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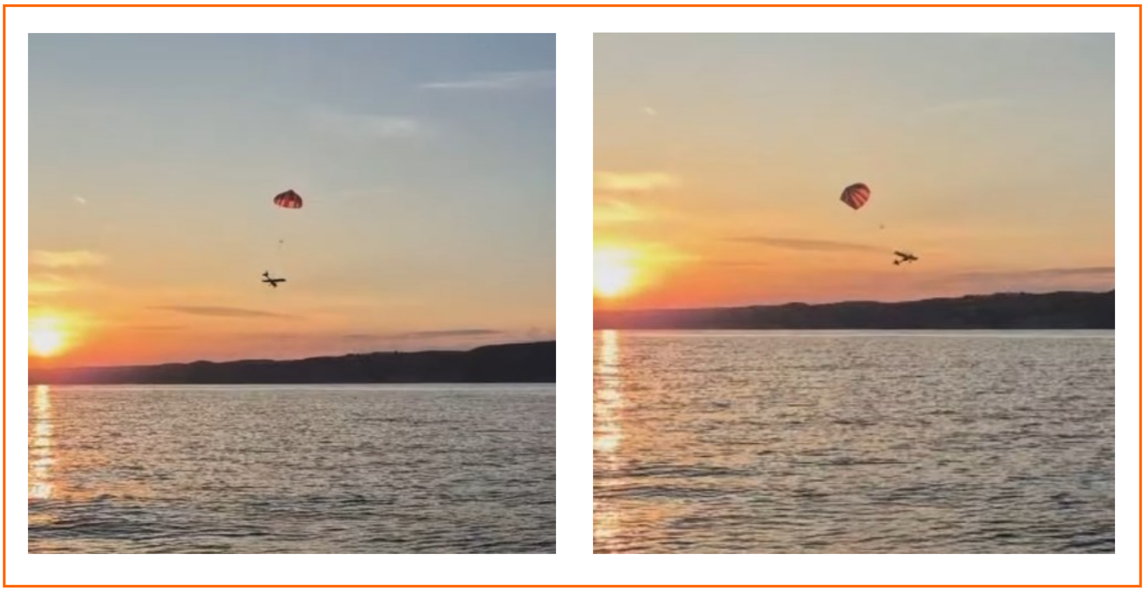
SAFETY STUDY

Activation of ballistic airframe parachute: cognitive, emotional and physical mechanisms



(images from an Instagram video @felicieaussi)

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January 2026

Contents

This is a courtesy translation of the study by the BEA. As accurate as the translation may be, the original text in French is the work of reference.

SYNOPSIS

Activation of ballistic airframe parachute: cognitive, emotional and physical mechanisms

Certain aircraft are equipped with ballistic parachutes attached to the airframe, allowing them to reach the ground safely in an emergency situation. While some certified aeroplanes are equipped with these systems, they are mostly installed on fixed-wing microlights. Recent investigations have revealed occurrences in which all the circumstances for the parachute to be used seemed to be present, without it being activated by the pilot or a passenger.

The aim of this study is to gain a better understanding of the (cognitive, emotional and physical) mechanisms involved in the activation or non-activation of a ballistic airframe parachute.

Period	**January 2015 - August 2022**
Aircraft category	**Light, single-engine aeroplane** **Fixed wing and flex wing microlights**
Investigation authority	**BEA (occurred in France or was delegated to the BEA)**

The study focuses on occurrences known to the BEA, both investigated and not investigated, in which a ballistic airframe parachute was activated or could have been activated.

A total of 95 accidents were selected for the study. Among the occurrences selected, 88 accidents, including 38 fatal accidents, involved microlights; 34% of fatal microlight accidents fall within the scope of the study.

There were 21 cases of parachute activation. It would seem that the parachute was activated for the occurrences selected:

- just over one in five times in fixed-wing microlights;
- just over two in five times in aeroplanes.

The study highlights the benefit of the ballistic airframe parachute, when deployed within its field of use, in mitigating bodily injuries. In the majority of cases (18 out of 21), there was no technical malfunction of the parachute during its activation or deployment.

Four types of situation leading to the activation of the parachute were identified:

- loss of control;
- loss of visual references;
- excessive speed;
- lack of a suitable field for an off-aerodrome landing.

Of these 21 cases, 9 were investigated by the BEA (59-CAW, 34-ABF, N19BV, 01ACM, N842CD, 59DAE, N918SE, 37AAH, 40FJ). The examination of the parachutes and their attachment gave rise to technical feedback including the need to shut down the engine before deployment, and information about the installation of parachutes and the assembly of cables.

These investigations revealed several cases of delayed deployment, without it being possible to explain the underlying decision-making process. In fact, they mainly concern fatal microlight accidents where it is not possible to learn from the pilot's statement. This is why the study focuses on occurrences where the BEA did not open an investigation, in order to identify factors influencing the pilots' decision to activate their parachute.

The 12 pilots who activated their parachute in an occurrence that did not give rise to a BEA investigation were contacted to gather their statements and feedback. A total of 10 pilots responded positively.

The analysis of the occurrences and the associated statements has identified key factors that contribute to the parachute being activated: first and foremost is the pilot's **assimilation** of the parachute through **knowledge, rules (activation criteria) and a willingness to use it**, or at least a lack of aversion to its use.

On losing control, the pilot’s first actions are focused on attempting to regain control of the aircraft. Given the small amount of time available to pilots in these highly dynamic situations, the decision cannot be the result of a complex process consisting of an evaluation of all the possible alternatives. Identifying the situation and understanding its urgency must be a trigger. To this end, activation rules which have been clearly established beforehand are the means for a pilot not to engage in a real assessment of the risks or benefits associated with this option.

The stress and surprise generated by the situation can hinder taking this decision. However, it is facilitated if the **parachute activation procedure is reviewed during a briefing**. What's more, practising the actual action beforehand during specific training that certain aircraft manufacturers may propose and/or by simulating the action just before the flight can ensure that the pilot **performs the action nearly automatically** in an emergency. Lastly, good command of the activation action (position of the parachute handle, amplitude of the action and force to be applied) facilitate its execution in stressful situations and in unusual flight attitudes.

To take the decision to activate the parachute requires the pilot to make a major effort to change his plan of action and accept the consequences (possible damage to the aircraft, sense of failure, potential impact on reputation of pilot).

To facilitate its use, pilots must have a clear idea of when to use it: while it may not be the first option chosen, it must be present from the outset and **seen as a positive option**. Beyond the rules, **knowledge of real-life stories**, whether through statements or videos, seems to facilitate seeing it as a positive option; for this reason, the BEA has chosen to publish all the statements collected as part of this study (see appendix).

Factors such as the assimilation of the parachute, having already performed the action, knowing real-life stories, and the identification of situations where it can be deployed will allow pilots to better assess their resources, increase their ability to cope, and reduce their stress. Not wanting to think about it, or dismissing its use, which may be a symptom of an ego-defensive bias (in the form of denial), may (unconsciously) serve to reduce the pilot's anxiety and reassure them in the short term, but is counterproductive in an accident situation.

