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CIA Wearables
Team 505

11/14/2023

Team Introductions

Kartika Ahern
*Systems
Engineer*

Maxwell Orovitz
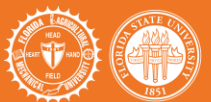*Mechanical
Design
Engineer*

Eliot Hamilton
*Mechanical
Design
Engineer*

**Malachi
Johnson-Taylor**
*Thermal Fluids
Engineer*

Patrick Molnar
*Dynamics and
Controls
Engineer*

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Sponsor and Advisor

Teaching Faculty
Shayne McConomy
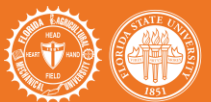*FAMU-FSU College of Engineering*

Team Sponsor
Franklin Roberts
Central Intelligence Agency

Secondary Stake Holder
David Merrick
Director of FSU Emergency Management & Homeland Security Program

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Objective

The objective of this project is to develop an innovative wearable for the CIA, featuring an integrated gas detector, as well as additional technology to aid in building collapse search and rescue missions.

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Background

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Key Goals

Successfully collaborate to implement a gas sensor into our wearable technology

Improve operative safety and communication

Develop a reliable and fully functional prototype

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Assumptions

The device will not exceed 40 lbs.

The device will be powered for the entire mission and not restrict movement.

The device will be used in a building collapse scenario.

Team 506 will recognize relevant gasses and calibrate their detector accordingly

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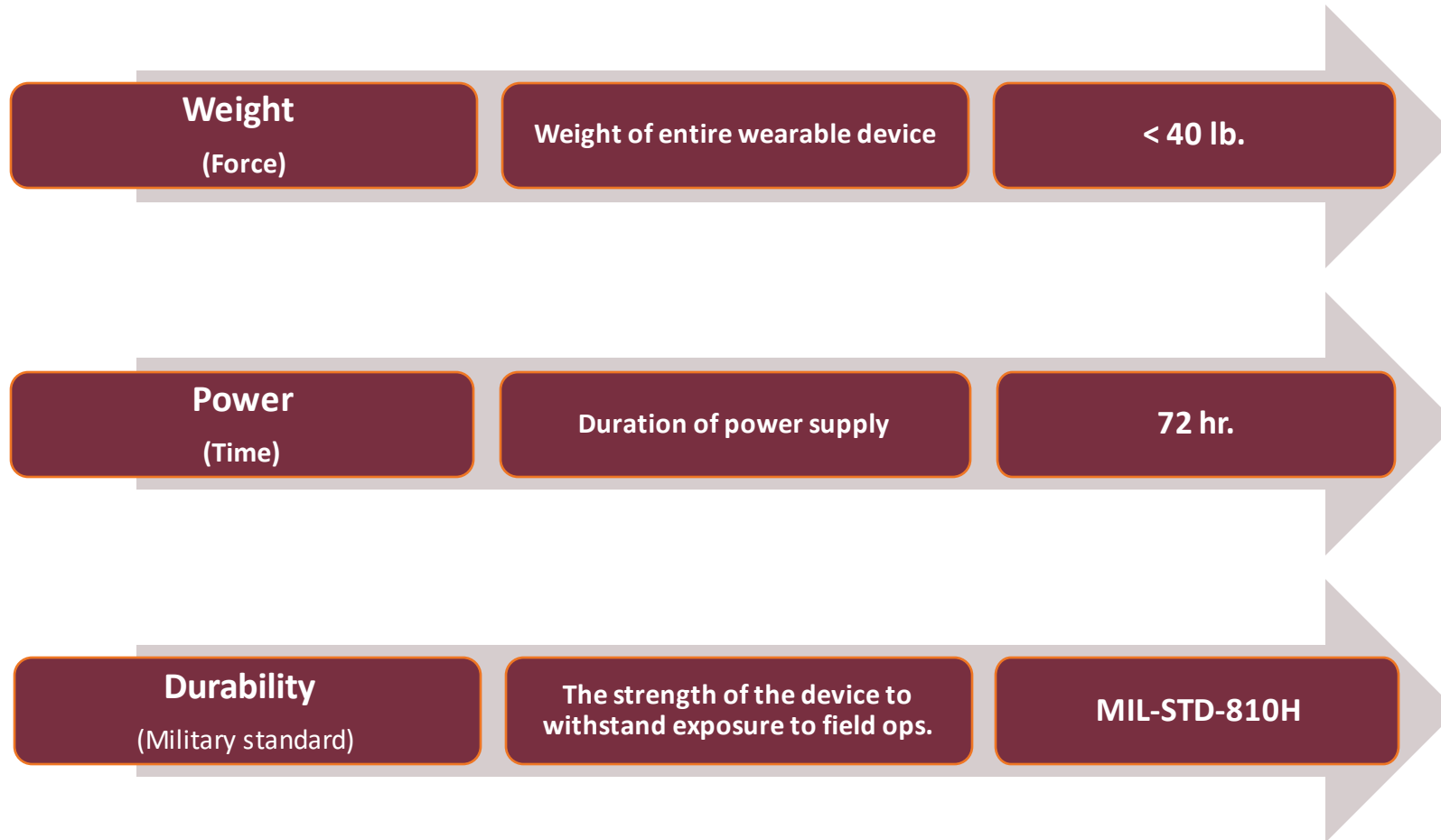Engineering

