DebriScan

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Design Challenge 1:

Airport Safety, Operations, and Maintenance

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Executive Summary

In this report, a team of five undergraduate students at The Pennsylvania State University developed a rolling topographical sensor to enhance the detection of foreign object debris (FOD) on airport runways. By incorporating force-sensing resistors and mapping technology, DebriScan enables users to detect even the most minute specimens of FOD seamlessly and accurately, preventing such hazards from threatening the safety of airport personnel, crew members, and passengers and hampering the efficiency of airport operations.

FOD accumulates in all shapes and sizes, ranging from as miniscule as nuts and bolts to as massive as aircraft parts. Debris of this sort tends to accumulate often on runways every day from all kinds of airport operations. In addition, FOD can consist of passenger items, loose objects blown onto the runway due to weather, wildlife, and even volcanic ash. Ultimately, all kinds of FOD are prone to interfering with aircraft operations as they can interfere with plane sensors, damage aircraft parts, and be hazardous for any personnel working on runways.

Current methods of FOD detection and/or removal include the use of a variety of radar and electro-optical sensors, magnetic bars underneath trucks to pick up metallic material, wind barriers to prevent the displacement of airborne FOD, and fencing to prevent wildlife from entering runways. These methods prove impactful in their respective responsibilities, but the most frequent method of FOD detection and removal is reliance on the human eye to scan runways manually. This methodology proves to be inefficient and risk-bearing, so DebriScan aims to improve this technique.

DebriScan is a cylindrical rolling device that can be attached to the back of vehicles airport personnel may typically drive throughout runways to scan for FOD. As these vehicles tow DebriScan, DebriScan can detect any compression exerted upon it due to physical contact with FOD. After detecting FOD, DebriScan will send an alert to the driver, who can then remove the FOD. Along with this process, DebriScan will record to its associated application where on the runway FOD was observed, and this data collected over time will allow DebriScan to map out on an airport's runway where FOD accumulates in the long run. This added benefit will allow airports to exercise more particular practices of FOD mitigation, further improving their safety and efficiency of operations.

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Problem Statement and Background

In this report, a team of five undergraduate students from The Pennsylvania State University's College of Engineering and College of Science addresses the challenge proposed by the Airport Cooperative Research Program (I-B) – Airport Safety, Operation, and Maintenance Challenges: Improved methods of foreign object detection and removal from runway surfaces. On July 25th, 2000, tragedy struck Air France Flight 4590 as upon takeoff the passenger jet ran over foreign object debris (FOD) on the runway, exploding one of its tires into fragments that would rupture a particular fuel tank. Subsequently, the jet burst midair, crash-landing into a hotel killing all 100 passengers, nine crew members, and four hotel employees. The specimen of FOD responsible for this worst-case accident was a relatively microscopic titanium strip that fell off another airliner's engine cowl. In general, FOD accumulates from a variety of activities on runways in all shapes and sizes, ranging from bolts the size of mere inches to massive aircraft parts, all of which threaten the safety of passengers, airport personnel, and crew members. In addition, less horrific repercussions due to FOD like delayed takeoffs still impact the efficiency of airport operations and ultimately, lead to an estimated four billion dollars in damages to the United States aerospace industry annually (Skybrary).

Summary of Research

Literature Review

During the preliminary research process, the different types of FOD, current solutions, and quantification of damages were the primary focus.

As of June 2008, over 60% of the FOD items were made of metal, and 18% of the items were made of rubber. Dark-colored items composed nearly 50% of the FOD collected. Common FOD dimensions are 1” x 1” or even smaller (Federal Aviation Administration [FAA], 2023). Not only does this indicate that FOD detection methods must have striking precision, but also that even such microscopic debris proves detrimental as they make up the majority of FOD.

Examples of FOD include aircraft and engine fasteners, aircraft parts, mechanics' tools, catering supplies, flight line items, apron items, runway and taxiway materials, construction debris, plastic and/or polyethylene materials, natural materials, and contaminants from winter conditions.

Airport personnel and users currently are the primary FOD detection method on airport surfaces. This concept was further emphasized in the team’s interaction with industry experts. Recent technological developments have improved FOD detection through automation. These methods mainly pertain to commercially available technologies, which incorporate radar and/or electro-optical sensors to detect FOD items rapidly and provide operations staff with alerts to enhance the removal process.

Various airports in the United States report astronomical numbers in terms of FOD damages on a yearly basis. In 2020, an average of $37,000,000 in damages was recorded among the 10 most costly airports in the United States with regards to FOD [*Figure #1*] (Sides, 2020).

