Deliverable C:
Design Criteria and Target Specifications

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Introduction

Creating a design process for an innovative engineered tool that aligns with our client's needs and project restrictions involves several aspects which are outlined. Prioritizing the design

criteria, benchmarking, target specification and reflection of the user's needs. Functional requirements, non-functional requirements and constraints are included to ensure that all essential parts are covered. Technical and user benchmarking will enable comparisons of existing products and user feedback for measuring target specifications, which will allow for a tool that covers all bases and fosters positive feedback. Through the client's needs our design will be refined and adjusted to tackle all problems met in the workspace.

Design Criteria

Importance	Needs	Design Criteria
5	The device can communicate the major components of the sample retrieval process in real time.	Sensors and output (LED, buzzer, etc.)
5	The device can obtain and verify the sample without direct contact or viewing from the operator.	Scale Airtight container
4	The tool is easy to operate and control.	Basic controls and functions (input and output)
5	The tool is rigid and keeps a stable path.	Strong, inflexible material Guidance rails or shell
5	The tool can travel at least 15 ft.	Minimum length (15 ft)
5	The tool can obtain a sample that is between 30 and 80 mg.	Weight detection Complete containment Accurate sampling
5	The tool has an emergency fail-safe.	Fail-safe cable
5	The device has its own power source.	Battery powered
5	The tool can fit in a tube with an inside diameter of 4 inches.	Maximum diameter (<4 in)
5	The tool can be dismantled into parts.	Container release Connect sections
4	The device is easy to remove from the channel.	Minimal friction guidance rails Fail-safe cable
3	The sample is easy to extract from the container.	Container release
3	The tool can be used more than once.	Durable materials Replaceable materials Detachable components
3	The tool does not compromise the integrity and stability of the fuel	Weight (lbs)

	channels.	
2	The device's parts and materials are inexpensive.	Cost ($)
1	The tool does not resemble the Kinectrics CWEST or the CNL scraping tool	Original design
1	The tool is made of steel or aluminum	Durable materials

Functional Requirements

- Collecting a metal sample at a 15 foot distance
- Sensor feedback in real-time with sensors and LED
- Store the sample in container
- Easy to operate and control
- Be reusable and reliable
- Able to be removed from the fuel channel (Fail Safe)

Non-functional Requirements

- Materials
- Aesthetics
- Inexpensive
- Portable and easy to store
- Safety

Constraints

- Length of tool (15 ft minimum)
- Diameter of tool (<4 in)
- Maximum total cost of $100
- Light weight
- Reliability and effectiveness in sample retrieval
- Sample is between 30 – 80 mg

Technical Benchmarking

Device	Importance (Weight)	**ANDE**	**CWEST**	**SLAR & MODAR**	**Knife Pig**

Company		ANDE Tooling Systems	Kinectrics	Westinghouse Nuclear	Apache Pipeline Products
Cost ($USD)	2	200-000-250,000	300,000-350,000	150,000-200,000	Unknown
Weight (Kg)	3	60	40	70	28-36
Stored Size (Meter)	4	1.8 (Length) x 0.6 (Diameter)	1.5 (Length) x 0.5 (Diameter)	2.0 (Length) x 0.7 (Diameter)	0.6-0.8 (Length) X 0.4 (Diameter)
Material Strength	5	High-strength stainless steel (resistant to radiation and high temperatures)	Titanium alloys and carbon fiber composites (lightweight and durable)	Stainless steel with ceramic coatings (enhanced wear resistance)	Heavy duty metal/carbide blades (hard, heavy, but brittle)
Retrieval success rate	5	90%	94%	88%	Unknown
Total		38	49	32	36

Green = 3, Yellow = 2, Red = 1 X(Multiplied) By Importance Weight (1-5)

User Benchmarking

Company/ Device	ANDE	CWEST	SLAR & MODAR	Knife Pig
Reviews	• Praised for reliability and ease of use • Some users report higher weight as a drawback	• Highly rated for precision and advanced robotics • Some concerns about higher costs	• Well-regarded for durability in harsh environments • Criticized for bulkier design	• Versatile, have many uses within pipelines • Useful in harsh conditions

Technical Specifications

	Design Specifications	Relation (=,< or >)	Value	Units	Verification
	Functional Requirements				
1	Fail-safe cable	>	15	ft	Analysis, Test
2	Collecting a metal sample from 15 feet	=	Yes	N/A	Test

3	Easy to operate and setup	<	10	min	Test
4	Store sample between 30-80mg	=	Yes	N/A	Test
5	Sensor feedback	=	Yes	N/A	Analysis, Test
	Non-functional Requirements				
1	Rigid materials	>	120	GPA	Test
2	Inexpensive materials	≤	100	$	Estimate
3	Aesthetics	=	Yes	N/A	Estimate
4	Reliability/Consistency	=	Yes	N/A	Test
5	Safety: no operator contact	=	Yes	N/A	Analysis, Test
	Constraints				
1	Weight	<	28	kg	Analysis, Test
2	Cost	≤	100	$	Estimate
3	Length of tool	>	15	ft	Analysis
4	Sample measurement	=	30-80	mg	Analysis, Test
5	Operating conditions: pipe condition	=	Yes	N/A	Test

Reflection

The client meeting provided critical insights that enabled us to engineer a tool, that prioritizes certain aspects of the design criteria and specifics. The client's feedback led to the prioritization of communication between the device and the operator, the collection of the sample, the rigidity and stability of the device and the overall functionality of the device were all emphasized during the client meeting. The discussion analyzed the critical constraints in the design such as the dimensions, size, ease of operation, and lightweight and precise sample measuring. The clients needs led to the integration of sensors, seal tight containment, material selection, emergency fail-safes, detachable parts, self-powered and guidance rail designs.

Conclusion

The development of the design criteria and target specifications is one of the most essential aspects of designing innovative solutions that meet the needs of the users. Navigating the functional requirements, non-functional requirements and constraints, while also technical benchmarking, taking user feedback and target specifications the process allows for a successful and reliable tool. By prioritizing certain design aspects such as communications, precise sample retrieval, fail safes and power sources this optimal design can adapt to the workforce. All the feedback gained from the client meeting has only reiterated the functionality as well as the tool's

success and safety. Through taking the client's needs and determining design criteria along the metrics this project can develop a tool that addresses the challenges of sample retrieval.

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