Our team devised a system for cars that would improve driver safety. The car would detect when the driver starts to fall asleep while driving and take steps to wake them up. It would then communicate the car’s position and direct them to the nearest rest station to prevent an accident.
A. Definition of Needs and Requirements

Many aspects of life require a more improved connection between the user and the interface. These technological advances are needed primarily in the home, the car, and also wearable devices that better equip the user for everyday life. Technology in the home can provide a safer living environment through security and ease of use in everyday life. In the car, technology can allow better efficiency, safer driving, and the ability to multitask while maintaining secure driving habits. Also, wearable devices can allow you to live a healthier lifestyle, tend to your needs, and provide convenience in difficult tasks. Humans greatly benefit from real time connections within their environment as data and information are processed and tasks can be accomplished without a need for physical interaction.

Primarily, in the home, connectivity can be beneficial in a variety of ways. One focus of the connected home is aiding the elderly and disabled. There is a need for this due because currently many elderly and disabled people require assistance to live in a home but with connective technology they will be able to live on their own. This could solve many issues, such as when an elderly person falls and requires assistance but cannot reach a phone to call for help. This would improve safety within the home and allow an improved living environment for the parties involved. Technology and the elderly have a stereotype of not mixing well, however, so there have not been many technological advances made on in this area yet. This technology will need to be incredibly user-friendly and malfunction-free in order to be effective. Furthermore, systems integration throughout the house can improve convenience and efficiency. For example, a “smart house” would be able to turn the lights on and off, adjust the heat, etc. from your phone. Or you can have a “Siri” in the house that can respond to commands such as “preheat the oven” or “warm up the Jacuzzi”. This implementation will allow greater convenience in the house and provide the user with more time to accomplish other tasks.

Within a vehicle connectivity can save many lives by sending alerts if it detects that you are unfit to drive. Vehicles can also allow multitasking and a smart car with haptics can send alerts without being distracting to the driver. For driving drowsy, 60% of adult drivers have admitted to driving while tired and over 1/3 of adults (103,000,000) have admitted to falling asleep at the wheel. 100,000 car accidents are reported to be caused by fatigued driving every year. With connective advances, lives could be saved as cars can sense when you are driving poorly and send an impulse, either visually, audibly, or through touch, to alert you. Car manufacturers have also been developing technology to alert drivers when there is a vehicle in their blind spots so they can avoid an accident if they are distracted.

Lastly, wearable connective technologies can be incredibly useful in a broad array of industries and activities. We will be looking into predominantly sports/fitness related technologies. For example, a chip can be placed in the sole of a soccer boot that will record data, such as distance traveled, speed, force of the kick, etc. This data can be compiled to improve skills and make athletes play better. Also, this technology can be put into helmets of football players to detect impacts that are strong enough to cause concussions. This is necessary as concussions are a growing epidemic. A professional football player is projected to receive 900-1500 blows to the head over a season. There is a 75% chance for players to receive a concussion
during football. Another issue that can be solved by wearable technologies is extreme temperatures which can pose a threat to people living in environments prone to intense cold or heat. In 6 months, 40 workers passed away in Qatar from working in extreme heat. There are also many deaths due to hypothermia each year (See Sources for Chart). Devices are currently being designed that can create temperature regulated clothing, such as a coolant for workers in extreme heat in Qatar, or heated suits for those working in extreme cold that will respond accordingly to the drastic shifts in temperature. This technology can also be improved and used in space travel, as there is a broad array of temperatures that an astronaut will face as they travel outside of Earth’s atmosphere.

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B. Detailed Description of Competing Alternative Conceptual Options

Our team focused mainly on the safety aspects of inventions for the car. Below is the initial thought process of our team as we began narrowing down our decisions by using specific areas of focus for technology in vehicles.