Airport	Annual FOD Cost
Hartsfield-Jackson Atlanta International Airport (ATL)	{$58M}
O'Hare International Airport (ORD)	{$58M}
Los Angeles International Airport (LAX)	{$43M}
Dallas Fort Worth International Airport (DFW)	{$42M}
Denver International Airport (DEN)	{$38M}
John F. Kennedy International Airport (JFK)	{$29M}
San Francisco International Airport (SFO)	{$29M}
Seattle-Tacoma International Airport (SEA)	{$28M}
McCarran International Airport (LAS)	{$24M}
Orlando International Airport (MCO)	{$21M}

Figure 1: Total annual FOD costs at top 10 U.S. Airports (Sides, 2020)

Interaction with Industry Experts

During the research phase of the project, the team encountered various technical difficulties and challenges that proved challenging to overcome. Upon examining the database provided by The Pennsylvania State University, the team identified an industry expert whose profile closely aligns with the focus of the team's work for the semester.

Barry Bratton

Barry Bratton currently serves as a Senior Consultant at ADK Consulting & Executive Search. With over 40 years of experience in airport runway safety and security, Bratton brings valuable expertise to delve deeper into project topics and assist the team in understanding the improvements needed to address FOD issues.

During the team's first interview with Bratton, one of the main questions posed was how people previously dealt with the problem. According to Bratton's response, for the past 50 years, airports heavily relied on humans to physically detect any potential FOD left on the runway (Bratton). These insights truly sparked the ideation process, affirming that the project's underlying goal is to enhance efficiency while reducing costs.

Problem-Solving Approach

Point of View Statement:

We met Barry Bratton, an airport industry professional with years of experience in detection of foreign object debris (FOD) and management of airport safety systems. We were surprised at how he described that numerous small airports rely on people to scan runways with their eyes for FOD. He also mentioned that when it comes to conversations about better methods for detection of FOD, airport officials are all ears. It would be game-changing to develop a small metallic FOD detection and removal system that efficiently cleans up runways.

Ideation:

The ideation activities used were two round-robin style brainstorming processes. The first round-robin activity consisted of all the group members writing down any and all ideas they could think of to solve FOD issues at airports, no matter how outlandish some of the ideas were. Each group member would then pass their list of ideas to the next group member where everyone would generate a new list of ideas based on what the previous team member wrote down, repeating this process till everyone had the paper they started with again. As for the second round robin ideation activity the team selected the area of FOD which the previous ideas generated showed the most promise in solving to focus on. Then, following the same process, the team generated as many ideas as possible on small hard to detect FOD. From these activities, some of the top ideas generated included computer vision, autonomous runway-cleaning cars, FOD Detection drones, etc. The idea which continued onto the prototyping phase of the project was a topographical FOD detection roller. The whole idea of this being that a roller with force sensing resistors covering the surface in order to detect small FOD using spikes in force picked up by the sensors. Some feedback the team received on this both from an accomplished Penn State engineering graduate and an industry expert were that this solution is very unique and unlike anything they've seen.

Figure 2: Supplemental Image of detection idea used in ideation process

Figure 3: Supplemental image of FOD type chosen to give a visual representation of the FOD type

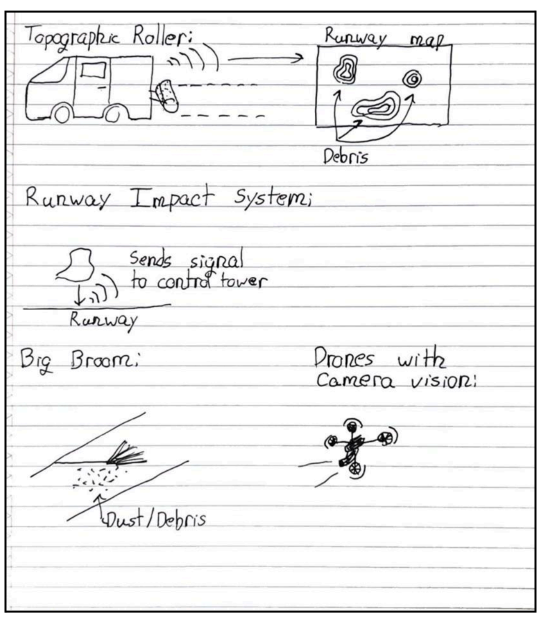

Figure 4: Image of initial drawings made in the ideation activities described

Rapid Prototyping:

Decision Matrix

The ideation activities allowed the team to pick out five distinct ideas for FOD detection and removal. Each solution had its own advantages and disadvantages, so to analyze them further and find the best solution to rapid prototype the team used a decision matrix. The team used various categories such as cost, durability, feasibility, originality, environmental sustainability, and ease to implement, each weighted according to their importance in the team's decision criteria. The team created the below matrix [*Figure 5*] and ranked each idea from 1st to 5th in each category.