In addition to the occurrences included in the study, since 2022, four accidents investigated by the BEA have benefited from the preliminary results of the study. Key elements identified in the study concerning the pilots' decision-making process for activating the ballistic airframe parachute were seen.

- Accident to the G1 Aviation identified 04IF
- Accident to the Aerospool WT9 identified 67BVN
- Accident to the Aerospool WT9 identified 04F0
- Accident to the Super Guépard ULS identified 12HP

1 INTRODUCTION

Certain aircraft are equipped with ballistic parachutes attached to the airframe, allowing them to reach the ground safely in an emergency situation. These parachutes are activated manually by means of a handle situated in the cockpit. While some aeroplanes are equipped with ballistic airframe parachutes such as the Cirrus SR20 and SR22 and more recently the Elixir, Bristell B23 and Virus SW121, the majority of the time, they equip fixed-wing microlights. Incentive policies (financing or weight savings) and promotional campaigns have contributed significantly to this development.

In 2019, following the accident to the microlight identified 01ACM during a revenue flight with a passenger, in which the pilot lost control and activated the parachute, the BEA recommended that:

- the DGAC require the installation of a ballistic airframe parachute, where technically feasible, on all microlights used for local revenue flights with passengers;
- the DGAC require that all companies operating microlights for local revenue flights with passengers ensure that their pilots are familiar with the procedure for using the ballistic airframe parachute.

The order of 17 February 2025 regarding the conditions for using microlights addresses these recommendations by making parachutes compulsory for revenue flights or by restricting operating conditions when installation is not possible.

The occurrences reported to the BEA do not indicate any large use or attempted use of the ballistic airframe parachute. On average, the BEA receives three notifications of the parachute having been used per year.

Recent investigations have revealed occurrences in which all the circumstances for the parachute to be used seemed to be present (height permitting effective deployment) but even so, it was not activated by the pilot or a passenger. One example is the accident to the fixed-wing microlight identified 59DUJ, in which the pilot lost control of the microlight at a height of approximately 8,000 ft.

The aim of this study is to understand the cognitive, emotional and physical mechanisms involved in the activation or non-activation of a ballistic airframe parachute.

2 DESCRIPTION OF THE SAMPLE

2.1 Population

Period	**January 2015 - August 2022**
Aircraft category	**Light, single-engine aeroplane** **Fixed wing and flex wing microlights**
Investigation authority	**BEA (occurred in France or was delegated to the BEA)**

The study focuses on occurrences known to the BEA, both investigated and not investigated, in which a ballistic airframe parachute was activated or could have been activated. More specifically, the selection was based on the following criteria:

- the aircraft was equipped with a ballistic airframe parachute;
- the use of the ballistic airframe parachute during the occurrence was a priori relevant, for example:
    - the pilot had lost or was in danger of losing control of the aircraft,
    - the condition of the aircraft was affected to such an extent that the safe continuation of the flight was compromised, or even that the aircraft was no longer controllable,
    - the pilot no longer had, or was at risk of no longer having, the visibility conditions necessary to ensure separation from the ground, terrain or other possible obstacles;
- the occurrence took place during an airborne phase, excluding initial climb, short final, flare or flight at a very low height.

A total of 95 accidents were selected for the study. These occurrences are represented in the following figure, showing the year and severity of the injuries.

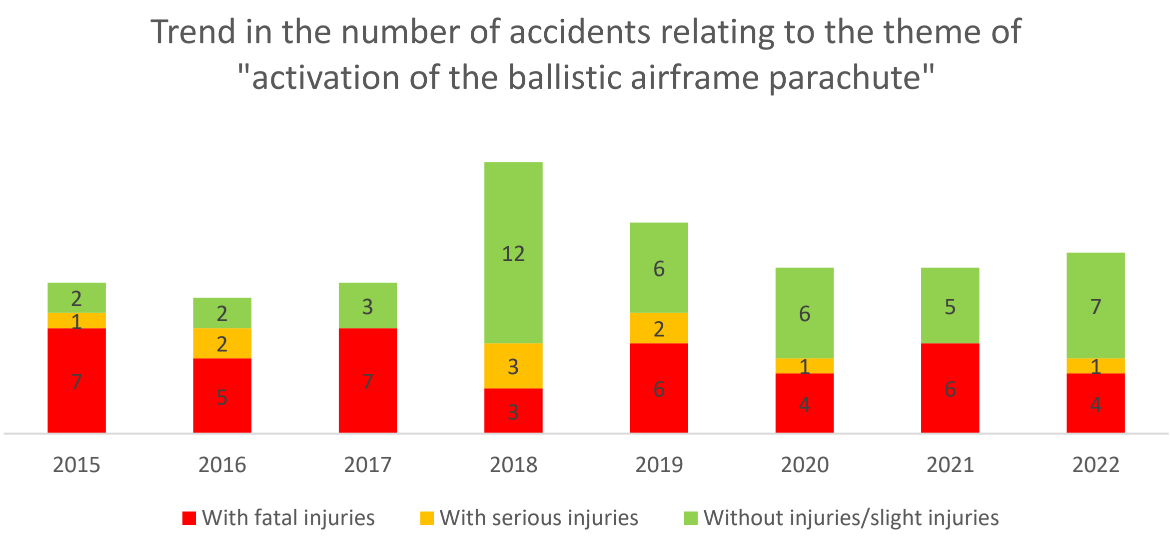

Figure 1: accidents relating to the theme of "activation of the ballistic airframe parachute"

Among the occurrences selected, 88 accidents, including 38 fatalities, involved microlights. Over the same period, there were 113 fatal accidents in class 2 (flex-wing) and class 3 (fixed-wing) microlights, which means that 34% of the fatal accidents involving these microlight classes come under the theme of “activation of the ballistic airframe parachute”.

	Number of aeroplane accidents		Number of microlight accidents	
	Total	**Of which fatal**	**Total**	**Of which fatal**
“Activation of ballistic airframe parachute” theme	7	4	88	38
Overall number of accidents[1]	982	88	644	113
Proportion of accidents concerned by the “Activation of ballistic airframe parachute” theme	1%	5%	14%	34%

Figure 2: proportion of accidents concerned by the theme of the study

2.2 Activation versus Non-activation of the parachute

2.2.1 Proportion of activations according to aircraft type

Of the 95 occurrences selected:

- the parachute was activated in 21 cases;
- the parachute could have been activated in 74 cases.

