



7 LESSONS LEARNED

IN FIELDING AUTONOMOUS VEHICLES

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MINING PROJECT MANAGER

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WHO WE ARE

- FOUNDED 15 YEARS AGO, ABOUT 100 EMPLOYEES
- LOCATED IN LOGAN, UTAH, USA
- STRONG TIES TO ACADEMIA:

STAFFING ROOTS:

Microsoft

Raytheon



Novell

GENERAL DYNAMICS



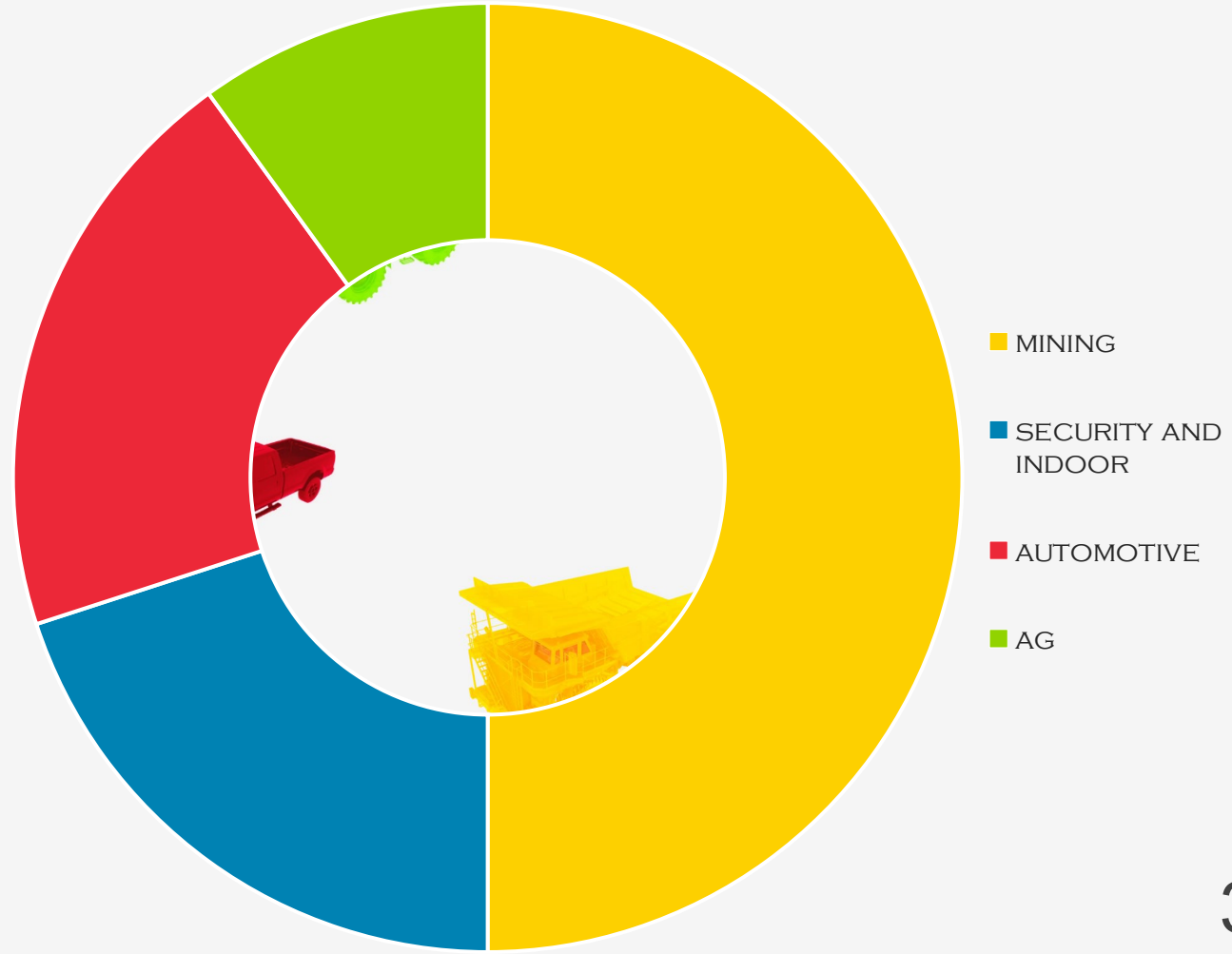


WHAT WE DO

Automate ground vehicle systems

WE ADAPT OUR PLATFORM BUILDING BLOCK ALGORITHMS FOR:

