

Prepare for Impact: Familiarizing Passengers with Aircraft Emergencies through First-Person Simulations

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Acknowledgements

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- “Prepare for Impact” created together with:
 - Fabio Buttussi (software development)
 - Nicola Zangrando (computer graphics)
- We are grateful to Cynthia Corbett, Mac McLean, and David Weed for their feedback and encouragement

Contents

- **Motivation:**
 - Traditional safety briefings and their limitations
 - Need for more effective, alternative/additional tools
- **Solution explored in this presentation:**
 - 3D simulations of emergencies
 - serious games
- **Developed applications and their evaluation**

Aviation Safety Education



- **Goals of Aviation Safety Education:**
 - provide airline passengers with accurate cabin safety knowledge
 - cultivate positive passenger attitudes, to appropriately affect passenger behavior when emergencies occur
- **Level of passengers' Aviation Safety Education affects:**
 - probability of survival (Muir & Thomas, 2004)
 - level of stress and fear during the emergency (Edwards, 1990)
 - likelihood of “cognitive paralysis” phenomenon (Leach, 2004; 2005)
 - their knowledge, attitudes and behaviors (Chang & Liao, 2009)

Scarce efficacy of current approaches

- Current approaches: **preflight safety briefing, safety briefing card**
- Major issues:
 - **Lack of engagement.** Passenger attention to current briefings is poor (NTSB/SS-00/01, 2000; DOT/FAA/AM-08/20, 2008)
 - **Lack of comprehension.** Even passengers who pay attention to briefings show comprehension levels below acceptable limits (DOT/FAA/AM-08/20, 2008)
- Interview-based studies of survivors (e.g. Chang & Yang, 2011):
 - pre-flight safety briefing not useful (86%)
 - safety card not useful (84%)
- FAA reports (DOT/FAA/AM-04/19, 2004; DOT/FAA/AM-08/20, 2008; DOT/FAA/AM-15/14, 2015) call for improved, more creative methods to educate passengers about safety



Airline Response: Creative Safety Briefing Videos



Are creative safety briefing videos effective?

- Some airlines (e.g., Air New Zealand, Delta, Qantas, Thomson, Virgin,...) have created safety briefing videos that aim at being more engaging by using techniques such as involving celebrities, humour or dance
- Seneviratne and Molesworth (2015) contrasted the effectiveness of a traditional safety briefing video vs. two new types of videos, one based on humour and the other presented by a celebrity. Although the humorous video did slightly better, the two authors:
 - defined the overall results as “alarming” (participants recalled only about half of the safety knowledge)
 - concluded that “airlines and aviation authorities need to rethink the way in which they convey safety critical information to passengers”

Proposed Approach

- Educating passengers through interactive tools and games (*serious games*) would allow to:
 - make safety education materials more appealing
 - keep attention alive
 - simulate aircraft emergencies, be more thorough and realistic than current methods
 - highlight links between cause (passenger's actions) and effect (positive or negative consequences of the actions)
 - try the educational experiences whenever and how many times the player wants, also at home
 - increase exposure time to personal safety content
 - promote repetitive rehearsal of safety procedures, which improves retention of knowledge

Design Opportunities for On-board and Off-board use

- **Off-board:**

- **Any situation** can be represented, including very realistic emergencies
- Applications can be developed for any kind of hardware:
 - Mobile devices (smartphones, tablets, laptops)
 - **PCs and Gaming Platforms**
 - **special Virtual Reality (VR) devices** such as VR headsets (e.g., Oculus Rift, HTC Vive, Samsung Gear, Google Cardboard, Google Daydream) and body tracking technology (e.g., Microsoft Kinect, HTC Lighthouse)

- **On-board:**

- Design must concentrate on **non-scary content**
- Applications can be developed for:
 - In-Flight Entertainment systems (**IFEs**) with game controls (available only on selected long-haul flights)
 - Passengers' Personal Electronic Devices (**PEDs**) such as smartphones and tablets (latest FAA and EASA policies allow PED use to all phases of flight)

