

BUILT FOR THE MINE

Quarry of the Future Forum



March 3, 2025
Virginia Tech





Take a step into the future of the aggregates industry at the "Quarry of the Future" Forum, where we discussed technology changes and anticipated what is to come.

Hosted by **Built For The Mine**, this event was designed to inspire forward-thinking professionals to anticipate and embrace technology and industry evolution.

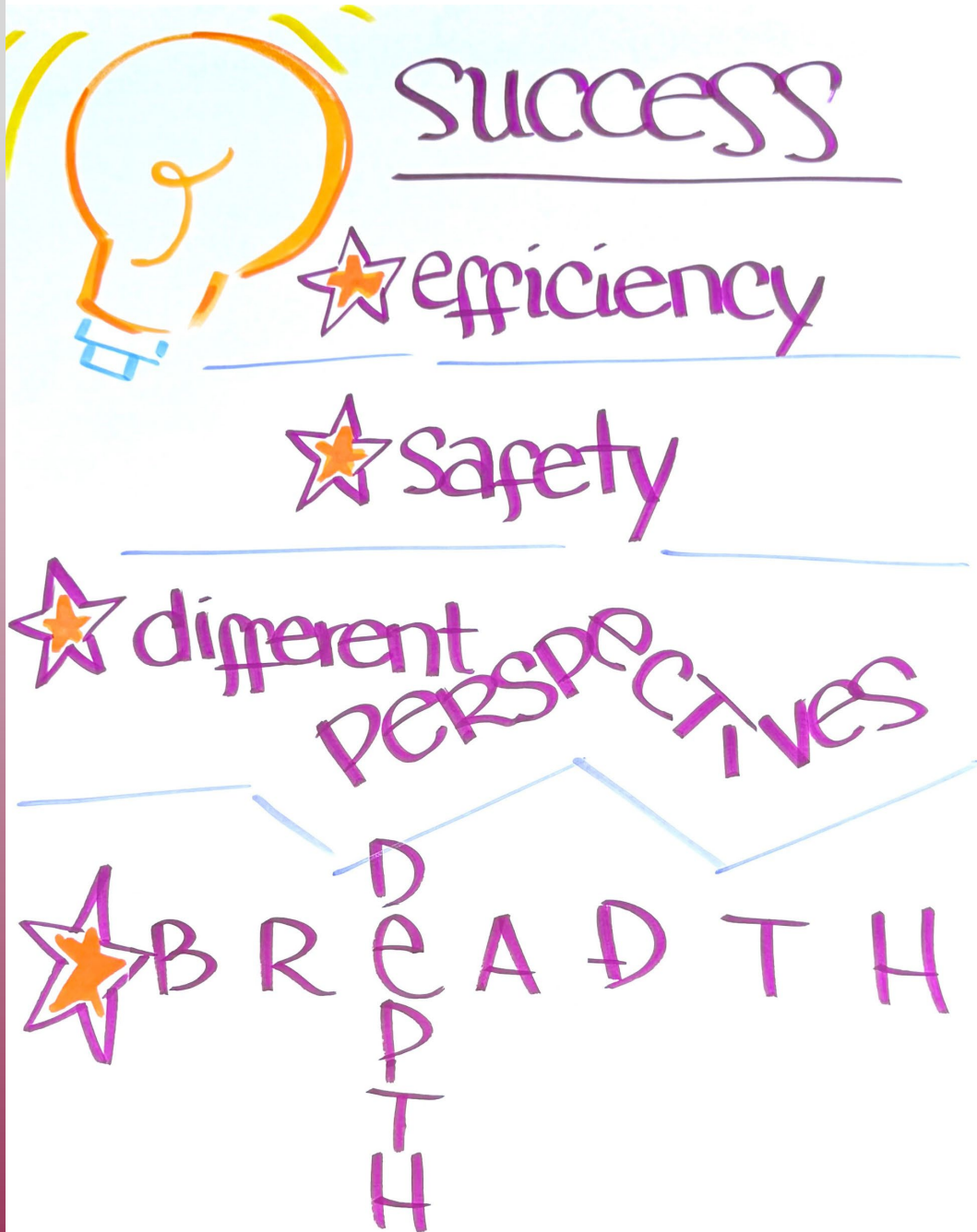
The Forum had more than 60 attendees from nearly 40 companies.

