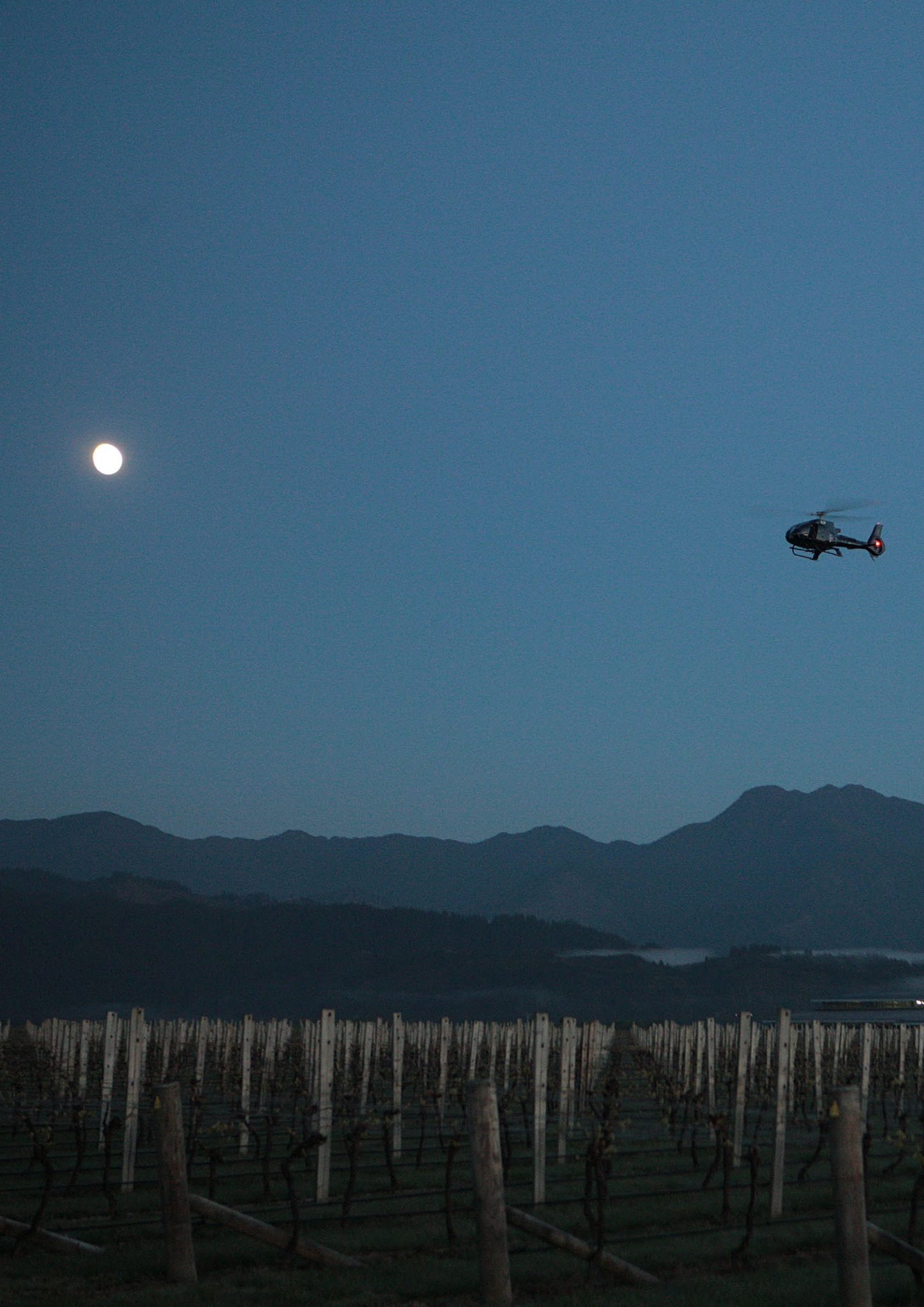
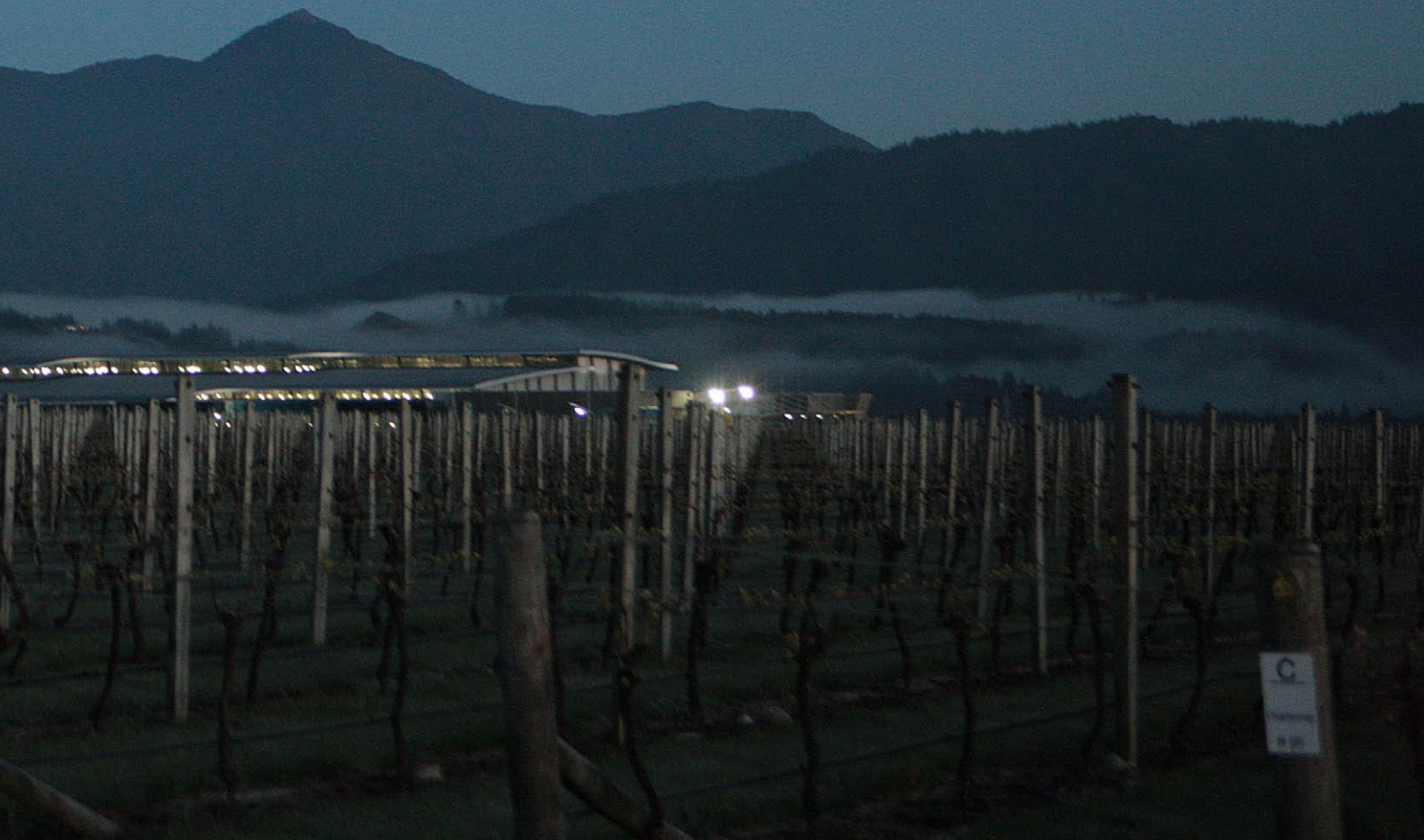


# WHO IS FLYING THIS HELICOPTER?

The question should be, are you flying the helicopter or is your body flying the helicopter? You could say both, and you would be right, but far more of the minute minutiae that it takes to fly a helicopter is done by automatic learned muscle memory an analytical thought. **Glen White** explores the brain's mechanics in flying a helicopter.

