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Measuring Machine Productivity Using Modern Data Collection System

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Problem Statement

Agricultural manufacturers of all sizes are not able to consistently measure productivity and efficiencies of machines to make effective comparisons between one make and model or multiple makes and models using current data collection systems. This is due to an unchanged metric system that current technology in agriculture uses to measure the productivity. This way doesn't measure non-productive time effectively.

Disciplines

Bioresource and Agricultural Engineering | Industrial Technology

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IOWA STATE UNIVERSITY

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TSM 416 Technology Capstone Project

Measuring Machine Productivity Using Modern Data Collection System

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1 PROBLEM STATEMENT

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Agricultural manufacturers of all sizes are not able to consistently measure productivity and efficiencies of machines to make effective comparisons between one make and model or multiple makes and models using current data collection systems. This is due to an unchanged metric system that current technology in agriculture uses to measure the productivity. This way doesn't measure non-productive time effectively.

Business Case Statement

When a grower is considering purchasing agricultural equipment, they often look for the machine that will offer the greatest productivity inside of their budget. With current agricultural technology, machine manufacturers can record and monitor many productivity metrics; however, there is no standard in place to ensure that all manufacturers are calculating and presenting productivity data the same way to the grower.

2 GOAL STATEMENT

Our fundamental goal is to analyze a few different field productivity regions and make recommendations on our findings that will lead to more discussion and advancements in field productivity standards.

Main Objective

Develop a system that accurately represents field efficiencies and productivity so the customer can then make changes in his/her operation to save time and money.

Specific Objectives

Research current industry standards on efficiency and productivity for major farming operations. Then, recommend definition for industry standards for non-productive time calculations and suggestions on how to calculate using current systems with current or additional enhancements to logic. Also, to develop a full report with assumptions, recommendations, report out with pre-read, formal presentation with Q&A, and additional time to re-work areas that have unanswered questions.

Rationale

The best result is to produce a system that exhibits use of the measurements on a working farm. This system will record the results of our measurements during testing, provide customer feedback, as well as refine recommendations for the customer (farmer).

3 PROJECT PLAN/OUTLINE

Approach

During this project, we referenced various standards that already exist on the market such as ASABE or Nebraska Tractor Test Lab. We began to make recommendations to improve these standards so we can compare various agricultural equipment to one another. The end goal will be to have a system that farmers and customers can relate back to so that they can justify buying a certain piece of equipment versus its competitor.

Data collection

We analyzed the current standards and determined where there need to be improvements. These improvements can be influenced by environment. For example, the standard that we create is to be used in real field work and not on a test course or paved roadway. This will help the customer to make real world decisions that can positively affect their operation.

Skills

Being that all of our team members come from slightly different backgrounds, it gives us a variety of knowledge that helped us to determine a solution. We could do research on different standards to learn what information was available currently. What we learned was the definition of industry standards regarding field efficiencies, what time is included in the metric to calculate field efficiencies, a definition for non-productive time. The skills needed to complete this project are research, knowledge of industry standards, and the ability to use information on JDlink. The classes that are used most in this project would be TSM 330 and TSM 333.

Solutions
Comparing past industry standards, we found that many resources show a high variety of constraints. We sought after to develop a system that would unify these statistics as what make or model a grower should invest in. To do this, we broke apart past data, from a corn grower in Eastern Iowa, into headland productivity vs. center of the field productivity. Overall, we found that field efficiencies between headland and center to be within 5% of one another, we can conclude that there is no direct correlation between the two.

Organization
Our team has communication with each other and our client every week. There are consistent email communications as well as skype, phone, and we have traveled to meet in person as well. We have a plan that is open to our client and we have weekly milestones to keep us all accountable. Each team member has a responsibility that varies each week, this means that the milestones change for each person every week. Our major milestones throughout this project were determining that there is no standard available to calculate unproductive time, determining an algorithm that can be used to show unproductive time in the field, and using real world data to implement our algorithm. Unexpected setbacks during our project didn't keep us from accomplishing out goals. When a setback occurred, for example, we had a difficult time obtaining multiple forms of data for our testing, we used what we had and continued completing our project.

