
TACK TILES
Improving accessibility for
the vision impaired in urban environments

introduction

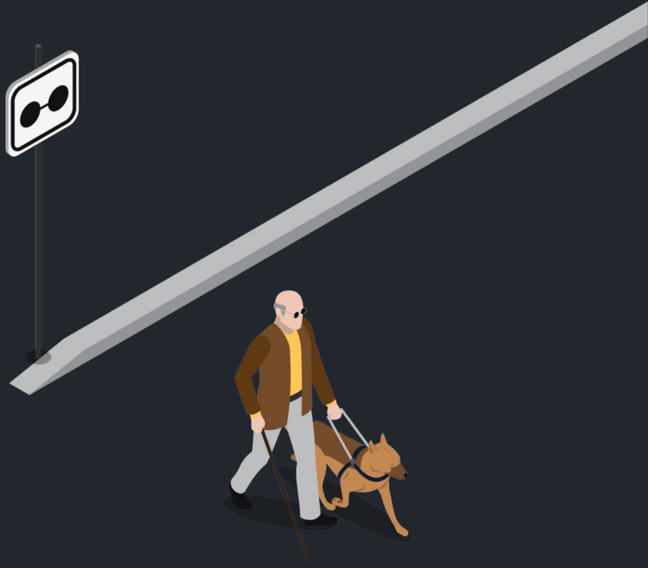
Background

Over **575,000** people currently living in Australia are **blind** or **vision impaired**

70% are **over** the age of **65**

66,000 people are **totally blind.**

Problems faced include **loneliness**, **loss of orientation** and mobility-related **accidents (Tong, 2015)**



Problem Overview

"If a blind person cannot find a bus stop, locate and board the proper bus, navigate through a complex transfer station, or find boarding areas, fare machines, amenities, and doorways, they face functional barriers, every bit as daunting as structural barriers, to equal access to transit and buildings."
(Marston, 2000)

Despite advances in smart infrastructure, our modern cities fail to meet a sufficient standard of accessibility for the vision impaired and the differently abled across the board. This not only diminishes practical mobility but is disempowering and places the vision impaired at life-threatening risk that can have a significant impact on their mental health and sense of personal autonomy.

After conducting our rounds of primary and secondary research we concluded the following **problem statement:**

> *The vision impaired require assistance to navigate modern cities independently. This includes assistance in orienting themselves, identifying hazards and using existing public transport and public infrastructure.*

Product overview

During the design of our product we developed a meaningful design intervention to tackle this issue, accomplished through an integration of interactions from existing accessibility infrastructure. Our product could be constructed using affordable mass produced components, no more expensive or complex than the automobile-centric traffic lights we have currently.

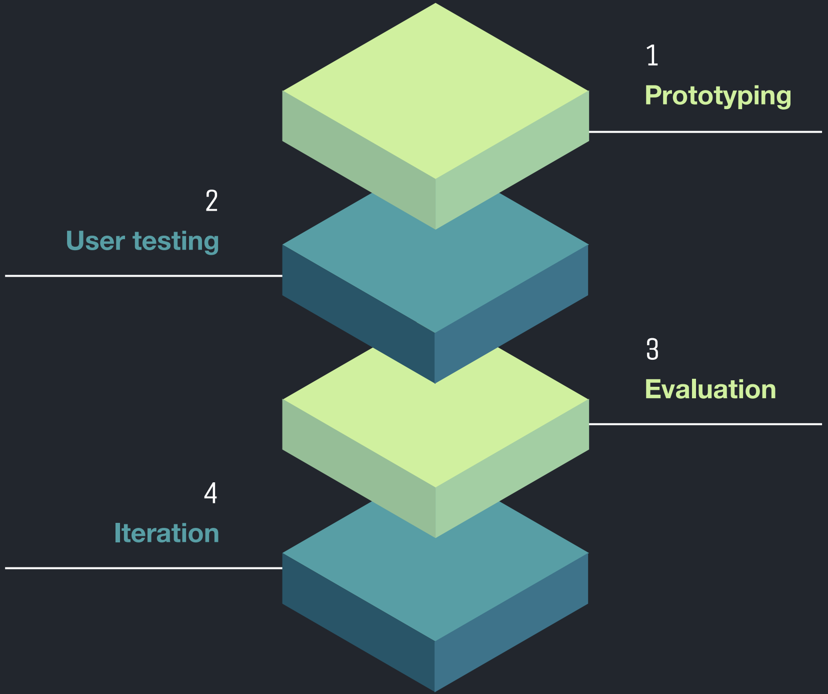
Our Tack-Tiles are modular pads that are designed to be implemented at zebra crossings and unmarked crossings, where there is currently no smart infrastructure. Visually they will appear almost identical to the existing tactile indicator pads you see at crossings already with the addition of a LED lightstrip and other electronics embedded beneath the pad.

