

## Element D: Design concept generation, analysis, and selection

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*Our team decided to brainstorm at least 30 possible solutions for our problem statement. We choose 30 to get a large number, and go beyond the obvious solutions. Therefore, by using 30, we stretched our brainstorming abilities. At first we had a very narrow mindset about how to fix our problem by simply using an OBDII reader and affixing the device to different spots in the car. We concluded that these solutions were not creative and did not effectively fix the problem because our initial solutions were too simple and used already invented technology. Next, we focused more on computer related solutions that used technology effectively, yet had a good presentation in the car itself. A lot of our creative and original ideas came from ideas that were initially unreasonable. After we discussed these crazy ideas more, we were able to use similar concepts to spark new plausible ideas. Some of these crazy ideas included a self-fixing car, and a screen projection on the front windshield of a car.*

*After these wild ideas, we focused on using the same concepts from these ideas to make them feasible. The result was a list of creative and unique ideas. However, by the end of 30 ideas, we began to exhaust the list of possible solutions.*

#### Our 30 ideas include:

1. OBDII reader connects to onboard computer while car is running
2. OBDII reader connects to onboard computer and then displayed on dash cowl
3. OBDII reader connects to onboard computer and implemented in dashboard to present the code for the driver to see with more ease
4. OBDII reader connects to onboard computer and store in glove box when needed
5. OBDII reader connects to onboard computer and store on roof cowl area
6. OBDII reader connects to onboard computer with a wireless connection (Bluetooth) with a code displayed within the roof cowl
7. OBDII reader connects to onboard computer and store reader in center counsel
8. Using OnStar in car to provide alert and problem to driver when problem arises
9. Using Bluetooth OBDII reader, information is sent to drivers phone
10. Connect onboard computer to radio, using a radio frequency in the OBDII reader, and have it sent to a non-used radio station for information to be voiced
11. Create simplistic software to read car diagnostic from onboard computer
12. Connect a screen display in the steering wheel to show car diagnostic
13. Connect a printing system, like a receipt, and have print out in the glove box for drivers
14. Turn car ignition three times having a sequence of flashes for a certain code
15. Connect a digital display of car diagnostic in rearview mirror
16. Connect a digital screen to display car diagnostic inside of driver car visor
17. Connect onboard computer to steering wheel which has lights around the edges that remain unlit until check engine light goes off, displaying code within the side of the steering wheel
18. Create a list of codes in owner manual in all the manufactured cars, then must display code within the check engine light
19. Design a program that uses code from check engine light to list the possible system failures where every solution has a list of what the owner needs and how to fix it
20. Use multiple check engine lights representing a different code displayed throughout the dashboard
21. Projection of a certain code of the diagnostic problem on the bottom of the windshield
22. When you purchase a car you immediately sign up with retail stores or mechanic shops in which the cars diagnostic information when light comes on, transfers to stores, and they compete for price for your business
23. Within the onboard computer, create a system that determines if code is critical where car will have check engine light ding
24. Have ignition being a USB port so that a car may be turned by on by the data stored on said USB along with car system failures that update every time you put the USB into the ignition
25. When check engine light goes on the steering wheel will vibrate (more intense means more critical of a problem).
26. Have a string of LED lights on top of windshield that represent a certain code for car diagnostic
27. Tire pressure – the pressure decreases slightly, lowering the car until the problem is resolved
28. Car check engine light connects to phone and sends text with code and addition info
29. Drop down TV in front ceiling that shows code, possible failures and solutions
30. When check engine light goes on – car can't go above 30 mph