New Assumptions

User will be wearing the device over search and rescue gear	Operatives will wear the same device and be connected to each other at the start of mission	Team 506 will recognize relevant gasses and calibrate their detector accordingly

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Kartika Ahern

Targets and Metrics

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Targets and Metrics

| Weight (Force) | Weight of entire wearable device | < 40 lb. |

| Power (Time) | Duration of power supply | 72 hr. |

| Durability (Military standard) | The strength of the device to withstand exposure to field ops. | MIL-STD-810H |

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Targets and Metrics

Material (Military material readiness)	Composition of device	10 USC 118 (b)
Comfort (Degrees Fahrenheit)	Temperature of electrical components in contact with skin	98.6°F
Wearable (User fit)	How the device fits and wears on the user	Accommodates 95th percentile

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Targets and Metrics

User Interface (Time)	Lag in displaying user data in the U.I.	< 10 sec.
Safety (Military standard)	Safety features associated with the device	MIL-STD-882B
Data collection (Time)	Duration of user data collection and storage	Stores data for 1 hr. then overwrites

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Challenges

Drawing Boundaries

Battery Life Optimization

Interactivity and Connectivity

Resource Affordability

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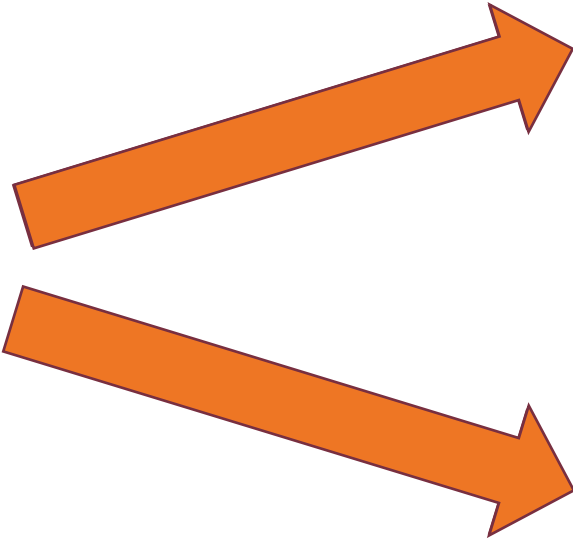
Kartika
Ahern