		Selection Criteria (Ranked 1-5)								
		Cost (x2)	*Durability (x1)*	*Feasibility (x2)*	*Originality (x3)*	*Environmental Sustainability (x1)*	*Ease to Implement (x3)*	*Total (Lowest Score is Best)*	*Rank*	*Continue?*
Solutions	*Topographical Roller*	2	4	2	1	2	1	20	1	Yes
	Computer Vision Cameras	1	1	1	5	1	2	27	2	No
	RC Drones	4	5	4	3	4	4	42	4	No
	RC Cars	3	3	3	4	3	3	39	3	No
	Big Broom	5	2	5	2	5	5	48	5	No

Figure 5: Evaluation of solutions through the decision matrix

This step left the team with one clear solution among the five top ideas, a topographical roller. This idea ranked highly in most of the categories, with only computer vision cameras coming close. The team chose to only move forward with the roller instead of prototyping the computer vision cameras as well since this idea was the more original and would be simpler for the team to prototype with the team's given expertise.

Rapid Prototypes

In order to have a better visualization of the team's idea to show shareholders and experts, the team made two rapid prototypes of the topographical roller. The first of these prototypes is a sketch of the topographical roller as seen below [*Figure 6*]. This shows the team's original ideas on how the inside of the roller would look like, containing spring-based pressure sensors to detect any FOD. There is also another sketch showing how this role may be hitched to the back of a vehicle so it can be used in conjunction with FOD checks that are already carried out at airports throughout the day. The team's second prototype is a rapid physical model of the topographical roller to convey how the exterior structure may look as seen below [*Figure 7*]. This modal used foam, paper, string, popsicle sticks, and paper clips to form the outside shell and show how the structure would be towed. Using these prototypes the team was able to get expert and shareholder feedback to incorporate into the final prototype.

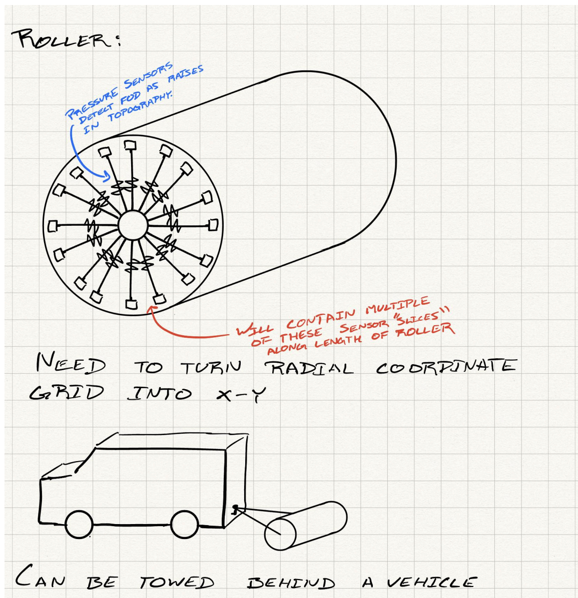

Figure 6: Topographical Roller Sketch

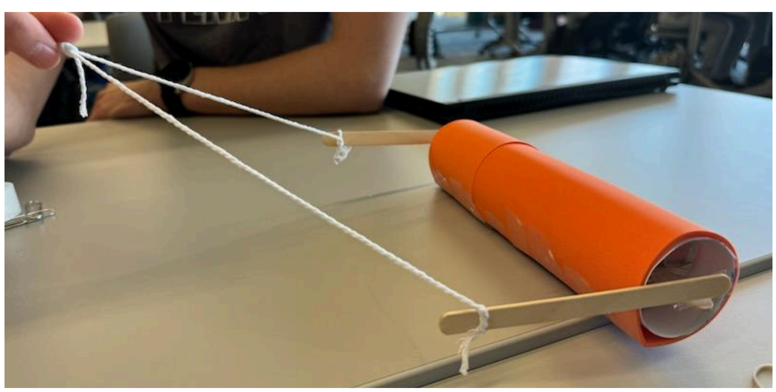

Figure 7: Topographical Roller Rapid Physical Model

Expert and Stakeholder Feedback

In the last part of the rapid prototype phase, the team contacted Barry Bratton again to gain feedback on the rapid prototype as the team moved into the final prototype design and build. In addition, the team also gained feedback from the team's engineering alumni, Braden Heisler, as an expert in the engineering field. There was a lot of feedback the team gained from these experts that were considered for the final prototyping phase. Mr. Bratton suggested implementing a trailer hitch to tow the roller so it could be pulled by a wide array of vehicles, considering the gradient built into runways for runoff that the roller would need to take this into account to lay flat on the runway, and building into the software a way to label imperfection in the runway that may cause false positives. Mr. Heisler suggested having software that immediately alerts the driver of the vehicle if FOD is detected rather than once the mapping is completed, and instead use the mapping for long-term data collection for long-term mitigation strategies.