The pads are linked to an ultrasonic sensor that detects the presence of cars, when cars are detected the Tack-Tiles vibrate at a steady pulse and a red LED flashes for those with partial sight. When it is safe to cross the Tack-Tiles vibrate rapidly, letting users know it’s safe to cross as the LEDs turn green. These signals replicate design patterns that Sydneysiders are familiar with from current pedestrian crossing buttons. The decision was made to replicate these existing signals so that new users do not need to be taught how to use the product, and the likelihood of confusion or misinterpreting the signals is reduced.

design process

Addressing the Problem

Throughout our design process we strived to address the problems that blind people face everyday whilst navigating cities. We developed multiple concepts and received feedback from people who are vision impaired, who helped us select and develop one concept further. Our chosen product is a form of inclusive design which assists people with varying degrees of vision to cross roads safely, empowering them to navigate independently.



Design Roadmap

received brief

showcased product

initial research
Investigated the problem space (navigating cities as a blind person). Researched existing solutions

ideation
Came up with three concepts to solve the problem: Braille map, Beacon and Tack-Tiles

feedback
Received written responses from two people with vision impairment about our concepts and the problems they face

analysis
Made an affinity diagram to identify common themes and weaknesses of each concept

user testing
Conducted user testing for each prototype and gauged responses through observation, post-test interview, survey

prototyping
Developed lo-fi paper prototypes of each of our concepts

evaluation
Developed a decision matrix to rate each design according to feasibility, usability, helpfulness and relevance.

selection
Based on our analysis and evaluation, we chose Tack-Tiles as the concept to develop further

further testing
Conducted a second round of testing to refine aspects of the Tack-Tiles concept, experimenting with different kinds of audio and haptic signals

delivery
Delivered our working prototype at the showcase and received further feedback

development
We developed a final high fidelity product controlled by an Arduino and designed an enclosure for it.

sourcing
We researched the requirements of our product and sourced the materials we needed

iterative approach

Interview/survey

Following user testing, we interviewed participants and had them fill out surveys on each concept

Observation

We ran participants through our experiment and recorded live observations and transcripts of the testing

Iteration

After learning that participants were having difficulty interpreting our vibration sounds, we adjusted the sounds to be more distinct and informative.

Analysis

We analysed our data with affinity diagrams and a product decision matrix

core functionality

What is Tack-Tiles?

TACK
TILES

Tack-Tiles is a piece of smart pavement infrastructure, alerting pedestrians about roadside traffic conditions. Our concept aims to improve the ground surface indicators already present in most developed cities. While existing designs have proven effective in defining hazards, they lack effectiveness in conveying the type of obstacle present and alerting users to changes in traffic conditions.

The physical form of Tack-Tiles is similar to a traditional tactile ground surface indicator typically found at traffic light crossings or train platforms. The product conveys vibration and audio based messages to alert visually impaired individuals on traffic conditions or other potential hazards. For example, Tack-Tiles installed at Zebra crossings produce vibrational messages and audio instructions depending on whether the crossing is clear or a car is approaching.

HAPTICS

Users can step on on Tack-Tiles or touch the surface with a white cane to begin receiving messages. Ultrasonic sensors placed on either end of a crosswalk pick up traffic information. Tack-Tiles receive this data and convert it into haptic feedback, updating the user on when to stop or walk. If impeding traffic is present, Tactile pads begin to vibrate at slow regular intervals. If no traffic is present, Tack-Tiles vibrate quicker in succession.