Concept Generation and Selection

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Ahern

Medium Fidelity Concepts

Concept #4:
Backpack + Goggle HUD

Concept #81:
Vest + Gas Mask with UI on Lense

Concept #74:
RC 4-Wheel Drone

Concept #10:
Tech Sleeve

Concept #71
Backpack + Watch with UI

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High Fidelity Concepts

Concept #1:
**Back Brace +
Helmet HUD**

Concept #2:
**Back Brace +
Arm Sleeve
UI/Display**

Concept #16:
**Two Strap
Backpack +
Retractable
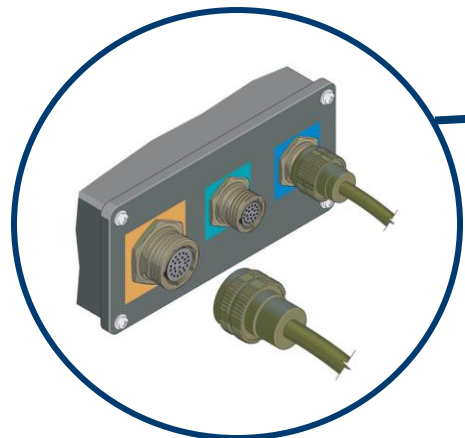UI/Display**

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Concept Generation
High Fidelity Concepts

Patrick Molnar

Concept #1: Back Brace with Helmet HUD

HUD on visor

Computer/ Battery/ Electronics Stored on Back

MIL Spec Connectors for Helmet HUD

Concept Generation
High Fidelity Concepts

Patrick Molnar

Concept #2: Back Brace with Arm Sleeve UI and Display

Flexible Display with UI on wrist
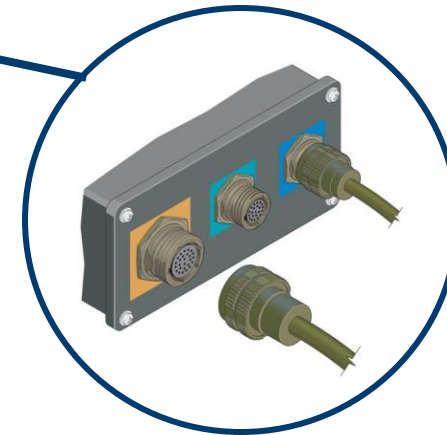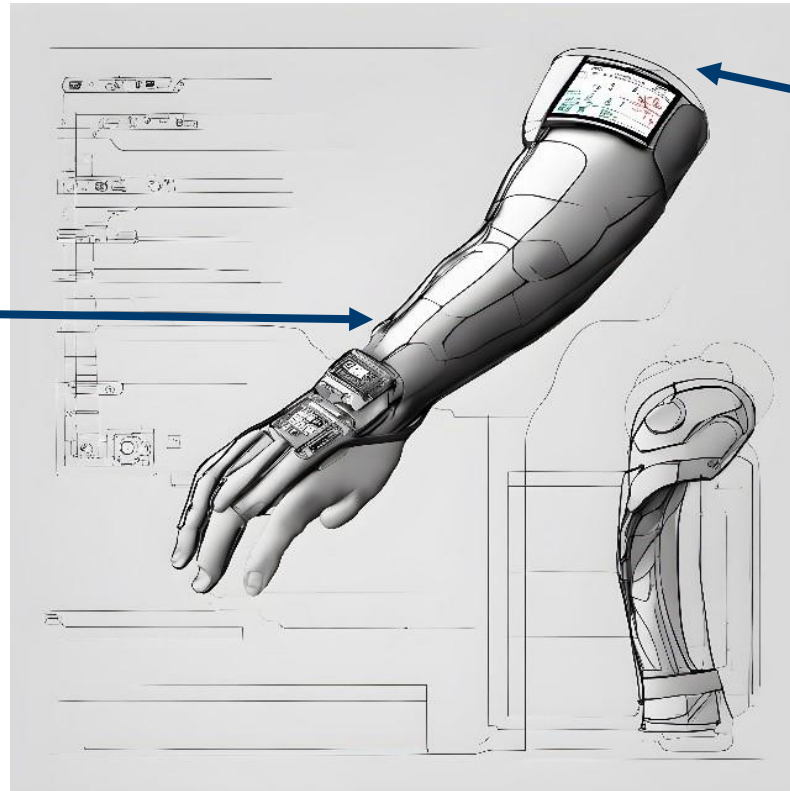
*Same Back Brace as Previous Concept Except MIL Spec Connectors Lead to Arm Sleeve

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Concept Generation
High Fidelity Concepts