Final Prototype:

After conducting the decision matrix and discussing the team's options with an industry expert the team decided to focus on the topographical roller design and to continue to develop a finalized prototype for this project. After conducting further research into sensor technology to create the prototype the team discovered that linear displacement sensors would suit the original design best. However, these sensors turned out to far exceed the team's prototyping budget so a cheaper alternative was found with force-detecting resistors. The team then began to model the design in SolidWorks to decide how to best create a physical prototype that best represented what the device was designed to do. The finalized model of the roller can be seen in [*Figure #8*].

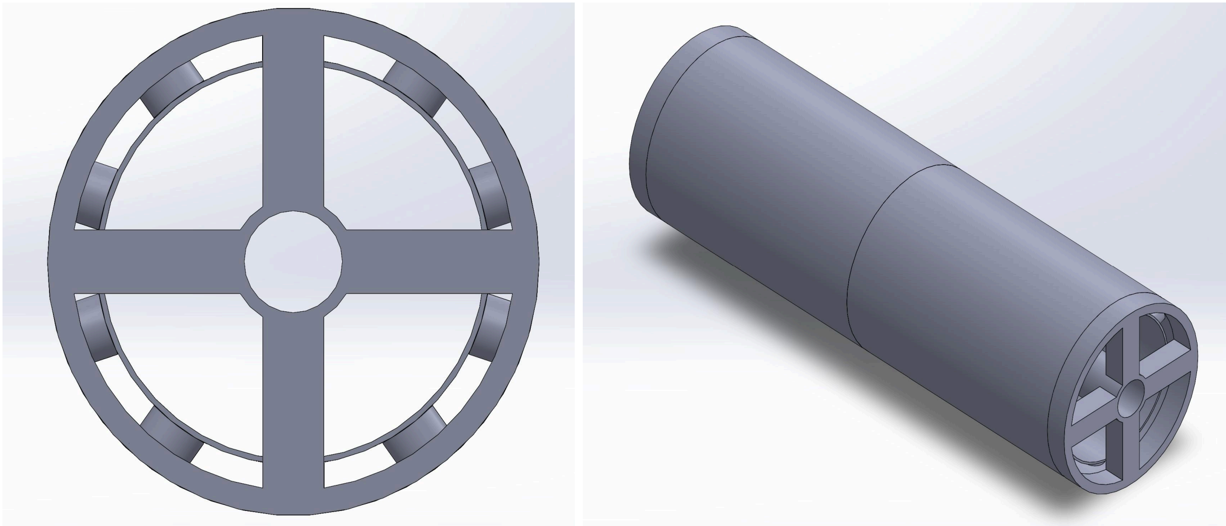

Figure 8: Topographical Roller 3D Model

After creating the model the team then decided that the best way to show how the device detects FOD would be to 3D print a slice of the scaled-down roller with one of the aforementioned force-detecting resistors placed on the surface of the structure seen in [*Figure #9*]. The sensor was then covered with a protective layer that the team decided would be rubber, like a tire, in the final product.

Additionally, the team developed software to work in tandem with the roller that would present the force detected as a function of time that gave live updates in order to alert the operator of the device of any detected FOD as soon as it meets the roller. The software does this by presenting a spike in force on the graph as well as a loud alarm sound to ensure the driver doesn't miss anything as seen in *[Figure #10*] and [*Figure #11*]. The software was developed to take input from the force sensor through an Arduino that was then connected to a computer to output the data.

The force sensor works as a resistor whose resistive value varies based on the amount of pressure applied to it. When no pressure is applied it has infinite resistance and when you apply pressures the resistance drops. To read this data, the team combined the force sensor with a static resistor to create a voltage divider that produces a variable voltage that can be read by the analog-to-digital converter in the Arduino as seen in [*Figure #9*]. The team-developed software takes a reading every one millisecond and then converts the voltage drop across the pull-down resistor to the voltage dropped across the force sensor, which can then be converted to how many newtons of force are being sensed. Using Javascript, HTML, CSS, and Node, the team was then able to develop a functioning website that was able to take the output of the converted Arduino data, display it, and alert anyone on the site if FOD is detected as seen below in [*Figure #10*] and [*Figure #11*].