**Vehicle Alerts:** The main focus of vehicle alerts currently is combatting the issue of driving while drowsy. Volvo, the ring-leader of driving safety, has been spending a lot of time coming up with a solution to the issue of falling asleep while driving. The car pays attention to factors such as position within the lane, time of day, and how long you’ve been driving. If the car notices you drifting between lanes without signaling, it will alert you, through audible, visual, or haptic alerts. To further improve this technology the car can use a smart camera to view your facial features, such as relaxed facial muscles, frequency of blinking, and longevity of blinks. This will allow the car to determine whether or not you are cognitive and whether it should wake you up with a sudden vibration, noise, or visual alert so you can pull over and rest.

**Haptics:** Many cutting-edge cars are implementing the use of haptics into the center console to provide ease of use and safety within the car. For example, the Lexus Remote Touch and Opel Touchpad are haptic surfaces that can react to your touch, much like a mouse does on a laptop. This surface will be used to adjust essential car controls, such as temperature, navigation, and entertainment. These touchpads will vibrate when the cursor is over an icon for a program which allows the driver to control the panel with minimal distraction. Though this technology will be advantageous by allowing the driver to achieve and accomplish more while driving it may cause safety hazards or ethical issues. The haptic technology itself makes using the central console safer since the vibration will require less visual interaction but the draw to the technology may cause users to more frequently tinker with the console. This would make the driver more distracted overall. Furthermore, the level of technology going into the car will provide less of a social environment for families and friends.

**Cognitive Overload:** Cognitive overload is an overload related to the executive control of working, short-term memory. For example, in a workplace workers can suffer from cognitive overload through; increased quantity of the decisions the workers must make, increased frequency of interruption, and increased need for time management in everyday activities. Because of all of these factors workers experience more anxiety and their work suffers. Some concerns are that too much information will be supplied, too much information, the need to deal with multitasking and interruption, and inadequate workplace infrastructure to help reduce metacognition, or the awareness and understanding of one’s own thought process. As technology increases, the amount of information increases, which causes workers to become overwhelmed. A solution to this issue is representation of the data and information. Also, a sort of filter mechanism, such as an algorithm that will weed out unnecessary information pertaining the user. This mechanism will be able to learn who you are,
and what your interests are as a way to better serve you.

**Distracted While Driving (DWD):** Distracted while driving is any activity that could divert a person’s attention away from the primary task of driving. Common types of distractions are texting, using cell/smart phones, eating/drinking, talking to passengers, grooming, reading (including maps), watching a video, and adjusting the radio/MP3 player/CD player. The U.S. department of transportation is leading the effort to stop texting and cell phone use behind the wheel. In 2012, 3,328 people were killed from distracted driving. One possible solution would be a ‘phone detector’ inside the car. The device would force the driver to place his or her phone in a special place and lock this place in order to start the engine of the car. Another solution would be a ‘signal preventer’. This device would automatically disallow cell phones in the car by blocking signals from traveling into and out of the car.

**Multitasking:** In recent years multitasking while driving has become a large issue in the United States. Many people attempt to talk on their cell phones, scold fussy children in the back seat, eat and drink, and apply makeup while operating a vehicle on the road. It has been proven that these actions are incredibly dangerous for both the driver and others around them. Close to 80 percent of car accidents are the result of inattention within three seconds of the accident. This surprising statistic makes it quite obvious that multitasking in a moving vehicle needs to be minimized at all costs. In this situation, it would be best to focus on creating cars that drive themselves or require minimal attention from the driver. This way the driver can multitask without having an increased risk of crashing.

**Situational Awareness:** It has become evident that many drivers do not always pay attention to their surroundings while they are operating a vehicle. This limited awareness can be a result of different issues, such as sleeping while driving and drinking and driving. These are two major issues that should be prevented as much as possible. About 100,000 car accidents that are reported each year are the result of sleeping at the wheel. These accidents could be prevented with new installments in a car. We feel that there should be some sort of “sleep detection system” in vehicles that would alert the driver when they begin to doze off. Though there have been several products geared towards combatting this issue we feel that the car sensing that it is drifting into the wrong lane is not enough. Cars should also contain a heart rate monitor in the steering wheel that can sense the slowing pulse of a sleepy driver so that an alarm can sound and the seat will vibrate, which would cause the driver to wake up and pull over. Deaths due to drunk driving cause about 30% of fatalities in vehicle crashes. Precious lives can be saved with some adjustments made to vehicles in order to prevent driving while intoxicated. An advancement in vehicles that hopes to prevent these statistics would be installing a Breathalyzer that would only allow the car to start if the driver’s blood alcohol concentration is at a safe level. If the driver’s blood alcohol concentration is too high, the car will automatically contact a nearby taxi service or other safe transportation system.

