MIKE BECKER

Crash Dynamics

15-minute presentation

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A discussion around helicopter design

Presentation Objectives

By the end of the 15 minutes, you will be able to

Discuss with a peer Helicopter Crash Dynamics including

- Dispensable structure
- G Force,
- Terrain considerations, and
- Termination options

Disclaimer and Origin of information

Some of the numbers and detail within this section have been referenced from the Department of Flying Safety, United States Army Primary Helicopter Centre student handout titled

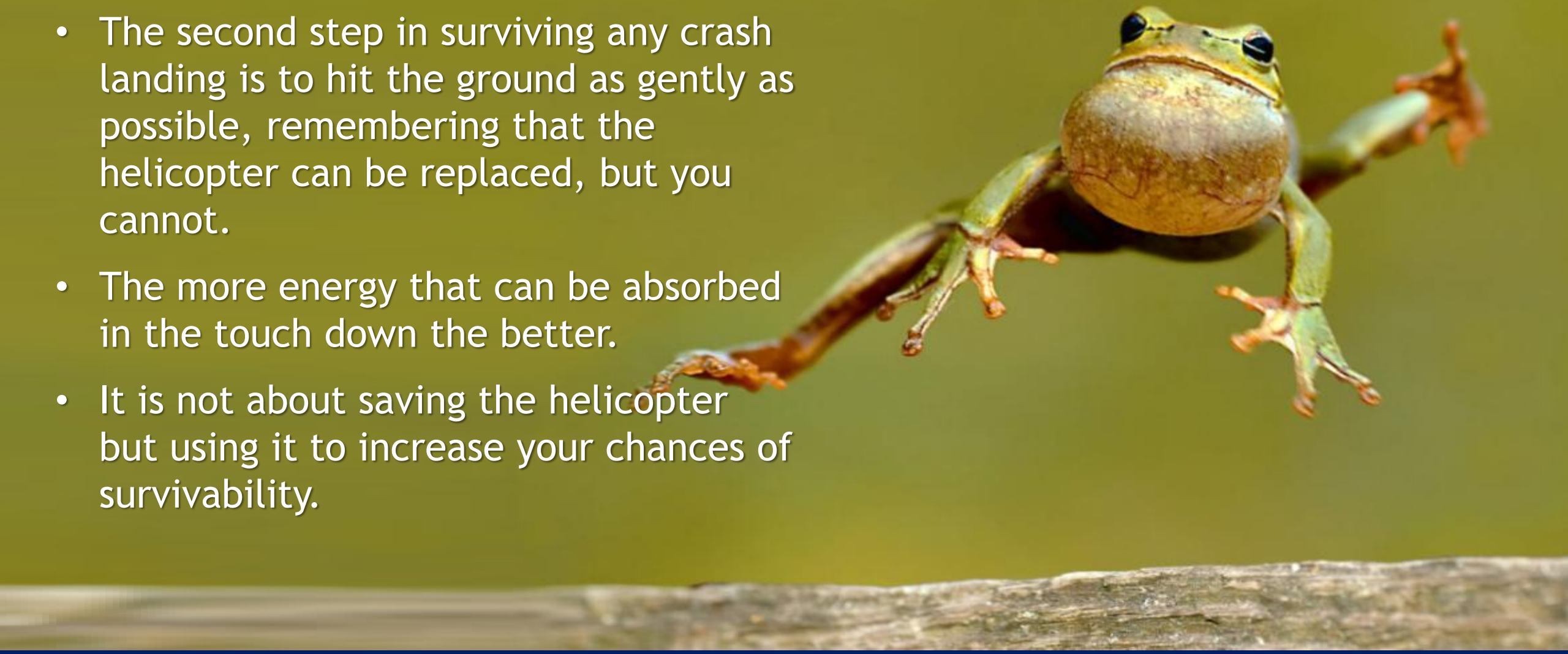
"How to Crash a Helicopter".

Crashing

- If conducting a real Forced Landing, you are **“crashing”** a helicopter
- The bottom of any real autorotation is, in effect, a **“crash landing”**
- Understanding this and accepting it is the first step in surviving it

Crashing

- The second step in surviving any crash landing is to hit the ground as gently as possible, remembering that the helicopter can be replaced, but you cannot.
- The more energy that can be absorbed in the touch down the better.
- It is not about saving the helicopter but using it to increase your chances of survivability.