PHOTOS BY **NED DAWSON**




## Reflex Conditioning

You may ask, "what difference does it make"?

Well the truth is, not understanding the mechanics of how your body manipulates the controls, your mental participation in the event, and how you can avoid stress and/or fear in the cockpit could prove to be fatal.

As pilots, we would love to believe that our flying ability is due to our mental capacity to operate an aircraft. But the truth is that the more your brain participates in the event, the more mechanical your flying becomes. Our ability to fly a helicopter has come from many hours of automatic reflex conditioning, with our brain making suggestions to the body on what it would like it to do. The problems occur when the body refuses to do what the brain has commanded or reacts to the current event with a will of its own.

Muscle memory is not as the name implies, as in, no muscle moves without command of the brain. But the concept and understanding of muscle memory is more easily understood when looking at the event as the body verses the mind as opposed to the reality of the ever-ending feud within our cranium.

The brain has three main parts with each of these parts sub divided into further regions. Each of these parts and regions have a purpose to facilitate our reactions, memories and vital life functions. The portion of the brain that performs conscious reasoning is the cerebral cortex, but studies have shown that when addressing muscle memory from the learning stage through to the implementation stage, various portions of the brain are participating in the event. So, when addressing muscle memory in the cockpit, we will refer to automatic movement as "body" and reasoning as the "brain".

A good analogy of muscle memory is the event of teaching a young child how to catch a ball. The adult first explains to the child how a ball is caught and perhaps throws the ball up and catches it to show the child how it's done. To the child, this now appears to be a very easy task to master. He or she just saw it done, and it did not look terribly difficult.

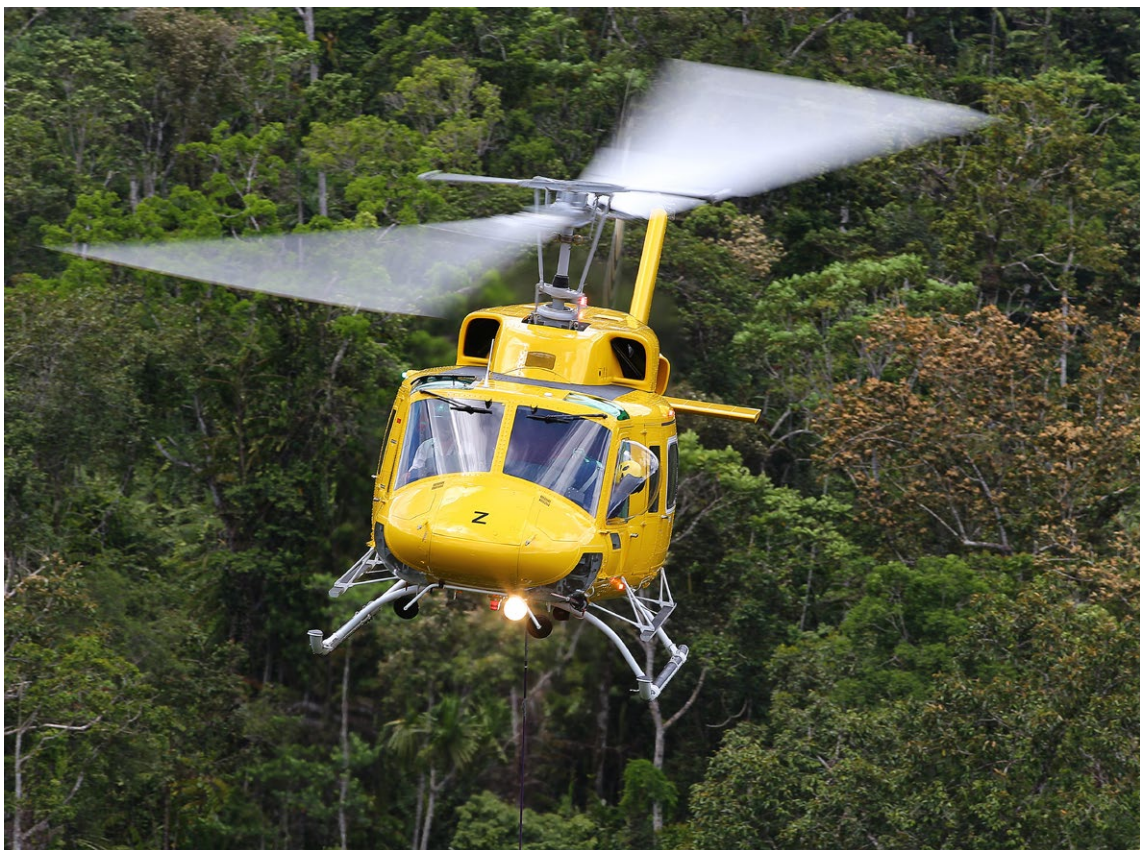
At this point, only the mental reasoning portion of the brain contains the mechanics on the upcoming event. In our overconfident ability to utilize our brain to command our body, the child is now convinced that the ball will be caught perfectly the first time. With great excitement, the child sees the ball thrown at them for the first time and is confident in the outcome of the event. To the horror of child, the ball now seems to be moving toward them with the speed of a meteor. And before another thought has time to manifest itself, the ball strikes the child in the chest, followed by the brain commanding the arms to flail upwards in a vain attempt to grasp the projectile.