- MULTIVEHICLE BEHAVIOR
- COORDINATION
- OPERATION OPTIMIZATION



ASI FACILITY

- 100 ACRES
- 24 HOUR FUNCTIONAL SAFETY AND DURABILITY TESTING AND SUPPORT
- FIBER OPTIC CONNECTION TO CUSTOMER SITES





7 LESSONS LEARNED

IN FIELDING AUTONOMOUS VEHICLES




LESSON 1

SIMPLICITY

SIMPLICITY

It can never be too simple:

- SIMPLE INSIDE
- SIMPLE TO MODIFY
- SIMPLE TO SETUP
- SIMPLE TO OPERATE
- SIMPLE TO SERVICE

A photograph of a dark blue wall with white text and a white handrail. The text is written in a sans-serif font and is arranged in a list. The handrail is a simple, cylindrical metal bar mounted on the wall with a bracket. The background is a dark blue wall, and the text is white. The overall scene is a close-up of a wall-mounted handrail and its supporting structure.

*Simple inside.
Simple to modify.
Simple to setup.
Simple to operate.
Simple to service.*

SIMPLICITY



“Follow them Home”

- Scott Cook



CO-FOUNDER

SIMPLICITY

Find every way possible to observe how your customers are using your system.

VIRTUALLY FOLLOW THEM HOME

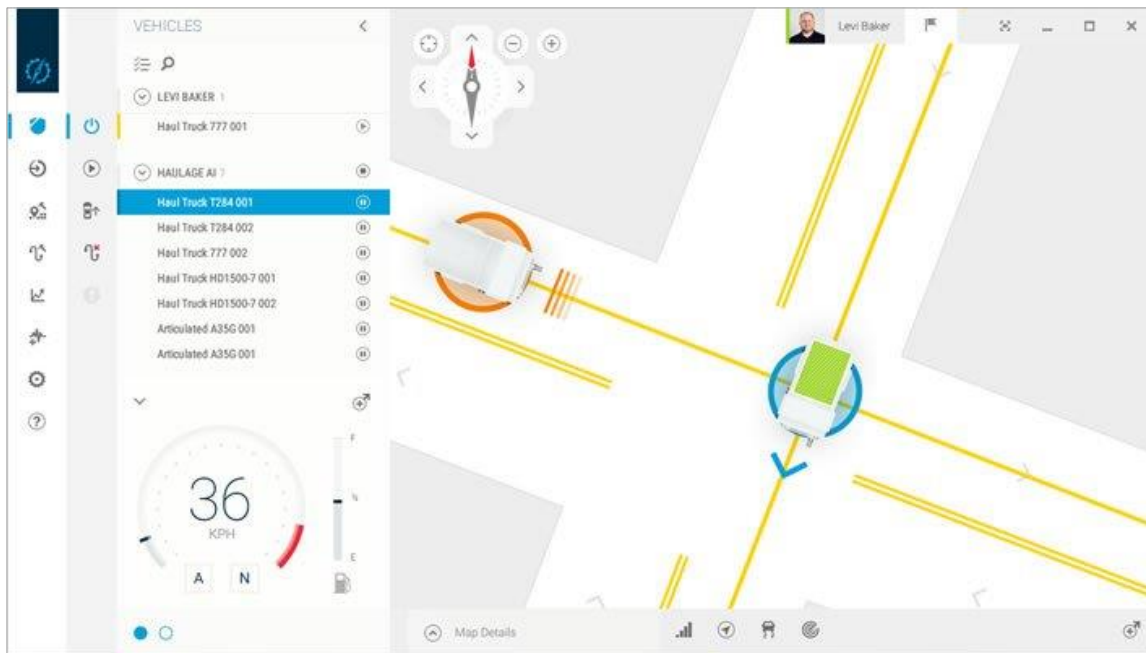
- PRODUCTIVITY DATA IS NOT ENOUGH
- SOFTWARE USE CAPTURE AND ABILITY TO PLAY IT BACK