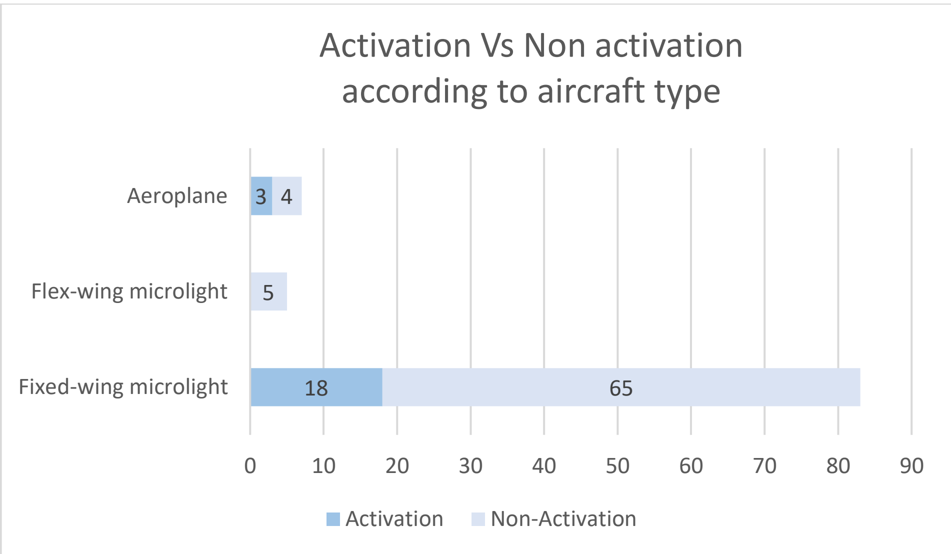

Figure 3: activation of parachute according to aircraft type

[1] Aircraft accidents known to the BEA. Only the figures for fatal accidents have been consolidated; for these, the proportions shown are exact.

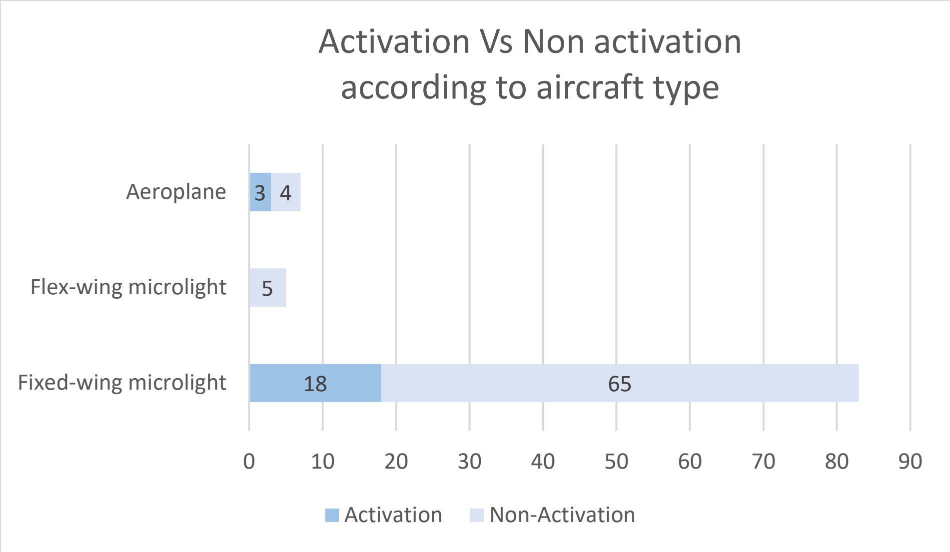

Figure *3* makes the distinction between cases where the parachute was activated and the aircraft type. It can be seen that the parachute was activated:

- just over one in five times in fixed-wing microlights;
- just over two in five times in aeroplanes.

2.2.1 Proportion of parachute activations according to occurrence category

Figure 4 shows the proportion of activations and non-activations according to the occurrence category, no significant difference can be seen.

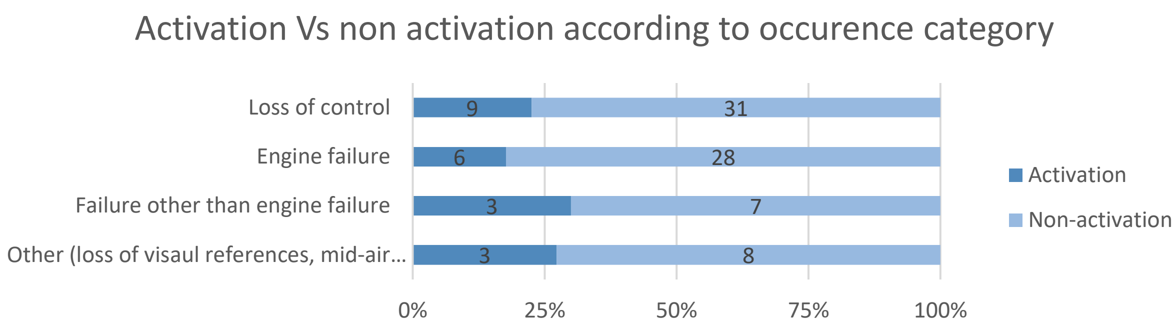

Figure 4: proportion of activations according to occurrence category

2.2.2 Bodily injuries

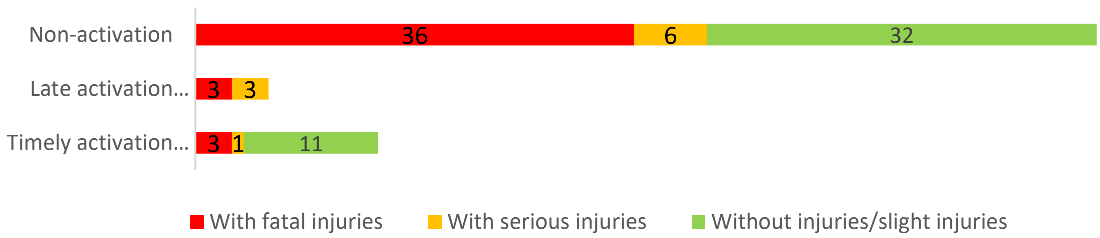

Figure 5: injuries according to the non-activation, late activation and timely activation of the parachute

Figure 5 highlights the benefit of the ballistic airframe parachute, when activated in its field of use, in mitigating bodily injuries.

With respect to the six cases of fatal injuries that occurred when the parachute was activated, three were related to late activation, and three others were related to:

- a post-impact fire: the aircraft fell onto a roof with the engine still running, slid and caught fire on the ground;
- a failure of the ejection rocket igniter;
- inappropriate installation of the cables connecting the parachute to the aircraft.

2.2.3 Possible influencing factors

Pilot experience
The pilot’s experience was known for 17 of the 21 activations and for 23 of the 74 non-activations.