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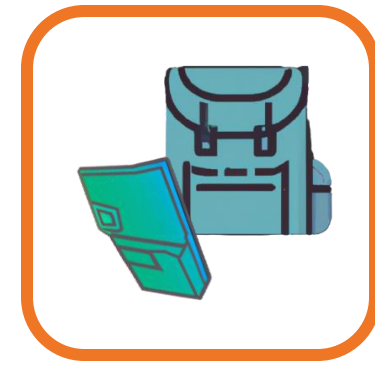
Concept #3: Two Strap Backpack with Retractable UI with Display

Retractable UI with Display Attached to Backpack Strap

Computer/ Battery/ Electronics Stored in Backpack

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Concept Selection
House of Quality

Outputs Clear Display	Alerts User via Notification	Alerts Team Problems via Notification	Monitors Vitals
Collects Data From Sensors	Stores Energy and Data	Transmits Power	Maintenance

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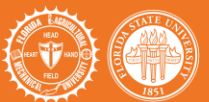
Concept Selection
Pugh Chart: First Iteration

Datum:

Handheld Gas Detector

1
Backpack + Goggle HUD

2
Vest + Gas Mask and UI on Lense

3
RC-4 Wheel Drone

4
Tech Sleeve

5
Backpack + Watch with UI

6
Back Brace + Helmet HUD

7
Back Brace + Arm sleeve w/ UI/Display

8
Two-strap Backpack + Retractable Ui/Display

22

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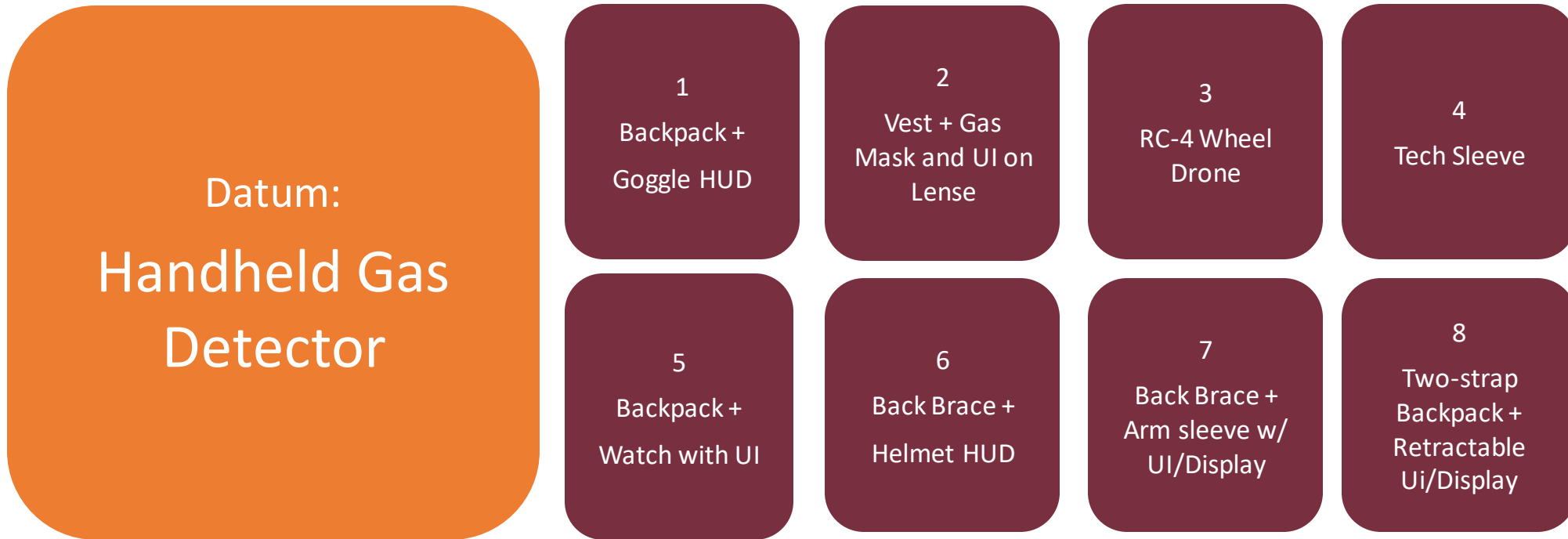
Concept Selection
Pugh Chart: Second Iteration