Deliverables
We want to be able to consistently measure machine performance, create a better way to measure headland, breakdown and other non-productive time, and measure performance across multiple types of equipment and manufacturers. The best way to achieve this is to implement a monitor prompt system that tracks why an operator has stopped productivity. If the operator gets up out of the seat while the tractor is stopped, a pop-up window will display options that are related to its field operation. For example, if a grower is planting and stops to check its seeding depth, a window will pop up on the GPS monitor asking why he got out of the seat with the options: check seed depth, refill planter, planter breakdown, operator break, or other. At the completion of a field, a summary of the field operation will be emailed to the grower displaying how much unproductive vs productive time was spent in the field and its reasoning. An example of this summary is below in Figures 1 and 2.

4 BROADER OPPORTUNITY STATEMENT

This project is appealing to those who work in an agriculture environment. This concept is relatively simple to understand because it is just the equations behind how efficient different machines in different applications are. Our project addresses many big challenges we face in everyday life, such as providing jobs, creating greater efficiencies (reduced ozone emissions and less fuel cost), and improving health by growing food to feed the world. We plan on our project creating jobs by, companies hiring people to interpret the data regarding the unproductive time on a farm, and then comparing it to other tractors of similar size to see which is the most efficient. This also relates to improving energy efficiency, if you are using less energy to do the same amount of work versus using out of date equipment that is less efficient and produces a lot more emissions while operating.

The leading implement companies should care because they need a way of showing why their machine is actually better for a customer's operation than one of a different brand. This solution can mainly be applied to the agricultural industry, but also the construction industry. Many companies are currently trying to manipulate the current standards in a way that benefits them the most and showing the skewed information to the customer to hopefully generate a sale. They are avoiding the risk of a versatile equation that can be substituted in for every make and model to show a real comparison and put the power back in the farmer's hands.

Companies are willing to spend a great deal of money to accurately monitor the true performance of their machines and compare it directly to the competition. This is going to generate both income and costs savings in the long run, due to many companies will have to reevaluate the performance of their machines, while others will have the more efficient machine and be able to make the sales due to direct comparisons of machine performance and efficiencies rather than a skewed test that misleads the customer.