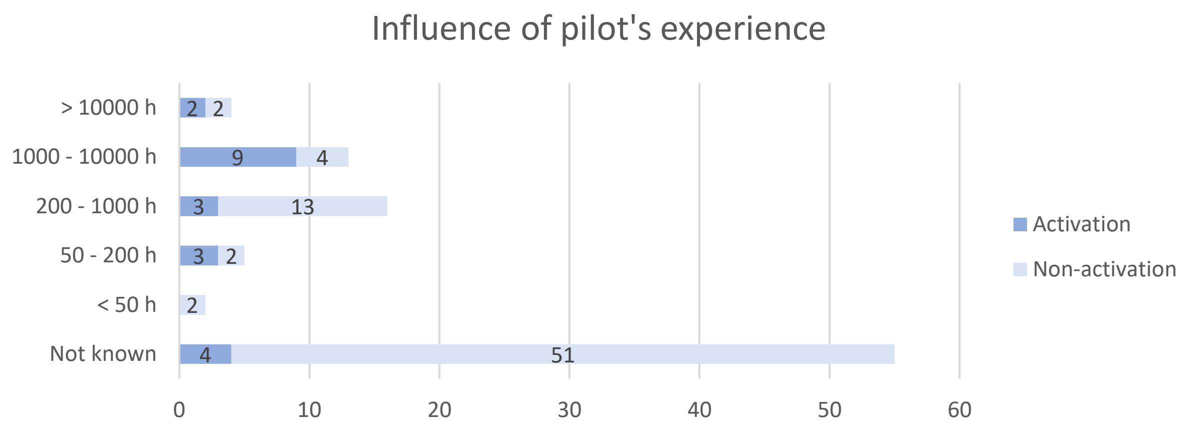

Figure 6: influence of pilot’s experience on activation

The proportion of activations seems to be greater when the pilot has an experience of more than 1,000 flight hours, however the sample is not sufficient to affirm or not this link.

Presence of a passenger
Figure 7 shows the distribution of activations and non-activations according to whether a passenger was on board or not. No significant difference can be seen.

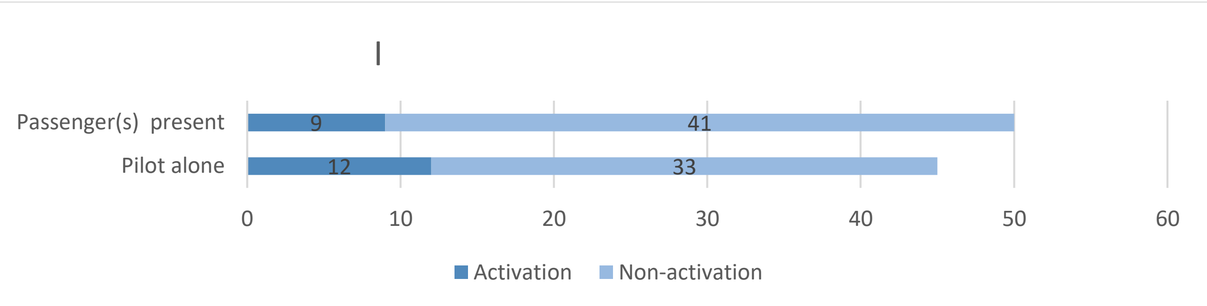

Figure 7: influence of presence of passenger(s)

2.3 Activations

2.3.1 List of occurrences

The 21 activations are listed in the following table. For the nine occurrences where there was an investigation, the identification of the aircraft is indicated in bold and includes a link to the published report.

The table gives detailed information about each activation occurrence:

- level of injury;
- height at which the occurrence occurred;
- height at which the parachute was activated.

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This table also lists the circumstances of the occurrences.

Date	Reg. Ident	Level of injury	Type	Height at start of sequence (ft)	Activation height (ft)	Description
24 May 2015	59-CAW	Fatal	Fixed-wing microlight Pélican 450 S	300	300	Loss of visual references in cloud coming in off the sea, activation of parachute, landing on a roof, fall from roof, fire
12 July 2015	83ANX	None	Fixed-wing microlight Shark AERO	8,200	150	Rupture of a propeller blade, incomplete extension of landing gear, activation of parachute
13 July 2015	34ABF	Fatal	Fixed-wing microlight Motoplaneur Pipistrel Taurus 503	1,500	1,000	In-flight loss of control in turbulent air, activation of parachute without effective deployment, collision with ground
08 October 2015	39KD	None	Fixed-wing microlight Aviasud Albatros	1,400	500	Folding of right-hand wing, loss of control, activation of airframe parachute
16 May 2016	N19BV	Serious	Aeroplane Cirrus SR22	1,100	300	Decrease in engine power in cruise, activation of parachute, collision with ground
01 November 2016	31RM	None	Fixed-wing microlight Flight Design CTSL	1,000	1,000	Landing aerodrome in fog, VFR flight, dusk, activation of parachute
01 July 2017	01ACM	Slight	Fixed-wing microlight ICP Savannah	1,300	1,200	Loss of control in climb after take-off, activation of parachute, during a local revenue flight
02 August 2017	74AJA	None	Fixed-wing microlight Tétras	5,500	1,500	Engine failure, impossible to reach a suitable field, activation of parachute
07 August 2017	24QI	None	Fixed-wing microlight Avid FLYER Lite	2,300	1,500	Engine failure, impossible to reach a suitable field, activation of parachute.
24 October 2018	05JB	Slight	Fixed- wing microlight	Not known	Not known	Loss of control, activation of airframe parachute
18 December 2018	N842CD	None	Aeroplane Cirrus SR22	1,500	1,200	Erroneous positioning of oil cap, oil leak, engine failure, area largely unfavourable for an off-aerodrome landing, use of parachute
06 December 2019	2BDK	Serious	Fixed-wing microlight Tecnam P92	700	30	Engine failure, arrival at field too fast, activation of ballistic airframe parachute
22 May 2020	59DAE	Fatal	Fixed-wing microlight AVEKO VL-3-A	1,200	70	Speed increase towards VNE in turn, in-flight failure of RH horizontal stabilizer and collision with ground
31 May 2020	26AFM	Serious	Fixed- wing microlight	1,500	300	Loss of control, activation of airframe parachute
12 July 2020	65QU	Slight	Fixed-wing microlight Blériot XI	100	30	Loss of control in turbulent air, activation of airframe parachute
28 September 2020	N918SE	Fatal	Aeroplane Cirrus SR22	2,000	500	Non-stabilized approach, loss of control during missed approach, collision with ground then fire
10 October 2020	37AAH	Fatal	Fixed-wing microlight Alpi Aviation Pioneer 300	1,000	N/A	Mid-air collision, activation of ballistic airframe parachute, separation of parachute cables from microlight
23 April 2021	40FJ	Fatal	Fixed-wing microlight JCC Aviation J300	Not known	Not known	Loss of control, collision with ground, during a cross-country flight

05 March 2022	88RG	None	Fixed-wing microlight ZENAIR CH650	1,800	300	Bird strike, evasive action, loss of control, activation of ballistic airframe parachute
09 May 2022	57APJ	Serious	Fixed-wing microlight Ekolot JK-05L Junior	10	80	Yaw to full left-hand deflection during flare, go-around, activation of ballistic airframe parachute
09 July 2022	54AXD	Slight	Fixed-wing microlight AirLony Skylane	2,000	400	In-flight loss of control, pilot breaks two control sticks, activation of ballistic airframe parachute

2.3.2 Triggering event and activation situation

Figure 8 represents the scenarios of the 21 occurrences during which the parachute was activated. The size of the circles is proportional to the number of related occurrences.