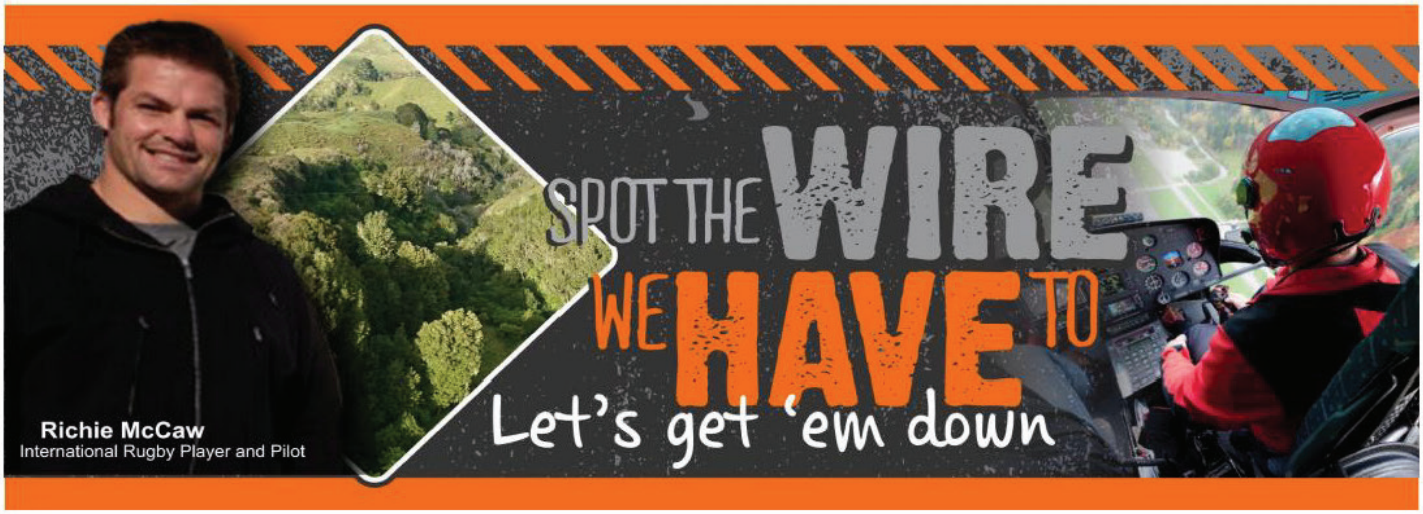
## Skill Set

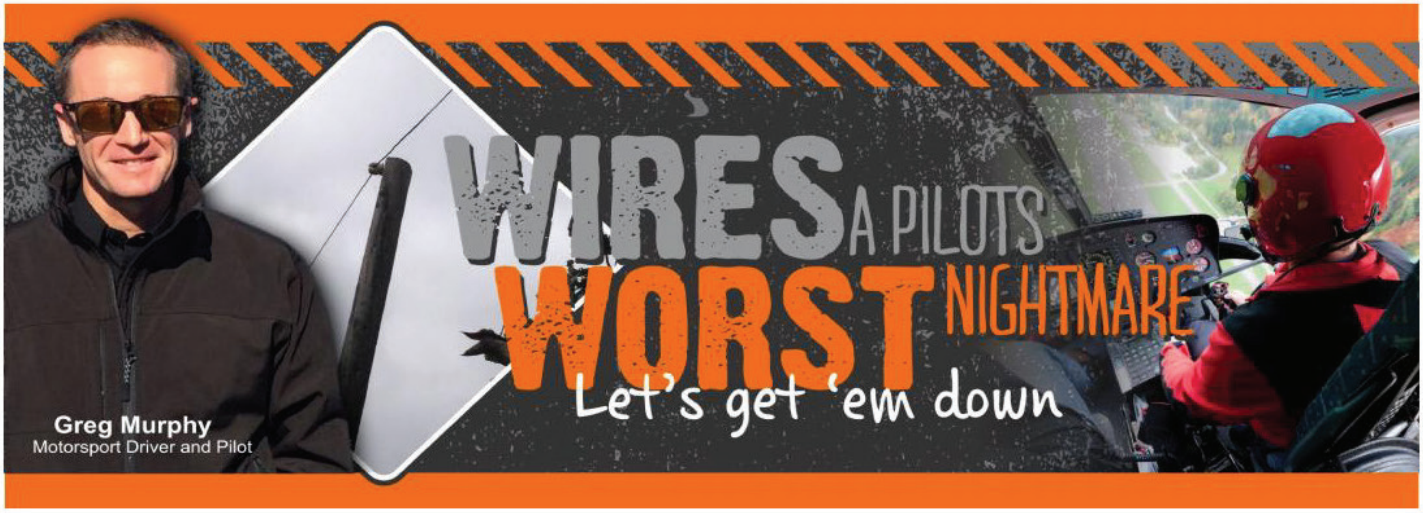
The reality is that unless we have a skill set from a similar activity which provides transference, we will not perform any activity well the first time. It takes continued exposure to the movements to gain proficiency. During this learning process, if we intellectually get over-involved in the process, the task seems to become harder to master. This can lead to frustration and self-doubt, which further slows the learning process. If we do finally achieve some sort of success utilizing our brain to learn the task, we appear to be very mechanical in our execution, or lacking in grace. Whereas if we allow our body to gain proficiency in the task, we perform the action with more gracefulness.

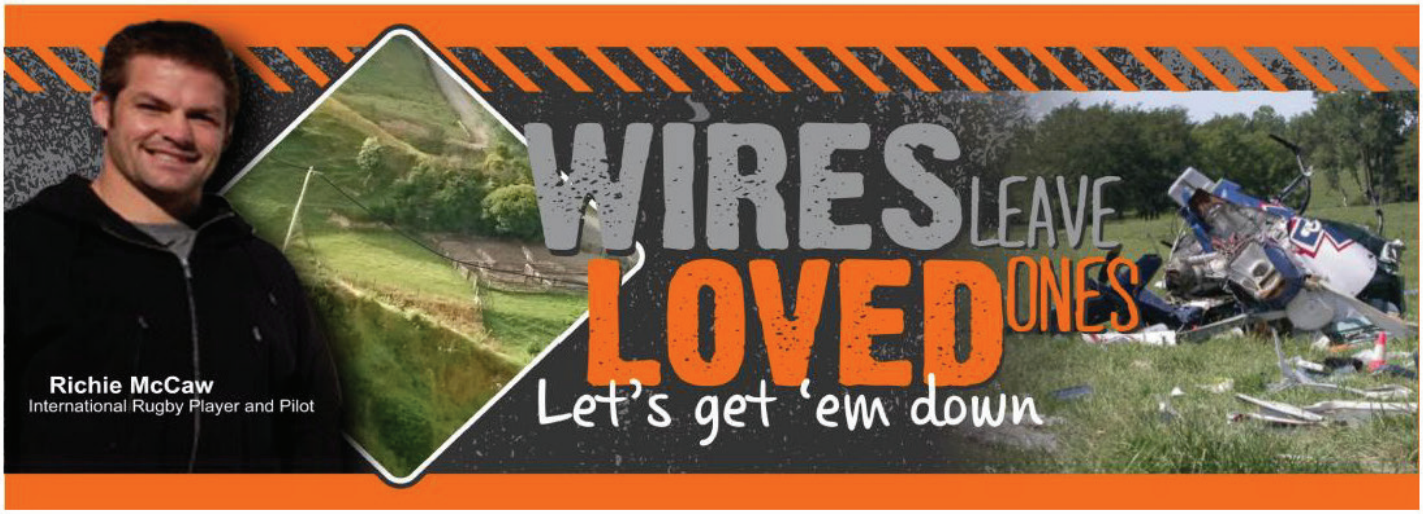
A good example of this is dancing. If you intellectually try to command your feet and hands to manipulate to the pulse of the music, you will have all the grace of a newly-born calf. "Feel" in a way is allowing your brain to take a back seat during the activity and allowing your body to perform the action.

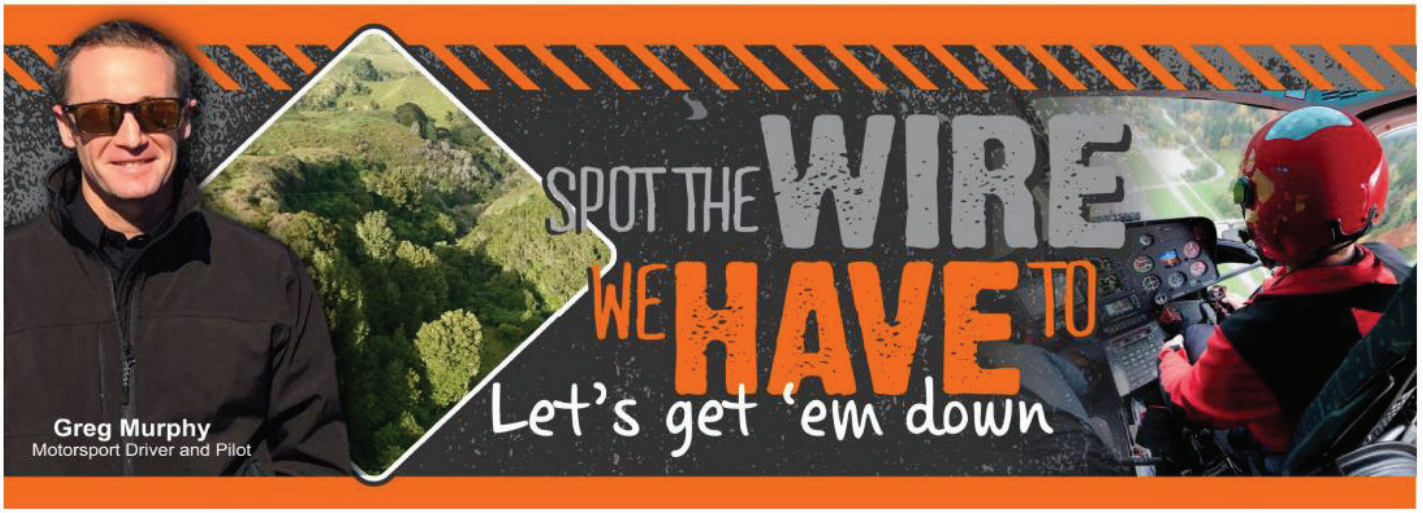
Once we have a basic ability to perform an action, it takes repeated practice to gain expertise. This does not happen because we think about the actions better, but rather




