DROWSY DRIVER: KEEPING THE SHIFT WORKER AWAKE

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SHIFT WORK IN THE US

INTRODUCTION

1 in 5 people work shift work

15 million shift workers in the United States

Night Shift has the highest prevalence of sleep deprivation

3 million work night shifts
DROWSY DRIVING IN THE US

INTRODUCTION

60% of adults admit to drowsy driving

37% have fallen asleep when driving

71% of US workers drive to work everyday

60% of adults admit to drowsy driving

Drowsy driving = 1 million accidents / 500,000 injuries / 8,000 deaths per year
PROCESS MAP

RESEARCH PROCESS

START
Subject Selection

INFORM
Literature Review / Market Review

INTERVIEW / OBSERVATION
Semi-structured / Exploratory

DATA COLLECTION / ANALYSIS
AEIOU / Insight Cluster Matrix

PROBLEMS
Identified

REFINED RESEARCH
Focused

DESIGN CRITERIA
Establish

CONCEPT IDEATION
Problem Solving

DESIGN REFINEMENT
Refinement / Solution

LIGHT

CIRCADIAN RHYTHM

HEALTH + LIGHT

SLEEP

SHIFT WORKER

A activities
E environments
I interaction
O objects
U users

DROWSY DRIVING

SCHEDULE

MARKET REVIEW

COMP ANALYSIS / OPPORTUNITY MAP

NON INVASIVE

3D MODEL

PASSIVE VS ACTIVE

USER VALIDATION

TOUCH POINTS

USER FEEDBACK

3D RENDER

BACKGROUND RESEARCH

DATA COLLECTION

CONCEPT / REFINEMENT

SLEEPING
RESEARCH QUESTION

What are the effects light has on an individual with a misaligned circadian rhythm, and what can be done to help these issues?
TOPIC EXPLORATION

BACKGROUND RESEARCH

LIGHT → SHIFT WORK → DROWSY DRIVING
The spectrum of electromagnetic energy called radiation
Visible light is the spectrum that is visible to the human eye
Visible Light

Circadian Rhythm

Light Sources

Natural Sources

Artificial Sources
Sun light provides a specific wavelength of light - consisting of a balanced spectrum of color.

Humans have evolved to prefer this spectrum of light for optimal biological function.

Artificial light contains only a portion of the visible light spectrum.

It has been associated with an increase risk of disease.

Recently, artificial light has been able to capture the beneficial properties seen in natural light.
Work that takes place outside of the ‘traditional’ 9 am-5 pm daytime hours; includes evenings, nights, early mornings, alternating, rotating, and split shifts
Sleep Deprivation
Misaligned Circadian Rhythm
Disturbed Sleep / Wake Cycles
Poor Health / Disease
Drowsy Driving
WHO ARE SHIFT WORKERS?

LITERATURE REVIEW

Business
- Accountant
- Stockbroker
- Customer Service
- IT Support
- Corporate Jobs

Healthcare
- ER Physicians
- Overnight-Pharmacists
- Nurses

Leisure, Hospitality, Entertainment
- Bartenders
- Servers
- Chefs
- Casino Dealers
- Performers
- Radio DJs
- Concierges
- Doormen

Transportation, Production, Manufacturing
- Truck Drivers
- Pilots
- Flight Attendant
- Steel Workers
- Textile Workers
- Factory Workers

Protective Services
- Firefighters
- Dispatchers
- Police
- Security Guards
- Rescue

Wholesale, Retail
- Warehouse Worker
- Department Store
- Retail Store
The operation of a motor vehicle while being cognitively impaired by a lack of sleep, increasing the risk for accidents, injuries, and deaths.
One sleepless night can equate to driving drunk (blood alcohol level of .10%).

Shift workers are one of the most at risk groups due to their lack of sleep and inconsistent sleep on a regular basis.

Shift workers are also 10% more likely to drive tired than all other groups.

Drowsy Driving is not only a night time problem, daytime drowsy driving is also a major issue.

Not all accidents caused by drowsy driving are reported or accounted for.

Light, Sleep, Shift Work, and Drowsy Driving have a large impact on one another.
RESEARCH GOAL

Identify the behaviors and needs of a night shift worker to inform a design that will help them better manage a problem they encounter.
METHODS AND PARTICIPANTS

DATA COLLECTION METHODS

Participants: **10 shift workers** (5 Female, 5 Male) Ages 24 - 54
(Nurse Practitioner (NP) / Registered Nurse (RN) / Fireman / Police officer / Housekeeper / Truck Driver)

Years of Experience: **1 - 25 + years**

Shifts: 5 worked 12 hr. shifts / 2 worked 24 hr. shifts / 2 worked 8.5 hr. shifts

Work Schedule: 3 consistent / 3 irregular / 2 rotating / 1 alternating
SHIFT WORKER SCHEDULES