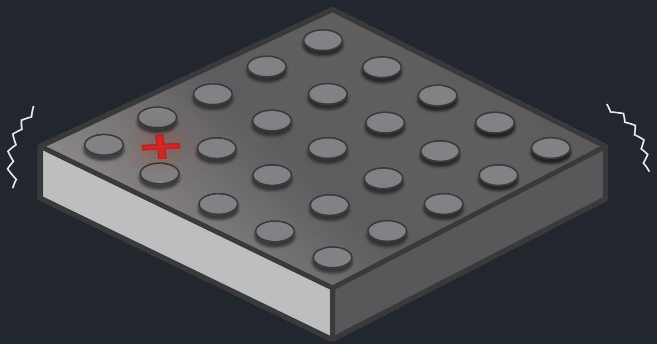
VISUAL

Embedded LEDs help provide further indication at crossings. When cars are present,
red LEDs form a X and blink slowly to indicate to users that it is not safe to cross. Once no hazards are present, a strip of green LEDs turn on and off in a sequence, moving in the direction of travel. Applying LEDs to this context assists those who suffer from partial visual disabilities and rely on high contrasting colours when wayfinding throughout public spaces.

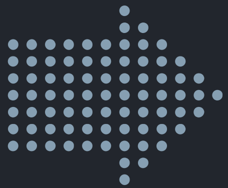
AUDIO

Speakers embedded within Tack-Tiles warn users when vehicles are inbound. If no traffic is present, spoken instructions direct users to cross. With sufficient utilization of Tack-Tiles, the objective is for users to interpret messages without relying on sound in circumstances, where overwhelming noise, due to traffic, crowds, construction or other forms of background noise, may cause inaudibility.

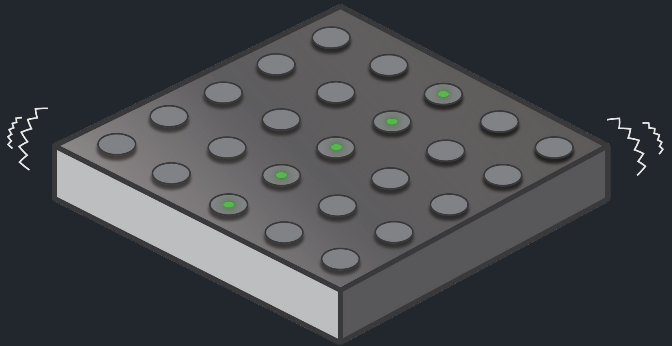
STATE 1



- Red LEDs flash
- Slow and sparse vibrations
- Audio instructing users to wait



STATE 2



- Green LEDs blink in direction travel
- Rapid vibrations
- Audio instructing users to cross

Hardware/Software

Sensors

An ultrasonic sensor is used to detect approaching traffic. A sound wave in the ultrasonic frequency range is sent out and if an object (such as a car) is in the way, it will be reflected back to the receiver and trigger a signal to be sent to the Arduino.

Actuators

An array of 6 green LED lights are connected to a shift register and powered by the arduino. A single red LED is also included.

A small DC motor with an offset weight acts as a vibration motor

A portable speaker is connected to the Computer by bluetooth.

