally, and how it translates to real-world danger. Partly because of this, safety is still not taken seriously enough.

Our risk assessments in gliding are also much less thorough than they ideally could be. Analyzing gliding risk factors is in some respects more complex than for a space program. Not from a technical point of view obviously, but the human error factor is much more opaque. It would be incredibly useful if all accident reports would be gathered, analyzed and categorized in an organized manner. There are some databases, and some numbers available (some even tracked over decades), and there have been some excellent studies done, but not yet at the level of detail as would be optimally desirable.

This would be an excellent topic for a university research project, such as a Master thesis, or for an Akaflieg group to study.

Micromorts

The concept of the micromort is related to the PRAN as described above: it is a unit of risk defined as a one-in-a-million chance of death “per exposure”.

Micromorts, is a very useful concept in risk assessment, as they make it possible to put risk into context and compare the actual riskiness of different activities. They are also simple to calculate if you have the right data.

The Space Shuttle’s PRAN of 1 in 78 would equal a 12,820 micromorts per flight. This means that for each 1 million people who fly on the Space Shuttle, on average 12,820 deaths would occur.

“Exposure” is a vague term, which gives some flexibility to the use of this concept. In aviation, we could use a micromort per takeoff, a micromort per flight hour, or a micromort per kilometer distance. In theory, you could also make specific micromort statistics per flight type, for mountain flying vs flatland, for pilot age groups, for experience categories, per type of accident, etc. That would require a lot of data.

More general than micromorts, is the concept of microprobabilities: it is a unit of risk defined as a one-in-a-million chance of “something happening” “per exposure”. “Something happening” in this context often means very serious accidents with or without deadly consequences.

So, what are these statics for gliding?

Micromorts of competitions:

Based on data obtained from the IGC Accident report 2018, during 19 EGC and WGC in the period from 2008-2017, 24 serious accidents occurred involving 29 people. 2 people died.

We were lucky however, as the amount of mid-air collisions during those EGCs and WGCs would have made it statistically very probable for an additional death to have occurred, and so the odds of mortality are probably even higher (more on that in a future article).

A survivability ratio of about 1 in 10 to 1 in 15 for serious accidents is in my opinion rather plausible, this means that you have 90%+ chance of survival of a serious accident (which does depend on how “serious accident” is defined).

Roughly calculated, this corresponds to 148 micromorts per competition flight, and 2,141 microprobabilites of a serious accident per competition flight.

Put differently, that amounts to 1 death for each 6,773 competition launches, and 1 serious accident for each 467 competition launches (that's more than 1 in each competition).

A 2011 study Eric de Boer for the IGC, which looked at WGC and Grand Prix finals from 1948 to 2010, came up with 1 death for each 6,690 competition launches. That's an astonishingly similar result. So, accident rates do not seem to be dropping at all at this level of competition flying.

A single competitor has a 0.12% chance of a fatal accident during a single EGC or WGC participation. He has a 1.7% chance of a serious accident during that competition.

A complete national team of 12 pilots, has 1.4% chance of at least one fatal accident per year, and a 18.6% chance of at least one serious accident.

This is of course calibrated to WGCs and EGCs, and I do not know for certain how this translates to lower ranking competitions. I couldn't find a study on this neither. It's very possible (and in my opinion very likely) that the risk per flight is a lot lower for less competitive competitions. For the following calculations, I did equate the risk to all competitions, which is something that could be refined.

It's also certain, that competitions do not carry the same amount of risk for each participant. This is something that will be addressed later on.

Micromorts of all flights (in Germany):

According to the BFU Jahresstatistik Unfalle, in 2017 there were 12 deaths due to glider accidents in Germany. That number is in line with the past 28 years.

Combined with the data of Destatis on amount of glider flights in Germany for 2017, this leads to about 17 micromorts per flight.

