Flight Control Failure

What to do if something sticks — or snaps

by BARRY SCHIFF / AOPA 110803

■■ It happened during the student pilot's fifth lesson. The instructor was demonstrating an accelerated stall when the control wheel suddenly fell limp in his hand. As the nose plunged earthward, the instructor desperately pulled the wheel full aft. But there was no response. It was impossible to raise the elevator.

Or was it? During those agonizing moments of panic, the instructor caught a mental flash of a technique often discussed but rarely practiced. He reached for the pitch-trim wheel and rotated it rearward. The crippled aircraft reacted sluggishly; total nose-up control had not been lost.

For the next half hour, the crippled Cessna 150 was nursed toward a nearby airport. But during the landing approach a burst of power was applied to prevent an undershoot. The resulting pitch-up could not be countered sufficiently with trim. The beleaguered aircraft stalled 50 feet in the air and impacted the earth nose first. Both occupants were injured critically.

A portion of every pilot's training is devoted to the most common emergencies, especially engine failure. Unfortunately, there are other potential crises that are given little or no attention. One of these is the partial or total failure of a primary flight control.

Such an emergency occurs infrequently, but not so rarely that it can be ignored. NTSB records annually reflect numerous accidents attributable to flight control difficulties.

The most serious such problem, of course, is the loss of elevator control. Yes, the trim tab can be used to control pitch within limits, but few pilots appreciate how difficult it can be to *land* without a fully functioning elevator. Anyone who makes light of such a problem probably has never done it. This was demonstrated dramatically during a series of test flights with experienced pilots in the left seat. One of them was Cal Pitts.

Pitts is a Project Officer at NASA's Ames Research Center; he's also a veteran pilot and a highly seasoned instructor. After we had discussed a recent accident involving a failed elevator cable, Pitts expressed confidence in *his* ability to take off and land an airplane without touching the control wheel. A five-dollar wager flew out of my hip pocket and landed neatly on the coffee table between us. It was met with an equal amount and we headed for the airport and a rented Cessna 150.

With his right hand, Pitts opened the throttle; his left hand, itching to grasp the control wheel, remained in his lap. At 50 mph, he cranked in a bit of nose-up trim. The 150 lifted off nicely. But at 20 feet agl, the Cessna pitched up unexpectedly. Rapid nose-down trim was applied and a stall averted, but now the Cessna was heading downhill. Nose-up trim was added—frantically. After more porpoising and trimming, the aircraft was stabilized in a normal climb. Pitts smiled smugly, not realizing that the most difficult challenge had yet to be met.

He skidded the 150 around the pattern with light rudder pressures and positioned us on the downwind leg. With one hand on the trim wheel, Pitts retarded the throttle with the other. The nose pitched down. Pitts decided it would be easier to raise the nose by reapplying power rather than bothering with excessive use of the trim wheel. Good thinking.

We were both surprised at the large amount of pitch change resulting from so little as a 100-rpm power change. In practice, aircraft attitude can be controlled, within limits, solely by judicious use of the throttle. Add power to raise the nose; reduce power to lower it.

While on base, Pitts made a major error—he extended the flaps. As soon as the spring-loaded switch was depressed, the nose pitched skyward—insistently. Considerable trim was required to return the nose to the horizon. But it didn't stop there. It kept going down. Nose-up trim was applied. Again, the nose returned to the horizon and failed to stop at the desired attitude. Several oscillations later, Pitts finally brought the Cessna under control. A lesson was learned: Flap deflection can create pitch changes much larger than can be controlled by trim alone. Flaps, if they are used during "stick- free" flight, must be used gingerly, extending or retracting them only one or two degrees at a time.

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After stabilizing the aircraft on final approach at a modest sink rate, Pitts felt confidence return. As the wheels neared the concrete, he gradually applied nose-up trim. But at 10 feet agl and without warning, the plane began diving toward the concrete. Pitts countered with rapid nose-up trim but it was too little and too late. He admitted reluctantly that had I not grabbed the wheel, the aircraft would have landed nose-wheel first. Damage, we concluded, would have been likely.