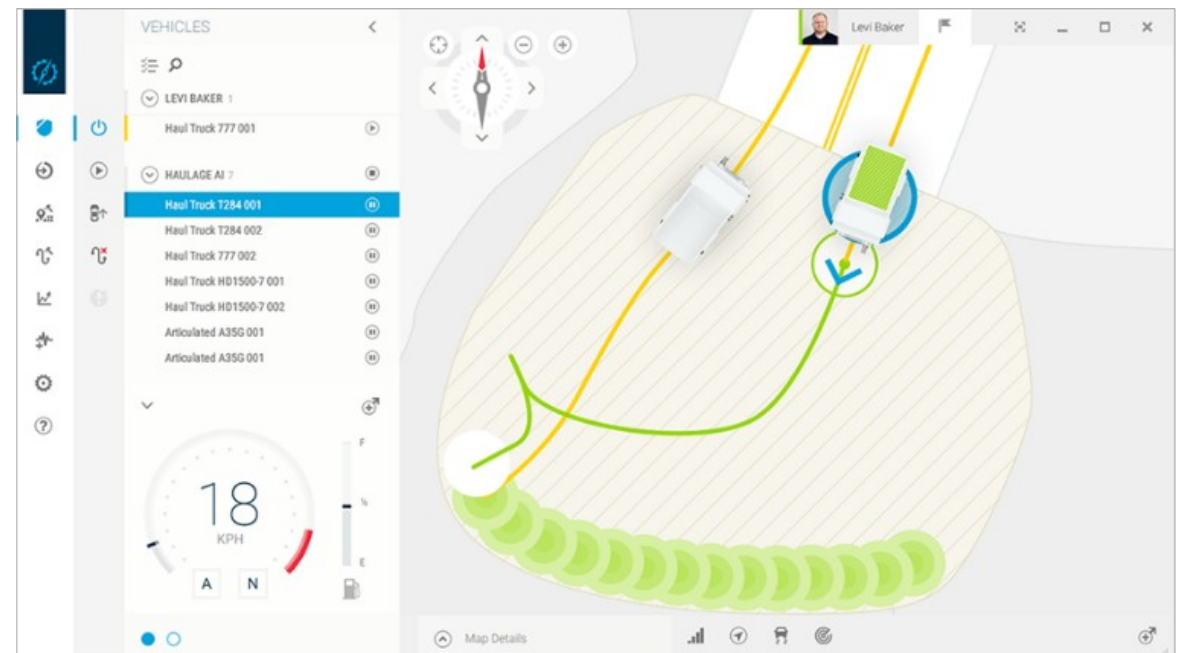
SIMPLICITY



UX professionals are worth the money!