Dispensable Structure

Fixed Wing

Helicopter

Dispensable structure refers to those design features that are built into an aircraft to protect the crew during a crash landing.

Crash Test - Belted vs Unbelted Passengers
https://www.youtube.com/watch?v=9_Af8w2SAT4

NASA Helicopter Drop Test
https://www.youtube.com/shorts/8JN199DIX9M

Zero Zero Landings

- A Zero Zero landing refers to:
  - zero vertical speed, and
  - zero forward (horizontal) speed at touch down.
- Zero Zero landings are the goal when terminating an autorotation …… but depending on the circumstances some forward motion can be accepted and be beneficial.
- Often there is a compromise in forward speed versus vertical speed depending on the terrain that the helicopter is going to crash into.
- The general rule is:

The worse the touch down terrain, the slower the run on speed.

Surfaces

Smooth, flat, hard

A run on speed of 10-20 knots is acceptable as the helicopter can slide without hitting anything

Trees, mountainous

A zero forward speed termination is preferred; avoid hitting anything and bringing the helicopter to a sudden stop and exposing the crew to a high G loading

G Loading

G loading is the force we feel when we change speed or direction (accelerate).

The tolerance of the human body to G force will depend on the:

- **magnitude** (amount) of the G force,
- **duration** (length of time) it is applied,
- **direction** it acts (vertical or horizontal and positive or negative),
- **location** of the application, and
- **posture** of the body at the time

G Loading

The known records for surviving a high G force are:

- Colonel John Stapp who in 1954 sustained 46.2G in a rocket sled, and
- Formula One racing car driver David Purley who survived 179G as he decelerated from 173kms per hour in 66cm after his accelerator stuck and he hit a wall.

Force acts	Positive (prolonged)	Negative (prolonged)	Instantaneous	Deadly
Vertical	5G (9G in a suit and trained)	-3G	40G (1500 feet per minute ROD)	100G (3000 feet per minute ROD)
Horizontal	17G (pushing the body backwards)	12G (pushing the body forwards)	40-80G	Greater than 100G

Colonel John Stapp

Helicopter Touchdown and G Force

Zero Zero touchdown

- Hard flat surface
- Descent 25 feet per second (1500 feet per minute)
- 0 forward speed
  = vertical load of 20-40Gs

Helicopter damaged/destroyed
The crew severely injured
Possible to survive

Forward speed touchdown

- Hard flat surface
- Descent 25 feet per second (1500 feet per minute)
- 5 - 10kts forward speed
  = vertical load <20Gs
  = horizontal load of 15-25Gs

Helicopter damaged
The crew less severely injured
Survivable

Problems with Forward Speed

If the terrain is not hard and flat, any forward movement may cause the helicopter to either roll or hit an object, e.g. tree.

Rolling

May cause fuselage to break-up, causing injuries

Hitting an object

Comes to a sudden stop, which it is not designed to do, and increases G force

Remember it is not the fall that will kill you, it is the sudden stop at the bottom!

Termination

Important to modify the flare and touch down technique based on what type of landing area is presented/available

- On approach determine and assess
  - Size of the area
  - Terrain
  - Obstacles
  - Wind (into wind is always best for slowest speeds)

Based on this information make a decision on the type of flare and termination that will work best

This requires knowledge and skill on various techniques

Terrain

Trees: Forest

Trees: Jungle

Mountains

Desert

Water

Slopes

Obstacles and More

Wires Wires Wires

Agricultural

Livestock

Ploughed

Roads

Populated

Populated Areas

Aiming for an open space in a populated area can be difficult, but the only option.

Looking at the image below, just where would your best touchdown options be?

Pre-Flight Planning

In the planning stages, prepare for the worst
but hope for the best
by considering