After cleaning up the aircraft (both inside and out), we taxied back to Runway 21 for another try. Six attempts later, Pitts made his first hands-off landing to a full stop. And his progress was better than other pilots tested.

Preparing for this type of emergency is difficult. Handling characteristics vary considerably from one airplane to another. Simply because a pilot can make a stick-free landing in one aircraft doesn't necessarily mean that he can do it in another. But some practice in any airplane helps to understand the complexities and variables. Stick-free landings, however, must never be attempted without a capable pilot with sharp reflexes in the right seat. Unfortunately, a stick-free landing cannot be simulated at altitude for reasons explained later. Also, be extremely careful during a "hands-off" missed approach. A gross and uncontrollable pitch-up may occur when full power is applied rapidly.

Five variables affect pitch: flaps, power, center of gravity, trim and ground effect. Each must be understood if a pilot is to successfully land an aircraft without a fully functioning elevator.

Figure 1a illustrates a wing with flaps retracted. The center of gravity is forward of the center of lift. Visualize what would happen without a horizontal stabilizer. The lift would pull up on the center of the wing while the weight of the aircraft, acting through the center of gravity, would pull down on the leading edge. The result would be a nose-down pitching moment. To prevent this, the horizontal stabilizer is designed to produce a downward force (negative lift) that maintains equilibrium (Figure 1b).