COLLISION AVOIDANCE UI



PADDOCK DUMP ZONE UI

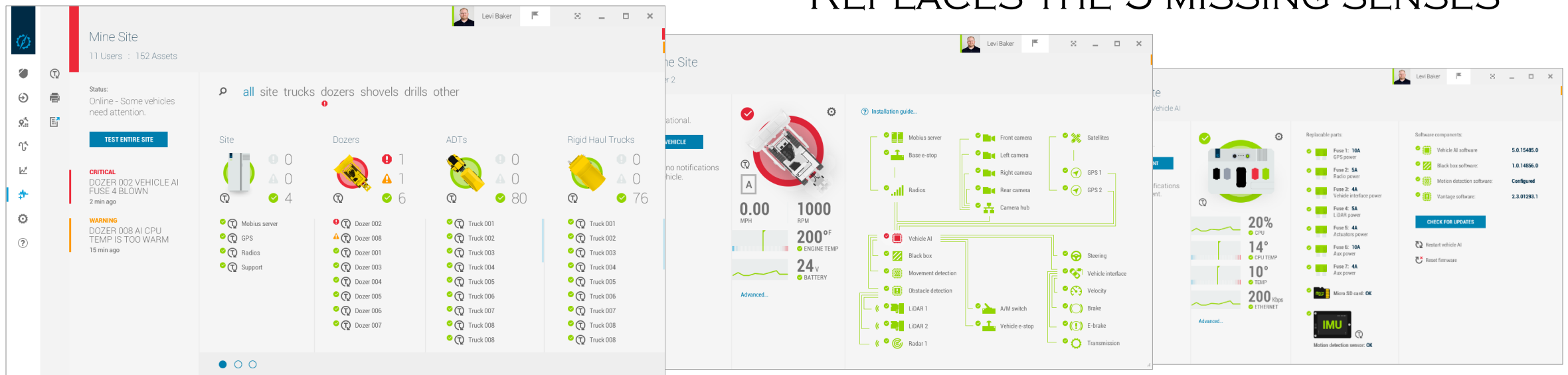


SIMPLICITY

Serviceability will limit your ability to scale more than a lack of customers

MUST HAVE TOOLS AND SENSING THAT:

- SIMPLIFIES COMPLEXITY
- REPLACES THE 5 MISSING SENSES



1. FLEET DIAGNOSTICS

2. DOZER DIAGNOSTICS

3. PROCESSOR DIAGNOSTICS



LESSON 2

SYSTEM FEEDBACK



SYSTEM FEEDBACK

Creatively find ways to assure installation and maintenance are done correctly

SENSORS



GPS, RADIO, & CAMERAS



FORECAST 3D LASER

VCU



ON BOARD COMPUTER

ACTUATORS

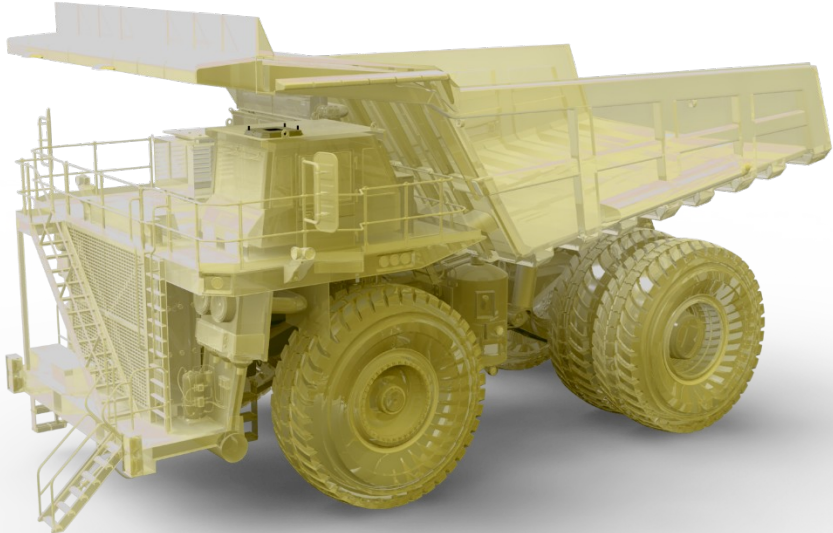


BRIDGE



STEERING RING (OPTIONAL)

TO NATIVE VEHICLE CONTROL >





SYSTEM FEEDBACK

Sabotage can kill programs and people.

PROACTIVELY AVOID IT!

- PUT PROTECTIONS IN PLACE AND EDUCATE WORKERS ABOUT THEM.
- SYNCHRONIZE BLACK BOX PLAYBACK OF DATA AND VIDEO FEEDS





LESSON 3

SAFETY



OVERRIDING SAFETY ALERTS QUICKLY BECOMES AUTOMATIC.

*EXAMPLE PICTURE — NOT OUR TRUCK

SAFETY

People blindly trust driverless vehicles far more than human driven vehicles.

IT'S A SLIPPERY SLOPE!

- STOP MONITORING THEM
- IGNORE THEM
- TAUNT THEM!