SPOT THE WIRE
WE HAVE TO
Let's get 'em down
Richie McCaw
International Rugby Player and Pilot


WIRES A PILOTS
WORST NIGHTMARE
Let's get 'em down
Greg Murphy
Motorsport Driver and Pilot


WIRES LEAVE
LOVED ONES
Let's get 'em down
Richie McCaw
International Rugby Player and Pilot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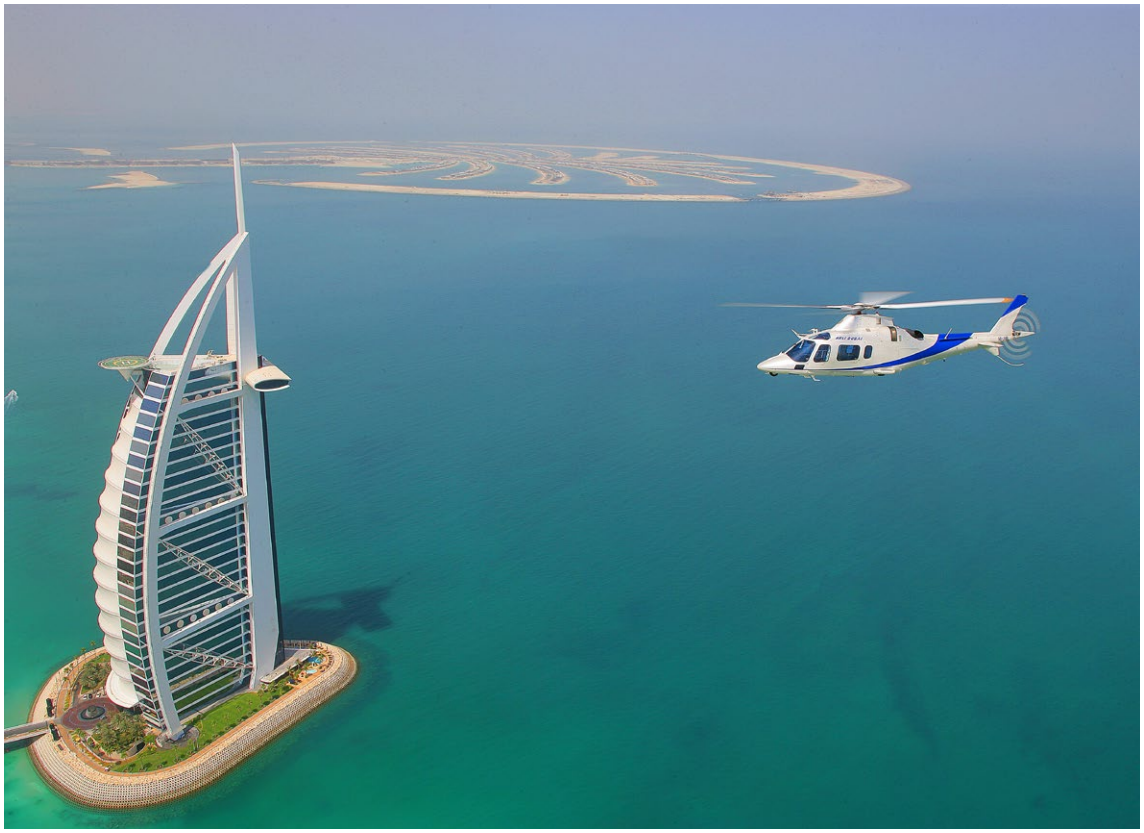

the brain's repeated neuron firing until connections become physically linked. Your brain actually changes.

Since our goal in the cockpit is to not only manipulate the controls smoothly, but to also react to an event properly, it is imperative that we arm our body with the correct reactions and to educate the brain so that it can continue to participate in the appropriate manner.

Much like the child is convinced that he or she will catch the ball perfectly the first time the ball is thrown, many pilots are convinced that if the day comes where the engine fails they will perform adequately. But if the pilot has not programmed their body to master the maneuver there can only be one outcome… the ball hits the chest.

After an engine failure in a single engine aircraft, the normal stimuli that the pilot has become accustomed to changes dramatically. If there is no physically-learned reaction to this change, the body simply does not move, often referred to as freezing on the controls. The brain is momentarily confused, not recognizing the shift, so it does nothing or performs an action that is similar to other stimuli.

## Confusion

Since the body does not have a concrete learned reaction to the event, it is the brain's responsibility to command the body to move. The problem is that as soon as we become stressed or confused, the speed at which our brain operates slows. We would love to believe that our brain works better when confused, but the reality is that the more stressed and confused we get, the less conscious-reasoning occurs. Physically parts of the brain actually stop firing neurons.

The problem is that we do not have time to analyze our situation before the helicopters' parameters become critical. The ball has been thrown to you, if your arms do not

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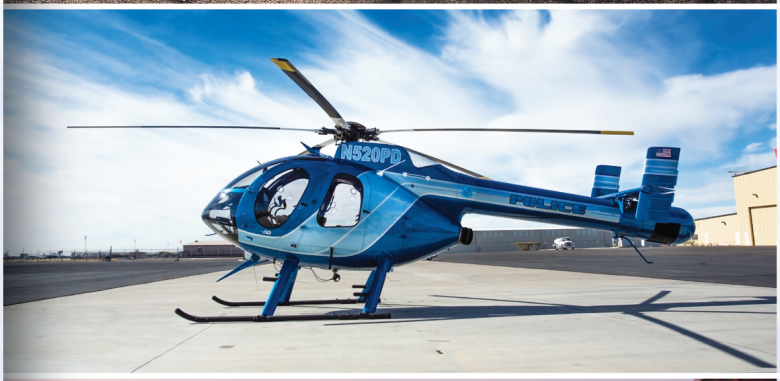


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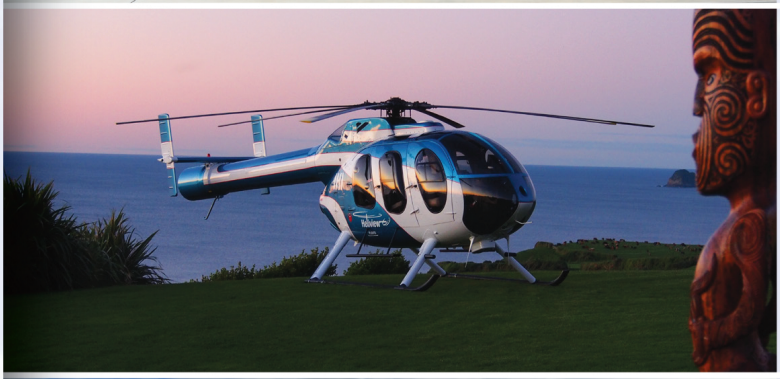

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automatically raise, your fingers spread, and grasp the ball as it contacts your hands, you do not get a second chance.

In our industry, the entry into autorotation is somewhat well practiced, and very rarely do I see pilots not entering the event smoothly. In a review of engine failures in the helicopter industry, the vast majority of pilots enter the autorotation after the failure of the engine.

If we look at accidents that involved a problem with the entry, we can look at the Mosby, MS and the Tucson, AZ accidents. During the Mosby accident, the helicopter made impact with the ground at a 42-degree angle and the blades were at a near standstill at the time of impact. This was indicative of a helicopter not entering an authoritative state after an engine failure. It appears the pilot either froze at the controls, psychologically not believing what had just occurred, or a crippling fear manifested itself preventing muscle reaction.