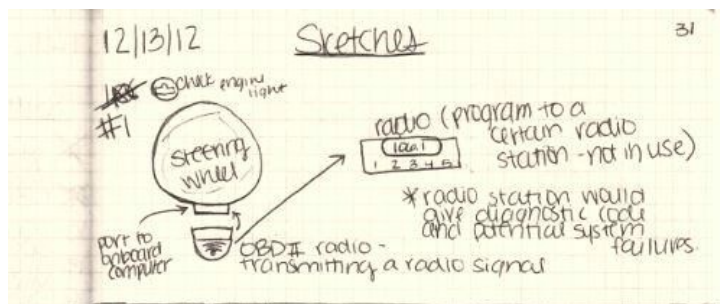
*Our next step was to evaluate our ideas and narrow down our solutions. Eventually after reviewing our solutions and talking with our experts (Mr. Allan Malecki and Mr. Thomas Kennedy Sr.), we narrowed our list to five main solutions. We eliminated other solutions by using our design specifications. The most important*

design specifications we focused on were the universal (using the OBDII system), safety, and accessible materials and technology. Essentially, we eliminated solutions for being unsafe, not have enough technology to be effective, too distracting, and not enough relevance. Therefore, we eliminated #1-7 for being too simple and not effective. We eliminated #8, 9, and 28 for not being universal for these solutions require certain devices such as Bluetooth and OnStar. For safety concerns, we eliminated #12, 13, 25, 27, 29, and 30. We eliminated #14, 17, 18, 20, 21, and 26 for not effectively addressing our problem statement by not giving information beyond a selection of lights. Lastly, we eliminated #11, 19, and 24, for not being feasible due to not having access to the materials to create a software and changing the key for every car ever made.

## Our top five solutions are:

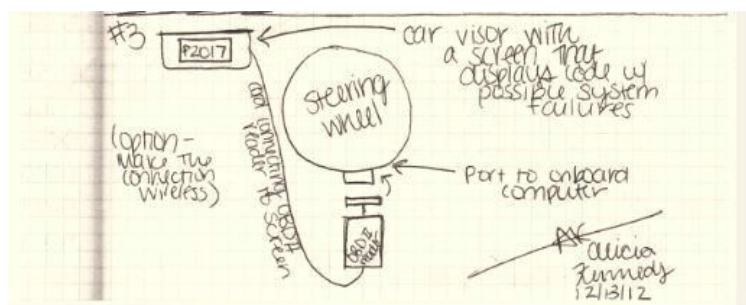
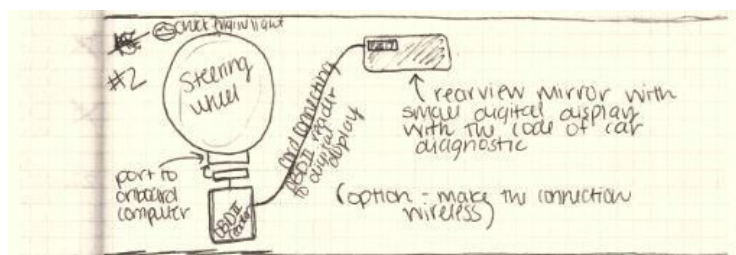
1. Connect onboard computer to radio, using a radio frequency in the OBDII reader, and have it sent to a non-used radio station for information to be voiced
2. Connect a digital display of car diagnostic in rearview mirror
3. Connect a digital screen to display car diagnostic inside of driver car visor
4. When you purchase a car you immediately sign up with retail stores or mechanic shops in which the car's diagnostic information when light comes on gets transferred to stores, and they compete for price for your business
5. Within the onboard computer, create a system that determines if code is critical. If it is critical the check engine light ding

## Sketches of our top five solutions from our engineering notebooks:



With these top five ideas, we made our first decision matrix. Based on our research and our expert opinions, we limited our ideas down to our top three. In the decision matrix process, we rated the five ideas according to our design specifications. Each idea was rated 0-5 (0 as the worst, and 5 as the best) for each design specification. We choose 0-5 so that we can be specific and have certain reason for each number that we give. Some of the design specifications, we limited to only a 0, 3, or 5 so that we were even more specific because numbers such as 1, 2, and 4 were too vague. The design specifications were rated accordingly:

1. Safety
  - 5: No distractions to the driver.
  - 4: 1-2 possible distractions to the driver.
  - 3: 3-4 possible distractions to the driver.
  - 2: 5-6 possible distractions to the driver.
  - 1: 7-8 possible distractions to the driver.
  - >9 possible distractions to the driver.
2. Inexpensive
  - 5: \$25-50
  - 4: \$50-75
  - 3: \$75-100
  - 2: \$100-125
  - 1: \$125-150
  - 0: >\$50
3. Accessible Materials and Technology