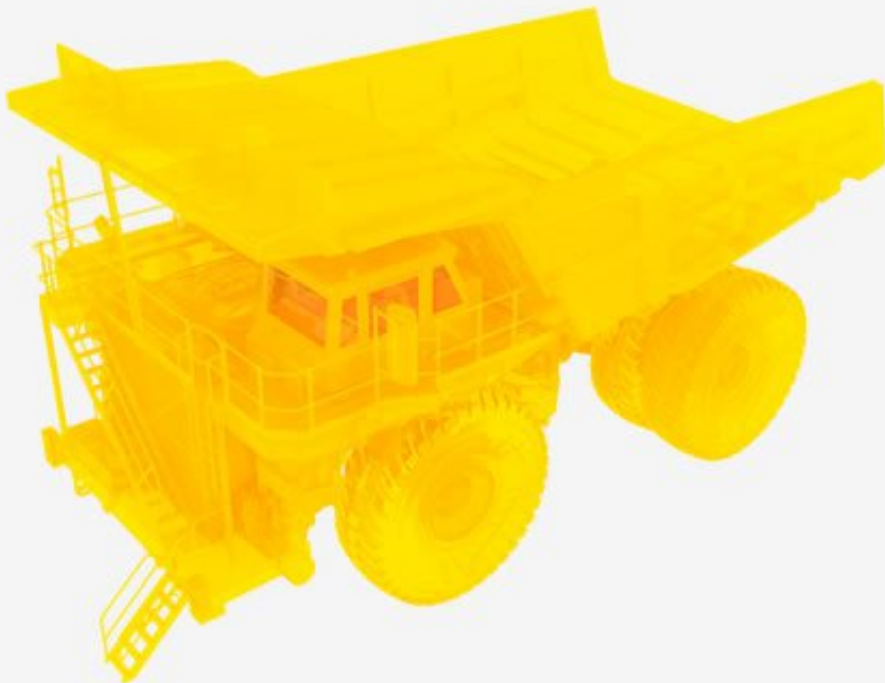
LESSON 4

SIZE: THE NEW MATH



SIZE: THE NEW MATH

Fuel, equipment price, service, shovel size, batch processing, transport, downtime impact