The triggering events, the situation in which the parachute was activated and the result of the (complete or partial) deployment of the parachute are indicated.

Four types of situation leading to the activation of the parachute were identified:

- loss of control;
- loss of visual references;
- excessive speed;
- lack of a suitable field for an off-aerodrome landing.

The losses of control had various causes: some were linked to aircraft integrity issues, others to adverse aerological conditions.

In the majority of cases (18 out of 21), there was no technical malfunction of the parachute during its activation or deployment.

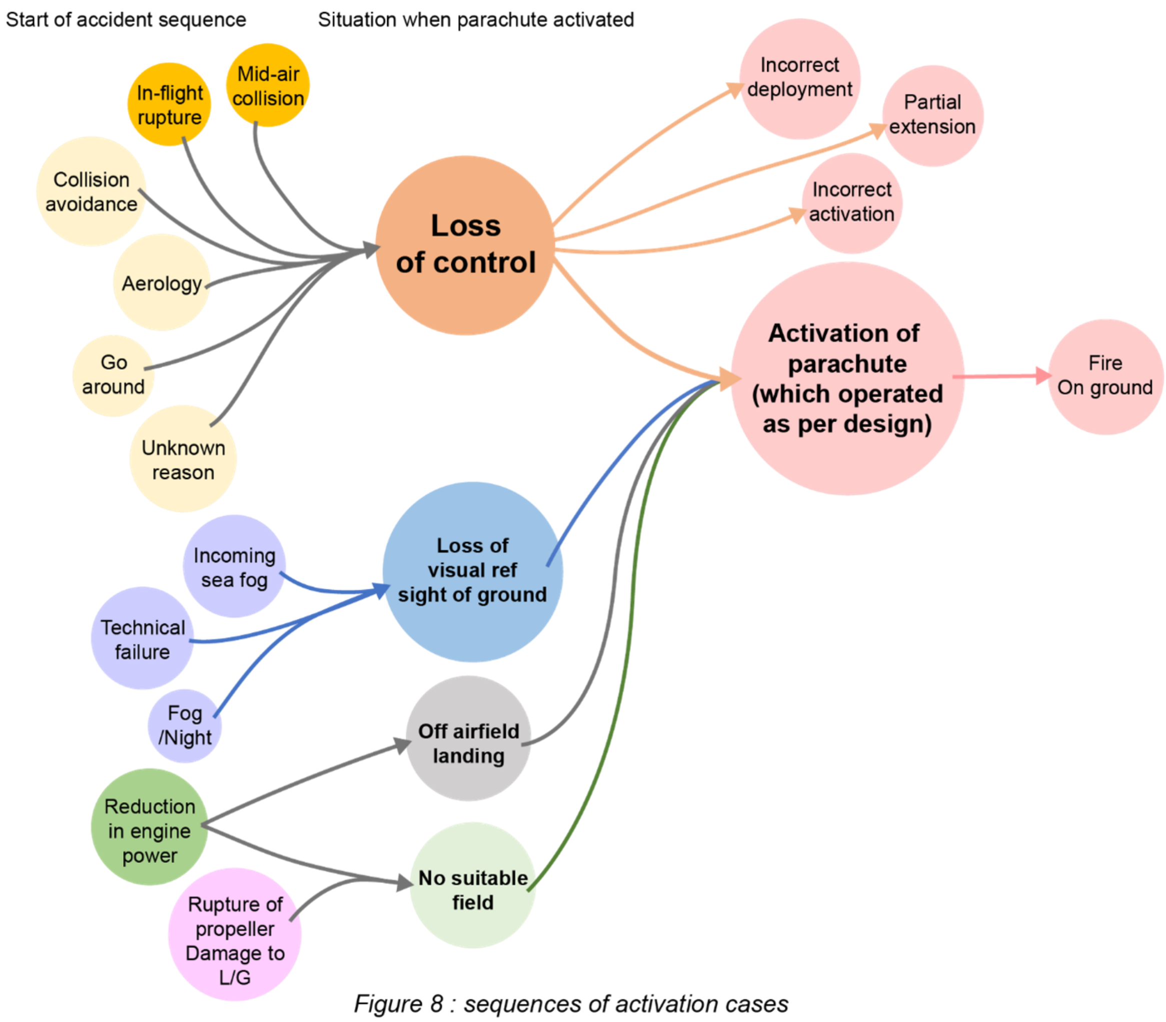

Figure 8: sequences of activation cases

2.3.3 Lessons and investigation limits

The nine occurrences investigated by the BEA (59-CAW, 34-ABF, N19BV, 01ACM, N842CD, 59DAE, N918SE, 37AAH and 40FJ) have meant that it was possible, based on the examination of the parachutes and their attachments, to obtain technical feedback including the need to shut down the engine before deployment, and information about the installation of parachutes and the assembly of cables.

The investigations revealed several cases of delayed deployment, without it being possible to explain the underlying decision-making process. In fact, the investigations carried out by the BEA mainly concern fatal microlight accidents where it is not possible to learn from the pilot's statement. This is why the study focuses on occurrences where the BEA did not open an investigation in order to identify factors influencing the pilots' decision to activate their parachute.

2.3.4 Statements from pilots

The 12 pilots who activated their parachute in an occurrence that did not give rise to a BEA investigation were contacted to gather their statements and feedback. A total of 10 pilots responded positively, all of these interviews are reported in the appendix to this study.

These statements, through the sharing of real-life experiences, provide a better understanding of the various mechanisms involved in the decision to deploy the ballistic airframe parachute.

The ten occurrences that gave rise to interviews as part of the study correspond to:

- five cases of a loss of control;
- four cases of a reductions in engine power;
- one case of it not being possible to continue the flight due to marginal visibility conditions.

The comments below are a translation of what the pilots reported, without any position being taken by the BEA at this stage.

Loss of control

In the case of a loss of control, the first actions are generally centred around trying to recover the situation.

54AXD	*I first tried to regain control.*
88RG	*I pulled on the stick to try and regain control.*
65QU	*My reflex was to exit the loss of control and apply full power.*
57APJ	*Seeing that I was unable to regain control of the microlight, I was seized with a sort of panic.*

The inability to maintain or regain control was reported as the trigger for the decision to activate in three cases.

57APJ	*I was worried about stalling. There is only one decision to take and as a reflex action, I cut off the magnetos and activated the ballistic airframe parachute.*
39KD	*I felt the microlight sinking as if it was no longer flying.*
54AXD	*I understood that I was no longer in a position to pilot the aircraft so the choice was simple: the only option left was the parachute.*

For the fourth occurrence, it was also the inability to regain control that was the trigger, but in a more conscious way by applying a learned rule:

88RG	*I pulled on the stick to try and regain control. The stick was very stiff. I then remembered that you cannot exit a spin in a microlight.*

Lastly for the fifth occurrence, the trigger was perceiving the proximity of the ground.

