VR and Serious Games to Improve Training in Aviation

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Our Human-Computer Interaction Lab

- Multidisciplinary approach:
  - combining psychology/neuroscience and IT/computer science expertise to...
  - ...design and develop applications for human use that are proven effective

- Active since 1998 (more than 100 man-years of research and development)

- Specialized in:
  - Training, Learning, and Education
  - Safety, Security, and Emergencies
Effects of VR experiences need to be assessed also physiologically.

Example:


Example:

Studying VR Experiences with fMRI

- fMRI (functional Magnetic Resonance Imaging) allows our team to measure indirectly neural activity of the player’s various brain areas
- Special glasses and joysticks (compatible with extremely high magnetic fields) allow users to interact with the VR experiences inside the MRI machine
Example: Fire Evacuation Scenario

- increased functional connectivity of the brain salience network (enhanced sensitivity to the threatening situation and potential danger) → players did not help the victim

- engagement of the medial prefrontal and temporo-parietal cortices (associated with the human ability of taking the perspective of other individuals and making altruistic choices) → players helped the victim

VR for aviation education and training

“Virtual Reality (VR)”… “Gamification”… “Serious Games”:
• The “next big things” in aviation education and training?
• Be wary of hype without substance!

Scientific studies are needed to:
• Assess actual effectiveness
  • “Do they work?”, “What are they useful for?”, “Can they be better than current methods?”,…
• Explore the design space
  • “Which specific designs and features work?”, “And which do not?”, “How should we do it right?”,…

In the last 5 years, this has been the main focus of several research and development projects at our lab, also supported by FAA grants
Our group on the official FAA site

www.faa.gov/data_research/research/med_humanfacs/aeromedical/cabinsafety/passengerinfo/
The “Learn to Brace” project

- In recent years, the FAA conducted dynamic impact tests that led to identify improved brace positions (DOT/FAA/AM-15/17, 2015)
- Under a FAA grant, we created and studied a mobile simulation game that teaches the new positions
- In April 2014, the game was publicly released for all major mobile platforms (250,000 installations as of May 2018). To download it, see http://hcilab.uniud.it/brace
Demonstration
“Learn to Brace”
The Learn to Brace study
( Knowledge Increase and Locus of Control)

🌳 Participants: 48 (23 M, 25 F)
🌳 Age: from 19 to 55 (Mean=29.88)
🌳 No previous knowledge of the new brace position; flights (last 2 years): from 0 to 15 (Mean=3.27)
🌳 Procedure: Half participants used Learn to Brace on a smartphone, while the other half used a safety card with traditional pictograms
🌳 Main Findings (statistically significant):
• Knowledge: increase in knowledge was considerably larger with the game rather than the card
• Attitudes: participants felt the outcomes of an emergency landing were more under their personal control (internal Locus of Control, LOC) after using the game, not the card
• Instructions efficacy: participants felt the efficacy of the instructions was higher when received from the game instead of the card


 Luca Chittaro – IATA AVARS 2018 http://hcilab.uniud.it/aviation
The “Life Vest” project

- In recent years, the FAA conducted tests of life preserver donning illustrations, showing that they are difficult to comprehend, even when study participants are given an unlimited amount of time to study them (DOT/FAA/AM-14/14, 2014).

- Under a FAA grant, we created and studied a mobile 3D app that teaches how to don a life preserver.

- In January 2015, the app was publicly released (http://hcilab.uniud.it/lifevest) for all major mobile platforms (92,000 installations as of May 2018).
Demonstration

http://hcilab.uniud.it/aviation
The Life Vest study
(Training Transfer, Efficiency, Human Error)

- **Participants:** 68 (61 M, 7 F)
- **Age:** from 20 to 24 (Mean=21.21)
- **No previous knowledge of life preserver donning:** flights (last 2 years): from 0 to 10 (Mean=1.68)
- **Procedure:** Half participants used the Life Vest app, the other half used the life preserver card that presented the same knowledge. Then, participants were asked to try wearing the real aircraft life preserver.
- **Main Findings** (statistically significant):
  - **Time to don the life preserver in the real-world:** participants who had used the app were able to retrieve and don the life preserver in less time than participants who had used the card
  - **Errors in donning the life preserver in the real-world:** participants who had used the app made fewer errors than participants who had used the card
  - **Users’ perception:** app perceived as more engaging, simple and effective than card

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“Emergency Water Landing VR”

- Study of different effects of using our immersive “Emergency Water Landing VR” system to live a fully interactive cabin emergency scenario
- Scenario based on US Airways flight 1549 (NTSB report AAR-10/03)
- Players can try any (correct or wrong) action and see its effects, including the most scary ones
Emergency Water Landing VR Study
(Memory Retention, Emotions, and Physiological Reactions)