80

->

800





SIZE: THE NEW MATH

Less compaction, fuel, service,
downtime impact, transport costs

OEMs WILL SELL SMALLER
MACHINES, LESS SERVICE, AND
FEWER TOTAL UNITS

OPPORTUNITY FOR SMALLER
VEHICLE COMPANIES TO
DISRUPT





LESSON 5

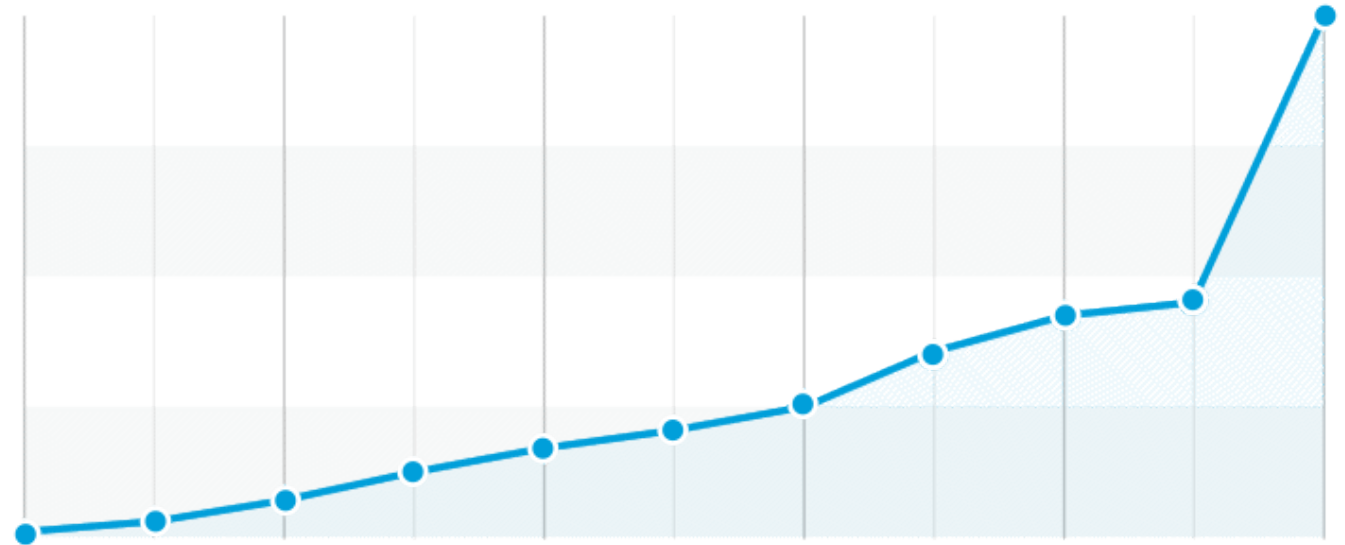
RETURN ON INVESTMENT



RETURN ON INVESTMENT

It is far beyond labor but must be quantified

- FEWER VEHICLES, LESS LABOR, LESS DOWNTIME...
- LESS MAINTENANCE: E.G. 3X THE TIRE LIFE
- 10 HOUSES!





LESSON 6

PARTIAL AUTONOMY



PARTIAL AUTONOMY

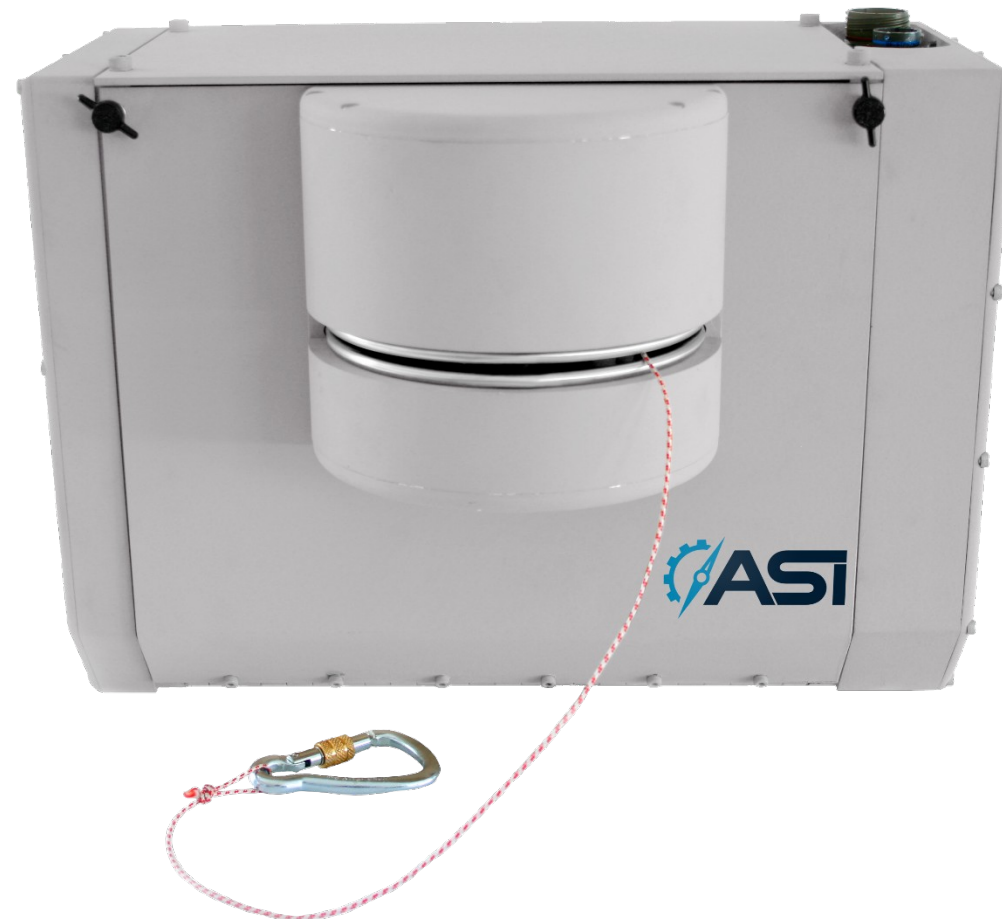
Sometimes Partial Autonomy is all that's needed.