These visual notes are intended to organize and capture the information that was shared.

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Forum Objective

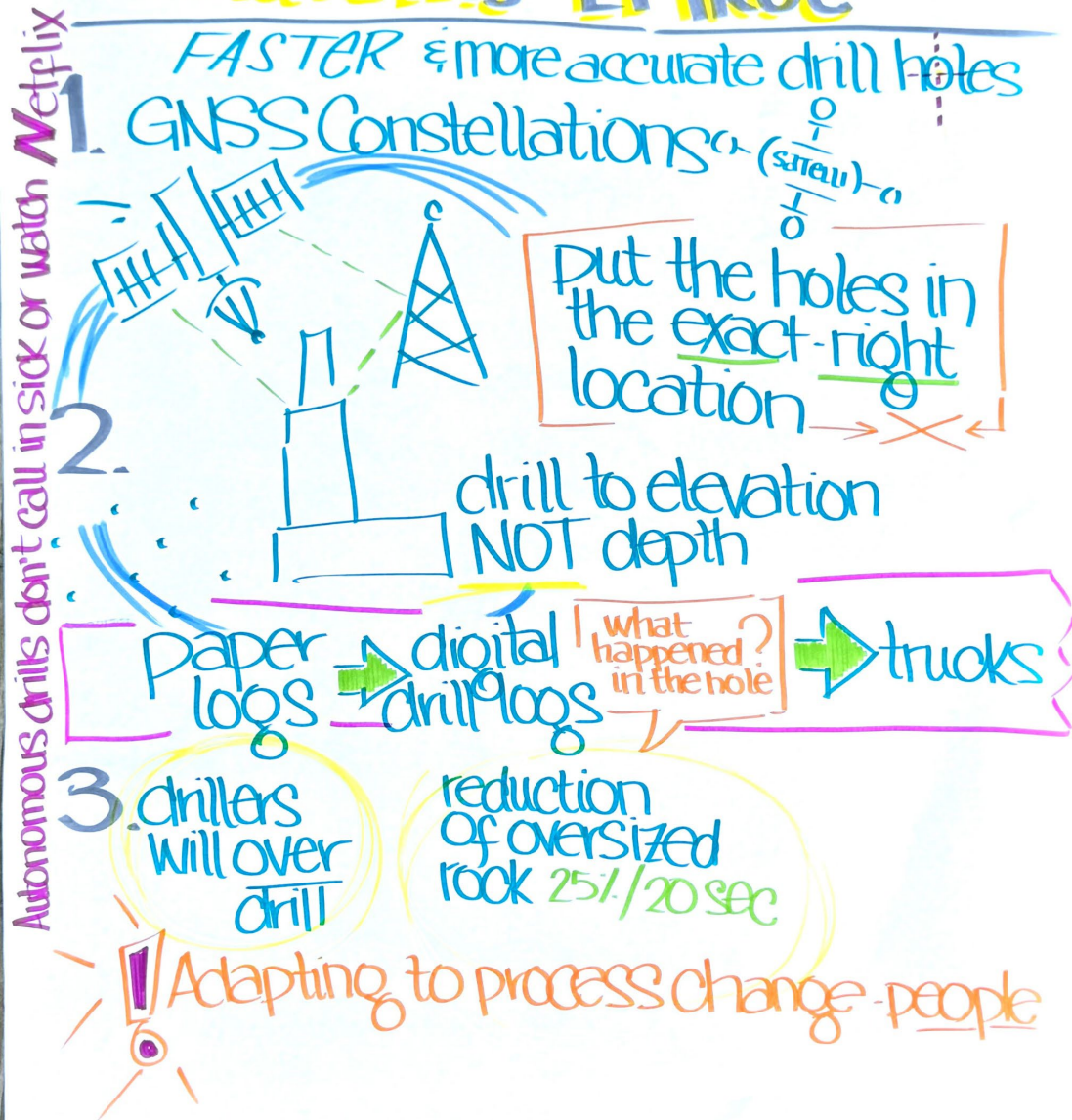


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Precision Blasthole Drilling