In a review of the Tucson accident, a photo showed the helicopter in a near vertical descent, approximately 300 feet from the ground after the engine failure. A logical explanation for a pilot placing a helicopter in this profile after an engine failure would be a situation where the airspeed was lost, and an attempt was being made to regain speed. This could occur because of the momentary disbelief in what was manifesting itself in the cockpit and a failure of an automatic response to the event. Once the pilot's brain was able to catch up, he was now behind the aircraft. It is my experience that once a pilot is behind during an autorotation, they fixate on either rotor RPM or airspeed. It is likely in this situation that the pilot was determined to get the airspeed back and lost focus on the rotor RPM. With

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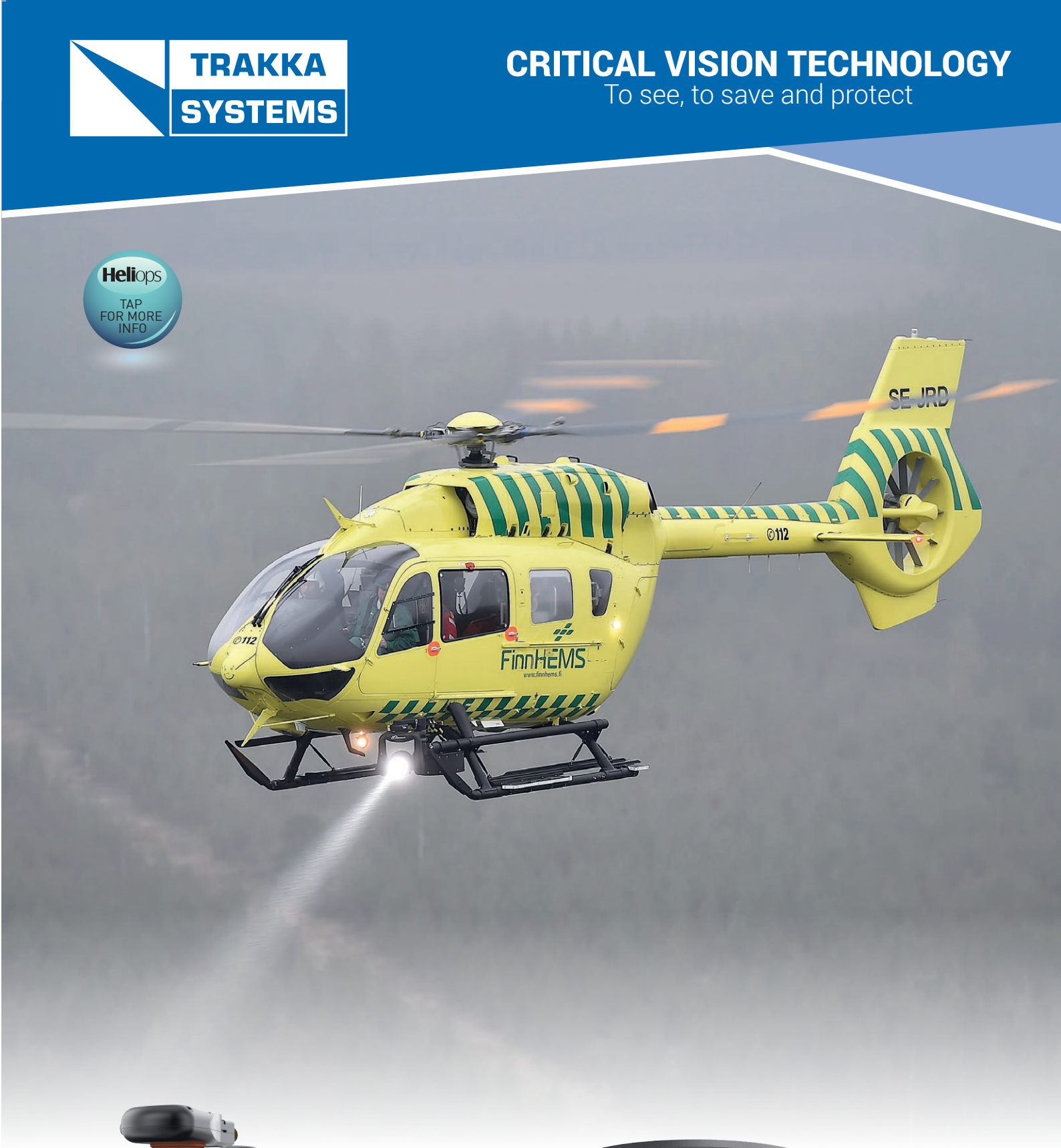


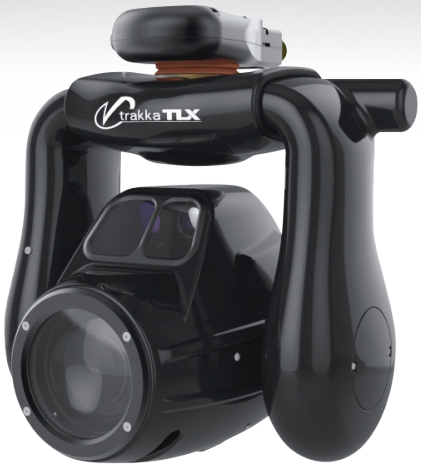


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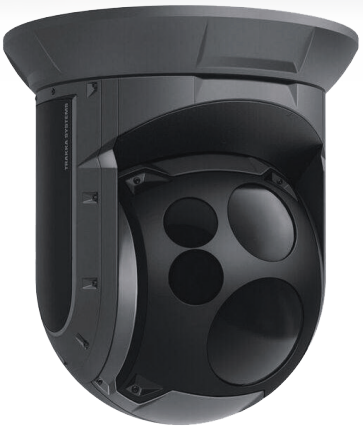

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the helicopter in a dive, and the rotor RPM decaying, it would have been impossible to regain a level flight attitude.

Though in the vast majority of engine failure events, the entry is made to the autorotation state successfully. This makes sense since it is a common training practice to remove engine power in order to simulate an engine failure. The pilot reduces the speed, maintains rotor RPM, maneuvers the helicopter to an area of intended landing and flares at the proper altitude. At this point, the engine is reengaged, and this stops the descent with engine power.