Datum:

Two-strapped backpack

+

Retractable UI/Display

2 Backpack + Goggle HUD	3 Back Brace + Helmet HUD	4 Vest + Gas Mask and UI on Lense
5 Tech sleeve	6 Backpack + Watch with UI	7 Back Brace + Arm sleeve w/ UI/Display

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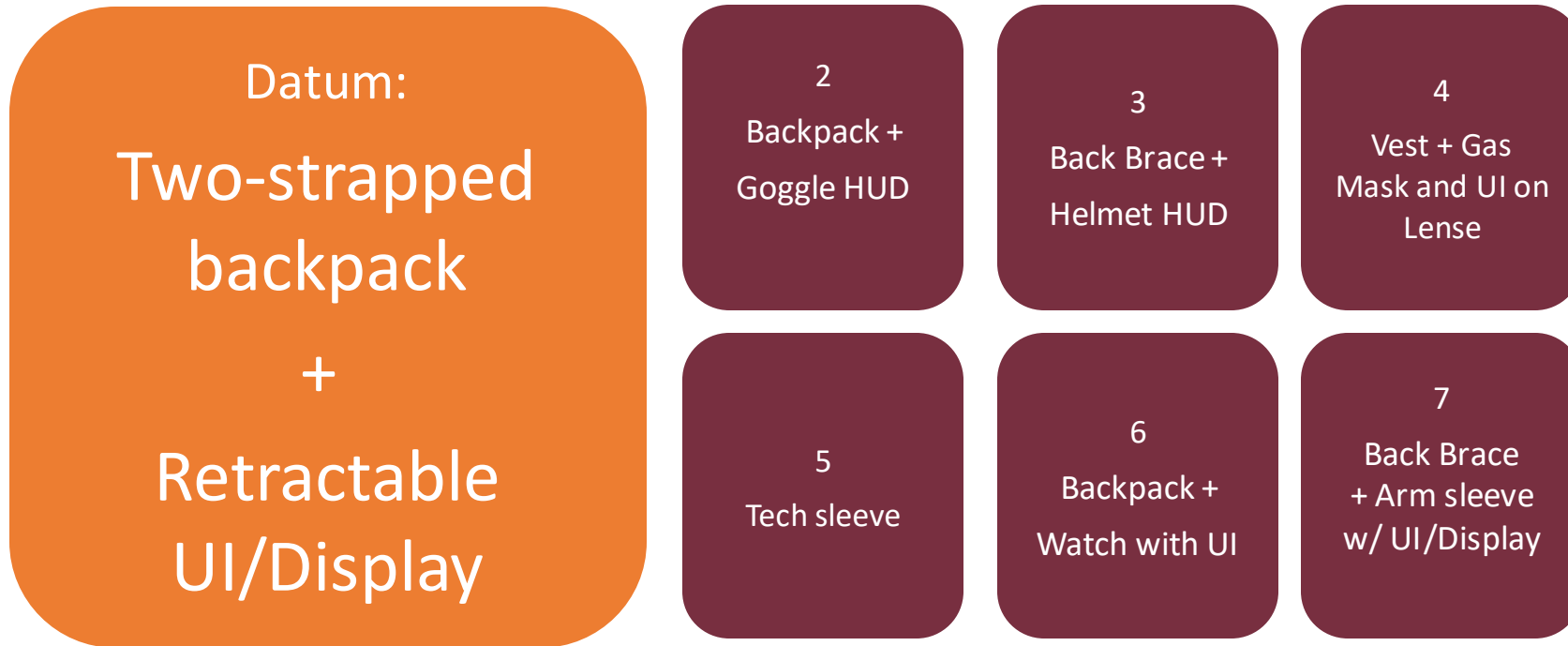
Concept Selection
Pugh Chart: Final Iteration

Datum: **Backpack** **+** **Goggle HUD**	3 Back Brace + Helmet HUD	4 Vest + Gas Mask and UI on Lense