Interactive Tools for Aviation Safety Education

Tue 25 Oct
10:00-10:30 AM

PREPARE FOR IMPACT

LEARN TO BRACE

Off-board use

On-board use

Tue 25 Oct
2:30-3:00 PM

INTERACTIVE SAFETY VIDEO

Possibly scary content

No scary content

PLANE TROUBLES

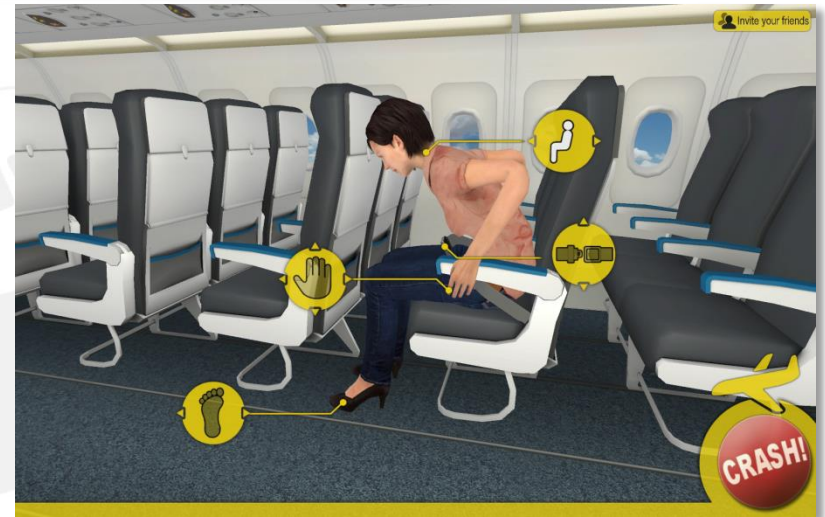
EMERGENCY WATER LANDING VR

LIFE VEST

Wed 26 Oct
8:00-8:30 AM

Download our apps from
<http://hcilab.uniud.it/aviation/apps.html>

Our first simulation game: Learn to Brace



- In April 2014, the game was published for all major mobile platforms (81'000 installations as of September 2016)
- The brace positions to assume in the app:
 - originate from the latest dynamic impact tests conducted by the FAA (DOT/FAA/AM-15/17, 2015)
 - are described in CABIN SAFETY AND FLIGHT ATTENDANT MANAGEMENT, Section 6, Safety Assurance System: Operations—Cabin Safety, 3-3563, BRACE-FOR-IMPACT POSITIONS, <http://fsims.faa.gov/>

Demo



App download links:
<http://hcilab.uniud.it/brace>



Video



The Learn to Brace study

- **Participants:** 48 (23 M, 25 F)
- **Age:** from 19 to 55 (M=29.88, SD=12.49)
- **Flights (last 2 years):** from 0 to 15 (M=3.27, SD=3.75)
- **Procedure:** Half of the participants used Learn to Brace, while the other half used a safety card. They were told to take the time they deemed appropriate to learn the position
- **Main Findings** (statistically significant):
 - **Knowledge:** the increase in knowledge after using the instructional media was considerably larger with the app rather than the card
 - **Attitudes:** participants felt the outcomes of an emergency landing were more under their personal control after using the app, not the card
 - **Instructions efficacy:** participants felt the efficacy of the instructions was higher when received by the app instead of the card

Chittaro L., Designing Serious Games for Safety Education: "Learn to Brace" vs. Traditional Pictorials for Aircraft Passengers, *IEEE Transactions on Visualization and Computer Graphics*, vol. 22, no. 5, 2016, pp. 1527-1539

Our second simulation game: Emergency Water Landing VR

- Simulation of a full aircraft accident inspired to the US Airways flight 1549 report
- Players can try right and wrong actions and see their effects
- Virtual Reality (VR) headset and game design techniques



VIDEO

Emergency Water Landing VR Study

- **Participants:** 48 (26 M, 22 F)
- **Age:** from 18 to 38 (M=24.19, SD=4.35)
- **Flights (last 2 years):** from 0 to 8 (M=2.25, SD=2.69)
- **Procedure:** half participants (Immersive Game group) used the game, the other half (Safety Card group) a safety card that presented the same safety knowledge
- **Main Findings** (statistically significant):
 - **1-week knowledge retention.** Significant knowledge loss with the Safety Card, no loss with the Immersive Game
 - **Emotions.** The Immersive Game obtained:
 - higher values of self-reported engagement and self-reported fear
 - higher physiological arousal (skin conductance, blood volume pulse amplitude)