Oddly, the BFU statistics also show that, while deaths and heavily wounded numbers have remained similar, the total amount of accidents decreased significantly over that period (from 179 accidents in 1990 to 64 accidents in 2017). If nothing else (such as reporting of accidents) changed, that means survivability ratio of serious accidents decreased from about 1 in 15, to 1 in 5. The average of those coincides roughly with the survivability ratio of competitions. This would mean 166 microprobabilites of a serious accident per flight.

Put differently, that amounts to 1 death for each 60,317 launches, and 1 serious accident for each 6,032 launches (or 1 in 11,309 launches using only the latest data).

The global study of de Boer 2011, puts the risk of death for average glider flights at 1 for each 70,422 launches (or 14.2 micromorts). So very similar results as well. Prof. Alfred Ultsch does a lot of research on this topic, and his findings are also in line with these numbers.

Comparison with other activities:

Micromorts by themselves are hard to interpret. How bad is 148 micromorts per WGC competition flight? It's thus useful to put these risk levels next to the risks of other activities.

Dying of all non-natural causes	0.8-1.6	per day (BASELINE)
Scuba Diving	5-10	per dive
Skydiving	8	per jump
Motorcycle	10	per 100km drive
Average Glider Flight	17	per flight
Average Glider Flight in Mountains	30	per flight
WGC/EGC Flight	148	per flight
Basejumping	430	per jump
WGC/EGC Contest	1,211	per contest participation
Climbing the Matterhorn	2,840	per ascent attempt
Flight on Space Shuttle	12,820	per flight
Climbing Mt. Everest	37,932	per ascent attempt

Another way of looking at this, is comparing the risk per distance for different modes of travel.

Travel distance equivalent to 1 micromort for different options:	
0.7	km by glider during WGC/EGC
4	km by glider on average
10	km by motorbike
27	km by walking
370	km by car
1600	km by jet aircraft

This shows how right Bruno Gantenbrink was in fulminating against the stupid common statement that the drive to the airport is the most dangerous part of gliding.

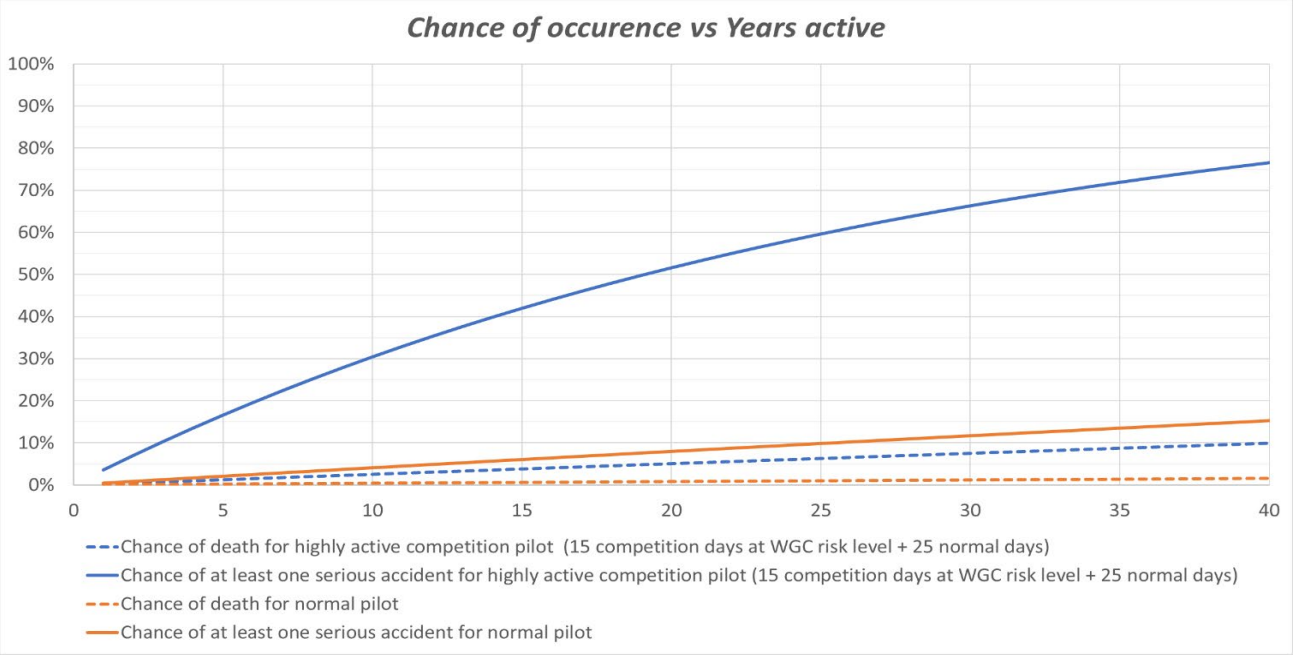
The lives of 2 different pilots:

Let us put these numbers into perspective by looking at a complete 40-year gliding career of 2 different pilots: an average glider pilot, and an extremely active competition pilot (15 competition flights per year on the risk level of WGC/EGC, plus 25 other flights per year).

That last one, can be seen as a worst-case scenario, and few people are in such circumstances.

The chance to die in a glider accident for the average pilot, is 1.6% over 40 years. The average pilot has about 15% risk to be involved in a serious accident.

For the extremely active competition pilot, he has a 10% risk to die in a glider accident over 40 years. He has a 77% risk to be involved in at least one serious accident.



The chart should also be read as years from this point forward. The chance of occurrence resets every day, no matter if you already have been flying for 20 years or not.

Some very necessary notes to those statistics:

At this point, it is good to remind you that I believe that lower level competitions than WGC/EGC, are much less risky. Thus 15 competition days per year at WGC risk level year in, year out, is rather unrealistic for most people, even those who actively fly competitions.

The above numbers are rough averages. You can drown by wading through a river that is 1 meter deep on average. There are vast differences between circumstances, and between pilots:

Mountains vs. flatland (one study says accident rate x 2), cross-country vs. local flight, wingloading, experienced vs. inexperienced, current vs. not-current, reckless vs. safe attitude, healthy vs. sick, age, relaxed vs. stressed or tired, …

Many things not captured by an average will influence your risk level.

A Sunday afternoon flight in fair weather by a well-trained, relaxed, healthy and experienced pilot in an ASK21, is vastly different from a world championship competition flight with thunderstorms in the mountains with a 60kg/m2 racing machine by a stressed-out pilot who has never flown such a competition nor in that area before, and who had too many beers in the bar the night before.

Personally, in about 3000 hours of gliding, most of which cross-country or in competitions, I have had no accidents. I did have one close call. This happened about 10 years ago and is a typical story of a normal competition final glide getting way too tight due to stronger than normal sink in the last kilometers (an all too common situation, easily solved by better competition rules). I was never the most reckless pilot. I do spend a lot of time thinking about safety, especially in the last 10 years or so. Personal attitude undoubtedly has an impact on accident risk.

On the other hand, one must be a bit careful with thinking like this, as few pilots would deem themselves to be more dangerous or worse than average. And if there are pilots with a profile that is less risky than average, then there are necessarily also pilots with a higher risk.

Is that risk acceptable?

With ballpark estimates of the risk involved, and knowledge about what increases and decreases that risk, you can make a balanced decision on which risks are “worth it”.

If you want to go and meet some friends for a beer, and you would know beforehand that driving there and back would carry just a one-in-a-billion chance of dying, you wouldn’t think twice about it and go out. If that same situation would carry a 1 in 10 chance, you would stay home that night. On the other hand, if a woman is pregnant, and due to complications carrying the baby to term would have a lethal risk for herself of 1 in 10, many women would choose to accept that risk.

The acceptability of the risk of an action thus depends strongly on the value you derive from that action.

I wrote an article about why gliding is valuable to me (004. Why I Love Gliding), and most glider pilots will agree that they thoroughly enjoy soaring. The joy we derive from gliding, is why we are open to a non-zero accident rate. I would thus never suggest that we shouldn’t go flying unless it was as safe as sitting on a couch watching tv.

