Research Report

Symbol Development: Lithium-ion Battery and Thermal Runaway

Introduction

The Interaction Group (TIG) Research Reports provide insights into how passengers perceive and understand safety information. This report outlines the development of symbols intended to inform airline passengers that:

1. Power banks must not be charged using in-seat power outlets.
2. Power banks must not be stored in the overhead compartment.

Airlines have varying policies regarding items that have lithium-ion batteries. However, incidents of thermal runaway continue to present serious safety concerns. Our work supports a unified, visual safety message to mitigate these risks.

Background: Spare Lithium-ion Power Banks

Lithium-ion batteries, including those in power banks, pose a fire risk due to thermal runaway—a rapid, uncontrolled chemical reaction. Currently there are on average two **[UL Standards & Engagement]** cabin fire incidents per week caused by this phenomenon.

Many carriers now prohibit storing power banks in overhead compartments and charging them via the in-seat systems. Yet, passenger awareness remains low. We aim to increase safety through symbol-based communication, free of language barriers.

Symbol Development Process

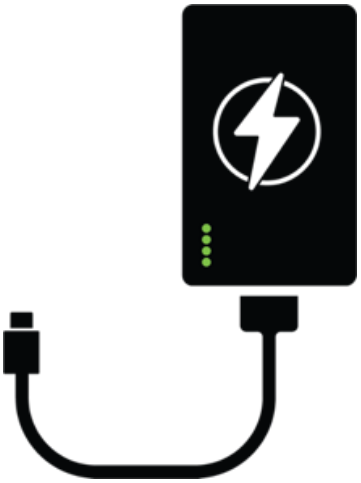
Conceptual Challenge

Creating a symbol for a "power bank"—a device that charges phones, tablets, or laptops—proved difficult. Technology evolves faster than public understanding. During testing, only 74.5% of participants had heard the term “power bank.” Many couldn’t define it.

Figure 1: Initial Symbol Design

In initial testing, only 68% of test subjects correctly identified this image as a power bank. Others mistook it for a phone, tablet, or iPod.

Figure 2: Improved Symbol with Cord



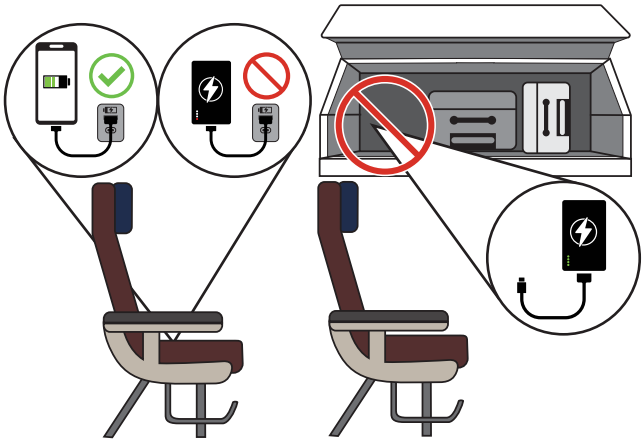
By adding a charging cable, recognition rose to 92%, meeting our symbol comprehension benchmark.

Multi-Message Symbol Development

Once symbol comprehension was achieved for the power bank, we developed visuals to communicate the following key safety instructions:

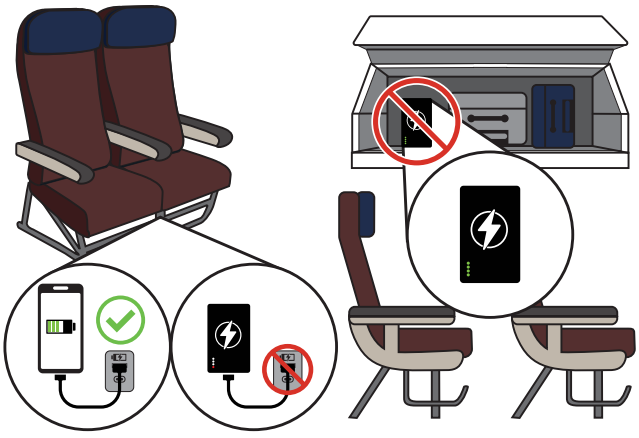
1. It is acceptable to charge a phone using the in-seat power outlet.
2. Do not charge a power bank using the in-seat power outlet.
3. Do not place a power bank in the overhead bin.

Figure 3: Initial Combined Symbol



- 92.2% understood the message about charging a phone using the in-seat outlet.
- 90.2% understood the instruction to not charge a power bank using the in-seat outlet.
- The overhead bin message was less effective; many interpreted it incorrectly as meaning that charging a power bank in the overhead bin is not allowed, rather than storing it.

Figure 4: Final Symbol



After refinement, 90.2% understood that power banks should not be stored in the overhead compartment.

User Testing Overview

Flight Frequency in Past 2 Years

Flights Taken	0	1–2	3–5	6–10	10+
Participants	20%	23%	35%	12%	10%

Gender

- Male: 51%
- Female: 49%

Results

Symbol Comprehension Area	% Understood
Power bank, overhead bin, seat outlet (overall)	92.2%
Charging phone using in-seat outlet	96.2%
Not charging power bank using in-seat outlet	90.2%
Not storing power bank in overhead bin	90.2%

Interesting Findings

Generational Gaps in Awareness

Older age groups (55+) were less familiar with power banks. Participants aged 60 and older frequently lacked understanding of what a lithium-ion battery is or what it powers.

Low Awareness of Lithium-ion Battery Usage

Participants were asked: **“Can you name three items in your home that use lithium-ion batteries?”**

- 17.6% named non-obvious examples (e.g., laptops, smartwatches, toys).
- 60.8% could not name any item beyond cell phones or chargers.
- The remaining participants only referenced the devices discussed during the test (phones or external chargers).

Conclusions

- The final symbol set meets comprehension criteria, achieving at least 90% understanding in key areas. This exceeds the U.S. standard for safety symbol recognition (ANSI Z535.3-1998), which requires a minimum of 85%.
- Symbols communicate effectively without language, supporting greater passenger awareness regardless of literacy or language fluency.
- The presence of these symbols on passenger safety cards can enhance both airline safety posture and reduce liability in case of an incident.
- Clearer global messaging and communication are essential regarding lithium-ion batteries. This includes informing the public about:

1. **Where they are found:** Lithium-ion batteries are in many everyday devices, such as smartphones, laptops, electric vehicles (EVs), power tools, and even some home appliances.
2. **Potential hazards**: These batteries pose risks like fire, explosion, and chemical leakage if damaged, overcharged, or improperly disposed of. Overheating, short circuits, and punctures can also lead to dangerous situations.
3. **Proper handling and safety**: Guidelines should focus on correct charging practices, storage away from extreme temperatures, and not overcharging. There should also be clear directions on how to dispose of or recycle them safely, and how to handle incidents like leaks or fires.

Overall, better communication would help prevent airline incidents, improve safety protocols, and increase passenger awareness about their impact.

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