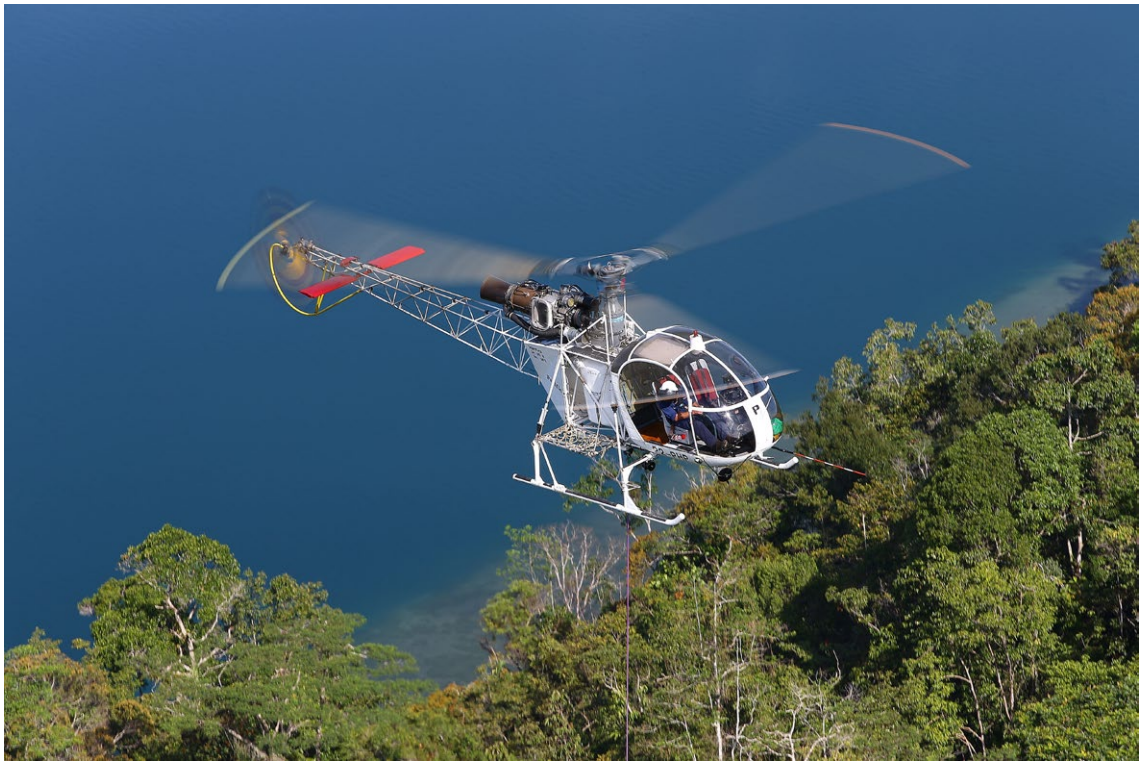
## Negative Training

Then the question begs…. why is it that the outcome of an engine failure is rarely positive in today's world? Is it that only bad pilots have engine failures? Of course not, many great pilots have had engine failures. Did the pilots of these helicopters make mistakes? Would it be logical to think all of them made mistakes? Then what is the answer?

It is simple, they performed the maneuver just as their body was taught. During a power recovery autorotation, the pilot either brings in the collective very early to make a spot or raises the collective when close to the ground. If the pilot raises the collective early in an actual engine failure, the engine will not assist in keeping rotor RPM within the green range and the NR will continue to decay until ground contact. If the collective is raised only a few inches when close to the ground, anticipating engine assistance, the helicopter will make hard ground contact.

So, training your body to perform a maneuver automatically and properly ensures the proper inputs will be made. But there are times when the pilot does not want the body to manipulate the controls in the manner in which it has been taught.

A good example of this is servo transparency in the AS350 model. This is a situation where the pilot puts such a dramatic load on the rotor system that the hydraulic servos cannot push against the induced pressure. This is not a

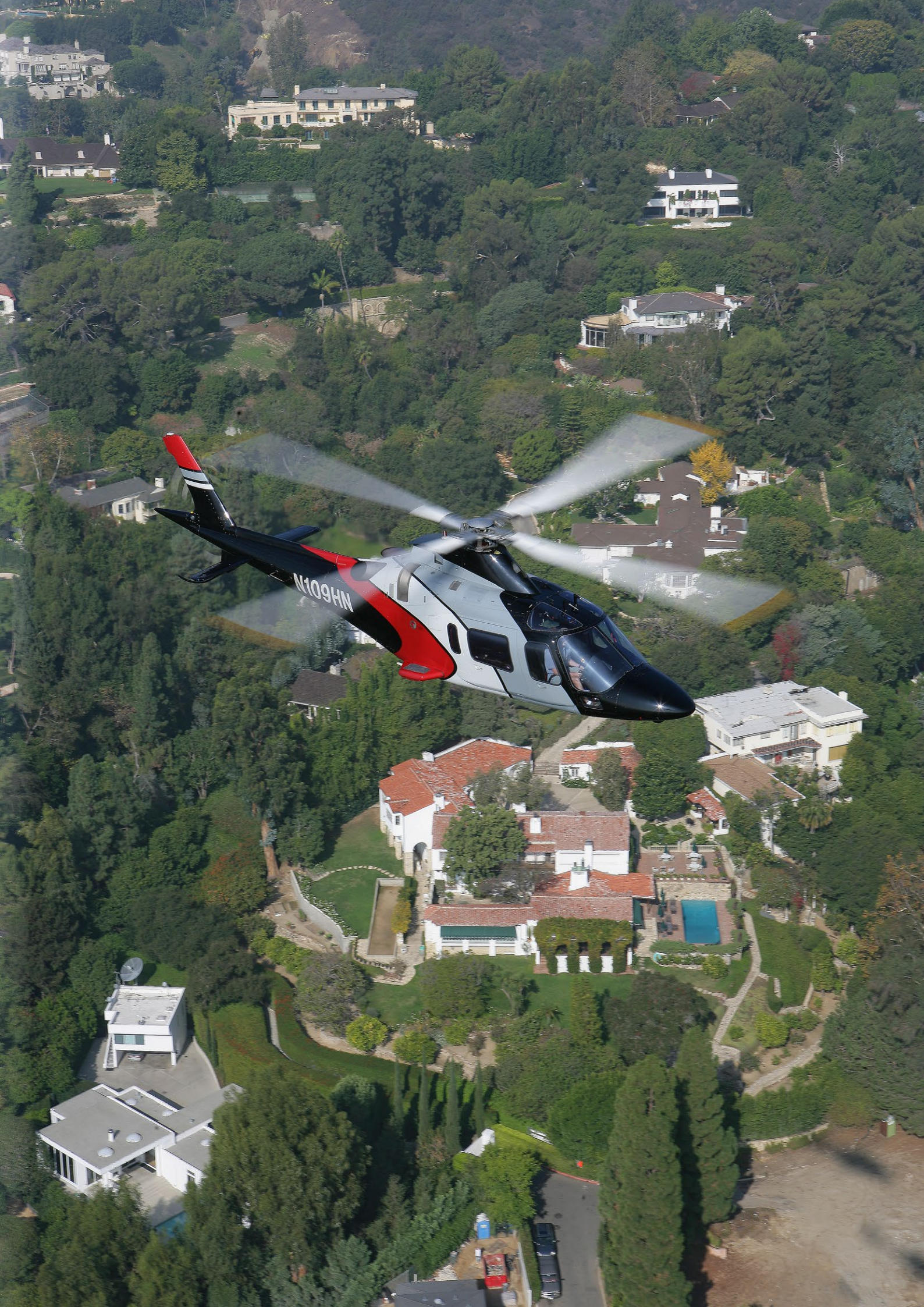


problem with the hydraulic system of AS350 as it provides all the necessary pressure for all normal maneuvers, but rather the pilot's dramatic manipulation of the controls or the exceedance of VNE.

If the phenomenon is encountered due to operating past the VNE limit (generally high altitude, VNE=155 kts minus 3 kts per thousand feet of altitude), the helicopter naturally pitches up during the event, slowing the pilot down and relieving the pressure on the rotor blades and hence the hydraulic servos. This automatically removes the phenomenon.

The problem occurs when the pilot flies in a dramatic fashion and in a situation where the cyclic needs to be placed in the opposite direction of an obstacle or the ground. If the helicopter is placed in a dramatic bank angle close to the ground, the pilot will eventually need to place the cyclic in the opposite direction in order to avoid ground contact. If this is done severely enough, the cyclic will seem to lock in place. Technically the system is at the end of hydraulic pressure assistance, and from there on it will take over 418 pounds of pressure to move the controls in a single hydraulic system model. A common misconception is that servo transparency cannot be encountered in the dual hydraulic system model, as each side contains 35 bars of pressure. The reasoning is that 35 bars of pressure and 35 bars of pressure equal 70 bars of pressure. In hydraulics however, 35 bars of pressure and 35 bars of pressure equal 35 bars of pressure, whereas the single hydraulic system has 40 bars of pressure. So, you are actually more prone to servo transparency in the dual hydraulic equipped AStar than a single bodied.

Once the cyclic appears to lock in place, in the opposing direction from the ground or obstacle the pilot is trying to avoid, the proper reaction to this event is to move the cyclic toward the ground or obstacle. Simply put, in the few seconds prior to making ground contact, your body is not going to allow you to do that. Much like if I asked you to let me throw a rock at your head, even if you allowed me to hit you in the head with a rock, as it approached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your head, your body's natural reaction would either throw its arms up to protect itself or duck out of the way.