A 1.6% lifetime chance of dying in a gliding accident for an average glider pilot, could be well worth the joy it brings for many.

Even a worst-case scenario of 10% chance might be considered worth it to some, considering they still have a 90% chance not to die in a glider.

However, from a personal, communal and societal perspective, I do regard both risk rates as very high.

Also a lifetime serious-accident-chance between 15% and 77% is problematic in my opinion. Let’s not forget that the last number corresponds to more than one heavy accident each world championships.

In the end, this is a very personal choice. But I do think many should take more time or effort to think about this. And if people would also do that for each flight, and within each flight, that would help tremendously with reducing accident rates.

For me, I decided about 10 years ago not to participate in high-pressure contests in the mountains anymore. Most accidents occur in those circumstances, and to me the risk is not worth it. For me, the risk of flying in the mountains is absolutely fine, even combined with a competition. But only if I do not feel any pressure to go flying in bad circumstances in complex areas. That means it is unlikely that I will ever fly a Europeans or Worlds in the mountains again. I don’t think of people who see that differently as crazy. Again, it’s a very personal choice. And if the competition rules would change in the future, in a way that accident rates decrease massively, I could reconsider this position.

An interesting point of view was written by Paul MacCready:

> *“Most dangerous was the final day in France in 1956 (ed. the final day of the World Championships) – a flight I didn’t have to make because my lead in the contest was more than the maximum points for a day.*
>
> *The middle part of the flight was in very strong winds, in mountains topped by clouds. The wake of one mountain would confuse the flows ahead of the next. In one valley, with no apparent exit, the gust strength would be comparable to the wind speed, about 100ft/sec. You’d be in a huge up, then down, then zero airspeed, then too fast – all in all being tossed about with no control possible. Your escape to safety depended only on luck. I hung on desperately and was lucky.*

Bill Ivans, the other U.S. single place entrant, got in a rather similar situation nearby and was not lucky. He barely survived the crash that reduced his wooden British sailplane to kindling, and he spent a long time in the hospital (initially in a town called "Die").

I have never been as exhausted as on the drive back that night, after my long and harrowing flight, and with the worry about Bill's situation. I never flew a contest again, and, with caution growing with age, can't recall any subsequent moments of terror in an airplane where your survival depended solely on fate's coin flip rather than on your skill or equipment."

The last competition flight Paul MacCready ever made, was on the day he became world champion.

Now, lots has changed in competition flying since then. The task of that day (straight distance out as far as possible with the wind in the back, without return to the airfield) are long since scrapped for good reason. The contest site of 1956 was St-Yan, which lies in the flatlands of France, far away from the nearest mountain. The weather of that day forced them to fly straight distance more than 200km away to the complex mountainous area of the South-West Alps. An area he had no experience in and was not well prepared for. Add the difficult weather of the day, and it is no wonder that pilots came back injured and traumatized. While this experience MacCready had is luckily not possible anymore today, it's a very valuable insight in a rational substantiated way of making decisions about risk.

For a different perspective, I would like to quote from Bruno Gantenbrink's infamous 1993 speech:

"Why don't I quit? A good question. I don't quit because it's more enjoyable and more rewarding than anything else I could imagine as an alternative.

Decisive is however a second reason, and this is the more critical one, and also why I give this lecture: I believe that gliding is not by nature as dangerous, as it is. It could be much less dangerous if we were more conscious of the dangers and if we would act accordingly. Which, unfortunately, we are not doing.

For my part, I am very aware of how dangerous gliding is, and I make an effort to conduct myself accordingly. Therefore, I have the hope that I can beat the statistics as an individual. If I didn't have this hope, if gliding was as dangerous for me as the statistical average actually is, I would stop immediately.

Almost all friends I lost while gliding died because of "human errors", because of pilot errors. They were ridiculous little things, carelessness of the simplest kind with fatal consequences. They are dead because at the decisive moment other things were more important to them than flight safety. If gliding should become less dangerous than it actually is, then one or the other measure is not enough. The fundamental attitude must change. And the fundamental attitude can only change at all if we realistically assess the danger to which we are exposed almost every day."

