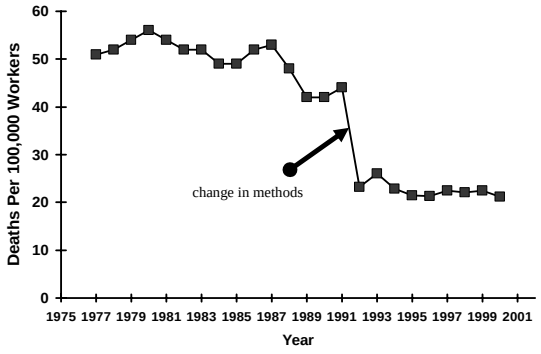
New Tractor Technologies -- Opportunities for Progress

John M. Shutske, PhD
Department of Biosystems Engineering
Associate Professor and Agricultural Safety & Health Specialist
University of Minnesota

Overview

- **We've Made Progress**
- **Future Technologies**
- **Remember Multiple Strategies**
- **Questions, Comments**

National Death Rate in Agriculture

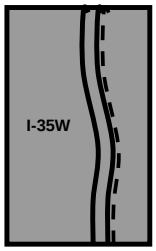


Building on What We've Learned

- **Animal power to mechanical power.**
- **Narrow machines, high CG to wider, squattier machines.**
- **Engineering standards (ASAE, SAE, ANSI, etc.)**
- **ROPS**
- **Ergonomic considerations in design**
- **Capturing and using <u>INFORMATION</u>**

Right Now, With Tractors and Other Types of Machines, We Can Readily Determine:

- **Where is the machine? (with respect to any "dimension" - global, local, within a given property)**
- **Is the machine moving?**
- **Are parts of the machine moving?**
- **Are key components of the machine operating within designed limits? (temperature, position, forward velocity, RPM's, etc.)**
- **Is a person sitting in the seat?**



Newer Wireless Technologies Add a New Level of Intrigue and Possibility

Certainly there must be ag-related applications to positively use these new technologies to improve safety.

Associated Press
Connie Adams testifies during a preliminary hearing in Kenosha, Wis., last month in the case of a man charged with stalking her with help from a satellite tracking device placed under the hood of her car.

Driverless Tractors and Machines

From the University of Illinois - Agricultural Engineering

Need to Apply Systems Safety Concepts - Risk Assessment of Old vs. New Technologies

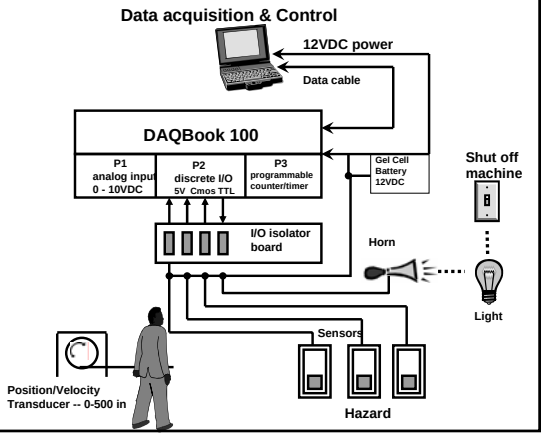
(driverless tractors, robotic milkers, etc.)

- **Basic Hazard Analysis (probability of occurrence and severity of outcomes)**
- **Failure Modes and Effects Analysis**
- **Fault Tree Analysis**

Human Presence Sensors - For Prevention of Machine Entanglements

This research work was funded in part through the Midwest Center for Agricultural Research, Education, and Disease and Injury Prevention: A NIOSH/CDC Cooperative Agreement Program, #U07/CCU507126-09.

1. Shutske, J.M., W. Gilbert and J. Chaplin. 2001. Evaluation of a Microwave/Infrared Human Presence System for Agricultural Equipment. *Journal of Agricultural Safety and Health* 7(4): 253-264.



What We've Learned

- **Multiple sensor technologies needed (performance overlap).**
- **Application in stationary applications is not terribly difficult.**
- **Tying sensor condition (on/off) to shut-off devices on new tractors is not difficult.**
- **Sensor system developed and tested gives about 0.5 to 1.0 second to take action (shut off machine, warn, etc.)**
- **You can buy more time by designing the sensor to "look" out a further distance from the hazard, but you dramatically increase false alarms.**

All This Applies to Future Machines

- **Professor Cole's paper "Cognitive-Behavioral Approaches to Farm Community Safety Education: A Conceptual Analysis," JASH8(2):145-159. (particularly page 155)**

Socioculturist Interpretation

Mr. Simms..and neighboring farmers had great respect for the tractors they used…they knew that their tractors were durable, reliable, easy to maintain, and safe machines…Mr. Simms… and his friends expressed strong loyalty and appreciation for the various brands… Mr. Simms and his peers thought that these older tractors were not originally equipped with ROPS because it was unnecessary and costly…

Furthermore, they believed it remained unnecessary and costly to retrofit …with ROPS. He and his fellow farmers talked and told stories about government regulations that threatened their independent way of life.