The proper way to deal with this phenomenon is education and to simply not fly in a manner in which it can be induced. We need to understand that there are certain body reactions that we will have a very hard time stopping and be cognizant that we need to avoid these situations.

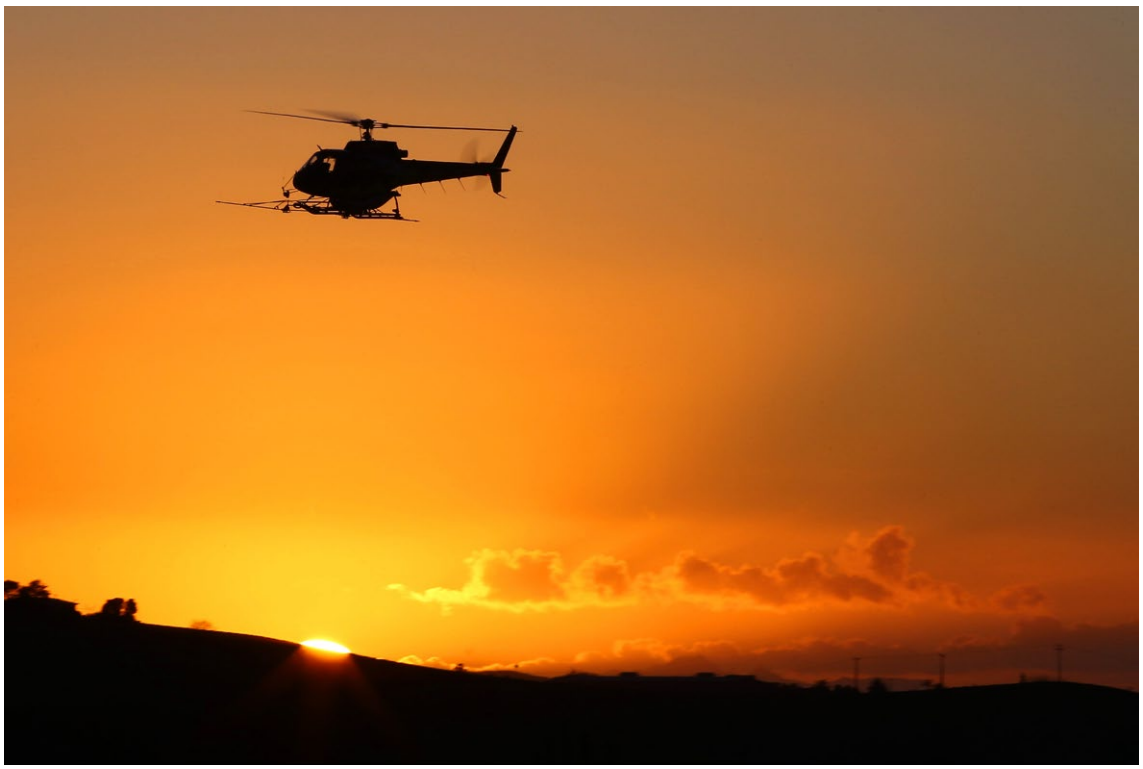
## Good Information

Though there are situations where your body will resist input from the brain, and many situations where it's better to allow the body to manipulate the controls autonomously, in many cases your body requires input from your analytical thought process. But in order for good recommendations to originate in the cerebellum, good information needs to be loaded for use.

If there is a lack of understanding of the helicopter's systems, and the pilot finds themselves with a malfunction, the body can make very dramatic and surprising reactions to an event without proper analytical input. Two accidents that highlight such a situation are a battery temperature light in Arizona and a hydraulic failure in New York.

In Arizona, a pilot experienced a battery temperature light. Unknown to the pilot, the reason for this occurrence was the fact that the generator's output was at allowable maximum. Of course, the voltmeter showed the excessive output, but it was either not noticed or the limits misunderstood. In the AS350BA model, the emergency procedures only address one reason a NiCad battery would go hot which is a thermal runaway. In later models of the AS350, the possibilities have been expanded to overvoltage, since the likelihood of a thermal runaway is extremely remote, since in the Airbus helicopters have batteries with vented cells.

Thermal runaway stories pose a legendary level of lore within our industry, and no pilot is without a story that was obtained through a litany of second-hand authors. It is therefore, no surprise that when this pilot encountered the battery temperature light, his stress



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level was elevated. As he was trained, the recommended emergency procedure in this situation is to disengage the battery from the electrical system by depressing the external power battery switch.

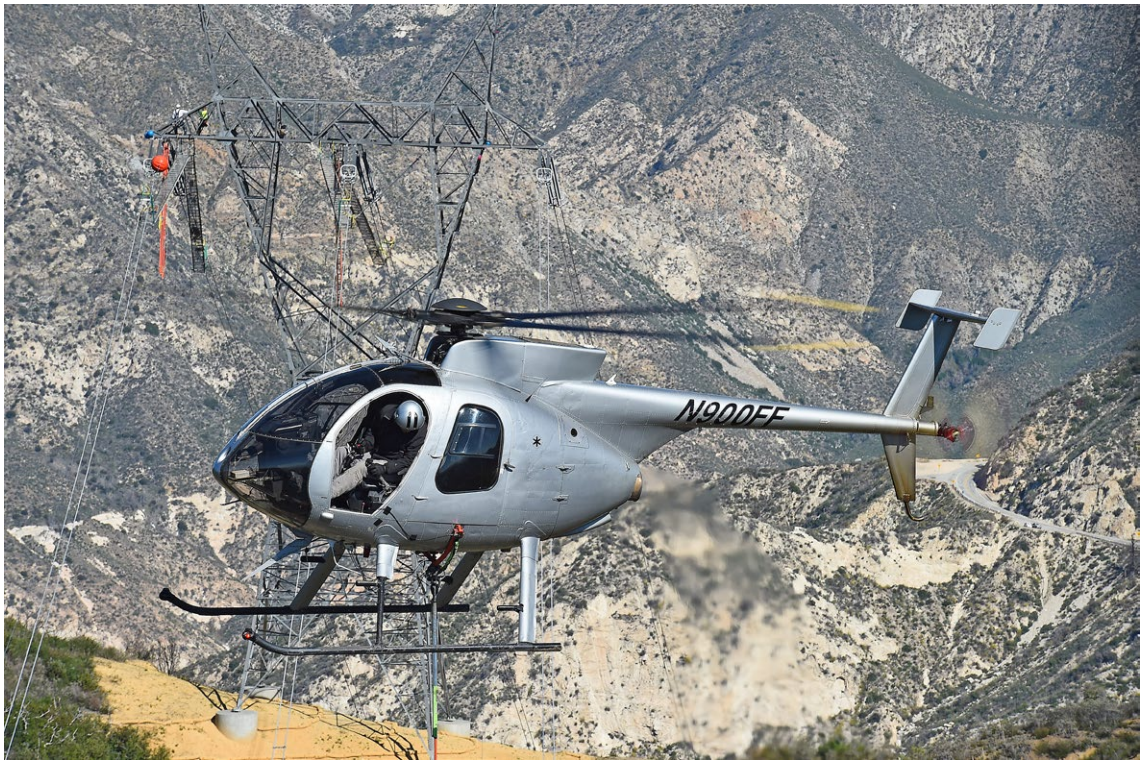
Since the battery is a consumer, when the generator is operating, the removal of the battery load was enough for the generator voltage to reach the overvoltage cutoff value (31.5 volts). With the battery and generator offline, all electrical systems in the helicopter cease to operate, which included the radios.

This fear of not knowing what was happening in the cockpit caused the pilot to make an immediate and rapid descent to the desert floor, and in the process, induced a hard landing which destroyed the helicopter (fight or flight response also known as acute stress response).