Chittaro L., Buttussi F. Assessing Knowledge Retention of an Immersive Serious Game vs. a Traditional Education Method in Aviation Safety, *IEEE Transactions on Visualization and Computer Graphics*, vol. 72, no. 3, 2015, pp. 529–538

Our latest simulation game: Prepare for Impact

- **Goals:**

- Providing players with a comprehensive set of accident simulations that covers several different situations one could have to face in a real emergency
- Twin-aisle as well as single-aisle aircraft
- Supporting smartphones and tablets to make it available to a very large user population
- Supporting competition through world leaderboards
- Collecting data from a large set of on-line players: naturalistic, “in the wild” study, instead of classical lab study

PREPARE FOR IMPACT

In March 2016, the game was published for mobile devices (440'000 installations as of September 2016)



<http://hclab.uniud.it/impact/>

Prepare for Impact: examples of media coverage



TECH APPS



This Terrifyingly Realistic App Teaches You How to Survive a Plane Crash

Alex Fitzpatrick @alexjamesfitz | March 17, 2016

Popular
Mechanics

Horrifying App Prepares You For Flying By Simulating Every Possible In-Flight Disaster



Learn how to survive a plane crash with the 'Prepare for Impact' app

Kathleen Wong, Mic
March 17, 2016



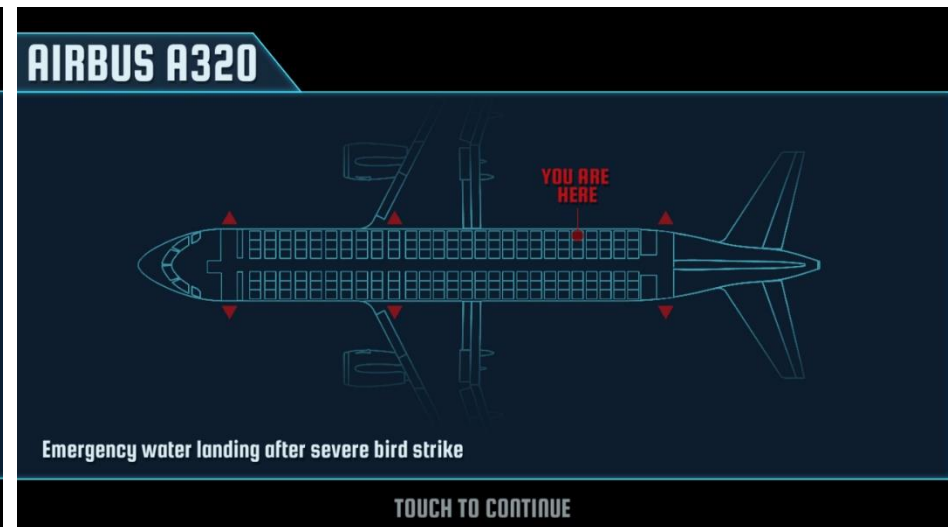
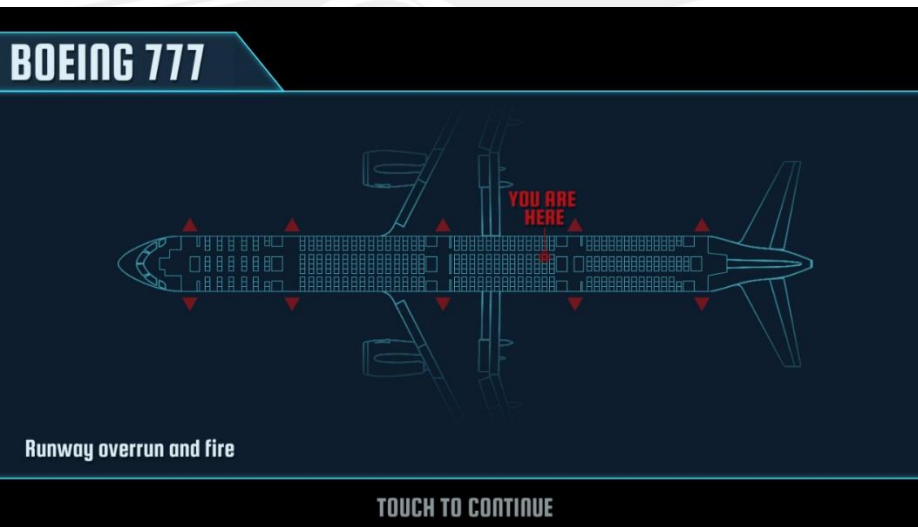
GIZMODO This Free App