Now observe what happens when flaps are extended (Figure 1c). The airflow

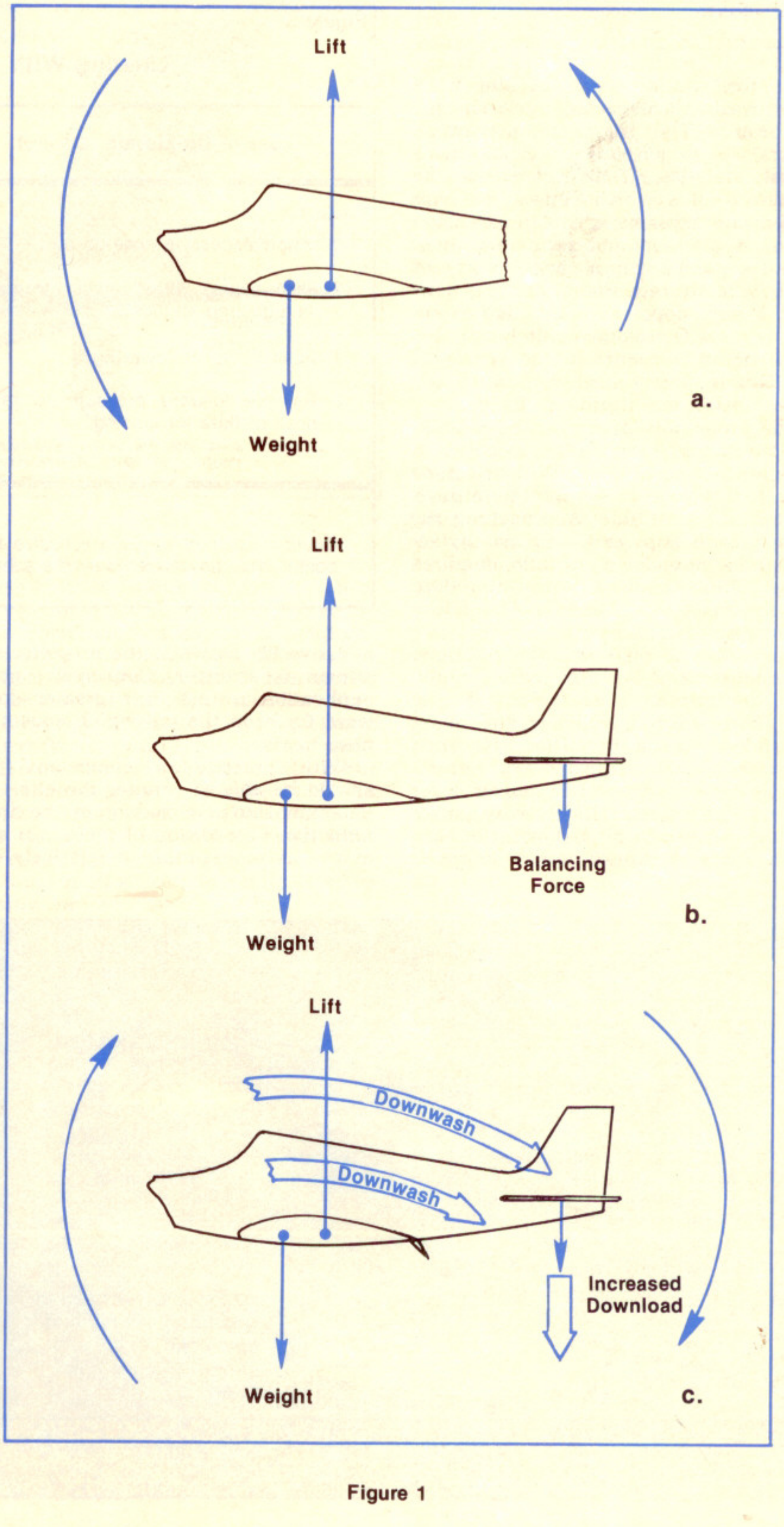


Figure 1

from the trailing edge of the wing (downwash) is deflected more sharply downward. The increased downwash strikes the upper surface of the horizontal stabilizer. This increases the tail-down force which causes the nose to rise and explains why flap extension causes a pitch-up and retracting them causes a pitch-down, a characteristic of most light aircraft. Some aircraft, however, behave oppositely (i.e., flap extension causes nose-down pitching) because of an aft shift in the center of lift. This is most typical of aircraft configured with cruciform or T-tails.

The probability of a successful stick-free landing, however, is increased when flaps are not used at all. With the flaps retracted, it is easier to maintain a nose-high landing attitude. Approaching the runway with flaps extended usually results in a nose-down attitude, requires larger pitch changes during the flare and increases the likelihood of landing nosewheel first.

The ability of the horizontal stabilizer to produce a downward aerodynamic force depends on wing downwash, the free airstream and propeller slipstream. It stands to reason, therefore, that when propwash weakens during a power reduction, the horizontal stabilizer loses some effectiveness. This is why power reduction causes a pitch-down; the horizontal surfaces cannot provide as much negative lift as when the propeller slipstream is stronger. Conversely, power application results in a greater downward force on the tail which causes the nose to rise.

With practice, a competent pilot should be able to counter the effects of flap extension or retraction by the timely reduction or addition of power, in such a way as to maintain a relatively constant attitude. This is an interesting exercise to try at a safe altitude.

The downwash from a wing that helps to produce a download on the horizontal stabilizer (on low- *and* high-wing aircraft) is altered when the airplane enters or leaves ground effect (about 20 feet above the ground for most lightplanes). When entering ground effect, the downwash (Figure 2) is reduced, which causes a nose-down pitching moment. It was this unexpected attitude change that caught Pitts off guard during his first attempt at a hands-off landing.

Conversely, when climbing out of ground effect, wing downwash increases to produce a nose-up pitching moment.

These pitching forces created by changes in downwash occur during every takeoff and landing, but the pilot is rarely aware of them. Necessary corrections are made subconsciously with subtle pressures on the control wheel. But when making a hands-off landing, this effect must be anticipated. It can be countered only by a perfectly timed application of nose-up trim and/or a few timely jabs of power. Considerable practice is required to master this technique.

Another variable is the center of gravity. Landing without up-elevator capability can be simplified by shifting aft the adjustable cabin load. By moving heavy items to the rear, for example, it is easier to make a hands-off approach in a nose-high attitude, a particularly