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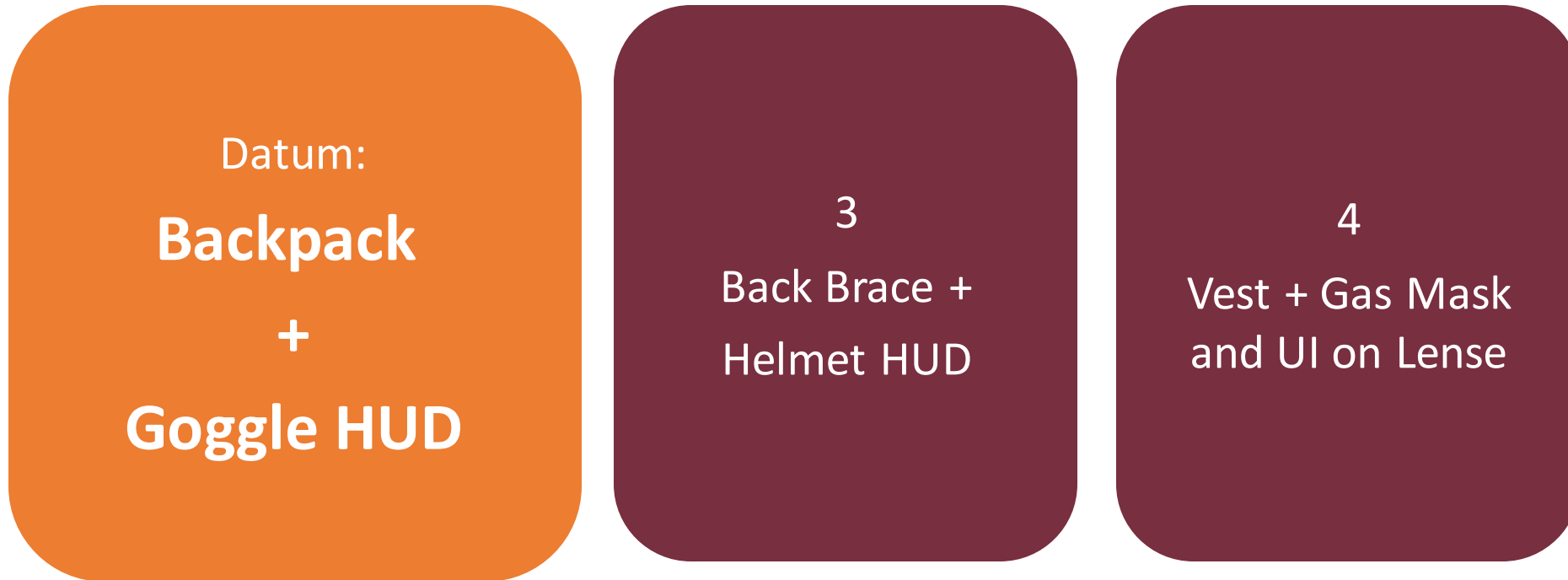
Concept Selection
Analytical Hierarchy Process

Concept	Alternative Value
Concept #1: **Backpack + Goggle HUD**	0.162
Concept #2: **Back Brace + Helmet HUD**	0.547
Concept #16: **Vest + Gas Mask and UI on Lense**	0.329

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Final Selection

Lightweight and Maneuverable physical design

Easy to See Displayed information

Central Location for Vital Collection

**Concept #1:
Back Brace + Helmet HUD**

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Future Work

Bill of Materials for CIA

CONOPS Update

Risk Assessment

Modeling/ Prototype

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Thank you from Team 505

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Concept Selection
Binary Piecewise Comparison (BPC)