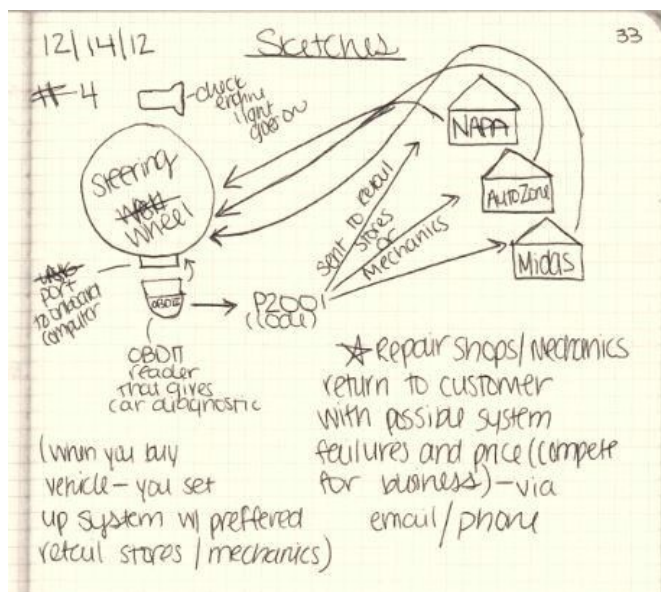


- 5: Easily materials/technology found, some parts needed for assembly
  - 3: A lot of extra work required (extra building/programming)
  - 0: no access to materials (impossible to find/build)
4. Universal
    - 5: Uses the OBDII system entirely.
    - 3: Uses basic OBDII system (not the entire system)
    - 0: Does not use the OBDII system
  5. Updatable
    - 5: Product updates on its own using wireless
    - 3: Updating requires a cost and/or the assistance of a store/mechanic
    - 0: Buy new product to update, or no update required (buy new product for latest design)

## First Decision Matrix:

After the first decision matrix, we concluded that our top three ideas were: Display in Rearview Mirror, Repair Shops/Mechanics, and Critical vs. Noncritical. To get more feedback, we took these three ideas back to our stake holders.

We conducted several interviews of teachers at Saint Thomas More to get their feedback on our top three designs. We got a range of ages and car maintenance experience to get a variety of ideas.



## Interviews getting feedback on top three designs:

Ms. [name redacted]<sup>[11]</sup> (Guidance Counselor, [school name redacted])

- She told us that she thought the least safe idea was the Repair Shops/Mechanics.
- She thought our other two ideas were equally safe.
- Willing to pay \$500 for product.

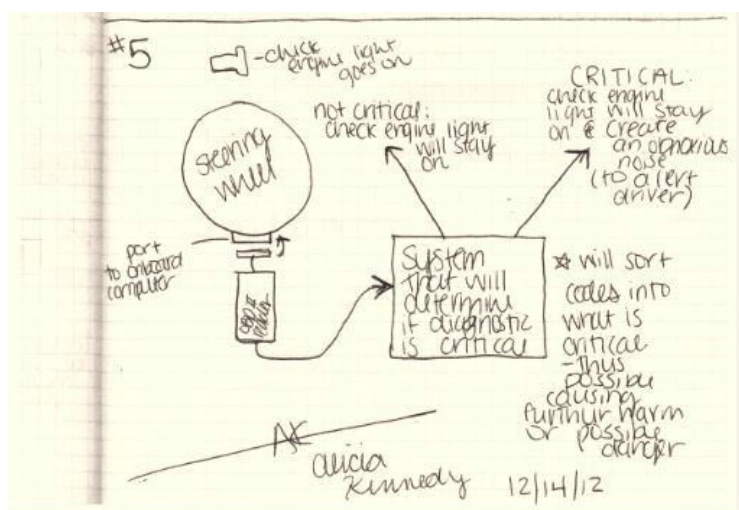
Mr. [name redacted]<sup>[12]</sup> (Campus Minister, [school name redacted])

- His personal favorite was the Critical vs. Noncritical lights.
- He believed that the Critical vs. Noncritical was the safest.
- Would not spend more than \$50.
- The rearview mirror display worried him due to safety concerns.