Other issues related to situational awareness would include drivers that do not pay attention to other cars in surrounding lanes, namely the vehicles in the car’s blind spot. Since this problem can prove to be dangerous, all cars should contain a blind spot sensor so that if a
vehicle attempted to switch lanes where another vehicle is driving, they would be alerted before they could switch lanes and potentially cause an unwanted accident.

**Security Assessment:** In 2012 over 700,000 cars were stolen. In addition the National Insurance Crime Bureau found that 40% of people do not secure their valuables when they exit their car and almost half of them don’t always park in a well-lit area. There have also been cases of criminals hiding in the back seat of a car. When the driver enters the car a gun is put to their head and they are given orders to drive to a specific location. To combat these dangers a comprehensive vehicle security system is needed. One idea would be to establish a system of sensors in the car that can be programmed to send text message alerts to the owner. Examples of such security features would be an automatic text message if the car detects forced entry or if someone attempted to open the hood to steal the battery or other parts from the car. In addition the car could have a series of cameras that would take pictures of the outside to show the crime in progress. This would provide the owner with a record of the attempt and could be given to law enforcement to help determine the perpetrators of various crime sprees such as the string of car jacking’s in Newark, New Jersey last year. These safety measures could also be extended to location services alerts. The car would send a message through cell towers that indicates its location which could be used by the police to trace the whereabouts of the car after it has been stolen. It should be noted, however, that while these measures could go a long way towards curbing the number of car thefts and kidnappings they could pose some issues. For example the camera system could be hacked and used to spy on the owners of the cars. This would create an immense violation of privacy and would have to be closely monitored.

**Driver Safety:** In 2010 there were over 10,000 fatalities due to drunk driving and numerous other injuries. While numerous campaigns have been started to curb driving under the influence it still remains an enormous problem in society that needs to be corrected. One of the easiest ways to fix this would be to install mandatory Breathalyzers in cars. The driver would be required to breathe into one to unlock the ignition for the car so they do not drive while drunk. If the test is failed a call system could then be used to send a message to a friend or taxi service to provide an alternative method of getting the driver home. Another method of ensuring driver safety would be to install GPSs in cars that would automatically transmit the location of the car in the event of a crash. This would allow emergency services to respond immediately to a crash even if the driver is incapacitated and unable to call the police.

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Diagrams:
Driver Safety System

- Breathalyzer
- Gasoline
- Key
- Ignition
- Car Engine
- Driving
- Accelerometer
- Crash Sensor
- GPS
- Location Data
- Emergency Services Alert System
  - Calls for help and transmits location in the event of a crash.

Car Security System

- Ignition Lock
- Sensor System
- Cameras
- Audio
  - Door
  - Hood/Trunk
- Forced Entry
  - Detected
  - Pictures/Video
- User's Phone
  - Text Message Alerts
  - Police Station to Report a Crime

Autopilot

- Steep Brake Pedal
- Bad Road Conditions
- Motion Sensors
- Other Vehicles
- Central Computer Unit
- Location Determination
- Voice Command
- GPS System
- Speed
  - Voice Command
  - Throttle
  - Engine
  - Car
  - Speedometer
- Voice Command
C. Concept Options Analysis/Selection and Combination

Human Needs:

- 1. Security Systems:
  - This invention earned a 4 due to the need for safety and security of expensive possessions. This is an efficient way to keep your car and possessions safe as well as safeguarding yourself.

- 2. Sleep Detector
  - We rated this invention as a 4 because of the need for safety from the skyrocketing number of sleep-related accidents. A good way to prevent injuries and death as well as financial issues.