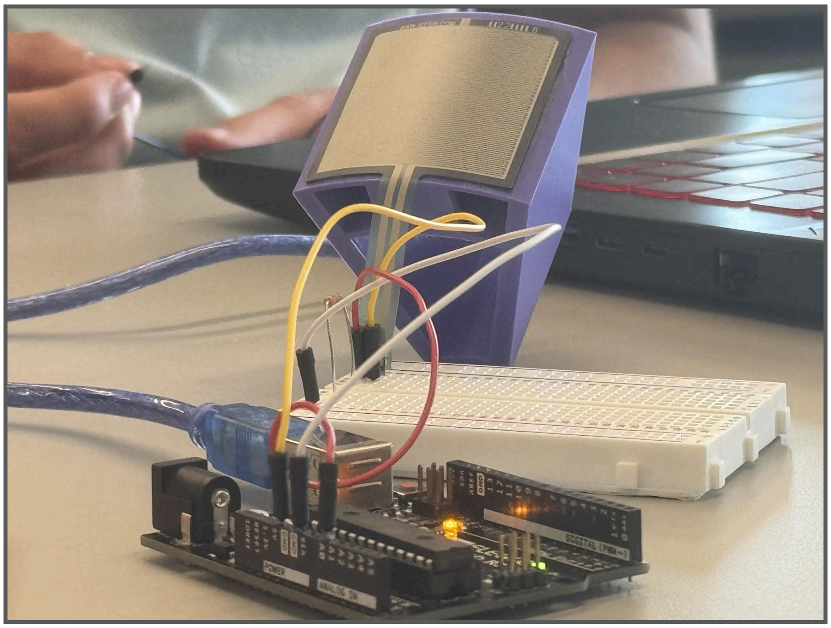

Figure 9: Final Prototype

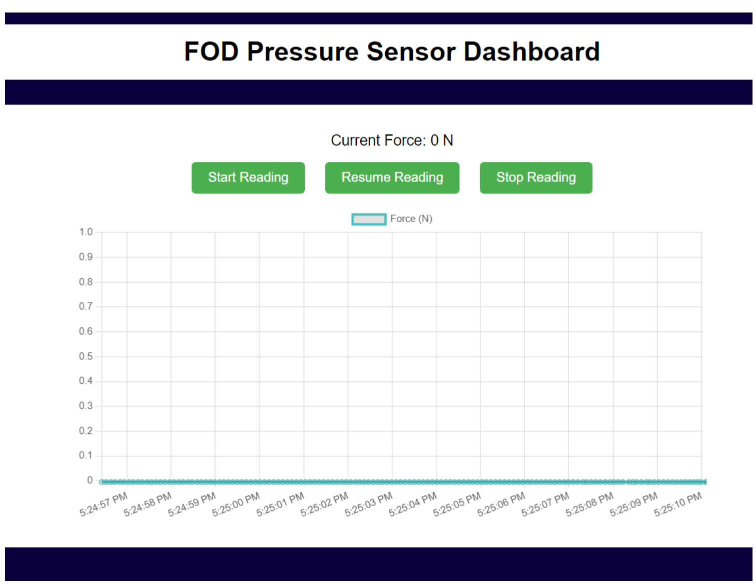

Figure 10: Software With No FOD Detected

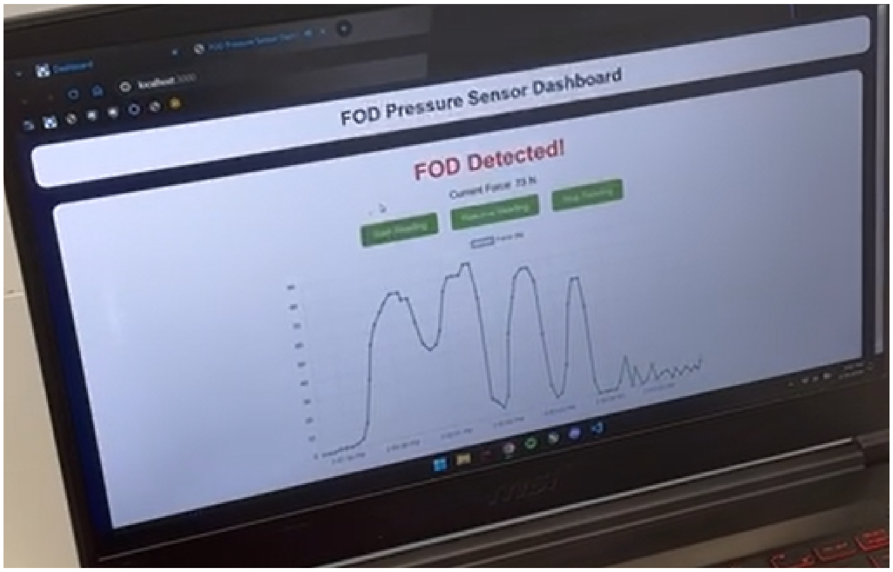

Figure 11: Software With FOD Detected

Future Modifications/Improvements:

The team's prototype covers the basic concept of how a small slice of the roller would work in a much larger design. However, there are many future modifications that need to be considered and improvements the team would like to make in the future. Firstly, the team would like to develop a full-sized prototype that includes all the sensors and is made of a high-quality steel frame and rubber protection on the outside. This will allow the team to figure out how to wire the components correctly in a cylindrical object and how it functions at a full scale when being towed. Secondly, the team would like to make all the sensor components run off batteries that then can be wirelessly transmitted to the software without having to be physically plugged into a computer. This will allow for easy transmission of data to the driver and to other access points in the airport that may monitor this data. Lastly, the team would like to implement long-term data collection using an onboard GPS that tracks where in the runway FOD is being detected. This will allow the use of long-term data analysis and machine learning to determine the spots where FOD is mostly accumulating and allow the airport to implement long-term solutions that can minimize the amount of FOD in the future. In addition, this can allow for the input of places where false positives happen in the runway due to bumps or cracks so the sensor can ignore these for a more streamlined process.

Risk Analysis

In order for the team's design to even be eligible for use in a high-risk environment such as an airport a thorough investigation is necessary to evaluate all the risks and their mitigations. The team utilized a risk matrix to ensure no situation that the DebriScan could be put into would create an unacceptable risk for passengers or airport personnel. This risk analysis allowed the team to be more prepared for potential risks and to mitigate them before they ever become a problem.

Several aspects of the design had to be considered to ensure that the team did not miss any major risks associated with the design. The most important risks that the team identified were the possibility of dangerously displacing FOD, breaking down, delay to airport schedule, false positives/negatives, and the potential of parts falling off the device and creating even more FOD. While some of these risks are much more severe than others, all of them were determined to be unacceptable risks without mitigation. These mitigations include but are not limited to things such as limiting maximum operational speed, allowing the purchase and requisition of spare/replacement parts, implementation of roller into already scheduled checks, and routine inspections. With these mitigations, the team determined that the risk had been reduced to an acceptable level as seen in [*Figure #12*]. The full list of mitigations can be found in [*Table #1*].

Severity / Likelihood	Minimal 5	Minor 4	Major 4	Hazardous 2	Catastrophic 1
Frequent A			4		
Probable B			3	1	
Remote C		2b	2a 3a 4a	5	2
Extremely Remote D		1b	3b 4b	1a 5a	
Extremely Improbable E					

Unacceptable Risk
Acceptable Risk with Mitigation
Acceptable Risk

Figure 12: Risk Matrix

Table 1: Table of Risks and Mitigations

#	Risks
1	Dangerously Displacing FOD
2	Breaking Down
3	Delay to Airport Schedule
4	False Positive/Negatives
5	Parts Falling off and Creating More FOD
	With Mitigations
1a	Limit maximum operational speed
1b	Implement driver alert system
2a	Allow purchase/requisition of spare parts
2b	Provide a manual with purchase to inform buyer of repair instructions
3a	Limit usage of roller to slow times, as in early in the morning and late at night
3b	Use with already implemented schedule to look for FOD
4a	Calibrate sensors to runway
4b	Track history of spots where false positives would happen
5a	Routine inspection of roller

Cost Benefit Analysis

For the Cost Benefit Analysis the team decided to split the costs up into three specific categories, as well as an extra overhead and profit cost of 25%, starting with research and development seen in [*Table #2*]. These costs consisted of items that the team determined to relate directly to the development of the device such as labor costs of design development, prototyping materials, and labor costs to test the design.

Table 2: CBA R&D Costs

Phase	Item	$/hour	$/unit	Hours or Units	Subtotal
Research & Development	Engineering design	$ 45		640	$ 28,800
Research & Development	Prototyping materials		$ 1,000	1	$ 1,000
Research & Development	Software development	$ 40		120	$ 4,800
Research & Development	Physical prototype development	$ 30		480	$ 14,400
Research & Development	Testing	$ 20		80	$ 1,600

The second category that the CBA was split into was Production, Marketing, and Distribution seen in [*Table #3*]. In this segment, the team had to think a lot about labor costs of many different industries which resulted in being quite a challenge due to the team's lack of industry knowledge. For the values, the team did some research into what rates jobs in the industries added to the CBA averaged as well as used some educated guesses when it came to things like the delivery cost. It can be clearly seen in [*Table #3*] that this was the most cost-heavy segment of this analysis.