PRECISION BLASTHOLE DRILLING ZACHILLUS • EPIROC

FASTER & more accurate drill holes



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DRONES & MACHINE LEARNING FOR BLAST DESIGN OPTIMIZATION RAVI SAHU · STRAYOS

1. >400K blasting projects
DRONE DATA



2. MAIN: make GOAL predictions

3. IMPROVES

- drilling efficiency
- digging rates

8-10 shots
to work well

Rock Mass Analysis:

- + Pre-drill
- + post drill
- + geo-tech analysis

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NOx Tracking in Blasting with Drone and Machine Learning

NOx TRACKING IN BLASTING WITH DRONE VIDEO & MACHINE LEARNING LUKE PROVENCER · AUSTIN POWDER

1. SAFETY → post blast fumes
[N, CO₂, H₂O]

Machine Learning: RIT
blast for fumes



2. Where in the blast did it come from?
Review in reverse!

(a) QUANTIFY
& IDENTIFY WHERE

(b) ID
Concentration
& Volumes

(c) Drone v/s
after shoot

3.

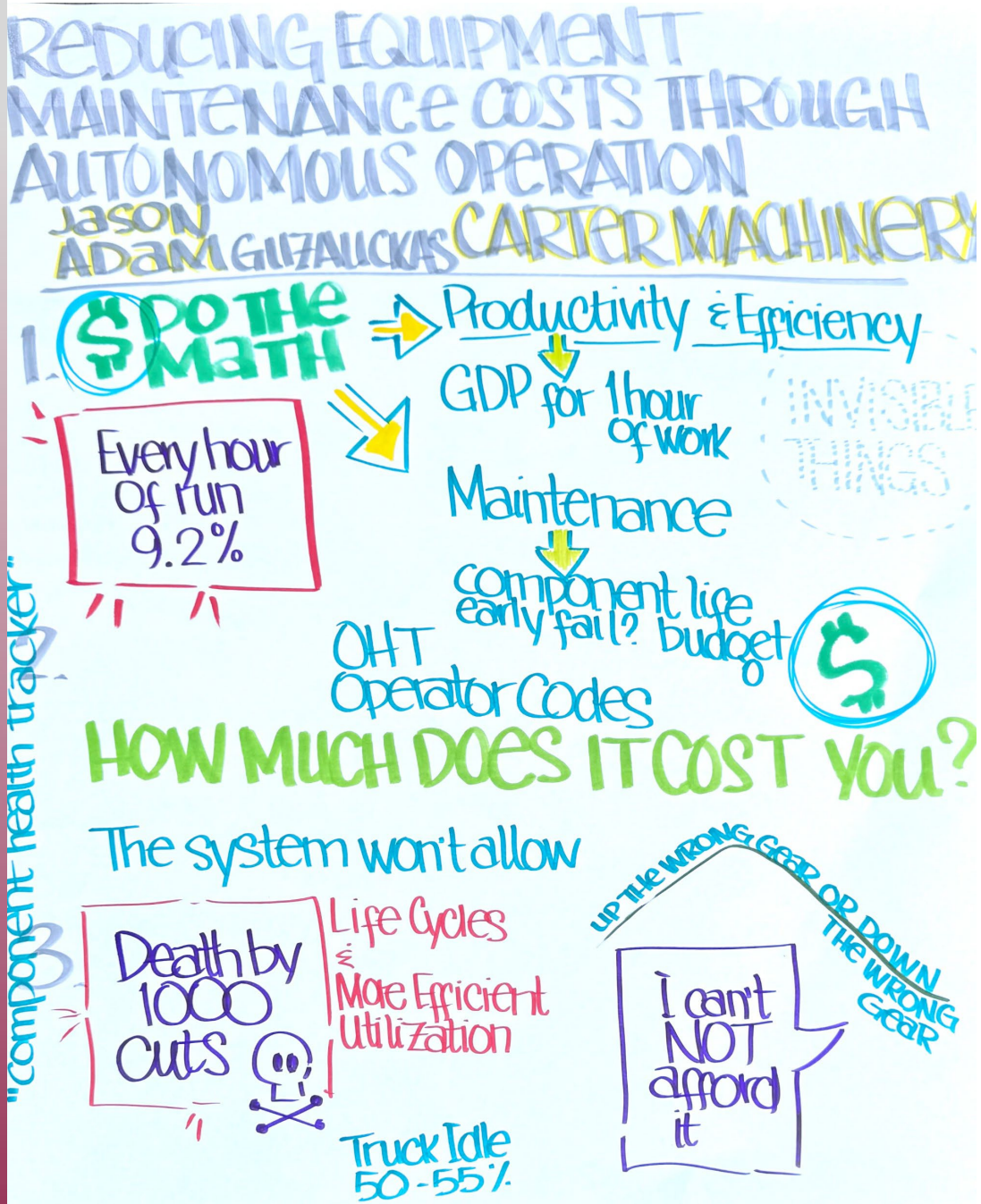
HEALTH
HAZARD
RISK

STILL PRODUCT
SELECTION &
BEST PRACTICES

evolving

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Reducing Equipment Maintenance Through Autonomous Operation



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Autonomous Haulage

AUTONOMOUS HAULAGE
TOM SMITH · CATERPILLAR
RUSTY MINIX · LUCK STONE

1. WHY?

efficiency
process
optimization
expose
inefficiencies
real
time

THE PEOPLE
Big Change

BUILD
RAMPS
unexpected

2.

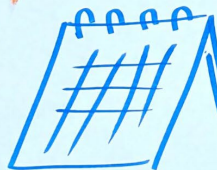
7 people → 3
(4 people to other jobs)

lot of material
not a small
endeavor

downtime just
isn't there

happens
when people
don't want
to trucks

3.



12-mo
implementation

+track
+learn
+prevent
INTER
ACTIONS

MORALE?