- **Participants**: 48 (26 M, 22 F)
- **Age**: from 18 to 38 (Mean=24.19)
- **Limited previous cabin safety knowledge**, flights (last 2 years): from 0 to 8 (Mean=2.25)
- **Procedure**: half participants (Immersive VR group) used the serious game, the other half (Safety Card group) a safety card that presented the same knowledge

**Main Findings** (statistically significant):
- **1-week knowledge retention**:
  - **Significant knowledge loss** with the Safety Card
  - **No loss** with our Immersive VR serious game
- **Emotions**. The Immersive VR serious game obtained:
  - higher values of self-reported engagement and self-reported fear
  - higher physiological arousal (skin conductance, blood volume pulse amplitude)

“Prepare for Impact” project

Goals:

• Providing users with a comprehensive set of realistic cabin safety scenarios that cover several different situations described in real-world accident reports

• Supporting complex simulations on immersive HMDs as well as common smartphones and tablets, making the game playable by a very large user population

• Supporting competition among game players through world leader boards

• Collecting telemetry data from a massive set of online players for in-depth data analytics

Demonstration
The Impact of “Prepare for Impact”

▾ Released in March 2016 (to download it, see http://hcilab.uniud.it/impact/)

▾ The most successful serious game so far:
  • more than 3.5 MILLION installations as of May 2018
  • keeps growing at a rate of more than 4,000 new installations per day

▾ A large effort was required to research, design, develop, evaluate, and deploy the serious game in the right ways

TIME
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
**The Prepare for Impact study**
(assessing training needs through game telemetry)

**Example:** When do you have to inflate the life vest in a ditching?

- a. Before impact
  - 30%
- b. Before leaving your seat
  - 23%
- c. While you are running in the aisle towards the exit
  - 13%
- d. When you are going through the emergency exit
  - 40%
- e. After you find yourself in water
  - 40%
Demonstration
“Air Safety World”: first reactions

- Rapidly growing (about 500,000 installations in the first 12 months)
- Described as ‘perfect app’ by Australia’s Civil Aviation Authority (CASA) flight safety magazine
AVIETRA: VR for airlines

- We created the company specifically to address airlines’ VR/AR needs
- AVIETRA stands for AVIation Education and TRAining
DEMO: Cabin Crew Training in Immersive VR

A well-designed VR training system must:

- Vividly simulate any type of normal or emergency scenario with any low-cost VR headset
- Maximize:
  - realism
  - engagement
  - usability
  - knowledge retention
  - resilience
Importance of Multiplatform Architecture

AVIETRA VR Engine

Smartphones and Tablets

AVIETRA VR Engine

Portable VR systems

AVIETRA VR Engine

Room-size VR systems
DEMO: Cabin Crew Training in Mobile VR

Headsets are not always the best choice:

• Some trainees prefer to conveniently experience the 3D training on the touchscreen of their smartphones and tablets, at any time and place.
Room-size VR Interaction DEMO

Room-size VR solutions track:

- Head
- Both hands
- Position in the room

Room-size VR headsets need connection to a VR-ready PC
Portable VR Interaction DEMO

- Current portable VR solutions track:
  - Head (orientation, not position)
  - One hand (orientation, not position)

- Portable VR headsets do not require to set up a room, and do not require a PC
New training applications developed

- **Security training**
  - Suspicious Item
  
  **Do not cut or disconnect any wires and do not open or attempt to gain entry to internal components of a closed or concealed suspect device. Any attempt may result in an explosion.**

- **Unruly passenger management**
  - Calm down, you are overreacting
  - I understand how you feel
  - Shut up! You’re disturbing the other passengers
  - I can store your luggage for you in another compartment
New training applications developed

- Service training
- Galley and catering checks
AR/VR in airline digital transformation

- 3D assets created for one airline department (for example, training) must be re-purposable for other departments in digital transformation strategies

- **Case study 1:** Marketing
  - Virtual prototyping of cabin designs (and testing on customers)
  - Promotion of the different classes of service to customers through VR

- **Case study 2:** On-board information
  - Generation of 3D photorealistic IFE tutorials for the aircraft on-board features/services
  - Generation of 3D photorealistic IFE safety videos
Summary and new studies

The international, published studies of our applications show that they improve:

• Learning
• Knowledge retention
• Knowledge transfer
• Engagement
• Efficiency
• Error prevention
• Personal resilience factors, such as perception of control over emergencies (internal LOC) and self-efficacy

We are currently completing studies that compare the effects of:

• different VR types (immersive vs. non-immersive, room-size vs. portable)
• different presentation types (for example, features of virtual instructors)
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