Andrew Liszewski

3/17/16 9:00am - Filed to: SIMULATORS

Prepare for Impact: game start menu



Main topics covered by Prepare for Impact

- **When to fasten seat belts** [Video Example](#)
- **What to do when oxygen masks drop down** [Video Example](#)
- **Brace position** [Video Example](#)
- **Where to find life vests**
- **When to don live vests**
- **When to inflate life vests** [Video Example](#)
- **What to do with luggage**
- **What to do in case of smoke in the cabin** [Video Example](#)
- **Which exit should be reached** [Video Example](#)
- **When to open a closed door** [Video Example](#)
- **What to do after going through a wing exit** [Video Example](#)

Optional Knowledge Test

**How much do you know about your safety on a plane?
Take a quick test to see how much you know!**

Take the test now!

Skip the test, and never ask me again!

Example of question page


- Each page of the knowledge test contains a complex, multiple-choice question

Tick ALL the boxes that you think are correct
(there can be ONE or MORE correct answers)

3/12

When do you have to inflate the life vest?

- Before impact
- Before leaving your seat
- While you are running in the aisle towards the exit
- When you are going through the emergency exit
- After you find yourself in water



Database Analysis

- **Database at the moment of the analysis:**
 - 141'269 users
 - 849'943 played levels

- **Device language:**

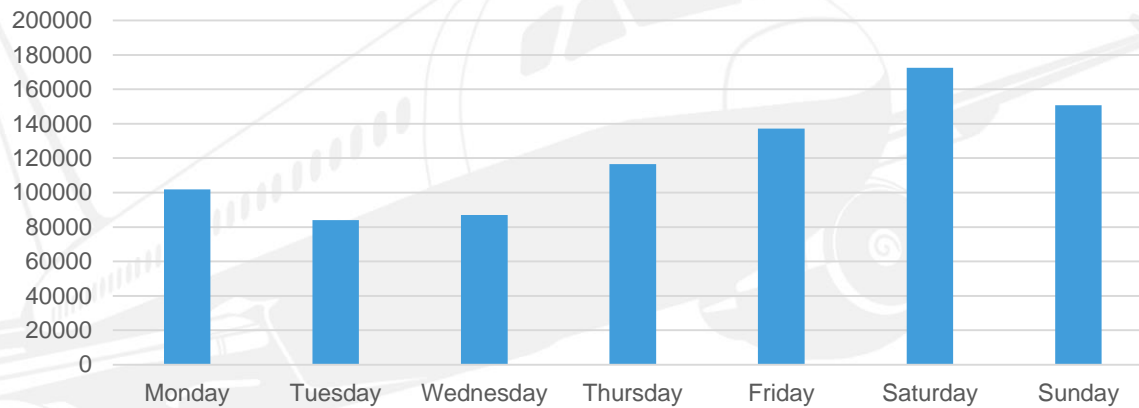
Language	Users	Percentage
English	54250	38,40
Russian	17921	12,69
Portuguese	8282	5,86
French	7350	5,20
Turkish	6969	4,93
German	6225	4,41
Spanish	5876	4,16
Chinese	5719	4,05
Czech	4454	3,15
Italian	3886	2,75
Japanese	2727	1,93
Arabic	2338	1,65
Indonesian	1657	1,17
Dutch	1559	1,10
Polish	1322	0,94
Thai	1250	0,88
Romanian	1218	0,86
Swedish	1033	0,73
Greek	986	0,70
Hungarian	767	0,54

Language	Users	Percentage
Finnish	648	0,46
Vietnamese	614	0,43
Korean	562	0,40
Slovak	496	0,35
Hebrew	386	0,27
Bulgarian	308	0,22
Ukrainian	237	0,17
ChineseSimplified	171	0,12
Danish	167	0,12
Norwegian	136	0,10
Lithuanian	134	0,09
ChineseTraditional	109	0,08
Latvian	108	0,08
Slovenian	68	0,05
Estonian	60	0,04
Icelandic	55	0,04
Catalan	48	0,03
SerboCroatian	19	0,01
Afrikaans	2	0,00
Unknown	1152	0,82