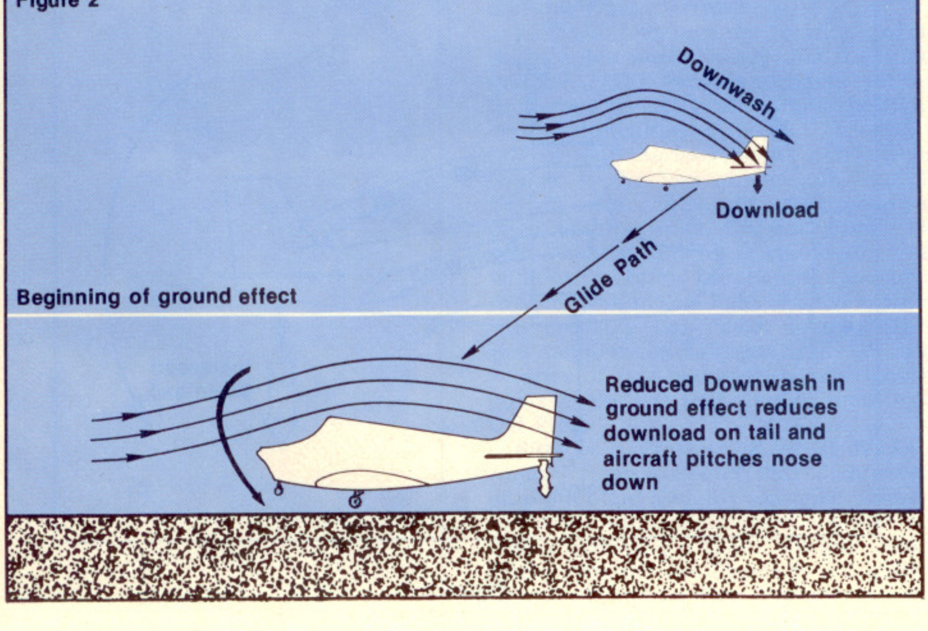
Figure 3

Landing With A Failed Elevator Cable

Loss of Up-Elevator Control	Loss of Down-Elevator Control
1. Apply *excessive* nose-up trim.	1. Apply *excessive* nose-down trim.
2. Push control wheel forward to maintain desired attitude.	2. Pull control wheel aft to maintain desired attitude.
3. Push harder to lower nose.	3. Release back pressure to lower nose.
4. Release forward pressure to raise nose or flare for landing.	4. Increase back pressure to raise nose or flare for landing.

Caution: Do not remove *excessive* trim prior to landing because two-way elevator control may be needed during a subsequent missed approach or go-around.

Figure 2



important consideration when flying tail-draggers.

Finally, there is the elevator trim tab. Little can be added to what a pilot already knows about this supplemental control except that the effect of a trim tab varies considerably from one aircraft to the next. It might prove interesting to determine just how well the trim tab can control pitch attitude in the plane you fly regularly. A practice exercise involves stabilizing the airplane in a full-power climb. Then retard the throttle and see how rapidly the aircraft can be stabilized in a normal glide attitude (using trim only). Then reverse the procedure and re-establish the climb. Most pilots tend to overreact to this problem. Several roller-coaster-type oscillations usually are induced before an aircraft is brought under positive control.

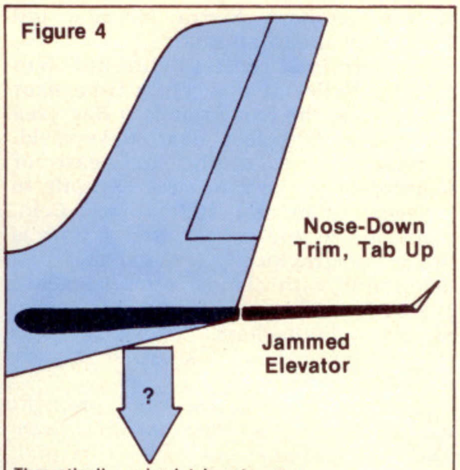
A *single* broken or disconnected elevator cable usually doesn't result in a *complete* loss of pitch control. In most airplanes, a failed cable represents only a partial loss. For example, it is usually possible to apply "up" elevator even though "down" elevator capability has been lost, or vice versa.

Assume that the up-elevator cable has failed. The wheel moves aft easily, but produces no response. Forward wheel movement beyond the "neutral" position produces a nose-down attitude. In such a case, the pilot should apply considerable nose-up trim, enough to produce a moderately nose-high attitude. From then on, *any desired attitude* can be obtained by either relaxing forward pressure on the control wheel (for nose up) or increasing forward pressure (for nose-down). This technique essentially restores total pitch control to the control wheel. Conversely, if only nose-up elevator is available, pitch control can be maintained by applying considerable nose-down trim (refer to Figure 3).