I completely agree with his vision. I believe gliding can be safe, and that we can make gliding significantly safer for everyone.

How safe exactly, is a difficult question to answer. Any progress is welcome of course. But if we could reduce accidents by for instance a factor of 5 (to 2 deaths in Germany per year, 1 serious accident each 5 world championships, and 1 death for each 50 WGCs), I would deem the safety problem of gliding completely under control. It would be a worthwhile target, but if it is possible is unknown.

And this leads us to the final question of this article:

What can be done to make gliding significantly safer?

To achieve material improvements, there are 3 main avenues:

1. Better technology
2. A Safety Mentality and Culture
3. Better procedures and rules

This article is an introduction to concepts, so what follows is a broad overview. Some aspects will be more explored into detail in upcoming articles.

Better Technology

Technology has been a crucial driver of safety improvements in the past. Better stall-characteristics due to the invention of washout, automatic rudder connections, crash-cockpit testing, parachutes, and other improvements have saved countless lives.

There surely is still a lot of potential in new technologies: software analysis to filter out dangerous pilot behavior, angle of attack / stall warners, anti-collision lights becoming standard, standardized and more professional oxygen system installations (according to Jean-Marie Clement, lack of oxygen is the probable cause of a certain amount of unexplained high-altitude accidents), electric motors instead of internal combustion engines (ICE), …

Let's take that last one as an example. Take-off by winch or aerotow, off-field landings, and getting trapped in a position without landable fields, are all great sources of risk. A reliable, quick to deploy, and easy to use propulsion system with sufficient power, would solve these issues almost completely. Unfortunately, ICE turbo's and selflaunchers have a non-perfect track record. Electrical systems are quickly becoming more mainstream. And although there are still some issues to be ironed out, they do hold the potential of a vastly higher reliability.

There is however an unresolved issue with this, which can be made clear with a thought experiment:

- If you have an ICE with 99% reliability, and you make sure that 9 out of 10 times you use the engine you start it over a good landable field with sufficient altitude, 1 out of each 1000 times will end in disaster.
- If you however have a 99,9% reliable electric motor, but because of the higher reliability you now always start it low over unlandable terrain, still 1 out of each 1000 times will end in disaster.

People's confidence in safer technology could result in no net decrease in accident rates, simply because people will behave riskier.

Anecdotally, there are some examples of this already happening. A pilot I know, had a glider with an electric motor. Already on one of his first flights, he started the motor above a forest without other options. He would never have brought himself in that situation without the motor. Another example is of a pilot who borrowed a glider with an electric motor for a contest. To avoid landing out, he used the

motor 3 times during that contest. The first time he used it at 146 meters, the second time at 138 meters, and the third time at 55 meters above hardly landable terrain.

Electric motors have a great potential for the future of gliding, but even a very reliable system needs to go hand in hand with discipline. The same is true for other technological improvements.

Another problem with technological progress, is the time it takes for it to become widely used. For accessory equipment, like parachutes or Flarm, it can happen quickly. But our gliders last decades and are expensive to replace with new ones. That longevity is great to keep costs down, but is less great from a safety perspective. There are still many gliders flying without crash-cockpits, without automatic control connections, and with unsafe stall-characteristics. It's impossible to replace them due to cost considerations.

So, even if a new technology like reliable electric motors would be installed in every single new-built glider, it would take many decades to replace the current stock.

In conclusion, yes, technology has potential to improve safety records, but it is for certain not enough, and it will not be overnight.

Creating a Safety Mentality and Culture

Both types of changes strive to establish a mindset which brings safety to the forefront of decision making. A mentality change concerns the individual, and a culture change is more related to organizations (organizations like IGC and national gliding association, local aeroclubs and its management and instructors, and also contest organizers).

A Safety Mentality means being more aware of the risk of your actions, and accordingly making informed rational decisions. This is a very large topic, with many facets. Too large to go into every detail in this article.

