Autonomy Product Safety at John Deere

Global Environmental, Health, and Safety Policy

General Rule for Product Safety:

- An acceptable design must not present an unreasonable risk of injury to a product user or others nearby.

APPLYING THE GENERAL RULE:

- Consider persons, environmental conditions and other products with which a product is likely to be involved.

Standards:

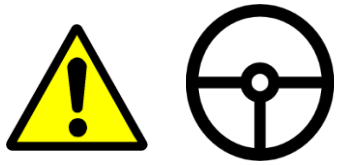
- Meet or exceed the intent of relevant and applicable industry safety standards.
  - Examples: International Organization for Standardization (ISO), American National Standards Institute (ANSI), American Society of Agricultural and Biological Engineers (ASABE)

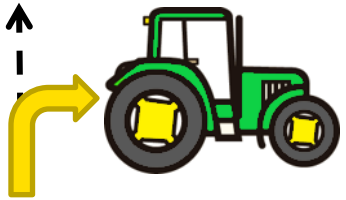
How do we approach Product Safety for Autonomy?

Product Safety is the collection of having the machine perform in a safe manner (Operational Safety), remain safe in the presence of faults (Functional Safety) and has the adequate capability to make safe decisions during operation (Safety of the Intended Functionality).

Product Safety

Operational Safety	Functional Safety	SOTIF
"Function Driven" Guides functional design - Safety Interlocks - Instructions & Warnings - Operate safely - Fail to Safe State	"Fault Driven" Guides design process - Maintain a Safe State - Protect from Hardware failures - Protect from Software faults - Design a robust system	"Performance Driven" Guides performance requirements - Reduce likelihood of a hazardous event - Expected use and misuse - Driven by scenarios



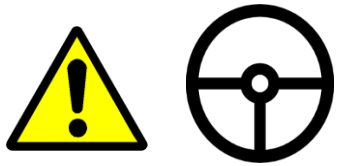


How do we approach Operational Safety for Autonomy?

Operational Safety

"Function Driven"
Guides functional design

- Safety Interlocks
- Instruction & Warnings
- Operate safely
- Fail to Safe State



Operational Safety is *function driven*.

– Define operational conditions and operational design domain

Design measures such as system interlocks, safety signs, operational indicators, and human factors evaluations.

Define the safe state

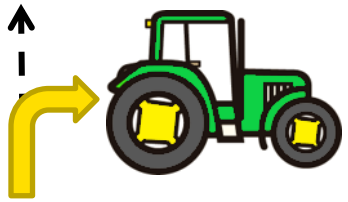
– Most cases for agriculture is to come to a stop

How do we approach Functional Safety for Autonomy?

Functional Safety

"Fault Driven"
Guides design process

- Maintain a Safe State
- Protect from Hardware failures
- Protect from Software faults
- Design a robust system



Functional Safety is *fault driven.*

Achieved through detection and reaction when failures are present.

Defined strategy to bring the machine to a safe state.

– Can include reliability and redundancy methods.

Example: Prevent autonomous motion without indication sequence.

How do we approach SOTIF for Autonomy?

SOTIF

"Performance Driven"
Guides performance requirements

- Reduce likelihood of a hazardous event
- Expected use and misuse
- Driven by scenarios

Safety of the intended function is *performance driven*.

Performance of the safety function under the defined operating conditions.

– Include both the nominal and foreseeable misuse cases.

Examples of System Design Considerations

Zones: areas around machine that need consideration for monitoring and action

Speed: consideration of factors that affect stopping distance to define areas requiring monitoring

Hardware selection: evaluate sensor capabilities against needs for the operational design domain

Image recognition: utilizing training data sets that include a wide variety and variability of items