- 3. Cognitive Overload
  - This system earned a 4. It provides humans with data pertaining to their everyday lives, while saving them time and money.

- 4. Center Console
  - Given a 4 because it allows the driver to focus more on driving while interacting with other features.

Technology:

- 1. Security Systems:
  - Rated a 3; we felt that this invention has a lot of potential, but the camera aspects and security systems are still a bit ahead of the time.

- 2. Sleep Detector
  - We gave this invention a 4; the technology is currently present, but it will take some time to bring all the aspects together into one functional system.

- 3. Cognitive Overload
  - This invention earned a 1. Even though it is an innovative design, the technology is not currently present.

- 4. Center Console
  - This system was given a 4. The technology required to construct it is present today, but it will take time to turn it into a unified system.

Standards:

- 1. Security Systems:
  - Rated a 5; this system complies with present laws. Citizens have the right to protect their property

- 2. Sleep Detector
  - Rated a 5; this invention is primarily for one’s own safety. It is not breaking any laws.

- 3. Cognitive Overload
• This system was given a 5 because it is just processing personal information; no laws are broken.

4. Center Console
• This invention was given a 4 because even though it will be a safe system, there is always the risk that multitasking while driving has inherent dangers.

Economic Viability:

1. Security Systems:
• This invention was given a 3. It would probably be quite expensive, but those in the upper middle class would be able to afford it.

2. Sleep Detector
• Rated a 3; this idea would be expensive to implement, but those in upper middle class status would still be able to afford it.

3. Cognitive Overload
• This invention was rated a 1.5 because it is highly unaffordable at this point in time. Its aspects are a bit futuristic.

4. Center Console
• This invention was given a 3; it is an expensive invention, but upper middle class people could afford it.

Ethical Issues:

1. Security Systems:
• This system was given a 2. Even though it is a primarily safe machine, someone can manipulate the cameras to spy on others.

2. Sleep Detector
• Rated a 3.5. This invention is overall a safe system, but it does record some personal data when detecting the driver’s facial expressions and recording locations and driving schedule on the GPS.

3. Cognitive Overload
• Rated a 3. This system can be hacked by outside users and can be used to infiltrate personal information between competing business, enemies, etc.

4. Center Console
• This system was rated a 3 because it presents the unethical idea of driving while distracted.
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Part D: Detailed Description of the Selected Final Concept Proposal

“Smart Camera”, Location Tracking System, and CPU

Vibration Component

Motion Sensor

Heart Rate Monitor

Motion Sensor

Vibration Component

“Smart Camera”

CPU

Location Services

Vibration Component
**Smart Camera:** A “robotic eye” mounted into the dashboard. This camera will view the face of the driver as it searches for signs of driving while drowsy, such as frequent blinking, long periods with closed eyes, or slack muscles in the jaw.

**Heart Rate Sensor:** A sensor that will be installed within the steering wheel. When the driver’s hands are in contact with the wheel (which it should be most of the time), the sensor will take in data, which it will continually process to look for a decline in heart rate, which denotes drowsiness.

**Motion Sensor:** The sensors are installed on both sides of the front bumper. Contains a camera that will view markings on the road to detect swerving/irregular driving. An accelerometer will also be part of the sensor to notice quick and “jerky” driving, which is associated with drowsy driving.

**Vibration Component:** This component will be housed within the driver’s seat of the vehicle. Whenever the system compiles evidence that the driver is falling asleep, a signal will be sent from the CPU to the driver’s seat to cause it to vibrate and wake the driver.

**Location Services:** Whenever there is enough evidence to show that the driver is sleepy, a signal will be sent from the to the nearest cell tower that will use triangulation to determine the driver’s location. From this, the cell provider’s database will alert the driver of a nearby safe location to pull over and rest.