A good example of a mindset change is protesting when you see something you deem to be unsafe or something that can lead to unsafe situations. This is still too little ingrained in our culture right now.

About a decade ago, a strong sidewind flared up while we were standing in the grid during a competition day. During launching, it increased to 40 to 50 km/h completely cross. The grid itself was a bit shielded from the wind. A few hundred meters down the runway, there was a gap in the treeline, and at that location planes taking off got blasted with full force. As I was in the back of my class that day, I had time to look at the first take-offs: they seemed extremely challenging. To be honest, the complete situation was far outside of legal limits. Everyone saw it unfolding, and some comments were murmured, but nobody protested heavily. To the credit of the competition director, he did say over the radio to the tow pilots that launching would stop if they thought that it became too dangerous. During my own take-off, at the worst point I had no reaction to control inputs anymore. I was like a leaf in the wind, behind a tow-plane that had to give full rudder deflections to pull us through. I immediately thought: this is madness.

No accidents happened that day, and the competition day itself went without further hiccups. After landing I went to talk to many other pilots and a tow pilots about their day and especially about their experiences during take-off. Not a single person disagreed: it was highly unsafe, and we were very lucky nothing had happened. The only reason nobody spoke up, was because they didn't want to ruin the day for all. Some said they were about to, but finally decided against doing so.

That was an eye-opening moment for me: do we really need to wait to stand up until after an accident has taken place? It's the reason why I have often spoken up when I deemed it to be necessary in recent years.

Interestingly, when you do protest in such a situation, it is very often exactly the tiny push that the guy in charge needs, to make a call. For instance, a competition director feels a huge amount of pressure from the pilots to enable as many flying days as possible. To halt a contest launch or to cancel a day, is a hard decision for him to make, even if he knows it to be the right one. If he feels that he has the support of the pilots (or at least a pilot), that makes it a lot easier for him to make a good decision. Very often, such safety remarks are thus welcomed.

Safety complaints should be taken seriously. And most often in my experience, they are. Of course, the person who is responsible still has the right to discuss and critically evaluate such complaints and make their own balanced decision after careful consideration.

This is just one aspect of a mentality change that leads to fewer accidents. Many accidents, however, happen differently. They are caused by an individual pilot, making an individual error. And very often the actual accident is caused by the error of bringing yourself into an avoidable hazardous situation. What would help tremendously, is if pilots would just refuse to put themselves in such situations.

Another related issue is self-restriction. Imagine you have saved up for a trip to go flying in Africa for two weeks. On arrival there, you fall ill for several days. Not bad enough to be hospitalized, but not completely fit to fly neither. If you would be home, you wouldn't climb into the cockpit. But considering the uniqueness of the situation and the large amount you paid to be there, many people would decide to go flying. It's absolutely understandable. Self-restriction, and deciding that something is not for you, or not for you at that particular moment, are hard.

Unfortunately, mentalities have proven resistant to change. Despite all the talks and articles about the topic in the past decades, easily avoidable accidents still occur far too often.

Part of the reason is that we still do not take accident risks serious enough because it just isn't the sexiest topic.

However, there are some projects that seem to obtain better results. By establishing a safety culture at the organizational level, it is possible to sustainably raise mindfulness about safety of individual pilots.

It has been tried since 1990 in Sweden (currently called Flysafe), where they try to create proactive environments. They do this with training focused on the system, club leadership and instructors, with incident and safety issues reporting tools, and with audits. It has been credited to reduce accidents in Sweden by an order of magnitude from 50+ accidents per year to less than 5. In the period of 2010-2014, the microprobability of accidents was about 67, and thus 1 accident for every 14,925 launches. I couldn't find information on mortality, but if we use the ratios we found previously, that would suggest 4-7 micromorts per flight, or 60-75% lower than in Germany (as a note, there is less mountain and competition flying in Sweden than in Germany, possibly skewing these numbers a bit).