Belonging to the same class of emergency is the more serious *jammed* elevator. Although various combinations of power and flap extension offer limited pitch control, the prospects of a successful landing are poor.

One incident serves as an example of this problem. A student was on his second solo cross-country flight. All sorts of paraphernalia were strewn on the cockpit floor: a plotter, a computer, a clipboard, a bag of sandwiches—you name it, he had it on board. During a period of moderate turbulence, the E6-B computer was lifted off the floor and came to rest in a crevice behind the instrument panel in such a way as to prevent the application of down elevator. The frightened pilot used all of his strength in a frantic attempt to move the control wheel forward and lower the nose. Fortunately, the plastic computer gave under the strain and crumbled to the floor in pieces. Similar, sadder stories can be read in the NTSB accident files.

Figure 4



Theoretically, raised tab acts as a mini-elevator to raise nose. Don't count on it.

There is a theory, circulating among hangar flyers, stating that "reverse trim" can be used to control pitch in the event of a jammed elevator (Figure 4). If the elevator is jammed, so the hypothesis goes, the application of nose-down trim, for example, would cause the tab to rise and, in effect, act as a mini-elevator causing limited nose-up pitching.

This theory was tested and debunked in a Cessna 172. The effect of trim application alone (the control column was held firmly in place) caused no detectable attitude change. This effect, or lack of it, is attributed to slop in the elevator control system. Nose-down trim, for example, causes a very slight movement of the elevator in the opposite direction as the slack is taken up in the cable. This minute elevator deflection cancelled any effect the "reverse trim" technique might have had.

This procedure might work, however, in aircraft with larger tabs, adjustable horizontal stabilizers, or the more rigid push-rod control systems.

The closest I ever came to a jammed control was on a flight to Las Vegas, Nev., in a Luscombe 8E. Joe Stanley, a long-time companion, sat in the right seat. He spent most of the trip maintaining a navigation log to break the monotony of a slow flight across the bleak Mojave Desert.

East of Clark Mountain, we encountered strong thermal activity. The left wing dipped and I countered by moving the stick to the right. Klunk! It stopped dead center. I tried again, but further attempts to move the stick to the right failed. Klunk! Klunk! Still no luck. The Luscombe was now in a steep left turn. Stanley looked to me for an answer but I had none. Fifteen seconds and 180° later, I was attracted to a reflection on Stanley's lap. I reached over to his right knee and slapped away the aluminum clipboard that was positioned between his stick (the dual control) and the right sidewall. For one brief moment, we had felt that hollow sickness that creeps into the stomach when aircraft controllability seems lost. It's a feeling neither of us is likely to forget.

Although a loss of aileron or rudder control is not normally as serious as an elevator problem, it can be. Case in point: A charter pilot was departing Oakland after the Twin Beech had been in the shop for major maintenance. After liftoff, the control wheel was moved to the right to counter a small gust that had lowered the left wing. The airplane rolled farther left. The pilot turned the wheel farther right but the big twin had a will of its own. The left wingtip scraped the runway surface as the pilot suddenly realized what was wrong.

Reacting brilliantly, he turned the wheel *toward* the lowered left wing. The ship righted itself and the pilot nursed the aircraft around the pattern, substituting right aileron pressure when left was needed, and vice versa. Investigation revealed that a mechanic had rigged the ailerons in reverse. The whole problem could have been avoided by a more careful preflight.

Loss of total or partial aileron control because of mechanical failure can be combated by making shallow, skidding turns using rudder only. Another interesting technique can be used in airplanes with two cockpit doors. By opening both doors and allowing them to float freely, directional control can be maintained by pushing on one door or the other. Pushing open the left door of a Cessna 150, for example, results in a surprisingly coordinated right turn, and vice versa. But, watch your airspeed.

A combination of doors and ailerons can be used in case of rudder failure, but avoid crosswind landings.

Irrespective of the type of control difficulty, attempt to land only at an airport with ultra-long runways and crash-rescue facilities. But most importantly, reduce the possibility of such an emergency by increasing the diligence of your preflight inspections. □