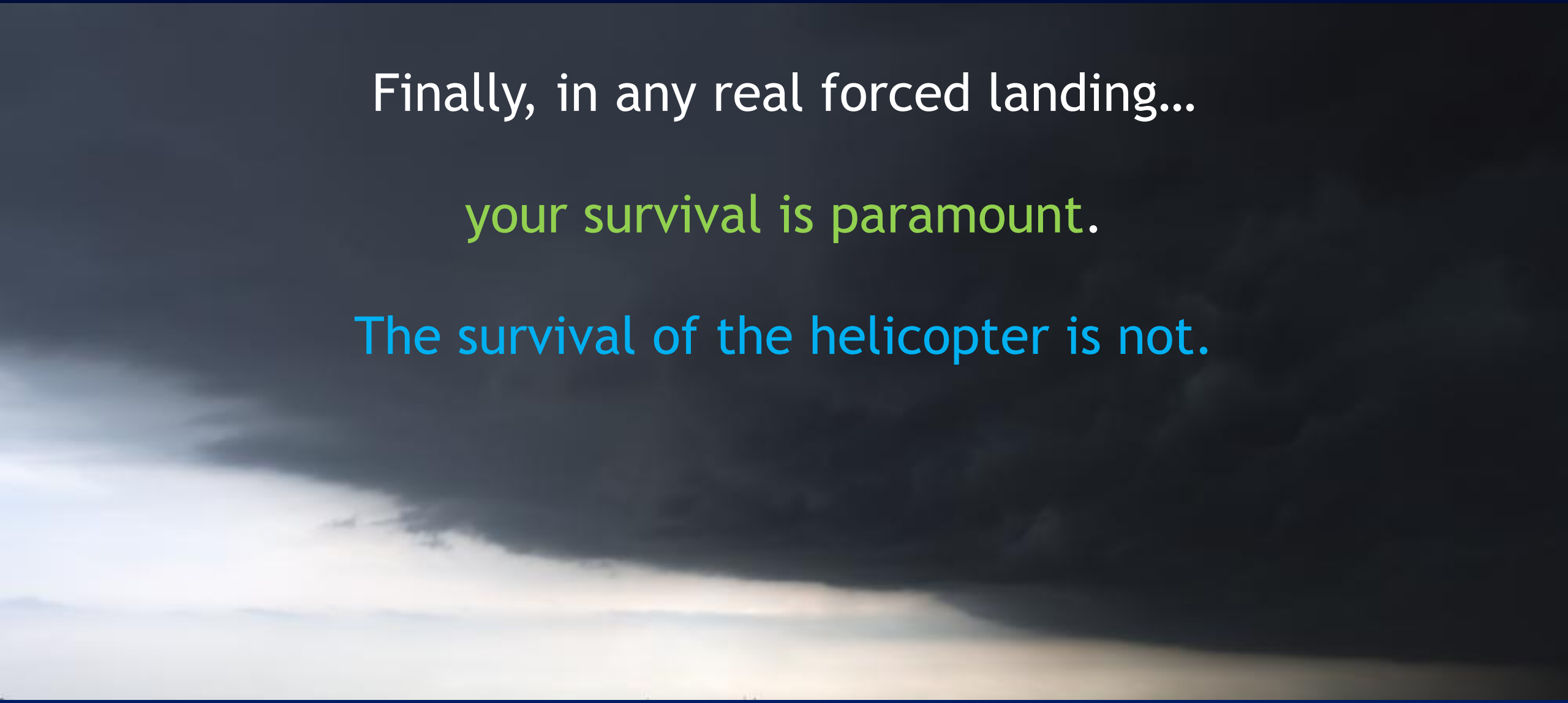
- The weather
- The route
- The altitude and airspeed
- The wind
- The type of terrain, such as:
  - Trees (Forest, Jungle)
  - Water
  - Desert, or
  - Mountains

Either accept the risks or plan around them

Summary

- Helicopter crashes are very survivable if the pilot reacts immediately and decisively.
- Injuries come from two areas:
  - High G impact, and
  - from the dissipation of energy as the helicopter rolls, tumbles and basically breaks apart around you.
- The impact can be avoided by crashing gently. The ground is your friend. Fly the helicopter all the way to the termination point and then stop it with the flare and the collective pitch which may vary depending on the terrain.
- The dissipation of energy can be reduced by limiting forward speed
- Zero Zero landings are to be encouraged and aimed for as this is what the helicopter is designed for.
- A crash from 5 feet is going to be very survivable.
- Touching the ground nose high rather than nose low is preferred, as you can use the tail and fuselage to absorb some of the energy.
- Always wear your safety equipment.
- Protect your spine by sitting properly in your seat using the seat as support and the seat belt to hold you in place.

Conclusion



Finally, in any real forced landing…

your survival is paramount.

The survival of the helicopter is not.

Review Objectives

By the end of this presentation, you will be able to

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  - G Force,
  - Terrain considerations, and
  - Termination

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Thank You