JOB 1 → JOB 2

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Hydraulic Nuts

HYDRAULIC NUTS ON SCREENS NICK COX - PASCHAL

- 1. TORQUE**
↓
large nuts/bolts


STRETCH

FRICITION
RUST
LUBRICATION

35%
- 2.**


XFR hydraulic to mechanical

hammer until it's tight
& not measuring torque

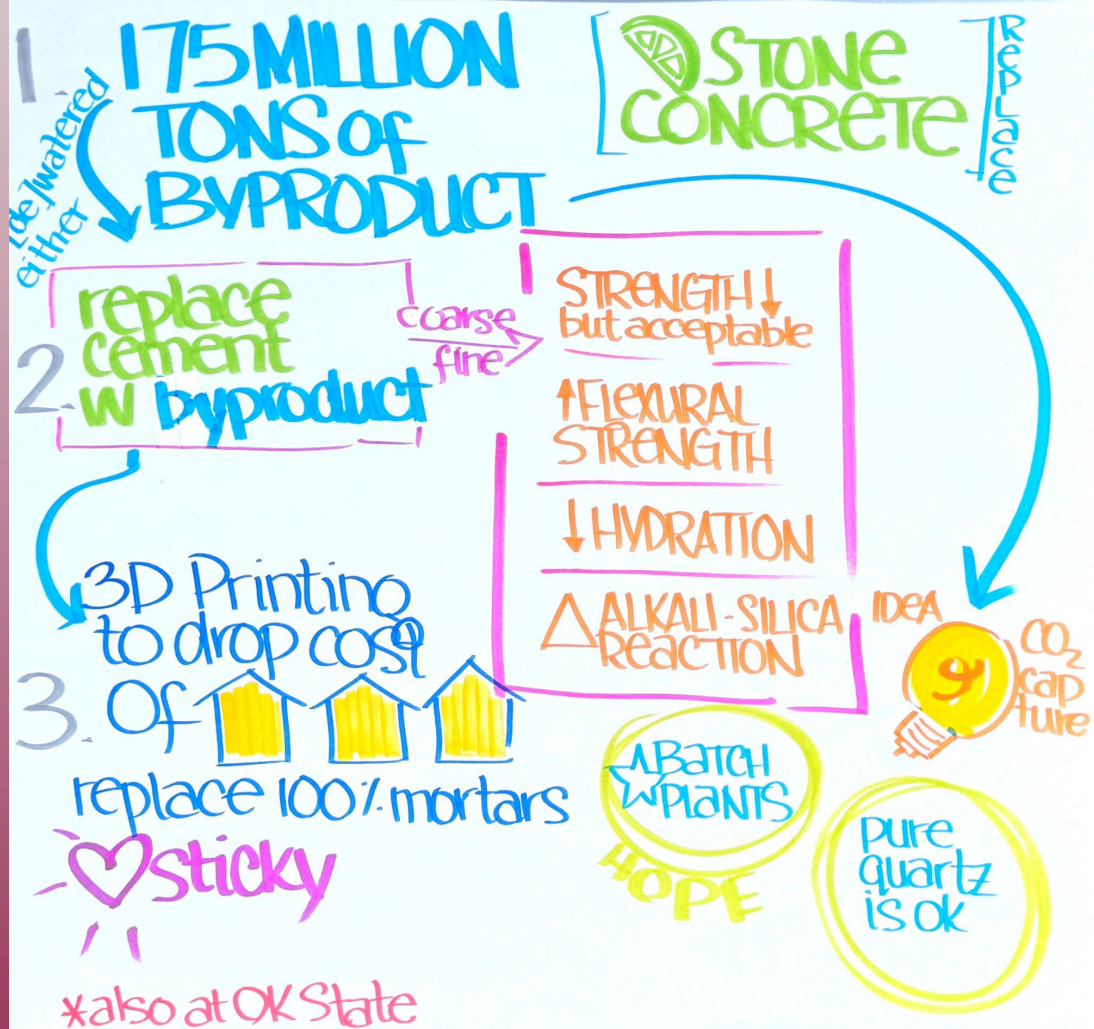
daisy chain ~30 min
- 3. safer & efficient & quick & precise**