65QU	*I was battling to regain control. I then saw a corn field. The activation for me was like a reflex.*

It was also on perceiving the proximity of the ground that was the real trigger in the following case even if the decision had already been made:

54AXD	*At that moment, the microlight was spinning towards the ground, nose down at a 45° angle, and I could see the field below me was very close. I activated the ballistic airframe parachute.*

Reduction in engine power

In the cases where there was a reduction in engine power, in addition to restarting the engine, the initial option was to look for an obstacle-free place to land.

In two of the four cases, it was because it was impossible to land safely that the pilots chose the "parachute" option.

74AJA	*I saw that I would not be able to reach the field. I didn't think twice, I activated the parachute without qualms.*
24QI	*The ground was very hilly and there were a lot of houses. Seeing no option for landing, I decided to activate the airframe parachute at 1,500 ft AGL.*

In the other two cases, the pilots opted for an off-aerodrome landing, while keeping the "parachute" option in mind. And then, as they approached the ground, they activated the parachute:

2BDK	*I looked at the activation handle and said to myself, not just yet. I first wanted to land the microlight in a field. When I saw that I was arriving too quickly, I activated the parachute. It was like a last chance survival reflex.*
83ANX	*"As soon as the [propeller] blade ruptured, I thought about it. It was the sight of the tree tops that was the trigger, when I saw that I was too low, it was a reflex action.*

Impossible to continue the flight or land due to visibility

31RM	*I saw that the fog was very dense, I became very concerned and carried out a missed approach. I thought about the parachute after the go-around in the fog. I activated it in the minute that followed.*

2.4 Occurrences with activation since 2022 which were investigated

In addition to the occurrences considered in the study, since 2022, four accidents have been investigated and have benefited from the preliminary results of the study. Key elements identified in the study concerning the pilots' decision-making process for activating the ballistic airframe parachute were found.

2.4.1 Accident to the G1 Aviation identified 04IF

During an instruction flight, when the microlight was at an altitude of around 4,200 ft, on the lee side of the mountain, the two pilots heard a noise. Part of the canopy tore away, the microlight then banked right and entered a spin. The instructor took the controls and tried to regain control. After three full spins, at a height of around 1,200 ft, he activated the airframe parachute. After deployment of the parachute, the microlight descended to the ground. The two occupants were unharmed.

In his statement, the student pilot indicated that he was about to pull the parachute handle when the instructor pulled it. The instructor asked him to shut down the engine. He explained that in the past, his instructors had specified how to use the parachute. He stated that he had not read the section of the user manual concerning the ballistic airframe parachute and that he had looked up information on the internet. He had already seen the action to be carried out once or twice on the ground, and in flight, the instructor had explained to him the different situations that could lead to a decision to use the airframe parachute.

2.4.2 Accident to the Aerospool WT9 identified 67BVN

During an instruction flight and a stall exercise, the microlight inverted around its right-hand wing, the instructor was unable to regain control and activated the ballistic airframe parachute. The microlight descended under the parachute and finished its descent in a vine field. The two occupants were unharmed.

In his statement, the instructor indicated that the microlight turned over during the spin and at that point, he heard a noise and thought it was a structural failure. He tried to exit the spin but unable to regain control of the microlight, he activated the ballistic airframe parachute.

He explained that he systematically mentions the presence of the ballistic airframe parachute and when it should be used when carrying out sightseeing flights and instruction flights. In particular, in the before take-off briefing, he includes the minimum height for using the airframe parachute defined as 50 ft by the school.

2.4.3 Accident to the Aerospool WT9 identified 04F0

During an instruction flight, the pilot and the instructor climbed and then levelled off at an altitude of approximately 3,100 ft. It was observed that the speed then gradually decreased, which could correspond to a slow flight and stall exercise.

Observations made at the site and on the wreckage were consistent with a left-hand spin until the collision with the ground. The ballistic airframe parachute was found partially deployed, with the control handle in the pulled position.

Observations and witness statements indicated that the parachute was activated at an insufficient height for the parachute to have enough time to deploy.

The spin recovery procedure in the flight manual was modified following this occurrence and the one that involved the WT9 identified 67BVN. It now specifies that the airframe parachute (if installed) shall be used if the recovery procedure is ineffective, or below 1,000 ft.

2.4.4 Accident to the Super Guépard ULS identified 12HP

After taking off later than planned, the microlight pilot continued his night flight to reach Dragey microlight base. The pilot carried out three missed approaches very probably due to him not having sight of the runway. During the fourth runway circuit, the engine shut down due to fuel starvation. The pilot activated the airframe parachute at a height that was too low to allow its complete deployment.

The parachute user manual indicates that the minimum height for using the parachute in level flight is 180 m and the parachute opening time is three seconds. The microlight flight manual recommends immediately activating the parachute in the case of a desperate situation or accident, whatever the height may be.

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2.4.5 Activation of parachute in occurrences investigated since 2022

Two of the occurrences reveal several key factors that contributed to the activation of the parachute:

In one occurrence,
- the pilot had familiarized himself with the parachute system through personal research;
- he was familiar with the activation procedure and the defined and shared activation criteria;
- an unambiguous situation where the microlight was damaged.

In the other occurrence,
- the presence of the parachute was stored in the working memory due to the before take-off briefing with the definition of the activation rules;
- a situation where it was thought that the microlight was damaged.

In the other two occurrences, which were fatal, the parachute was deployed too late for it to be effective. The two occurrences had very different dynamics. In the case of 04FO, the time available to react after the loss of control did not allow for complex decision-making. The manufacturer's modification of the procedure is consistent with having simple activation rules.

In the case of 12HP, the pilot’s determination to reach his destination is highlighted in the investigation report. The three attempted landings show that he did not change his plan of action and did not choose the parachute option before the engine failure occurred.

3 COGNITIVE, EMOTIONAL AND PHYSICAL MECHANISMS

3.1 Decision process

The decision to activate the parachute may:
- be a reflex (the stimulus directly triggers the action);
- result from an analogy to a known situation in which activating the parachute proved effective;
- be more conscious and resemble rule-based reasoning (e.g. if the aircraft is uncontrollable at a certain height, then the parachute must be activated);
- or, for more complex situations, result from a genuine decision-making process during which the various alternatives are considered, the risks associated with each are assessed, and the “activation” option is chosen.

One of the key factors influencing the decision-making process to activate the airframe parachute is the perception of the time available to make the decision. The time available is determined by the dynamics of the accident sequence, the height of the aircraft, its attitude, flight path and speed. In the recorded occurrences, this time ranges from a few dozen minutes in the case of gradual fuel depletion to a few seconds on entering a spin or structural failure rendering the aircraft uncontrollable at low height.

In the interviews, several pilots used the word “reflex” which indicates how much the decision may not be the result of a conscious process, but rather a rapid reaction to a stimulus (whether it be something outside the cockpit or the situation itself). This “reflex” is not innate; it can be learned and maintained through reinforcement.

