1.3 Functional Decomposition

1.3.1 Introduction

Functional decomposition is a process of analysis that breaks a complex system to into smaller and simpler functions. The purpose of functional decomposition is to organize the functions of a project in a hierarchy, detailing what the project has to do. It begins by breaking down the problem statement and gathering information on what the customer needs. This process assissts in the steps that are needed to be completed in order to achieve the project goal and produce the final product. The following functional decomposition was gathered collectly with team 505, 506 and our sponsors. Additionally, the team utlizied past Senior Design projects for reference and used engineering design methods to gather the following data.

1.3.2 Data Generation and Hierarchy Introduction

Team 506 conducted an analysis of the project description, assumptions, key goals, and customer needs to determine the major and minor functions of the desired gas sensor system. The major functions were classified into systems based on important functional relationships. The gas sensor was broken down into 2 systems proceeding into 2 subsystems. Figure 1 displays a visual representation of our functional decomposition. The figure follows a tree hierarchy with the 2 main systems: gas sensing and the wearable component.

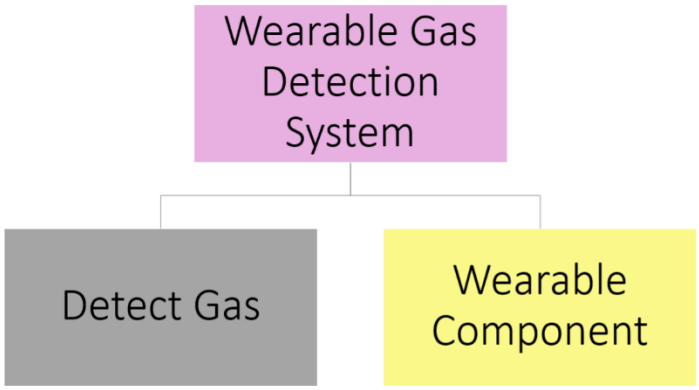

Figure 1: Team 506 Main Functions Hierarchy Chart

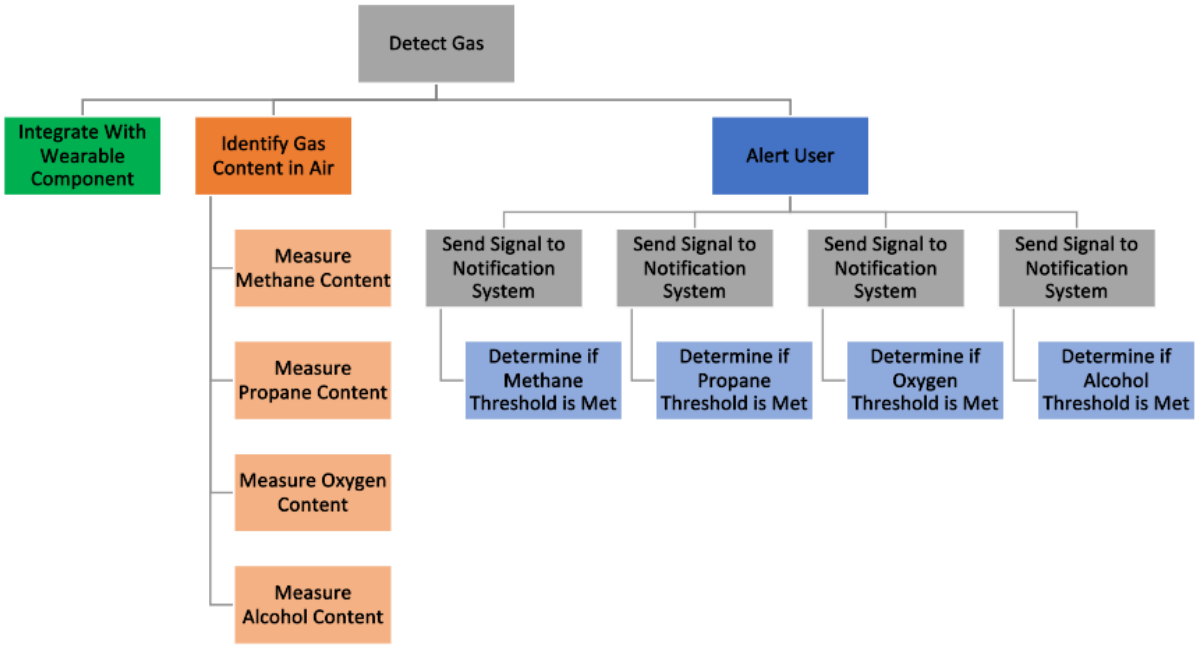

Figure 2: Detect Gas Hierarchy Chart

1.3.3 Hierarchy Chart Explanation

Figures 1 and 2 display the functional decomposition in the form of a hierarchy chart. The functions identified were classified into 3 different major subsystems: to integrate with wearable component, identify gas content in air, and alert user. This data was generated based off of our meeting with the CIA regarding the main functional needs this device needs to do.

The first branch is to intregrate with wearable component. Although having no subsytems below it, this is more towards our sister team 505 since our device will collabrate with their project.

The second branch is to identify gas in air. Simply stating that our device should be able to intake gas constantly and read out how much gas is being surrounded. The few gasses that the

sensor will be reading is the methane content, propane content, oxygen content, and alcohol content.