They viewed tractor manufacturers equipping newer tractors with ROPS and seat belts as an expensive and unnecessary concession to meddlesome regulations.

What should our balance of efforts be on old vs. new machines and technologies?

Another Guidance Document Due Out Shortly

- **NCR-197 -- Committee on Agricultural Safety and Health Research and Extension**
- **Some key areas related to tractors:**
  - **stability indicators**
  - **high speed ag vehicles (marking, braking, controls, suspension systems)**
  - **enhanced ROPS**

Questions/Comments??

Midwest Center Work - Related to Tractors and Machinery

John M. Shutske

Department of Biosystems and Agricultural Engineering

University of Minnesota

Within Minnesota - Related to Tractors and Machinery

- University of Minnesota sensor/shut- off system efforts.
- Regional Rural Injury Study II -- some focus on tractor injuries in the analysis.
- Proposed work --
  - –further development and application of systems safety analysis tools to examine net risks of old vs. new technologies.
  - –continuing education Institute on safety engineering for industry-based engineers

The Project

- Continuation of 1997-2001 work
- Explore use of low cost security sensors to protect hazard areas
- Focus on stationary equipment
  - –50% of cases involve stationary equipment
  - –Tested tractor and forage box

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Desired Outcomes

1. Test current sensor technologies
2. Analyze mounting height and approach angle
3. Create a functioning prototype system

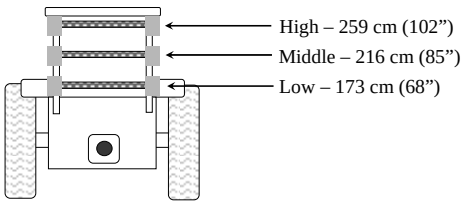
Method

- Design the experiment
  - –Sensors
  - –Heights
  - –Approach angles
- Update distance recording system
- Field testing of sensors
- Variable analysis
- Develop a working prototype

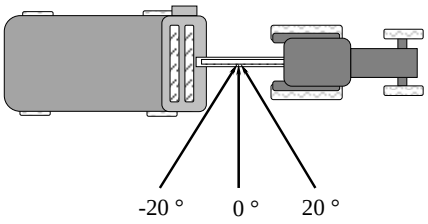
Sensors used

- Commercially available security sensors from Sentrol
  - –Radar
  - –Radar & Passive Infrared
  - –Microwave & Passive Infrared
  - –Passive Infrared

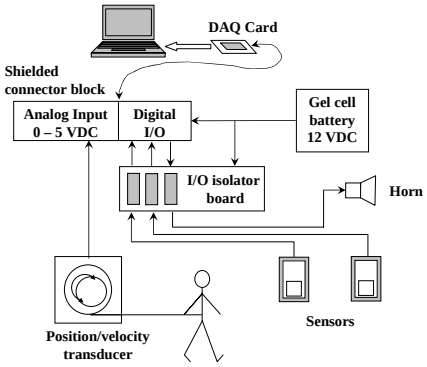
Heights to Test



Approach Angles



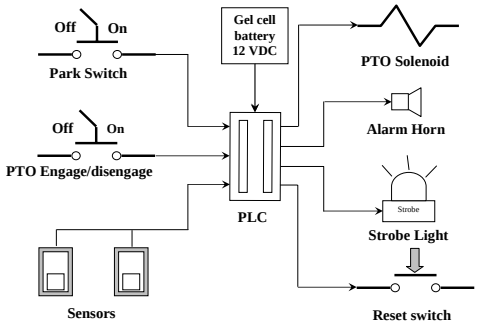
Testing System



Field Testing

- Completely randomized factorial design
- 4 sensors (blocked)
- 3 heights
- 3 approaches
- 8 replications
- Providing 288 walk tests

Prototype System



Conclusions

- Radar was the optimum sensor technology
- Height affects detection distance more than approach
- Applied advanced testing procedure
- Safety system was created that disengaged the PTO

Marshfield ROPS Directory Efforts

- Last printed in 1997
- On web -- 2,024 hits in 2001, 3,339 hits in 2002.

NAGCAT Guidelines

- **Several related to tractors and other machines.**
- **Tractor specific guideline**

University of Illinois Efforts

- **Dr. Zhang, University of Illinois Agricultural Engineering Department**