Table 3: CBA Production, Marketing, and Distribution Costs

Phase	Item	$/hour	$/unit	Hours or Units	Subtotal
Production, Marketing, Distribution	Skilled assembly labor	$ 21		1500	$ 31,500
Production, Marketing, Distribution	Marketing/sales labor	$ 25		240	$ 6,000
Production, Marketing, Distribution	Logistics labor	$ 37		300	$ 11,100
Production, Marketing, Distribution	Engineering management	$ 75		250	$ 18,750
Production, Marketing, Distribution	Product materials		$ 15,000	2	$ 30,000
Production, Marketing, Distribution	Delivery		$ 250	2	$ 500
Production, Marketing, Distribution	Marketing materials		$ 100	1	$ 100
Production, Marketing, Distribution	Product installation labor	$ 23		48	$ 1,104

The third and final section the team split the costs into was operations and maintenance seen in [*Table #4*]. This category consists of various ongoing costs that would be required to upkeep and maintain the DebriScan device. The subtotals seen in the table are calculated assuming this analysis was run over the course of three years of operation of the DebriScan and this is why all the values appear to be three times as large as they should be.

Table 4: CBA Operations and Maintenance Costs

Phase	Item	$/hour	$/unit	Hours or Units	Subtotal
Operations & Maintenance	Fuel		$ 1,100	1	$ 3,300
Operations & Maintenance	Worker training		$ 2,000	1	$ 2,000
Operations & Maintenance	On-site technician	$ 40		48	$ 5,760
Operations & Maintenance	Technician travel expense		$ 500.00	1	$ 1,000
Operations & Maintenance	Replacement sensor disk		1000	2	$ 6,000

After all these categories the team added a subtotal and overhead and profit margin of 25% seen in [*Table #5*]. As it can be seen in the table the total cost that the team determined the DebriScan to cost an airport over three years was $209,643 which seems like a lot of money however it can be seen that in the benefits analysis, this is quite reasonable.

Table 5: CBA Subtotal and Overhead/Profit Costs

Phase	Item	$/hour	$/unit	Hours or Units	Subtotal
Subtotal, internal cost					$ 167,714
Overhead & profit, 25%					$ 41,929
Sales price and annual technical service fees charged to airport: internal cost + markup					**$ 209,643**

After determining the list of costs that the airport would have to endure the team went on to create a list of benefits which, for this team, consisted of several costs that the airport would be avoiding as the DebriScan is not a revenue-generating source. To decide on a list of benefits the team first thought about tangible costs that this device would be reducing, such as decreased damages to aircraft, before moving onto intangible costs, such as decreased number of delays. As seen in [*Table #6*] this totaled $6,600,000 in reduced costs to the airport over three years. This meant that the payback period would be 0.09 years.

Table 6: CBA Benefits

AIRPORT benefits					
Benefit, tangible	Decreased damage costs to airplanes	$ 2,000,000		1	$6,000,000
Benefit, tangible	Decreased FOD detection labor	$ 50,000		1	$ 150,000
Benefit, intangible	Enhanced safety		$ 50,000	1	$ 150,000
Benefit, intangible	Decreased number of delays		$100,000	1	$ 300,000
Total Benefit					**$6,600,000**

Future Implications

DebriScan's incorporation in FOD detection operations for airport runways will reduce the risks associated with missing minuscule specimens of FOD, saving individual airports several millions of dollars in damages annually. The use of technology as opposed to the commonly applied manual eye-check will reduce erroneous possibilities and avert catastrophic accidents like that of Air France Flight 4590. In addition, DebriScan's long-term data collection of where FOD accumulates will prove helpful to airports in the long run as operations personnel can focus on mitigating such accumulations. This feature enables airports to save costs in damages and prevent delays much more frequently. With reductions in costs and delays, airports can now use that time and money to run more flights and improve upon leisure and commercial facilities. These focused improvements allow for greater revenue through those facets and more interest from potential customers/passengers.

Overall, DebriScan not only reinforces practices of safety at airports, ensuring that there is minimal risk to flight operations but also opens the door to liberating airports from severe damage costs and delays. With such freedom, airports can now focus on improving the customer experience while keeping up with the modernization of safety practices.

Appendix A: Contact Information

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Appendix B: University Description

Penn State University is an institution of higher education in Pennsylvania. It houses the college of engineering which includes numerous engineering degrees at both the undergraduate and graduate levels. The college of engineering supports an undergraduate minor in engineering leadership in which undergraduate engineers can build the non-technical skills to support the great technical skills they are developing through their engineering curriculum. The engineering leadership development program offers students classes in project management, leadership education and development, business basics, and cross cultural teaming. Students in the minor are dedicated to building these skills in addition to the technical work load required of their discipline's curriculum. The engineering leadership program also offers a graduate program in the form of a master of engineering and an online graduate certificate in Engineering Leadership and Innovation Management.