Customer Requirements	Long Shelf Life	Accessability	Lightweight	Comfortable	Durable	Supplies Sufficient Power	Assists in Team Communication	Improves User Safety	Captures Essence of CIA	Total
Long Shelf Life	x	1	1	1	1	0	0	0	1	5
Accessability	0	x	0	1	0	0	0	0	1	2
Lightweight	0	1	x	1	0	0	0	0	1	3
Comfortable	0	0	0	x	0	0	0	0	1	1
Durable	0	1	1	1	x	0	0	1	1	5
Supplies Sufficient Power	1	1	1	1	1	x	1	1	1	8
Assists in Team Communication	1	1	1	1	1	0	x	1	1	7
Improves User Safety	1	1	1	1	0	0	0	x	1	5
Captures Essence of CIA	0	0	0	0	0	0	0	0	x	0
Total	3	5	4	6	2	0	1	3	7	

Concept Selection
House of Quality (HoQ)

Customer Requirements	Importance Weight Factor	Engineering Characteristics								
Units		Resolution	Sec	Sec	% Accurate	% Accurate	Watt/hr	Watt/s	lbs	uses/year
Improvement Direction		^	v	v	^	^	^	^	v	^
		Display	User Notifaction	Team Notifaction	Monitors Vitals	Collects Data From Sensors	Energy Storage	Transmits Power	Load	Maintanance
Long Shelf Life	5				3	3	3	3		9
Accessability	2	9	1	1	1	3			1	3
Lightweight	3	1			1	1	3		9	
Comfortable	1	1			1	1	3	1	9	
Durable	5	9	3	3	9	3	3	3		9
Supplies Sufficient Power	8	9	3	3	9	9	1	9		3
Assists in Team Communication	7	9	1	9	1	1				
Improves User Safety	5	3	9	9	3	9			3	1
Captures Essence of CIA	0	3	1	1	1	1	1		1	
Raw Score (226)		44	18	26	29	31	14	16	23	25
Relative Weight %		19.47	7.96	11.50	12.83	13.72	6.19	7.08	10.18	11.06
Rank Order		1	7	4	3	2	9	8	6	5

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Concept Selection
Pugh Charts

Selection Criteria	Handheld Gas Detector	Concepts							
		1	2	3	4	5	6	7	8
		Backpack + Goggle HUD	Vest + Gas Mask and UI on Lense	RC 4-Wheel Drone	Tech Sleeve	Backpack + Watch with UI	Back Brace + helmet HUD	Back Brace + Arm sleeve UI/Display	Two Strap Backpack + Retractable UI/Display
Display	Datum	+	+	-	-	-	+	+	-
Collects Data from Sensors		+	+	+	+	+	+	+	+
Monitors Vitals		+	+	-	+	+	+	+	-
Team Notifaction		+	+	S	+	+	+	+	+
Maintenance		-	-	-	-	-	-	-	-
# Pluses		4	4	1	3	3	4	4	2
# Minuses		1	1	3	2	2	1	1	3

Selection Critera		Concepts						
	1	2	3	4	5	6	7
	Two Strap Backpack + Retractable UI/Display	Backpack + Goggle HUD	Back Brace + helmet HUD	Vest + Gas Mask and UI on Lense	Tech Sleeve	Backpack + Watch with UI	Back Brace + Arm sleeve UI/Display
Display	Datum	+	+	+	-	-	-
Collects Data from Senso		S	S	S	S	S	S
Monitors Vitals		-	+	+	+	+	+
Team Notifaction		+	+	+	-	-	-
Maintenance		-	-	-	-	-	-
# Pluses		2	3	3	1	1	1
# Minuses		2	1	1	3	3	3

Selection Critera		Concepts		
		2	3	4
		Backpack + Goggle HUD	Back Brace + helmet HUD	Vest + Gas Mask and UI on Lense
Display	Datum		+	+
Collects Data from Senso			S	S
Monitors Vitals			+	S
Team Notifaction			S	S
Maintenance			+	S
# Pluses			3	1
# Minuses			0	0

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Concept Selection
Pugh Charts