Mrs. [name redacted]<sup>[13]</sup> (Physics Teacher, [school name redacted])

- Her personal favorite was the Critical vs. Noncritical lights.
- She believed that safest was the Critical vs. Noncritical lights.
- She had safety concerns about the rearview mirror display regarding the time it would take to try and read the code. She believed it would take too long to read the code and take the drivers' eyes off the road.
- Repair Shops/ Mechanics concerned her safety wise as well, if this application would be on a phone. She believed people would be too tempted to use their phone while driving.
- She believed that the price of the product should be installed in the car when you buy it.

Mr. [name redacted]<sup>[14]</sup> (Phy-Ed Teacher, [school name redacted])



Ideas:	Universal	Inexpensive	Accessible Materials and Technology	Safety	Updatable	Total:
#1: Radio Station	5	2	3	4	0	14
#2: Display in Rearview Mirror	5	3	5	4	0	17
#3: Display on driver car visor	3	0	3	3	5	14
#4: Repair Shops/Mechanics	5	4	3	4	5	21
#5: Critical vs. Noncritical	5	5	5	4	0	19

- His personal favorite was the rearview mirror display, and believed it to be the safest.
- He would be willing to spend a range from \$1000-1500.

These interviews gave us new

insight and feedback on our ideas. We concluded from these interviews that the most popular idea was the Critical vs. Noncritical Display. We were also informed of the need for basic information, such as whether the check engine light diagnostic is critical or noncritical. Most of the interviewees, preferred to know basic information rather than a service that would give them more detailed information.

Next, we sent out a survey to adults ([school name redacted] teachers and teachers from Milwaukee Area Technical College) for their input on our top three ideas. We left each question to a free response answer to receive more open ended input. For each of the top three ideas, we asked for feedback, how they would rate it safety wise, and how much they would spend for that idea.

## Here are the free response answers taken from our survey:

### Feedback taken from Decision Matrix Survey for idea #2 (Rearview Mirror)

- Doesn't the current check engine light do this already on the dash board?
- The code on the rear view mirror is a good idea because it is not distractive but yet easily seen.
- This does not add any value compared to simply buying a code scanner and using it. PS Your survey should include \$0 option to indicate that someone would not purchase it
- Might be hard for some folks to follow
- I like the idea. I think rather than the code it could give you the actual problem. If you have the code, you still need to find out what

the code means.

- Simple and Clean. The "code manual" is always the frustrating part. I have a code number what does it mean. Maybe Bluetooth to a Smartphone or device that looks up the code and announces the meaning. The Smartphone app would be the code manual with audio feedback.
- If it is an emergency that needs to be dealt with before driving any further, it should flash or something. But, if it situation could wait; it would be nice to have an "ignore now" option. Much like a snooze button. It might be interesting to have a phone app. of the code manual. Instead of looking it up in a book, you could type the code into the program and it looks it up for you. That way you wouldn't need a book taking up room in the glove box.
- As long as it can be turned off once I've gotten the message.
- It sounds like a nice idea, but the cord hanging from the review mirror would be annoying. Maybe it could come up from above and sneak down? I hope that makes sense... or cordless.
- Love it but why in the rear view mirror?
- This system may not need any new technology installed in a car but this can possibly be incorporated into any vehicle that has a digital dashboard with odometer mileage indicators. The code can be flashed as a selection between trip miles and actual odometer readings. This would reduce the cost of adding an expensive display to the rearview mirror which will become a possible distraction to the driver. This does not communicate a solution to the driver but only indicates that they need to get some assistance regarding the repair of their vehicle.
- I think the cord would be distracting while driving. This could also get in the way if a driver also has a child mirror, which attaches to the rear view mirror in order to see a child sitting in the back seat.
- I still have to research the problem.
- I like the idea of a code manual, as long as the explanations of the codes aren't vague.
- Not bad.
- I think this could provide a distraction to drivers. A driver might be trying to read the code in the mirror instead of watching the road.
- Has potential, like wireless idea better though.
- Good idea. Visible, but not distracting. I'd like the problem, though, not the code, because I don't want to have to stop and look it up.