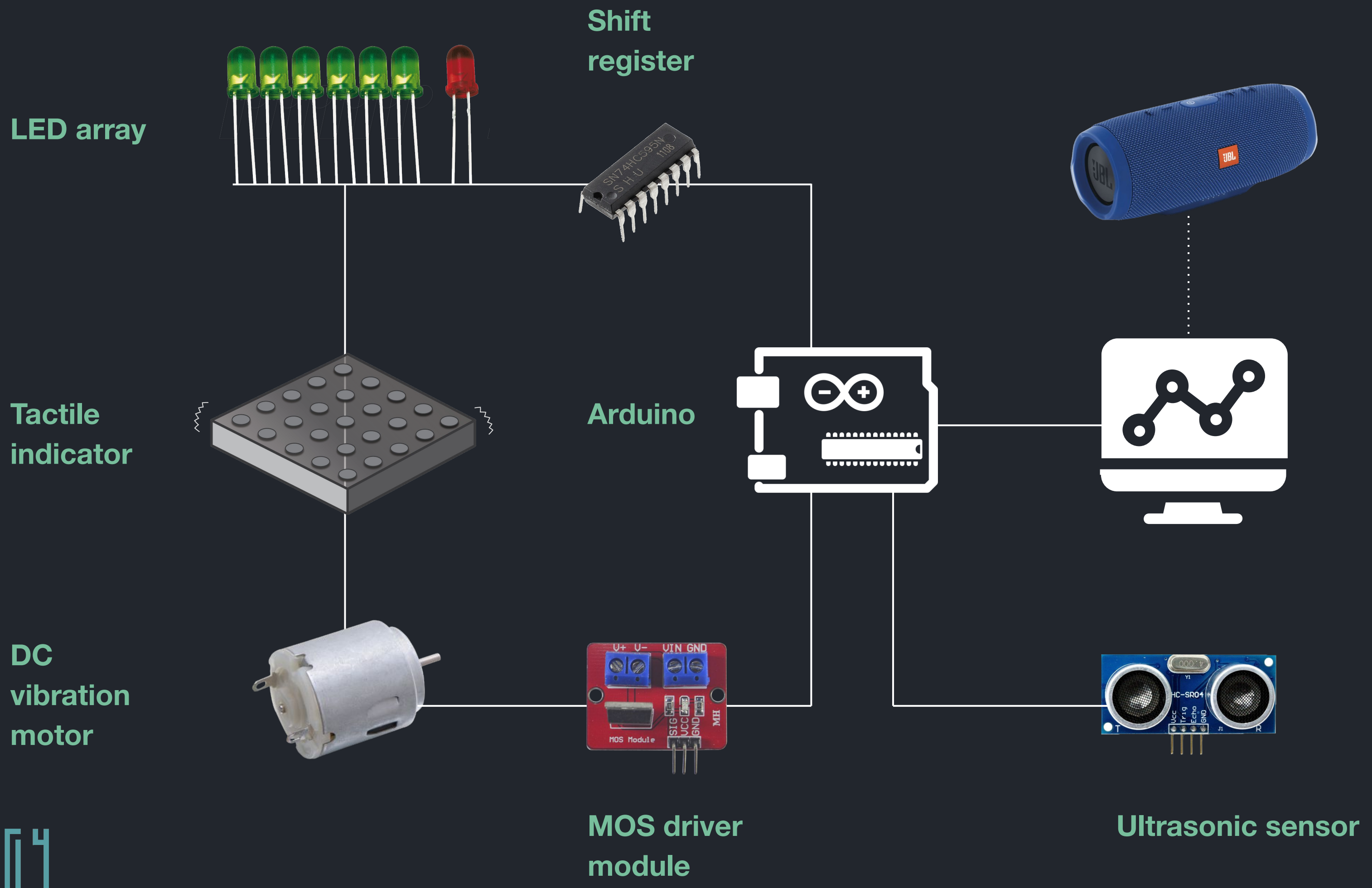
Each of these actuators are turned on and off at different rates, triggered by a change in signal from the ultrasonic sensor.

Software

The Arduino IDE is used to program the microprocessor. The code mainly consists of an if statement which checks to see whether the ultrasonic sensor has detected a car, and triggers a "wait" or "walk" pattern in the LEDS and motor.

An audio library and the processing IDE are also used to take the signal from the ultrasonic sensor and use it to trigger audio files to play on a laptop, which is connected to a bluetooth speaker.

Setup


Shift
register
LED array
Tactile
indicator
Arduino
DC
vibration
motor
MOS driver
module
Ultrasonic sensor
SN74HC595N
V+ V- VIN GND
SIG VCC GND
MOS Module
HC-SR04

Tack-Tiles are placed on the borders of crosswalks.

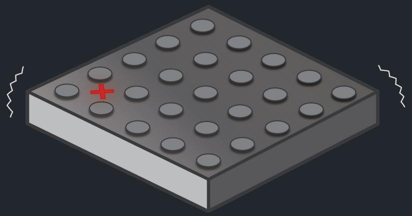
(Macrovector, n.d.)

Ultrasonic sensors strategically placed adjacent to crosswalks pick up traffic information.

Issues

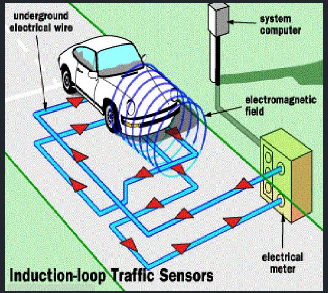
Placement of 'Don't walk indicator'

In future iterations we would improve the placement of the red "don't-walk" indicator. Currently positioned in the back left corner it is easily obscured by the user's foot. A better place would be in the middle of the tile. This problem could also be solved by using multiple tiles side-by-side, so that if one is covered, the others can still be seen.