Appendix C: Industry Experts

Barry Bratton - Senior Consultant at ADK Consulting & Aviation Expert

Throughout the interview with Mr. Bratton, the aspect the team mainly focuses on is to reduce the risk of accidents and the cost of operations. And based on that the team came up with sets of questions regarding the current solution for FOD.

1. How serious the damage will be if the FOD happen on the modern airplanes with better hardware setup?
2. What are some of the current solutions for the FOD, and how much will it cost the airports to maintain that?
3. What type of FOD have the most damage on the airplane?

Appendix E: Educational Experience and Evaluation Questions

Students:

1. Did the Airport Cooperative Research Program (ACRP) University Design Competition for Addressing Airports Needs provide a meaningful learning experience for you? Why or why not?

The ACRP challenge provided a meaningful learning experience for all team members in each respective lead period. By giving each team member a section of the project to lead in, every member was able to lead and organize a team efficiently. Additionally, it showed every group member what kind of leadership strategies work and don't work depending on the kind of people on the team.

2. What challenges did you and/or your team encounter in undertaking the competition? How did you overcome them?

Some of the various challenges that the team encountered in undertaking the competition were determining which idea was best to continue with for prototyping, how to best delegate tasks, and how to adapt to the cost requirements of prototyping. To overcome the choice of what to continue with for prototyping the team continued brainstorming on each idea in order to determine how far the idea could be taken and expanded which led to the team deciding on the DebriScan roller in the end. As for delegating tasks, each team member in their lead period tended to delegate tasks based on what each member was most interested in working on which kept all members motivated. Lastly, to combat the expensive cost of prototyping material the team researched and found a cheaper alternative to the sensor intended for the product initially which helped to massively decrease the prototyping cost.

3. Describe the process you or your team used for developing your hypothesis.

The team started by identifying what areas each member was most interested in working on, and then discussed all team members strengths and weaknesses and how these would apply to each category of the project. The team ended up discovering that the majority of group members had a broad knowledge of physical prototyping and products rather than software which led to the choice of FOD detection and removal for the focus topic. The team then brought the ideas generated to an industry expert who helped the team narrow their prototype to one idea.

4. Was participation by industry in the project appropriate, meaningful and useful? Why or why not?

Participation by the industry was appropriate, meaningful, and useful in many ways beyond what the group had envisioned. Speaking with an expert in the airport and FOD detection industry helped the team to gain insight to the more specific details of FOD such as what kind of FOD gets missed the most, how much damage FOD costs airports, how different airports deal with FOD, etc.

5. What did you learn? Did this project help you with skills and knowledge you need to be successful for entry in the workforce or to pursue further study? Why or why not?

During the course of this project, each group member learned both how to organize and lead a team more effectively. Having each team member lead the team through a different phase of the project helped all members become more adept in leadership through lead periods that played to their individual strengths. This project equally helped all team members become more prepared to both work with teams and enter the workforce because it showed all team members the best ways to work with team members, and how to resolve conflicts and lead effectively.

Faculty perspective:

l. Describe the value of the educational experience for your student(s) participating in this competition submission.

Students in our leadership course are learning how to lead within the engineering context. This project provides an exceptional and organized experience for our engineering students to apply the knowledge and their personal leadership style as they lead their teams throughout the semester. The challenges provided mimic a real-world experience giving students an opportunity to practice both technical and non-technical problem-solving skills.

2. Was the learning experience appropriate to the course level or context in which the competition was undertaken?

Yes, the learning experience was appropriate for the level of our students and fit within the context of our learning environment, per the note above.

3. What challenges did the students face and overcome?

Students faced some challenges getting in touch with experts and through that learned how important it is to talk with the “user” in order to come up with the best solution. Some students tried to jump ahead to the solution and not work through the design process to use all the information gathered in order to come up with a creative solution. They learned that user-centered research is important when coming up with solutions to challenges.

4. Would you use this competition as an educational vehicle in the future? Why or why not?

We have used this competition as an educational vehicle for the past several years. The competition structure allows us to combine innovative project development via the 5-stage design process while giving student teams opportunities to learn about leadership.

5. Are there changes to the competition that you would suggest for future years?

Yes. We plan to continue to use it based on the organization, the well thought out options for projects, the support, and the industry contacts. Making some of the appendices into an online form would be helpful, and perhaps allowing for one submission of some appendices if a group is turning in multiple projects.

Appendix F: References

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