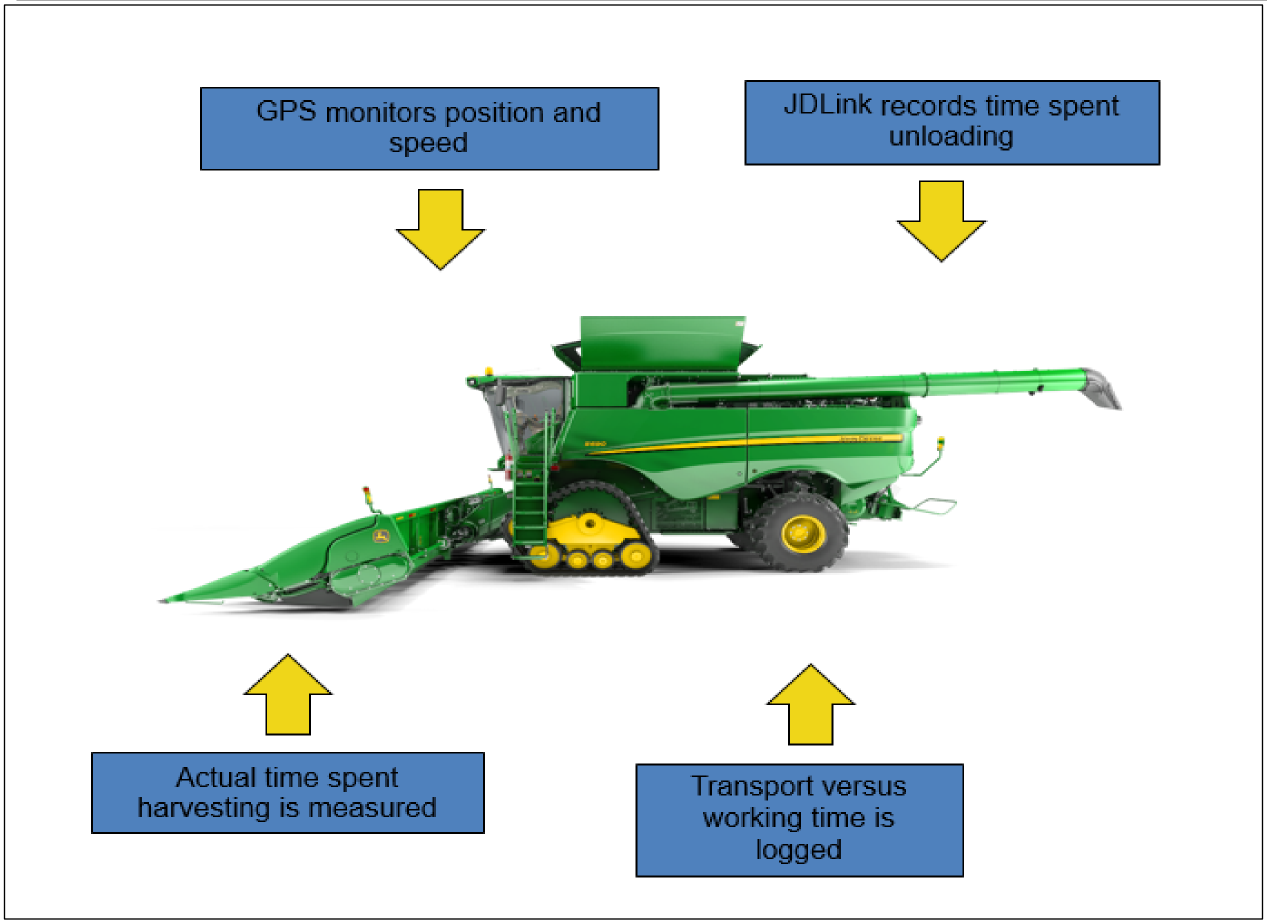
5 Project Scope

For this project, the main constraints that we must adhere to are the field boundaries. When talking to our industry representative he expressed to us that he would like us to focus on the operations and time spent in the actual field itself and not to focus on things such as travel time or preseason preparations.

The first step of this project is to research today's standards in field efficiency in order to understand and expand on them. The final step for this project is to report back to John Deere with our findings. This might include a working, interface calculator, real world testing of our standards, or simply just an update and report on the standards we chose to work on. Unfortunately, the main thing outside of our boundaries is actually sitting in a tractor or combine during harvest or planting with a stopwatch to get actual data to compare to current standards. This would be a huge help but field operations will not line up with our project due dates.

For our project, we will be working with the John Deere Intelligent Solutions Group out of Urbandale as well as an engineer at the John Deere Waterloo Analytic Center of Excellence. By working with our contacts we hope we can develop an updated standard equation to calculate efficiency.

6 Graphical Abstract



7 Appendixes

Figure 1: Theoretical view of the GPS monitor prompt

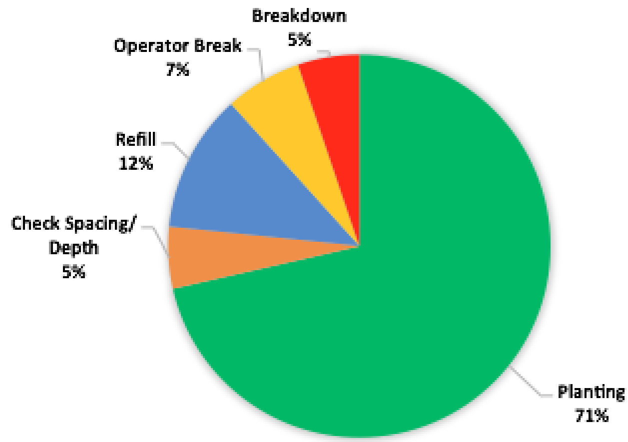


Figure 2: Theoretical pie chart that will displaying operator summery