- Examples include people, vehicles, objects and environments

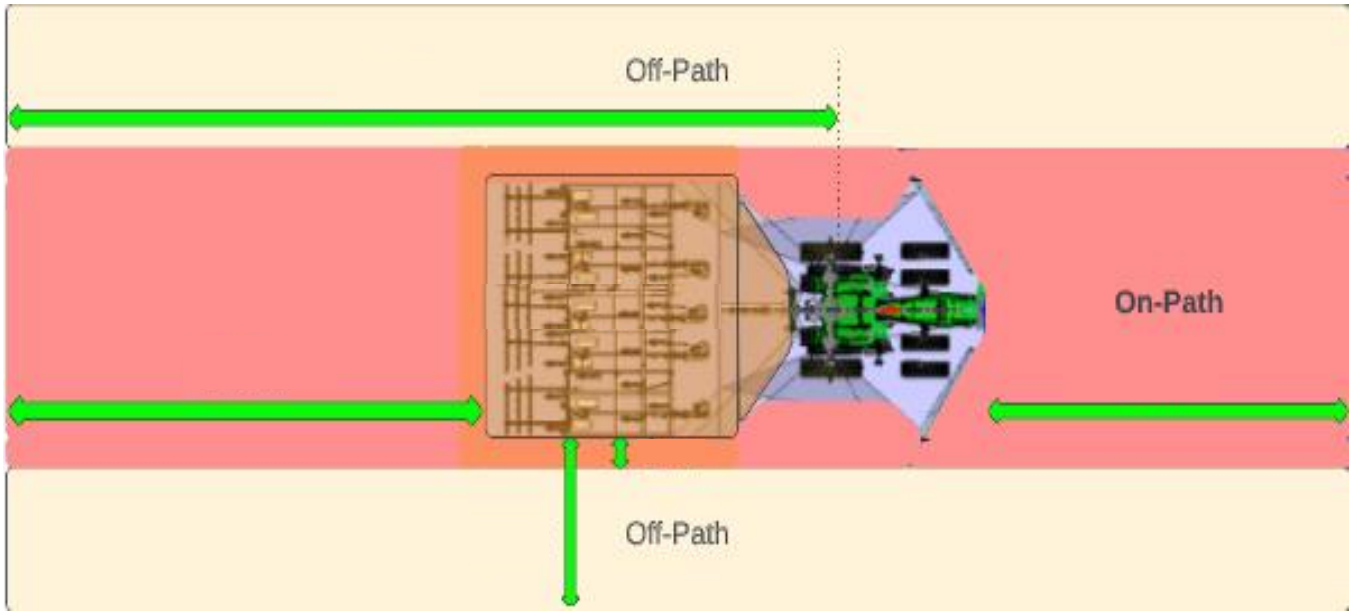


Image is not representative of any current product capabilities, nor to scale.

Process and Methods Utilized

– Product development process

– Testing methods including virtual, simulation, and physical testing

– ISO 12100 – Risk Assessment and risk reduction

– Product safety committee reviews

John Deere's Autonomy Journey

- Built off technology used in the field since 1990's
  - GPS positioning in 1996
  - AutoTrac™ introduced in 2002

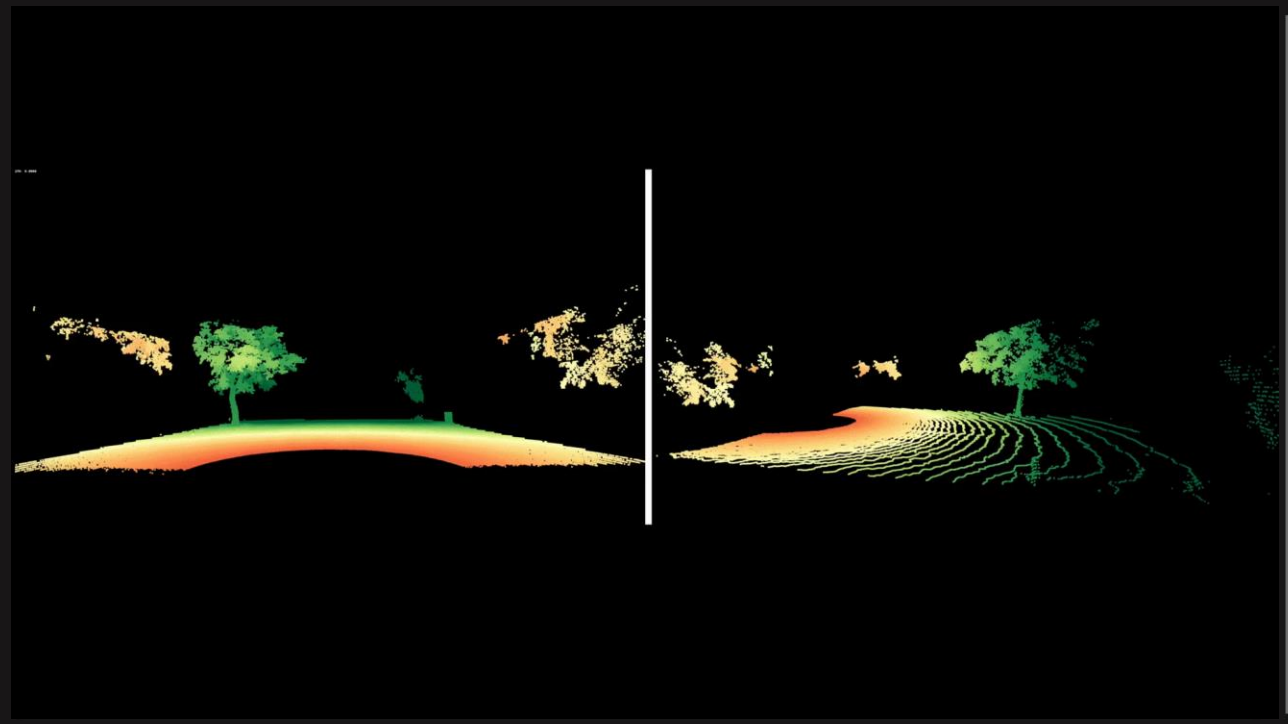
- Introduced autonomous tillage solution in 2023