The third branch is to alert the user to determine if each gas threshold is met to optimal standards. In some circumstances, the user will be around these gasses everywhere. So the threshold of gas until it becomes harmful or even deadly.

1.3.4 Connection to Systems

Each of the major subsystems, besides integrating with Team 505, have subsystems within them. Idenentifying the gas content of the air and alerting the user have been broken down to their most basic functions to establish the data-flow order.

Integration With Wearable Component

This project is broken into two teams, Team 506 is designing a gas sensor and alerting system, Team 505 is designing a wearable system that the gas sensor will integrate with. The ability to integrate with Team 505's system is a major function of this sensor, there are no sub-functions of this major function currently. As mentioned, this is priority number 2.

Identify Gas Content of the Air

A major function of this system is detecting and recognizing gasses present in the environment. The identification of each gas is considered to be its own function to emphasize the importance of each gas. Depending on the detection method used, different gasses will need to be tested with an independent sensing device. The gasses currently listed have been determined by analyzing which gasses are most likely to be present in our given scenario, as well as which gasses will present a clear and present danger. The device will detect the value of each gases' concentration or presence to be logged and communicated to the user. Since this is the teams main objective, this is priority number 1.

Alert User

Once gasses have been detected in the air and their concentration determined, the user must be made aware of the concentration of the air around them. The method by which the user will be notified is still to be determined and will depend on decisions made by Team 505 through the next iterations of the design process. The major function of alerting the user has two sub-systems below it. The lowest level function in alerting the user is comparing the measured gas concentrations to set thresholds where the gasses will become deadly. If these thresholds are met, a signal will be sent to the notification interface and the user will be made aware. Potential solutions to user notification will include constant updating of air quality, but thresholds will still be in place for emergency alerts to the user. This is priority number 3.

1.3.5 Cross Reference Table

The functional dcomposition cross reference chart, Table 2, demostrates how the functional systems of the device relate to one another. The columns are the 3 main systems and the rows are the 8 sub-systems. An ‘X’ denotes when a sub-system function will be directly affected by one or more of the 3 main systems.

Table 2: Cross-Functional Relationship Matrix

Sub-Systems	Integration	Identify Gas Content	Alert User	Total
Measure Methane		**X**		**1**

Measure Propane		**X**		**1**
Measure Oxygen		**X**		**1**
Measure Alcohol		**X**		**1**
Determine if Methane Threshold is Met			**X**	**1**
Determine if Propane Threshold is Met			**X**	**1**
Determine if Oxygen Threshold is Met			**X**	**1**
Determine if Alcohol Threshold is Met			**X**	**1**
Send Signal to Notification System (Methane)	**X**		**X**	**2**
Send Signal to Notification System (Propane)	**X**		**X**	**2**
Send Signal to Notification System (Oxygen)	**X**		**X**	**2**
Send Signal to Notification System (Alcohol)	**X**		**X**	**2**
Total	**4**	**4**	**8**	**16**

1.3.6 Smart Integration

When this gas sensor is implemented, the different subsystems will need to communicate with eachother for the total system to be effective. The main subsystems that will need to work in conjunction are the gas measurements and the checking of thresholds. When the gas measurements are taken, these values must be interpreted by a different subsystem to effectively notify the user. The interpreted values must also interact with the subsytem responsible for notifying the user at appropriate intervals. Communication methods between sub-systems is yet

to determined, but will likely incorporate wired serial communication, bluetooth/RF communication, or an analog method.

1.3.7 Actions and Outcomes

The Wearable Gas Sensor serves as an essential tool for safeguarding lives and ensuring successful outcomes during search and rescue missions. This type of device actively detects and monitors hazardous gases in real-time. Our device will provide first responders with crucial data to make informed decisions and protect their safety by issuing immediate alerts. Wearable gas sensors enhance the efficiency of rescue efforts and minimize exposure to toxic gases. This will ultimately contribute to a safer and more effective search and rescue operation.

The main physical action to be performed is to successfully display the accurate percentage of gas concentration and relate it to its lower explosive limit (LEL) and the upper explosive limit (UEL). Every gas has a different LEL and UEL; therefore, the team must find a way to integrate each of the 4 gases LEL's and UEL's. Gas concentrations vary from location to location; dense gases will be lower to ground and visa versa. Thus, when the user goes into a search and rescue mission with our device it is important to have a large margin or error in our percent readings in order to keep the user safe.

Another physical action to be performed is to successfully communicate with the wearble component. Depending on the following design steps, this integration between the wearable component and the gas sensor will become more clear. For example, if the final product is strictly mechanical device, the device could communicate with the wearable component through valves. On the other hand, if the final product is more eletrical and software based, the communication can happen via bluetooth or wires.

1.3.8 Function Resolution

The functional resolution of the gas sensor is tailored for search and rescue missions with a set of capabilities, including the detection of a wide range of hazardous gases, adjustable sensitivity levels, real-time monitoring, compact and wearable design with conditions to withstand extreme conditions, audible and visual alarm mechanisms for immediate notification, integration with other equipment, efficient battery management, and adherence to safety protocols. This comprehensive functionality ensures that the sensor provides critical, life-saving information in real-time while being seamlessly integrated into the search and rescue operational environment, ultimately enhancing the safety and effectiveness of missions in disaster-stricken areas.