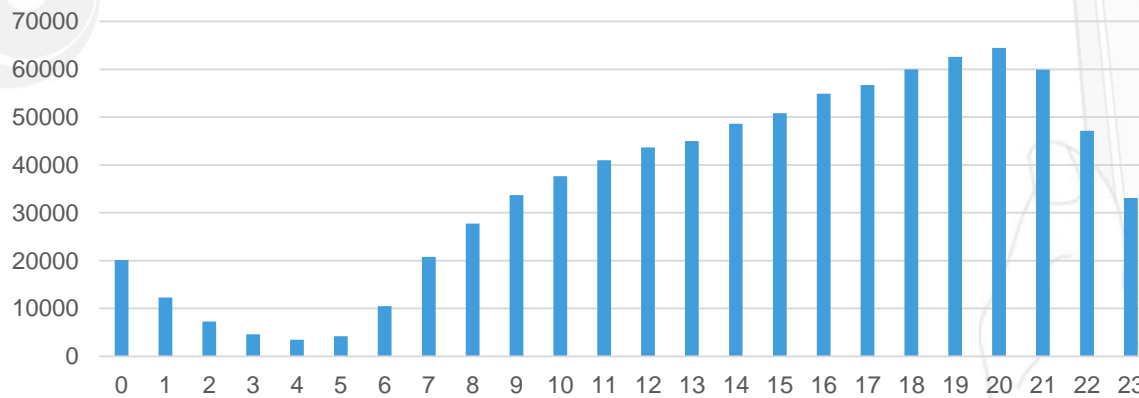
When the game is played

- **Distribution of played levels among days and hours:**

Number of levels played (days of the week)



Number of levels played (hours of the day)



Google Play demographics

- Limited to the 67'131 users who played after signing-in with Google Account

Age range	Users	Percentage
<input checked="" type="checkbox"/> Total	67,131	
<input checked="" type="checkbox"/> 26-35	7,246	10.0%
<input checked="" type="checkbox"/> 19-25	6,362	9.0%
<input checked="" type="checkbox"/> 36-45	4,701	7.0%
<input checked="" type="checkbox"/> 13-18	3,016	4.0%
<input checked="" type="checkbox"/> 46-55	1,683	2.0%
<input checked="" type="checkbox"/> 66+	504	0.0%
<input checked="" type="checkbox"/> 56-65	429	0.0%

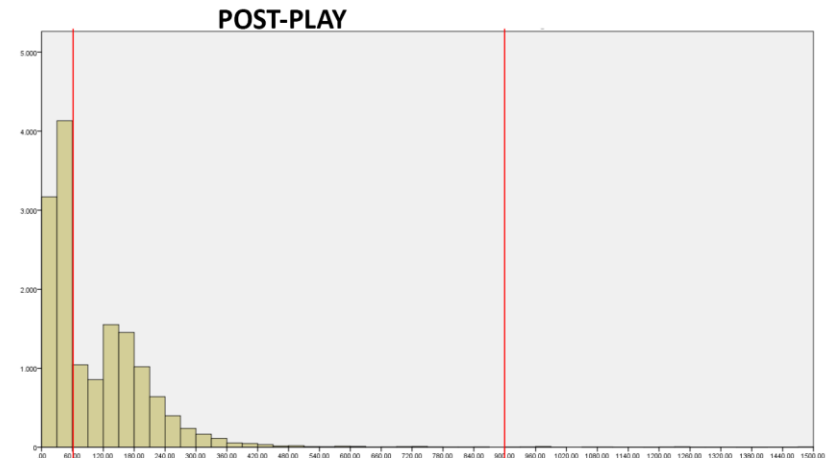
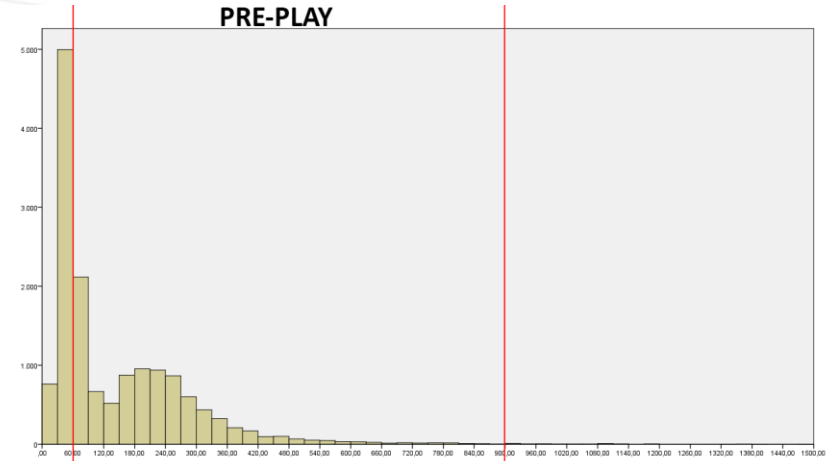
Country	Users	Percentage
<input checked="" type="checkbox"/> Total	67,131	
<input checked="" type="checkbox"/> United States	11,002	16.0%
<input checked="" type="checkbox"/> Brazil	4,925	7.0%
<input checked="" type="checkbox"/> Russia	4,831	7.0%
<input checked="" type="checkbox"/> United Kingdom	2,704	4.0%
<input checked="" type="checkbox"/> Indonesia	2,610	3.0%
<input checked="" type="checkbox"/> Turkey	2,548	3.0%
<input checked="" type="checkbox"/> France	2,336	3.0%
<input checked="" type="checkbox"/> India	2,210	3.0%