- Introduced autonomous orchard solution in 2025

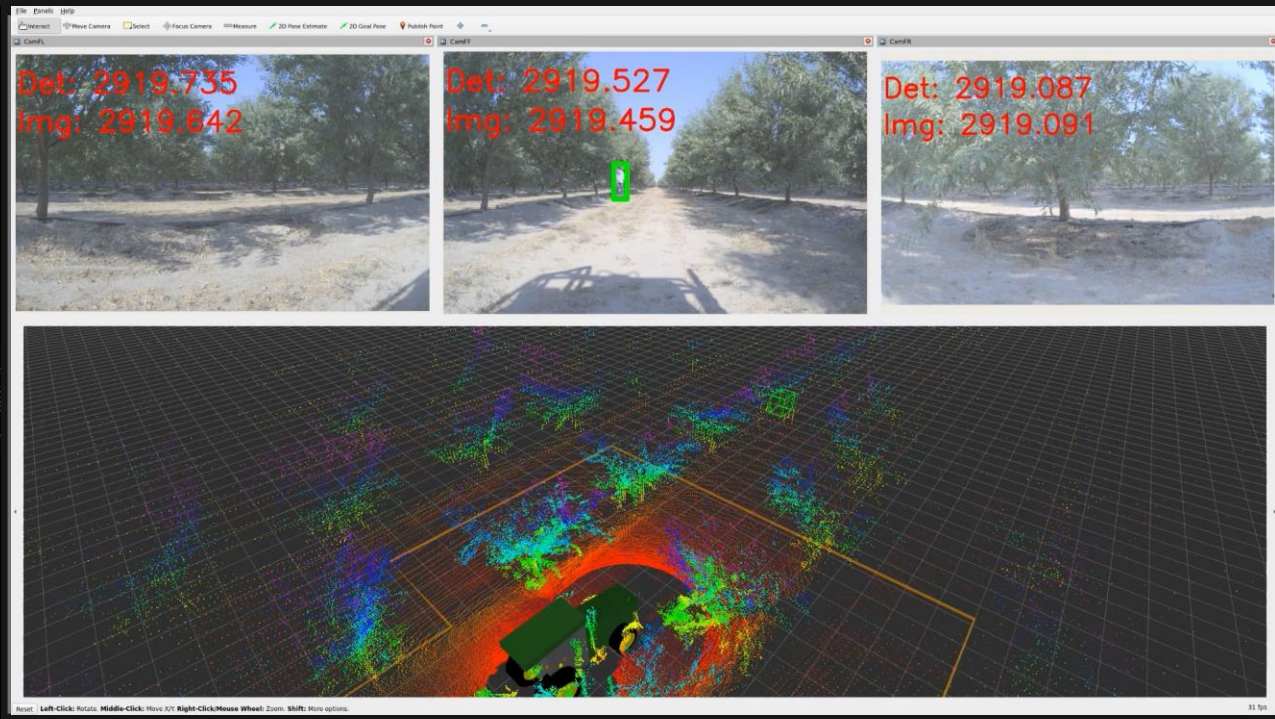

THE AUTONOMOUS ORCHARD TRACTOR

PERCEPTION TECHNOLOGY

PERCEPTION



CAMERA PERCEPTION



Sources Available Externally

Nothing Runs Like a Deere. Autonomously. | John Deere CES 2025 Press Conference
https://www.youtube.com/watch?v=HDzlPrPRBKU


JOHN DEERE