DATA COLLECTION PARTICIPANTS

Registered Nurse
- Day off: 12am-1am, 3pm-4am, 8pm-9pm
- First Day of Work: 1am-3am, 4pm-6pm, 7pm-9pm
- 2nd/3rd Day: 3am-4am, 6pm-8pm, 9pm-12am
- Last Day: 4am-6am, 6pm-9pm, 9pm-12am

Police Officer
- Day off: 12am-1am, 3pm-4am, 8pm-9pm
- First Day of Work: 1am-3am, 4pm-6pm, 7pm-9pm
- 2nd/3rd Day: 3am-4am, 6pm-8pm, 9pm-12am
- Last Day / First Day Off: 4am-6am, 6pm-9pm, 9pm-12am

Fire Fighter
- Day off before work: 12am-1am, 3pm-4am, 8pm-9pm
- First Day of Work: 1am-3am, 4pm-6pm, 7pm-9pm
- Day off: 3am-4am, 6pm-8pm, 9pm-12am
- 2nd Day of Work: 4am-6am, 6pm-9pm, 9pm-12am
- Day off: 6pm-8pm, 9pm-12am

Legend:
- Blue: Sleep
- Dark Grey: Work
- Orange: Commute
- Grey: General Activities
- Light Grey: Sleep / Work
INTERVIEW STATISTICS

DATA COLLECTION STATS

70% Stick to schedule
90% Tired commute
36 min commute
“I never had any formal teaching to educate me on how to best manage my schedule”

“I’ve literally held my eyes open with my hands before”

“I roll the window down or slap myself in the face if I’m close to sleeping”

“I don’t want to pull over to rest, I just want to get to where I am going”
“I don’t have a problem with my sleeping schedule, but I still get tired driving home from work in the early morning.”

“We see a lot of accidents due to drowsy driving.”

“Your mind will play tricks on you making you think you can make it.”
“I have my schedule all worked out in my head, but I only follow it half the time”

“It can be almost scary to drive home from work”

“It depends on how well I stick to my schedule on whether I get sleepy on the drive home”

“Rolling windows down, loud music...they just don’t work”
“I call someone on the phone every day to stay awake on the way home”

“I’ve literally held my eyes open with my hands before”

“I fall asleep driving home after work, half the time I don’t know how I made it home”

“I would put my car in park at the stop light I was so tired”
KEY INSIGHTS
Light is not an issue with many shift workers - they receive plenty of natural light (maybe not at right time but plenty)
No sleep hygiene education for shift workers
Shift workers’ schedules change almost every day making it difficult to follow schedule and manage time

MAJOR PROBLEM AREAS
Sleep - waking up / falling asleep / tiredness during and after work
Schedule - sticking to schedule / time outside of work
Driving - drowsy driving / falling asleep / driving after long wake cycles
AEIOU Analysis - Environments of shift workers

AEIOU

A  activities
E  environments  Home, Work, Public, Car / Commute
I  interaction
O  objects
U  users
Opportunity

Within the environments that a shift worker interacts with the driving commute is often overlooked, but can potentially be very dangerous.
REFINED MARKET REVIEW

CIRCADIAN RHYTHM / SLEEP

HOME
- Beddit
- Aura
- Lifi
- Glo-to Sleep Mask
- EasyWake
- Phillips Alarm
- Sleep Cycle App
- Re-timer glasses
- Delight Hugable

WORK
- Fukasawa sky desk
- Hue

PUBLIC SPACE
- Valkee
- Ostrich Pillow
- Circadian Rhythm Watch
- Vigo
- Lark

COMMUTE
- Ford's Driver Alert
- Mercedes Driver Assist
- Nap Zap
- Drive Awake App

SCHEDULING / LIGHTING / WORK PROGRAMS

OPPORTUNITY

Sources: Philips wake up light, Delight hugable pillow, Light Pillow, Glo Pillow, Ostrich pillow, Naoto Fukasawa - sky desk, Sleepcycle app
DESIGN CONCEPT
DROWSY DRIVER DETECTION AND ALERT SYSTEM
Incorporate user’s schedule

User’s schedules and sleep/wake cycles are important to determine the likelihood of sleep.

Detects drowsiness of driver

Physical Test + Performance Test + Prior State (eye detection + steering detection + schedule)

Alert drivers when fatigued

Gradually increasing warnings / alerts at contact points to alert but not interfere: seat, belt, rear-view mirror, steering wheel
**DESIGN CRITERIA**

**DROWSY DRIVER DETECTION AND ALERT SYSTEM**

- System should **work in background**
- Not requiring the driver to do anything extra)
- **Starts automatically** when you get in car
- **Comfortable** - like it's not even there

- Incorporate **schedule / sleep wake cycle**
- **Non-invasive** detection sleep/wake cycle
- **Keep driver awake** until impossible
- **Progressive Warnings** to continually alert drowsy driver

- **Don't compete** with imbeded technology
- **Compatible** with many vehicles
- Easily switch between vehicles
- **Easy Installation** - with any vehicle