Without it being a sort of "reflex," decision-making in a dynamic and complex environment can be quick and almost automatic. Klein[2], in the Naturalistic Decision Making school of thought, indicates how people can perform well by using their experience to make quick decisions in complex environments and opt for the "**first solution that works**" rather than going through and evaluating all possible solutions.

If the solution initially implemented does not work, opting for another solution requires having the available resources to switch to another solution in the working memory or long-term memory.

When the aircraft is intact, the parachute is not usually identified as "the first solution that works." In fact, in the event of a potential loss of control, the pilot, whether consciously or not, stays in the usual thought pattern for flying, maintaining or regaining control of his aircraft. In the event of a loss of engine power, pilots first refer to what they have learned in this situation: look for a clear area for a forced landing.

Having the parachute option on their short list implies that they have accepted the accident and the possible loss of the aircraft. The fact that the aircraft is no longer intact limits other alternatives and can simplify the decision-making process.

In cases where the parachute is not the first option identified, the pilot must be mentally flexible enough to switch to this option. Having predefined rules simplifies the decision-making.

When more time is available, pilots try to make the best decision using strategies that are more akin to the Classical Decision Making model. This is the approach taught through tools such as FORDEC and DECIDE[3]. In this case, the value that the pilot places on the parachute option compared to the other options becomes a determining factor.

The following two statements illustrate these different processes:

83ANX

The pilot reported that as the minutes passed, he wanted to use the parachute less and less. He explained that he had the use of the parachute in mind on starting flight preparation. As soon as one of the propeller blades ruptured he had thought about it [the parachute option is in the working memory, and available for several minutes]. *The first alternative was to land on the motorway, which he eliminated as a solution. Once the microlight was stabilized, he thought he would be able to reach a microlight strip to use the airframe parachute overhead. He wanted to avoid activating his parachute overhead a clearing as there were tree stumps which could damage the wings. He told himself that he was certainly going to use it but as the minutes passed, he increasingly looked for an alternative solution* [devaluation of the parachute option due to concern about financial repercussions]. *During the loss of control, he thought about righting the microlight. Then, when he started the forced landing pattern, he also looked for a*

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[2] Klein, Gary, Naturalistic decision making, Human factors: The Journal of the Human Factors and Ergonomics Society, June 2008

[3] "Decision-Making Tools for Aeronautical Teams" FOR-DEC and Beyond, by Henning Soll, Solveig Proske, Gesine Hofinger, and Gunnar Steinhardt, *Aviation Psychology and Applied Human Factors*, 2016.

suitable area for activating the parachute. His goal was to "save" the aircraft. Although he had the 1,000 ft limit in mind, focusing on the landing gear extension problem resulted in him descending below this limit. It was the sight of an external reference, the tree tops [Perception of proximity to ground enabled him to switch to parachute option], *that acted as a trigger and led him to activate the parachute as a reflex* [The pilot perceives the activation of the parachute as a reflex because the "stimulus" of the tree tops directly triggers the action].

N842CD (occurrence subject of an investigation report)

The pilot of N842CD explained in his statement that he was at an altitude of 2,280 ft at the time of the engine failure. The pilot observed the ground and realized that he was overhead marshes, rivers and ponds located around residential areas. He therefore decided to continue a little further on to avoid these wet areas and got ready to activate the ballistic airframe parachute [several minutes available].

At an altitude of around 1,700 ft, the pilot said that he was afraid of being too low and decided to pull the airframe parachute control [the pilot was aware of the deployment criteria]. *He added that he knew that he needed sufficient height in order for the parachute to deploy correctly.*

3.2 Activation facilitator: having the parachute in their memory

In their interviews, the pilots made numerous references to their memory, without the term being clearly expressed.

Whatever the situation, the pilot's relationship with the parachute, i.e., their level of knowledge, experience, and practices—in other words, the elements stored in their memory—will be paramount. These elements will determine the strength of the "stimulus → activation" association or the significance and value of the "parachute" option.

3.2.1 Short-term memory - working memory

The briefing was often mentioned. In addition to the simple check-list to ensure that the safety pin has been removed, some pilots give their passengers a full briefing, or when flying solo, verbalise the situations in which the parachute should be activated and/or mimic the action of pulling the handle.

The briefing helps to pre-activate certain thought and action patterns in the working memory.

Some pilots call up a mental image of the activation action before the flight (24QI), others have a written check-list or a visual scan, particularly for removing the pin (2BDK, 54AXD, 31RM, 74AJA and 65QU).

Some pilots think about the parachute during the flight.

The pilot of 31RM was flying from Corsica to Orleans. As always when he flies over the sea, he thought about the ballistic airframe parachute. He would activate it a few hours later, unable to land because he was in a blanket of fog at nightfall.

3.2.2 Long-term memory

3.2.2.1 Procedural memory

When the briefing is regularly carried out, and in particular includes miming the action, the activation of the parachute can become nearly automatic. This is sometimes referred to, somewhat simplistically, as "muscle memory."

The pilots of 24QI and 83ANX systematically enacted the activation action before each flight. The pilot of 54AXD "regularly" enacted this action.

3.2.2.2 Declarative memory

- **Episodic memory**

Several pilots remembered past experiences linked to the activation of the parachute involving some of their acquaintances or that they had heard about. Several explained that they had watched videos on the subject on their own initiative.

Examples of videos on the subject:

BRSAerospace, "Argentine Rans-7 Accident and BRS Parachute Save" 2010. [On line].

MechDesignTV, "Deployment of a BRS ballistic parachute during spin recovery testing of an LSA aircraft" 2017. [On line].

gbwez, "Ballistic Parachute Deployment" 2006. [On line].

BRSAerospace, "Mid-air Collision and BRS Parachute Save" 2011. [On line].

U.S. Air Force, "Ejection Decision - A second Too Late!" 1981. [On line].

Boris Popov - Sustainable Aviation Foundation, "Ballistic Recovery Parachutes for eVTOL Aircraft - Boris Popov at SAS 2018" 2018. [On line].

- **Semantic memory**

The semantic memory comprises knowledge about the ballistic airframe parachute and the rules.
The pilot of 39KD had had a more effective parachute installed on his microlight as he was not satisfied with the original one.

The pilot of 83ANX had set himself a rule: below 1,000 ft agl, if he did not have control of the microlight or if it was impossible to land, he would activate the parachute.

3.3 Emotions: obstacles or facilitators?

Based on the statements collected, it is possible to comprehend how emotions can impact the decision-making process by promoting activation, inhibiting it, or slowing it down.

3.3.1 "Fear"

There are two channels for processing information relating to fear-inducing stimuli. The first, direct channel bypasses conscious processing and authorizes immediate reactions (emotional behaviour, autonomic responses and hormonal responses). The second, slower channel allows for detailed processing of information, integrated with other cognitive processes, particularly memory.