#### Feedback taken from Decision Matrix Survey for idea #4 (Repair Shops/Mechanics):

- Love it.
- Is there a cost for the service?
- This is a very good idea. The fault code should be sent to your phone along with an explanation of possible causes. The option should then be for the user to send to a business of your choice or send it to no one if you are a home mechanic.
- not sure people will follow this
- like
- Hey, this is the Smartphone app I was talking about in the first idea. You could sell advertising space on the app to the stores listed to cut the cost of installing the unit.
- Who would take the time needed for every response that would come in? There would have to be a pretty heavy price for that type of feedback. It would possibly be on monthly rate that most consumers would not be able, or want to pay.
- no feedback at this time
- Amazingly interesting idea. I like this one the best. You must be a Conservative because only a conservative would come up with such a good idea.
- This seems like it might be a violation of privacy. I'd rather have the code accessible where I can see it, versus my car issues being broadcasted to a bunch of places.
- How can you change where info is sent?
- I would see if the repair places and mechanics would pay to belong to the network and therefore offset some of the cost of the development and distribution of these systems. Many companies pay money for marketing and this would be a definite marketing option to increase sales of parts and labor services. The companies can compete for the ability to be part of a subscription network and thus narrowing the competition but increasing the amount that you could charge the auto repair and parts places to be part of this repair network. The use of a smart phone interface would be good because a GPS coordinate system could be incorporated so that if you are traveling you could get information for the nearest parts or repair center and possible costs and time needed to make repairs. I think the safety of this is probably best as the module communicates with the person's smart phone or computer and typically a person does not read email or text messages while driving. Many municipalities have ordinances against this both the communication to a solution immediately is a great idea. I think that if this is chosen using a wireless device this also can be used for quicker emission testing in areas of the country that require emission testing. When a person needs to have their car inspected they can drive through an emission test center that has a Bluetooth or other type of wireless scanner which can receive the vehicle data and process any test results to the vehicle owner without the need of an attendant to plug in a hard wired piece of testing equipment. This would decrease costs for emission testing and reduce the cost to taxpayers and vehicle registration fees.
- Sounds good. What happens if the stores you set up your vehicle with go out of business, you move, etc.? Would you have to go back to the dealership to re-set up another location?
- That would work for me because I have a trusted mechanic but not everyone does.
- A more specific solution than the first idea. I'd like the option of choosing who to send it to.
- Not bad either. I like the first more. Safety should never be a problem, unless idiots are driving. (I know there are many like that).
- Does this (or something similar) already exist? This might be helpful in that you don't have to pay \$60-\$100 just to have the diagnosis.
- Like it. Wireless systems taking over the world.
- Interesting idea. I like the competition part.

#### Feedback from Decision Matrix Survey #5 (Noncritical and Critical Light)

- Good Idea most diagnostic checks cost \$100 - \$200. This would save a ton of money in the long run.
- Does this replicate what vehicles have in place now?
- This doesn't add value compared a typical engine light. PS Your survey should include \$0 option to indicate that someone would not purchase it
- same as before
- Like it.
- Too much information for the driver. Check for references on Ergonomic designs. They usually have a 'rule of thumb' for how much information you can safely provide to a driver. Lots of research done on Heads up Displays for fighter jet pilots.
- That would be a good idea.
- YES. That is what I stated in the previous feedback box.
- Good idea. I bet mechanics wouldn't like it much.
- YES - this would be awesome. However, I can see that some people might let "non-critical" issues go for too long. Also, this plan

doesn't let you figure it out yourself. You would still need to take it somewhere to find out what was wrong.