This is a situation where the brain could have guided the body to a more desirable outcome. It started with the voltmeter and understanding the importance of monitoring every system and be aware of the proper inflight values. Understanding the different possible scenarios that induce a warm battery could have provided an alternate course of action. A thorough knowledge of the system could have kept the pilot from a rush to escape the scenario with a rapid descent. An understanding of the system would have provided the knowledge that the battery could have been turned back on and would have facilitated a cooling of the battery by discharging the excessive electrons in the battery. Of course, the knowledge and confidence that a helicopter operates perfectly without any electrical system would have alleviated most of the pilot's concerns and induced events.

But before we sit back and say to ourselves… "I would never do that", think again. If you allow yourself to get into a situation where you get frightened or confused in the cockpit, you can start operating on automatic response mechanisms. This can lead to making decisions that later, once analytical thought returns, you regret.

Another accident that highlights your body-activating automatic responses to high stress

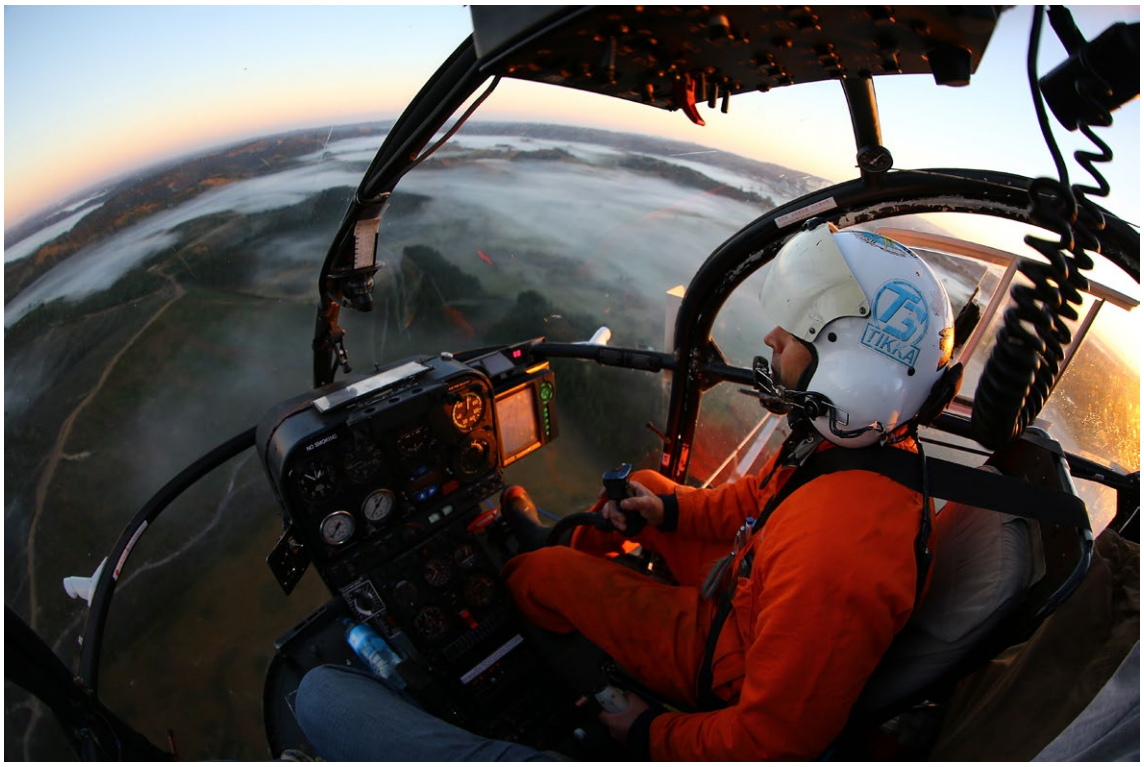


situations is a hydraulic failure that occurred in a news helicopter in Brooklyn, NY in 2004.

The helicopter was filming a news story from an out-of-ground effect hover at 1300 ft, when the aural warning horn activated. The aural warning horn in the AS350BA is a car horn and is located by the feet of the pilot. The horn is a steady tone for hydraulic failures and low rotor RPM and is an intermittent horn for high rotor RPM.

This horn is extremely loud, as a example of its volume I was once filmed by another pilot performing autorotations at The Burbank Airport. In order to capture the video, the pilot had to be a good distance away from the runway of our intended landing and outside the airport boundaries. In the zoomed-in video, you can see the helicopter in a 180-degree autorotation and at about 200 feet above the runway you can hear the horn sounding. Needless to say, for a pilot who has not had repeated exposure to this aural warning device, it can create a high state of stress and/or fear.

After the horn activated in the New York helicopter, the nose started rotating to the left and the pilot noticed a red light, though he did not know which one it was. Not knowing what light illuminated on a warning caution panel is a very common statement in accident reports. It is a very telling statement about the departure of analytical thought in that the pilot has lost the ability to read.




At this point, even though the hydraulic system has failed, the cyclic and collective remain boosted by the accumulators. For all practical purposes, at this point, the helicopter is completely functional with the exception of stiff yaw pedals.

The problem is that the pilot had no formal training in this model of helicopter and had no experience practicing the loss of hydraulics. Even if the pilot had read every publication on hydraulic failures he could find, the circumstantial evidence shows that his analytical thought was severely diminished.

With a deafening horn sounding, a red light on the caution panel illuminated, and the nose of the helicopter rotating to the left, the pilot dumped the collective and nosed the helicopter over. As the helicopter accelerated in descent, the wind flow over the vertical stabilizer set the nose straight and just as the helicopter reached building height, the pilot leveled off the helicopter. It appeared that helicopter was operational as it slowly made its way close to the buildings below.

But in the cockpit, confusion was still present as the horn continued to sound, and the pilot desperately searched for an answer to the malfunction that was occurring in the helicopter. This confusion and fear would soon escalate, as the pitch servo accumulator started running out of fluid. This loss of hydraulic boost caused the cyclic to travel rearward, which then caused the nose of the helicopter to pitch upward, which then caused a loss of speed.... the speed which was providing the airflow over the vertical stabilizer which was keeping the helicopter from rotating.

The helicopter then entered a wild rotation as the remaining accumulators gave up the rest of their pressure. If we could pause time in that moment and enter the cockpit, what status would we find the pilot in? I would imagine a place where no pilot would want to be, a situation that would seem to be out of control and out of hope.

But if you could rewind time back to when that red light first illuminated and inject practiced skill sets and knowledge into the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situation, what would have changed?

Though startled by the horn, it would have been heard many times. The accompanying hydraulic light would have confirmed a hydraulic failure had occurred. The pilot, having seen and practiced this often, knows that it is a very simple malfunction to contend with. This knowledge and confidence would have dramatically altered the pilot actions and emotional state allowing analytical thought to occur.

Simultaneously, the pilot would have put additional pressure on the right pedal to stop the rotation, while starting a slow acceleration to 40-60kts. Once at 40kts, the pilot would have activated the hydraulic cutoff switch on the collective, which removes all remaining hydraulic pressure and silences the horn. The helicopter is now flown to an area where a landing can be made without hydraulics which simply requires additional pressure on the controls.

Avoiding a state of confusion and fear in the cockpit is a task that requires a tremendous amount of effort. It is up to you the level of knowledge and skills you will possess the day that "that" occurs.

The responsibility that we have accepted when becoming pilot in command of an aircraft is a Herculean task. It is your responsibility to bring the helicopter and your passengers back safely. How much do you know about your aircraft? How often do you review airframe systems? How often do you review the emergency procedures? How often to you practice emergencies? How proficient are you with inadvertent instrument flight? Are there any issues with your airframe? Are you sure the weather is good enough to conduct the flight?

Any one of these items above could facilitate a situation where your abilities are diminished and or your reactions are less than ideal. It is up to you how you will face your hero'ing moment.

Of course, you could just hope you do it right.