Selection Criteria	Handheld Gas Detector	Concepts							
		1 Backpack + Goggle HUD	2 Vest + Gas Mask and UI on Lense	3 RC 4-Wheel Drone	4 Tech Sleeve	5 Backpack + Watch with UI	6 Back Brace + helmet HUD	7 Back Brace + Arm sleeve UI/Display	8 Two Strap Backpack + Retractable UI/Display
Display	Datum	+	+	-	-	-	+	+	-
Collects Data from Sensors		+	+	+	+	+	+	+	+
Monitors Vitals		+	+	-	+	+	+	+	-
Team Notifaction		+	+	S	+	+	+	+	+
Maintenance		-	-	-	-	-	-	-	-
# Pluses		4	4	1	3	3	4	4	2
# Minuses		1	1	3	2	2	1	1	3

Selection Critera		Concepts						
	1 Two Strap Backpack + Retractable UI/Display	2 Backpack + Goggle HUD	3 Back Brace + helmet HUD	4 Vest + Gas Mask and UI on Lense	5 Tech Sleeve	6 Backpack + Watch with UI	7 Back Brace + Arm sleeve UI/Display
Display	Datum	+	+	+	-	-	-
Collects Data from Senso		S	S	S	S	S	S
Monitors Vitals		-	+	+	+	+	+
Team Notifaction		+	+	+	-	-	-
Maintenance		-	-	-	-	-	-
# Pluses		2	3	3	1	1	1
# Minuses		2	1	1	3	3	3

Selection Critera		Concepts		
	2 Backpack + Goggle HUD	3 Back Brace + helmet HUD	4 Vest + Gas Mask and UI on Lense
Display	Datum	+	+
Collects Data from Senso		S	S
Monitors Vitals		+	S
Team Notifaction		S	S
Maintenance		+	S
# Pluses		3	1
# Minuses		0	0

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Concept Selection
C Matrix

Critera Comparison Matrix [C]					
Critera	Display	Collects Data from Sensors	Monitors Vitals	Team Notification	Maintenance
Display	1	0.2	0.33	0.33	0.14
Collects Data from Sensors	5	1	3	3	0.33
Monitors Vitals	3	0.33	1	0.33	0.33
Team Notifaction	3	0.33	3	1	0.14
Maintenance	7	3	3	7	1
Sum	19.00	4.86	10.33	11.66	1.94

Normalized Critera Comparison Matrix [NormC]						
Criteria	Display	Collects Data from Sensors	Monitors Vitals	Team Notification	Maintenance	Criteria Weights {W}
Display	0.05	0.04	0.03	0.03	0.07	0.05
Collects Data from Sensors	0.26	0.21	0.29	0.26	0.17	0.24
Monitors Vitals	0.16	0.07	0.10	0.03	0.17	0.10
Team Notifaction	0.16	0.07	0.29	0.09	0.07	0.14
Maintenance	0.37	0.62	0.29	0.60	0.51	0.48
Sum	1.00	1.00	1.00	1.00	1.00	1.00

Consistency Check		
Weighted Sum Vector {Ws}	Criteria Weights {W}	Consistency Vector
0.24	0.05	5.28
1.34	0.24	5.64
0.52	0.10	5.00
0.73	0.14	5.41
2.76	0.48	5.78
Lambda	5.42	
RI Value	1.11	
Consistency Index	0.11	
Consistency Ratio	0.09	

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Concept Selection
Final Rating Matrix

Final Rating Matrix

Selection Criteria	Backpack + Goggle HUD	Back Brace + helmet HUD	Vest + Gas Mask and UI on Lense
Display	0.11	0.71	0.16
Collects Data from Sens	0.14	0.23	0.82
Monitors Vitals	0.11	0.6	0.24
Team Notifaction	0.11	0.6	0.24
Maintenance	0.2	0.65	0.14
Sum	0.67	2.79	1.6

Transposed Final Rating Matrix

Concepts	Display	Collects Data from Se	Monitors Vitals	Team Notifaction	Maintenance
Backpack + Goggle HUD	0.11	0.14	0.11	0.11	0.2
Back Brace + helmet HUD	0.71	0.23	0.6	0.6	0.65
Vest + Gas Mask and UI on Lense	0.16	0.82	0.24	0.24	0.14

Concept	Alternative Value	Rank
Backpack + Goggle HUD	0.1615	3
Back Brace + helmet HUD	0.5467	1
Vest + Gas Mask and UI on Lense	0.3296	2

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