AGRICULTURE AUTO-PILOT MODEL

- SPOTTING
- DUMPING
- LONG HAULS

LEADER FOLLOWER CONVOY

- GPS
- GUIDELINE STRING





LESSON 7

MITIGATE LIABILITY

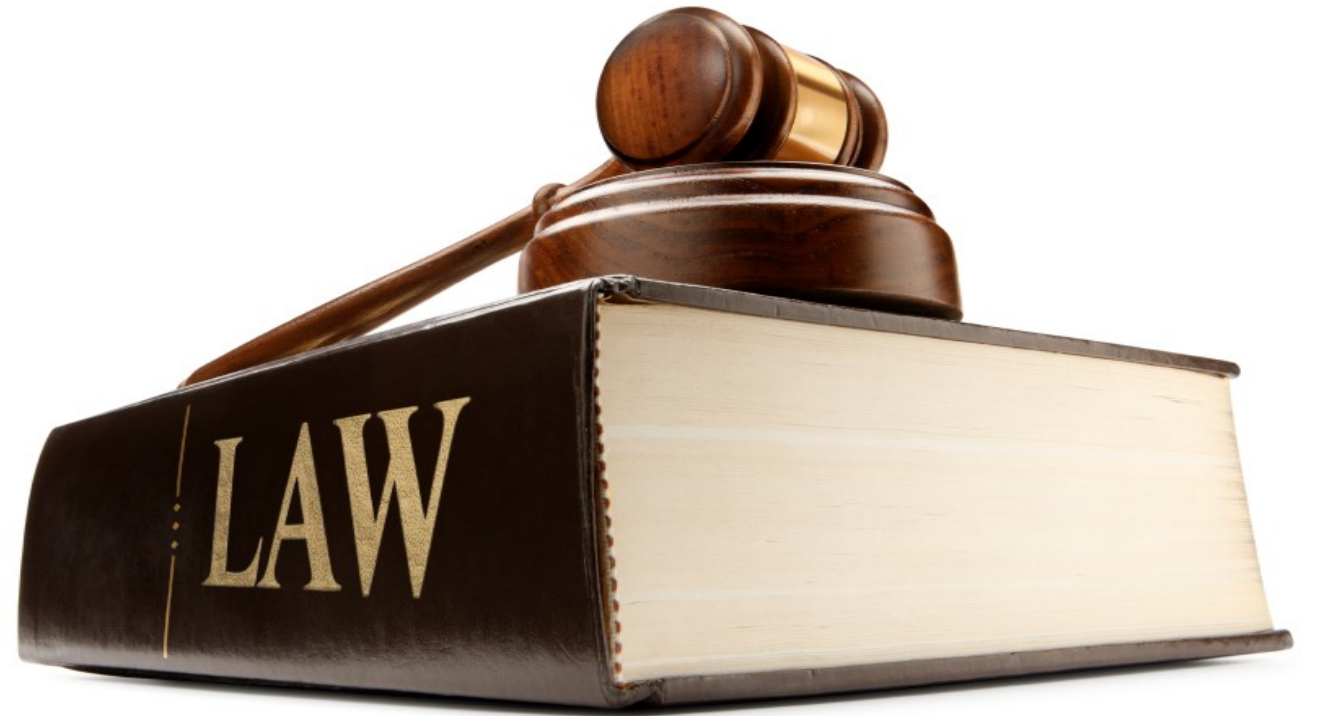


MITIGATE LIABILITY

Liability can be a bigger hurdle than technical challenges.

PEOPLE DISABLE SAFETY SYSTEMS AND WIN LAWSUITS IN EVERY INDUSTRY.

- SUPPORT BEST PRACTICE STANDARDS ESTABLISHMENT
- DESIGN TAMPER PROOF SYSTEMS
- GET GOOD INSURANCE



AUTONOMOUS MINING





QUESTIONS?

CORY ROWE
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