A similar system has been started in 2009 in Germany and Switzerland, called Flytop, developed by Prof. Alfred Ultsch. It gets good reviews by the clubs who have made use of their services. The difference between Flytop and Flysafe, is that the former is a private initiative, while the latter is part of the national Swedish gliding association, which seems to make it easier to convince all clubs of the merits of such a program, and thus quicker adoption.

Procedure and Rule Changes

Professional aviation has an excellent safety record. That would not be possible without well thought out, rigorously tested procedures and rules.

What attracts us to gliding are freedom and enjoying a relaxing time away from the world's sorrows. Discipline, procedures and rules do conflict with that somewhat. However, I am afraid better regulations, and stricter adherence to those, hold a large potential to reduce accident rates.

If you want to go flying in Namibia, it is mandatory to have at least 500 gliding hours total, 50 hours and 30 starts in the last 12 months, an English Proficiency Level 4 qualification, 48 hours of rest after arrival in the country before the first flight, mandatory theoretical and practical introduction to flying in the country, mandatory SPOT as equipment, and 1 mandatory rest day after each 7 flying days.

These rules are not invented without reason. Almost each of these rules was implemented after an accident or almost-accident. For instance, an English Proficiency Level 4 had always been written in Namibia's laws, but never checked. After a pilot with no English knowledge almost crashed head-on during landing into another glider because he had not understood that the runway was switched due to a wind change, this regulation is strictly enforced since a few years.

Regarding qualifications, I think we should be a bit stricter on some occasions. Currently it is allowed to fly a world championship with just 100 gliding hours and without ever having flown a single competition day. One of the deadly accidents in the last decade at a WGC was a pilot with very limited experience (which was deemed by IGC to be a possible cause). I also met a pilot once during the training week of an EGC. He came from a country with very few glider pilots and told me he had little experience in competitions. His national Aeroclub was just glad to send anyone. He crashed his glider on the first day of the competition.

I know we should try to be as inclusive and welcoming as possible, but we must as well protect people who don't have sufficient knowledge or skills yet. The same issue is for instance important for airfields in difficult terrain, such as the Alps, who receive guests.

Regarding contests, there are also some rules and procedures that are bloody dangerous. Our finishing systems should have long ago been rethought (both finish line, and small finish circle have caused way too many accidents). The way gaggles are implicitly incentivized in the point system, increases the likelihood of mid-airs. What truly is maddening, are rules that advantage pilots who take safety risks. Competition pilots respond to incentives (read: point gain and loss), and if those incentives reward bad behavior, pilots will behave badly.

Another aspect is better monitoring of pilot behavior, with eventual "punishment" if certain boundaries are crossed. Even a stern talking to a pilot can create a lasting impression that will change behavior. There is a pilot who was for years well known in the international competition circuit for constantly flying extremely aggressive. At a certain contest after a few incidents during gaggle flying and subsequent unofficial complaints, the pilot was told he would be disqualified from the competition if he would continue like this. He completely changed his ways after that, and I have not heard of a safety-related incident with him since.

I do think we can be more rigorous and methodological in that, and not only during competitions. Of course, we do have to be a bit careful with it, as we are all amateurs and not professional experts or judges, and nobody wants the Spanish Inquisition.

Finally, you need to be certain that good rules and procedures are also followed. For that, you need a culture in which the value of safety is well understood, which leads us back to the previous chapter.

Conclusion

I think there is an urgent need to further improve our safety records, especially regarding competitions.

I am rather hopeful. I currently see many people voicing similar concerns, and solutions that go in the same direction. A few high-profile accidents in the last years seem to have been the painful straws that broke the camel's back.

Channeling that, and coordinating it into well-conceived, well-tested, and lasting change will take a lot of effort. It also requires an everlasting effort from each individual pilot and from organizational structures.

Safety is an enormously vast topic, way too big to cover all in one article. So, let me just end it here with the wise words of Paul MacCready:

> *"Flying is sometimes useful and serious but is always supposed to be fun – and that means safe, no white knuckles. Danger is dumb."*