Gender	Users	Percentage
<input checked="" type="checkbox"/> Total	67,131	
<input checked="" type="checkbox"/> Male	52,115	77.0%
<input checked="" type="checkbox"/> Female	8,417	12.0%

- **Knowledge test:**

- Users in the database who completed both pre-play and post-play test: **15'326**
- Users who spent between 60" and 15' on each test: **6'979**
- Languages in this subset:

Language	Users	Percentage
English	5175	74,15
French	185	2,65
Spanish	182	2,61
German	166	2,38
Russian	152	2,18
Czech	118	1,69
Portuguese	112	1,60
Italian	97	1,39
Dutch	96	1,38
Japanese	70	1,00
Other 29 languages (with less than 1% each)	588	8,43
Unknown	38	0,54







Main Results

- Results show that playing the game **significantly improved users' knowledge**
- The knowledge test consisted of **12 complex, multiple-choice questions** (4 to 6 non-mutually exclusive answers each)
- Users improved on all questions, the following slides analyze in detail **some of the questions**, reporting **pre- and post-play values for each choice**
- Means were calculated by associating a value of **0 to unchecked choices**, and **1 to checked choices**
- Green lines highlight correct choices
- **All reported results are significant** (Wilcoxon test, alpha-level=0.001), except the ones for which the "NOTES" column does not contain a comment

Detailed Analysis of Question 2

2. During an emergency landing, which of these positions are correct to prepare for impact?

	PRE-PLAY MEAN	POST-PLAY MEAN	DIFFERENCE	NOTES
<p>a.</p> 	0,50	0,38	-0,12	Before playing, 50% of the respondents believed this brace position was correct. Then, many players probably looked at how other passengers braced during play, and changed their mind, improving the percentage (38%).
<p>b.</p> 	0,40	0,72	0,32	This is one of the largest improvements obtained: only 40% knew the correct answer before playing, 72% after playing.
<p>c.</p> 	0,18	0,06	-0,12	18% of the respondents believed this brace position was correct before playing, the percentage went down to only 6% (a third of the initial one) after playing.
<p>d.</p> 	0,34	0,16	-0,18	Before playing, 34% of the respondents believed this brace position was correct. The percentage was more than halved after playing (16%).

Detailed Analysis of Question 3

3. When do you have to inflate the life vest?	PRE-PLAY MEAN	POST-PLAY MEAN	DIFFERENCE	NOTES
a. Before impact	0,30	0,10	-0,20	30% of the respondents believed they had to inflate the life vest before impact. After playing the game, the percentage went down to just 10% (a third of the initial one).
b. Before leaving your seat	0,23	0,11	-0,12	23% of the respondents believed they had to inflate the life vest before leaving their seat. After playing the game, the percentage was more than halved (11%).
c. While you are running in the aisle towards the exit	0,13	0,10	-0,03	Only 13% of the respondents believed they had to inflate the life vest while running in the aisle, but there was a post-play improvement also in this case (10% after play).
d. When you are going through the emergency exit	0,40	0,77	0,37	This is one of the largest improvements obtained: only 40% knew the correct answer before playing, 77% after playing.
e. After you find yourself in water	0,40	0,21	-0,19	Before playing the game, 40% of the respondents believed they had to inflate the life vest in water. The percentage was almost halved (21%) after playing.