In some cases, particularly in unclear or ambiguous situations where the response is not immediately accessible, high levels of physiological and psychological stress can persist and block thinking. This is one of the hypotheses put forward to explain why, in certain very dynamic situations, pilots did not activate their parachutes.

Conversely, two pilots (31RM, 57APJ) reported feeling fear, which led them to end the situation as quickly as possible by activating the ballistic airframe parachute.

Stress can increase our tendency to act and seek immediate reward.

Stress results from an assessment of our resources in a given situation. Being prepared for an emergency situation, or having already experienced one that ended well, allows us to have a more positive assessment of the resources at our disposal.

The pilots of 54AXD, 88RG and 83ANX reported having experienced an accident before. The pilot of 88RG indicated that this previous experience allowed him to evacuate some of his stress when the event occurred.

3.3.2 Impact of stress on cognitive processes

In addition to panic and the search for immediate responses, stress can lead to simplistic thinking.

One possible impact is regression, i.e. forgetting recent knowledge and reverting to previous knowledge.

In its guide to using the CAPS[4], Cirrus refers to the "primacy effect" as an activation inhibitor. This effect describes the fact that relearning is more difficult than initial learning. Many microlight pilots previously flew aeroplanes. Without any parachute training, these pilots may not think about the parachute and act according to what they had learned to do on the aeroplanes they had initially flown, not equipped with a parachute.

The pilot of 65QU was caught in a descending air mass and gradually lost height, he activated the ballistic airframe parachute. This pilot had had a career as a commercial pilot before flying microlights equipped with parachutes. One of the success factors identified was that he was aware of the "primacy effect" (without naming it). He had asked his instructor to insist on the parachute, as it was a new element compared to his aeroplane training and flying habits.

Perseveration

In situations of high stress, planning abilities decline and all medium-term thinking is blocked. This can lead to perseveration, i.e. continuing with the initial plan of action despite evidence that the plan is no longer appropriate.

In several statements, the late activation of the parachute suggests that the pilots had difficulty changing their plan of action, and some indicate that an external factor was needed to trigger this change.

65QU	*I was battling to regain control. I then saw a corn field. The activation for me was like a reflex.*

[4] Cirrus Aircraft, Guide to the CIRRUS AIRFRAME PARACHUTE SYSTEM (CAPS™), 2014.

3.3.3 Aversion to loss

In their statements, the pilots mostly explained that they had not thought about the financial aspects of damage to their aircraft. When the dynamics of the event give time to think, aversion to loss can work against the parachute option. Activating a parachute means accepting an accident, accepting a certain loss.

One of the pilots explained that he attached particular importance to his microlight. He was carrying out a ferry flight on his microlight, which he was going to use for his business.

83ANX	*As the minutes passed, I wanted to use the parachute less and less.*

3.3.4 Illusion of invulnerability

Several pilots in their statements reported having heard comments such as “You won't need it.” Cirrus also cites this barrier to activation: “Real pilots don't need parachutes.” These comments show a lack of assimilation and highlight the illusion of invulnerability among some pilots.

The illusion of invulnerability reflects the tendency to perceive oneself as unlikely to suffer the adverse consequences of a negative event. This may be an ego-defensive bias (in the form of denial) that serves to reduce anxiety in people who have never been involved in an accident or unfortunate event. It may also be a need for personal control.

3.4 Physical mechanisms

3.4.1 Handle or button

Boris Popov, founder of BRS Aerospace, stands by his choice of a handle rather than a button. He wanted something large, simple, and easy to grab during high acceleration. Ejection seat activation systems also use handles.

A handle can also be easily safetied with a pin.

During high acceleration, and depending on the position of the handle, it can be difficult to grab.

39KD	*When I wanted to activate my airframe parachute with my right hand, it swung around the handle, so I had to hold it with my left hand to stabilize it and was finally able to activate the parachute.*

3.4.2 Position of handle

The activation handles are usually located on or below the instrument panel, within the pilot's field of vision. The pilot normally only has to reach out his hand to activate the parachute.

Another commonly chosen handle position is high up, in the centre, at the pilot’s ear level. To activate it, the pilot raises his hand to ear level and pulls it forward.

On the Cirrus, the handle is located on the overhead panel. It is normally covered by a Velcro-fastened cover with a check-list printed on it. Cirrus recommends removing the cover during flight so that the handle can be seen and activated directly.

Lastly, on some aircraft, the handle is located between the seats, but set back. To activate it, the pilot must turn around to reach the handle with their other hand. This posed a problem for one of the pilots interviewed.

24QI	*When I tried a friend's microlight, I tried to reach the handle, but it was set so far back in the cabin that for me, it was impossible to activate it.*

3.4.3 Handle resistance and travel

A certain amount of force is required to activate the pyrotechnic system. Generally, this requires a force of 10 kg over 20 cm (handle travel).

31RM	*When I pulled the handle the first time, nothing happened, so I thought, 'Huh?' I pulled it a second time, this time all the way, and I felt the click and the rocket fired.*

4 CONCLUSION

The analysis of the occurrences and the associated statements has identified key factors that contribute to the parachute being activated: first and foremost is the pilot's **assimilation** of the parachute through **knowledge, rules (activation criteria) and a willingness to use it**, or at least a lack of aversion to its use.

On losing control, the pilot's first actions are focused on attempting to regain control of the aircraft. Given the small amount of time available to pilots in these highly dynamic situations, the decision cannot be the result of a complex process consisting of an evaluation all the possible alternatives. Identifying the situation and understanding its urgency must be a trigger. To this end, **activation rules which have been clearly established beforehand** are the means for a pilot not to engage in a real assessment of the risks or benefits associated with this option.

The stress and surprise generated by the situation can hinder taking this decision. However, it is facilitated if the **parachute activation procedure is reviewed during a briefing**. What's more, practising the actual action beforehand during specific training that certain aircraft manufacturers may propose and/or by simulating the action just before the flight can ensure that the pilot **performs the action nearly automatically** in an emergency. Lastly, good command of the activation action (position of the parachute handle, amplitude of the action and force to be applied) facilitate its execution in stressful situations and in unusual flight attitudes.

To take the decision to activate the parachute requires the pilot to make a major effort to change his plan of action and accept the consequences (possible damage to the aircraft, sense of failure, potential impact on reputation a pilot).

To facilitate its use, pilots must have a clear idea of when to use it: while it may not be the first option chosen, it must be present from the outset and **seen as a positive option**. Beyond the rules, **knowledge of real-life stories**, whether through statements or videos, seems to facilitate seeing it as a positive option; for this reason, the BEA has chosen to publish all the statements collected as part of this study (see appendix).

Factors such as the assimilation of the parachute, having already performed the action, knowing real-life stories, and the identification of situations where it can be deployed will allow pilots to better assess their resources, increase their ability to cope, and reduce their stress. Not wanting to think about it, or dismissing its use, which may be a symptom of an ego-defensive bias (in the form of denial), may (unconsciously) serve to reduce the pilot's anxiety and reassure them in the short term, but is counterproductive in an accident situation.