- Like a panic button
- There may be situations where a non-critical light may create a sense that the repair is not needed. The lack of proper maintenance of a vehicle may result in reduced life span of the vehicle or possible voiding of warranties. I think any maintenance of vehicles should be assessed by the owner after advice from a professional or persons of knowledge of proper vehicle repair. It is known that some items that are not an immediate problem to the driver and engine and may only affect some non-critical emission systems but they still should be evaluated for loss of fuel mileage and other possible ill effects that may cost additional money for repairs in the long run. This also may be a distraction to the driver in that not only do they have a check engine light on the dash but they have to look at the indicators and think about decisions rather than concentrate on the driving tasks. Here the previous idea of a smartphone or computer taking the responsibility of starting the decision process without the driver having to be distracted other than the actual manufacturers check engine light coming on.
- Looks good.
- Hard for the average driver to distinguish between what is critical and what isn't.
- If this was paired with a code manual, it would be the best. My son was once driving and his check engine light illuminated on a Saturday night on the freeway, he immediately pulled over, checked his manual, and was told to call the dealership immediately or have the vehicle towed. After the expense of towing to a lot, lot storage fees until Monday, and then another towing charge to the dealer, and dealer service, the check engine light was due to his gas cap being loose!! Highway robbery!
- Even better. The best of the three.
- I think most people would opt for this. It lets the driver know if it is safe to continue driving the car or if he/she should pull over right away. A possible problem is that some people would keep driving until the problem became critical. Actually, most cars have a system where if the check engine is flashing the problem is critical. If the light is on steadily, it is not.
- Too many lights already
- Why is this "next level"? I like this idea, but would still like to know what the exact problem is.

After 23 people completed our survey, we read and analyzed the feedback. Through this analysis, we discovered that we were trying to reach out to two separate audiences. The first audience was the normal, everyday driver who cares more about whether the check engine light diagnostic is critical or noncritical. This driver does not particularly care so much for the best price for the repair. The second audience is the experts/mechanics who are more involved in their cars. These drivers want the detailed information of the car diagnostic and want the best price for the repair. Additionally, in conclusion the top two ideas were the Repair Shops/Mechanics and Critical vs. Noncritical Display.

We then used our feedback from the stakeholders in the survey and interviews to make our second decision matrix. We used the same ratings as before, but reevaluated each rating according to the new information that was presented to us.

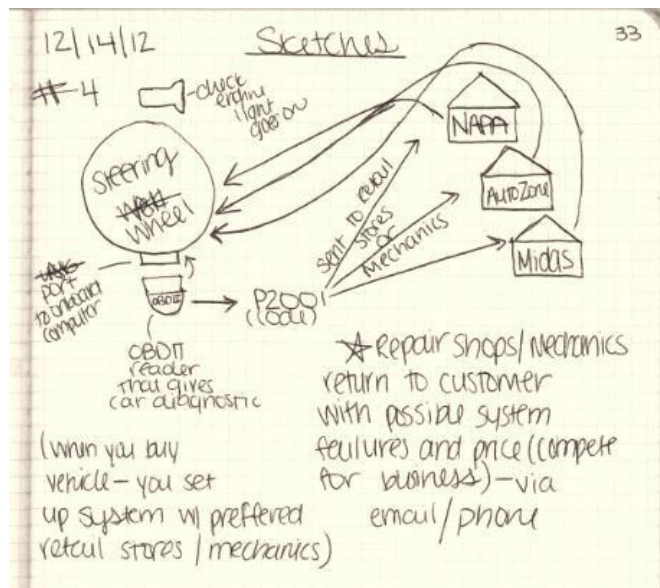
## Second Decision Matrix:

Top 3 Ideas	Universal	Inexpensive	Accessible Materials and Technology	Safety	Updatable	Total:
#2: Display in Rearview Mirror	5	3	3	3	0	17
#4: Repair Shops/Mechanics	5	3	5	5	5	23
#5: Critical vs. Noncritical	5	5	5	5	0	20

With the new knowledge of our two audiences, we talked with our experts and decided that it was best to go with our top two ideas. The top two ideas would address both

audiences' needs and serve as a multi-purposed solution. We then combined our top two ideas to sketch our final design.

## Final Sketch:



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[1] *[name redacted]*. Personal Interview. 11. Jan. 2013.

[2] *[name redacted]*. Personal Interview. 11. Jan. 2013.

[3] *[name redacted]*. Personal Interview. 11. Jan. 2013.

[4] *[name redacted]*. Personal Interview. 11. Jan. 2013.