Detailed Analysis of Question 7

7. If there is smoke in the cabin, what do you have to do while going to the exit?

	PRE-PLAY MEAN	POST-PLAY MEAN	DIFFERENCE	NOTES
a. Keep wearing the oxygen mask	0,31	0,21	-0,10	<p>Before play, 31% believed they had to keep wearing the oxygen mask during the evacuation, improved to 21% after play.</p> <p>This is one of the largest improvements obtained: 55% knew the correct answer before playing, 89% after playing.</p> <p>12% of the respondents chose this wrong answer before playing the game, most of them did not make the mistake again after play (percentage falls to just 1%).</p>
b. Bend over or crawl	0,55	0,89	0,34	
c. Follow floor lights	0,66	0,66	0,00	
d. Run upright as fast as possible outside the smoke	0,11	0,11	0,00	
e. None of the previous answers	0,12	0,01	-0,11	

Detailed Analysis of Question 10

10. During an evacuation on land, what do you have to do after you exit through a door on a wing?

	PRE-PLAY MEAN	POST-PLAY MEAN	DIFFERENCE	NOTES
a. Jump down from the wing immediately	0,18	0,14	-0,04	
b. Go down using the slides	0,70	0,89	0,19	The majority (70%) of respondents knew the right answer before playing the game, the percentage increased to 89% after the game. Before playing the game, 26% of the respondents believed they had to wait for instructions after exiting the wing exit. The percentage was more than halved (11%) after playing. Before playing the game, 16% of the respondents believed they had to wait for the rescue teams on the wings. The percentage was more than halved (7%) after playing.
c. Wait until flight attendants give precise instructions	0,26	0,11	-0,15	Only 10% of the respondents chose this before playing the game, but there was a post-play improvement also in this case (7% after play).
d. Wait on the wing until the arrival of the rescue team	0,16	0,07	-0,09	
e. None of the previous answers	0,10	0,07	-0,03	



Leaderboards

Best Time - Crash Landing

This week

Social All

2	1	3
IridescentMaestro227	GlamorousG...	GiantJackal2130
1:38	1:36	1:38

4	BadGamer1010	1:39
5	malome128	1:40

95%		Casper141999	8:21
IN TOP 95%		FoolishTreat2078	8:21
IN TOP 96%		EntrancedJustice2508	8:21
IN TOP 96%		GloriousNimrod2541	8:21
IN TOP 96%		GnarlyWillow395	8:21
IN TOP 96%		IrascibleJustice2811	8:22

Prepare for Impact BEST Time - Crash Landing

No Friends This Week All 339 Players This Week

1		"whengli"	0:01:39
2		"IceStorm320"	0:01:39
3		"~ PollyZ ~"	0:01:42
4		"ThatRaccoon..."	0:01:42
5		"Spera43"	0:01:42
6		"Grollo355"	0:01:42
7		"Mahpal Alias"	0:01:42
8		"Dani+Abril-b..."	0:01:43

On-going and future work

- Further Analysis:
 - The database keeps increasing every day
- Interactive Tools for **Off-Board Use**:
 - In Prepare for Impact, the view is first-person, and the player controls one character
 - Creating an accident simulator in which the view is third-person, and the player can control any character
 - Extending Prepare for Impact with new levels and features
 - Creating VR versions that include full-body tracking
- Interactive Tools for **On-Board Use**, e.g.:
 - Safety briefing videos with Interactivity (see my other presentation today, **Tue 25 Oct, 2:30-3:00 PM**)
 - Active exploration of safety procedures on touchscreens (see my other presentation tomorrow, **Wed 26 Oct, 8:00-8:30 AM**)

More Info

- **Project Web Site:** <http://hcilab.uniud.it/aviation>
- **News (follow us on):**
 - <http://www.facebook.com/hcilabudine>
 - <http://www.twitter.com/hcilabudine>
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