**CPU:** The Central Processing Unit is the brain of the system. Within this device, the interface will be able to compile and store the data collected by the three different sensors. The CPU will be able to view past driving habits to notice differences, and it will also take into account time of day, length of drive, and prior driving history to know if you may be more tired than normal. Here, the system will be able to conclude whether or not you are too drowsy to drive. If the system does conclude this, it will send signals to the alert system to wake you up and find you a safe place to rest. This alert systems entails a vibration in the chair, light on the dashboard, a noise coming from the GPS, as well as directions of where to go to exit the road and take a rest.
**Concept of Operations:**

**Drowsy Driving Alert System**

**Where:**
The system will be housed within a car, which can be found in nearly any location that has roadways.

**When:**
- Heart Rate sensor, Robotic Eye, and Road Sensor will gather baseline readings.
- All sensors will continue functioning as they search for changes in data.
- When data comes through that suggests drowsy driving, an alert system will wake you up with a vibration in the chair along with a noise and light from the dashboard.

**What:**
Known Elements: Heart Rate Sensor, Camera, Road Sensor, Central Processing Unit, GPS alert systems within car, WIFI, phone signal.

Capabilities: The Heart Rate sensor, Camera, and Road Sensor will be able to detect driving/physical habits that are on par with drowsy driving. This data will be processed by the central computer, which will take into account driving/user conditions. From here, the car will take measures to wake up the driver (vibration, light, sound) and recommend a location to sleep.

**Why:**
The system will provide AT&T with a stronghold in the automotive market. It is an opportunity for AT&T to use their networking to improve driving safety.

**Who:**
Designers and constructors of the system, those who will be using the system, and first responders who will see less accidents caused by drowsy driving.

**How:**
Resources: Money, AT&T Network, CPU, Cameras, Motion Sensors, Heart Rate Sensors, Alert systems.
Our proposed system, The Automotive Sleep Detector, was originally thought up of as a way to combat the issue of driving while drowsy, over-tired, or sleeping. Driving while drowsy is a very dangerous and prevalent problem facing society. 60% of adults have admitted to driving while drowsy, and there are 100,000 car accidents a year caused by sleeping while driving (Drowsydriving.org). Therefore, Team 4, along with AT&T’s resources have thought of, designed, and proposed a solution to this dangerous issue.

In regards to AT&T’s project, we decided to focus mainly on the communication between different technological machines (M2M). The Automotive Sleep Detector runs solely on Machine to Machine interaction, unlike many products which require the user to be involved in the functioning of the system. We felt that a lot of current advances in technology would not be possible without use of many different interfaces, so we wanted to think of a way to help people without them being extremely involved in the process. These devices will then work together to make one unified and user-friendly result with much more convenience.

The solution involves a series of detectors that interface with a CPU that can determine whether or not the driver is unfit to drive. If the CPU happens to determine this, it will send wired signals to alert mechanisms to different components of the car in order to wake you up, inform you that you are unfit to drive, and determine a course of action for you to pull over into a safe area to rest.

The detectors, as outlined above, consist of two motion sensors/cameras mounted on the bottom of each side of the front bumper; a camera on the dashboard that views your face and eyes, to search for signs of sleeping; and a heart-rate monitor in the steering wheel that will measure and record the driver’s heart rate throughout a trip to notice for any significant drops in beats per minute that would parallel sleeping. All of these detectors act solely to record data. This data is then processed through wired connections that lead to the CPU housed within the center console.

The CPU is the mainframe of the system. It acts as the brain, where it processes data, determining what is important to notice and what is consistent with prior trips. If the CPU finds irregularities that seem to suggest the driver is not conscious, or not alert enough to drive, it will take measures to confront this issue. The CPU will send wired signals to the alert the seat to vibrate and also for an alarm to sound (as outlined above), as well as a signal over a wireless carrier to a cell tower which will use triangulation to determine your current location and also the nearest rest stop. The driver will then be alerted to pull over safety via this “location system.”

Overall, as a system, the Automotive Sleep Detector will be able to collect data, process the data, and determine irregularities in the data collected that suggest the driver is unfit to operate. From this, the mechanism will take steps to lead the driver to safety, as it alerts, and directs him/her to a safe area to rest. We hope that this idea, along with the resources AT&T
can provide will help make the roads a safer place where drivers and pedestrians alike will not have to worry about operators falling asleep at the wheel.