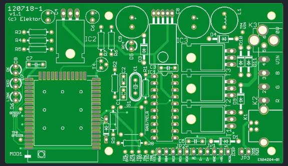
Sensor type

We used an ultrasonic sensor to demonstrate the product. However, if deployed at real crossings, it would be best to use an inductive loop. This is what is used in current traffic light car detection systems. It consists of a long wire embedded into the road, which detects a large metal object such as a car by generating a magnetic field.



Mass Production

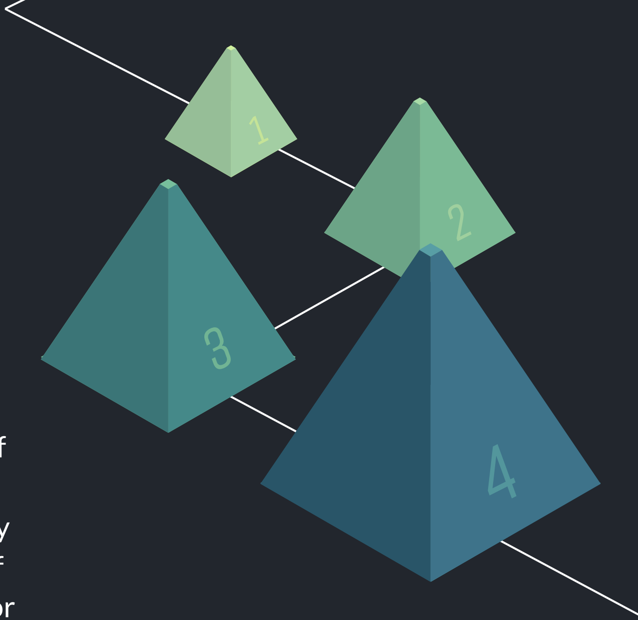
Our device contains an arduino, laptop and bluetooth speaker. If mass produced, the arduino and laptop would need to be replaced by a cheaper, more reliable PCB and microprocessor. The bluetooth speaker could be replaced by a cheaper standard speaker.



Future work

Iteration 1

IMPROVING TACK-TILES

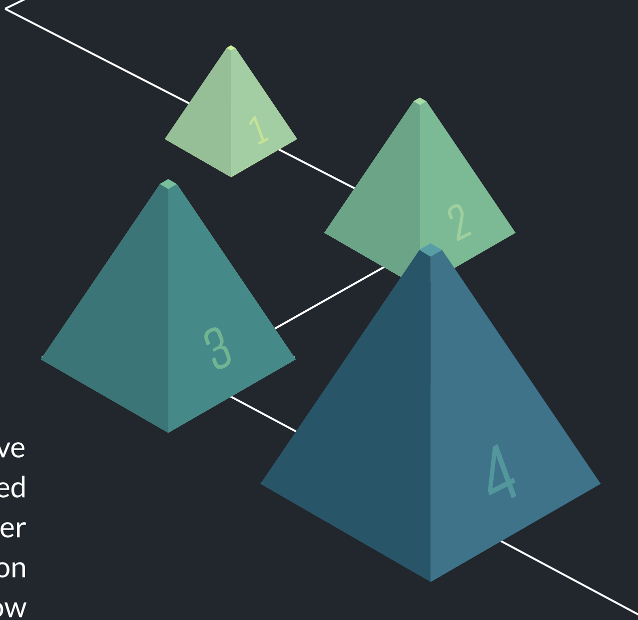


The next steps would see an iteration on haptic feedback that improve on the methods of communication. More concise vibrational feedback, would allow for the eventual goal of users instinctively understanding instructions at crosswalks without having to rely on audio. In circumstances where audio instructions may not be heard, users can still interpret messages communicated by Tack-Tiles.

Moreover, experimentation in the form of additions to haptic feedback could be conducted. Users may use this technology to position themselves in the least flow of pedestrian resistance along a crosswalk or become aware of the size of vehicle as they move into a crosswalk.

Iteration 2

EXPANDING TACK-TILES



The Tack-Tiles solution could conform to a range of other public areas with their on unique hazards. For example, Tack-Tiles could be used to showcase travel times along a platform, how many minutes a train is due to arrive or depart or where users should position themselves on a platform in relation to the doors on a train.

Further assistance in an effort to improve wayfinding among visually impaired individuals may also be applied to other forms of tactile paving. Haptic feedback on elongated style tiling (designed to show pathways) may provide additional information while on the go.

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Primary

Secondary

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