**EASY TO USE**

**FEEDBACK**

**FIT AFTER MARKET**
FATIGUE DETECTION DEVICE BRAINSTORM

% OPPORTUNITY MAP / COMPETITIVE LANDSCAPE

frequent eye blinking  yawning repeatedly
drifting from lane  restless
less eye movement  rubbing eyes
irritable  difficulty focusing
slow response time  daydreaming
trouble remembering
heavy eyelids
tailgating  swerving
trouble keeping head up
hitting the shoulder

detect device
in car

go pro
gps
facial recognition
infrared led
compact camera

x box kinect
ALERT DEVICE BRAINSTORM

DESIGN CONCEPT

temperature  switching tasks  exercise
sound  food / snacks  conversation
Light  nap  slapping face
laughing  air movement
vibration  holding eyes open

cold beverages  turning music up

holding head out window  good sleep hygiene

rolling windows down
DISCOVERY OF CONTACT POINTS WITHIN A CAR

DESIGN CONCEPT
STORY BOARD CONCEPT

DESIGN CONCEPT

1. Tired Driver Gets Into Car

2. Driver Fastens Seatbelt System is Activated and Detects Users Recent Activity - Submarine Cycles, Submerge Via Smart Phone

3. As Driver Begins to Drive Car, Introducing Lifesaver Safety: "Look For Someone Or Anything (Non-Driving, Non Belt, Non Wing Mirror)

4. Mental Stimulation Sensors - The Driver is Not Intuitive

5. System Activates a Sign of Warning: Seat Belt Warning & First Word of Reminder: "Multiple Turns, Please Follow Turn"

6. Light Shines in Face of Driver, Mode/Value Will Play to Alert Driver, Commands From Rear View Mirror

7. At Last Stage, or Final Mode, Driver is Forced to Talk of a Virtual Passenger, "These Real Persons on Phone, These Real Steps, Are Given to Driver, If That is Best Decision"

8. Driver Arrives at Home & Rest Time Simply
DETECT AND ALERT CONCEPTS

CONCEPT IDEATION

[Sketches and diagrams of various concepts related to detecting and alerting in vehicles.]

- Concept 1:
  - Enables voice input and position.
  - Examinations position on database.
  - Range line detection.
  - Users away from seat/airbag.

- Concept 2:
  - Range level indicating.
  - Audio and visual feedback.
  - Integrated gear shift.
USER FEEDBACK AND VALIDATION

DESIGN REFINEMENT
FINAL SOLUTION

SCHEDULE / DETECT / ALERT

APP + DETECT DEVICE in car + ALERT DEVICE in car
SCHEDULE / FEEDBACK APP

SMART PHONE APP

compares activity and schedule

schedule input

syncs with other devices

daily schedule

driving feedback

sleep / wake cycles

alerts to fatigue
DETECTION SYSTEM

CAMERA + IR LED

- wide angle compact camera
- infrared LED sensors
- power cord connection
- blue-tooth connection
- quick lock
- suction cup base
- mode / light button
- locator light
- photo luminescent
- speaker system
ALERT SYSTEM

SEAT BELT DEVICE

- Fabric covered
- Coin vibration motors
- Ultra thin design
- Remote powered
- Velcro
- Flexible sections
- Blue-tooth antenna + module
STEPS TO SET UP

1. INSTALL CAMERA / ALIGN FOR BEST VIEW OF DRIVER
2. INSTALL SEAT BELT ADJUST FOR FIT
3. INPUT SCHEDULE AND INFO INTO SMART PHONE APP
STEPS FOR USE

MIRROR CONCEPT

1. BUCKLE SEAT BELT
   SCHEDULE SYNCED

2. DRIVE AS NORMAL. WHEN SIGNS OF FATIGUE
   ARE DETECTED SYSTEM BEGINS TO ALERT

3. DRIVER IS CALLED ON PHONE AND
   DIRECTED TO SAFE AREA TO REST
**ALERT STEPS**

**MIRROR CONCEPT**

1. Light on camera glows (changes each level)
2. Flashing light + light vibration on seat belt
3. Flashing light + stronger vibration + alarm sound
4. Flashing light + pulse vibration + light audio alarm
5. Increase vibration intensity + response time questions
6. Increase vibration intensity + virtual passenger conversation
7. Strong vibration + virtual passenger
8. Intense vibration + virtual passenger
9. Intense vibration + phone call made to known contact
10. Call is made to driver and directed to pull over to safe rest area
INFRARED LED

DETECTING EYE / HEAD MOVEMENT
EYE AND HEAD DETECTION

DETECTING EYE / HEAD MOVEMENT
DETECTING FATIGUE

VIEW OF CAMERA LOOKING AT DRIVER
DETECTING FATIGUE

VIEW OF CAMERA LOOKING AT DRIVER
Value Proposition

A system that combines the user's daily schedule with early signs of fatigue to detect drowsiness and respond with a set of alerts in order to keep drivers awake for trips that they wouldn't normally pull over for. This will keeping drivers awake and alert on the roads as well as decreasing distracted driving such as texting or eating while driving.