removal is exact opposite

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Alternative Uses for Fines

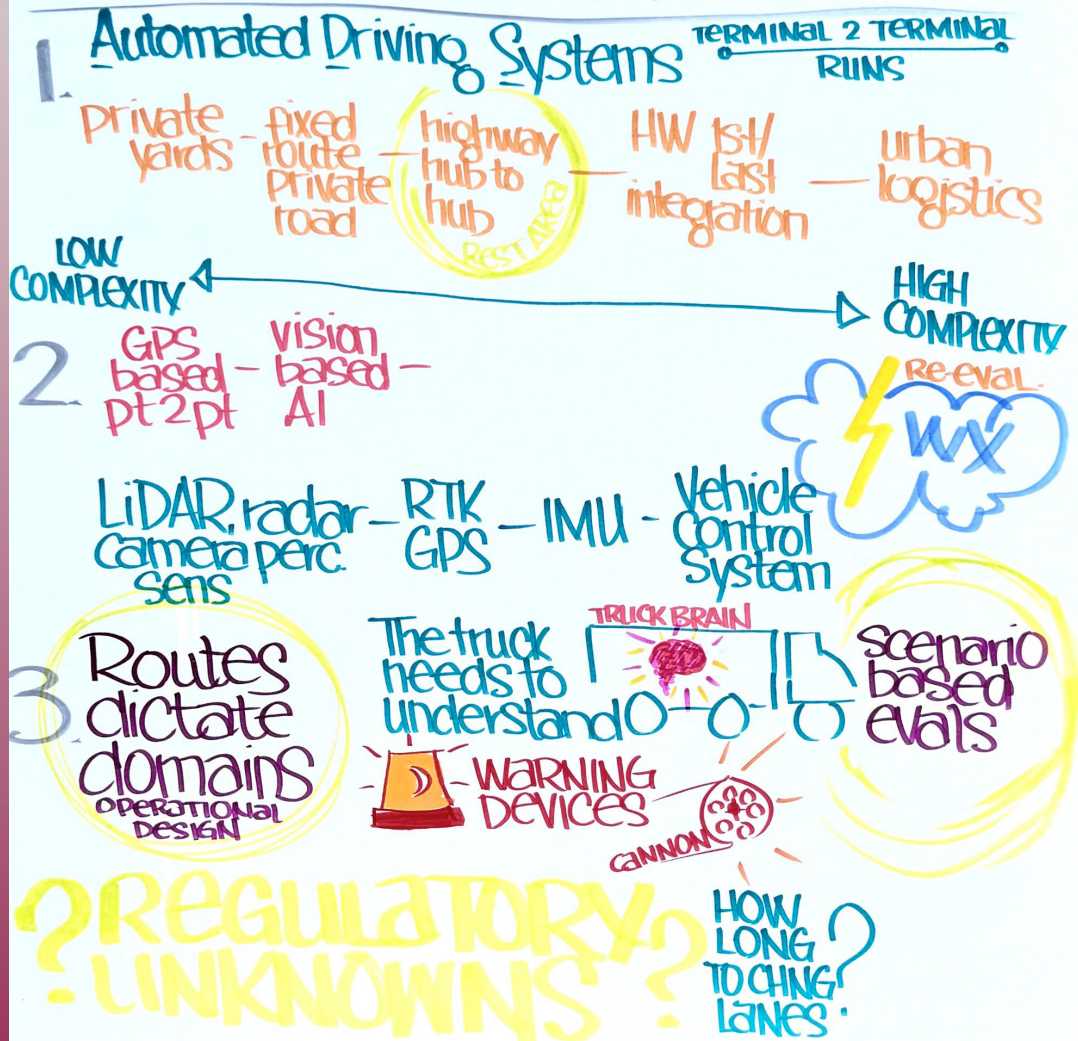
ALTERNATIVE USES FOR FINES DR. ALEX BRAND · VT CIVIL & ENVIRONMENTAL ENGINEERING



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Autonomous Tractor Trailer Technologies

AUTONOMOUS TRACTOR TRAILER DR. ANDREW MILLER VT TRANSPORTATION INSTITUTE



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Emerging Wireless Technologies

EMERGING WIRELESS TECHNOLOGIES

DR. MIKE BUEHRER · VT WIRELESS

3→5 YEARS:

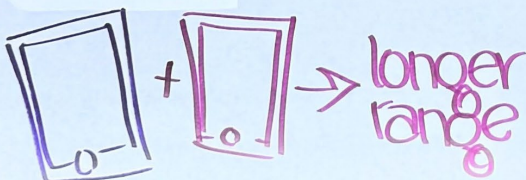
- + cellular - 6G incremental → ↑ data rates ↓ latency
- + WiFi 7
- + IoT - connect long range low power
- + LEOs - low earth orbit satellite - reliable connectivity
- + V2X — vehicle to EVERYTHING
- + AI - predict & modify move to the edge
- + Spectrum Sharing - 700 megahertz → crowded tolerating interference

10x more than

LA FIRES

ALERTS TRAFFIC

81



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Productivity Optimization with Data Analytics

PRODUCTIVITY OPTIMIZATION IN
OTHER INDUSTRIES W/ INDUSTRIAL
INTERNET DATA ANALYTICS &
DATA QUALITY · DR RAN JIN · VT
ISE



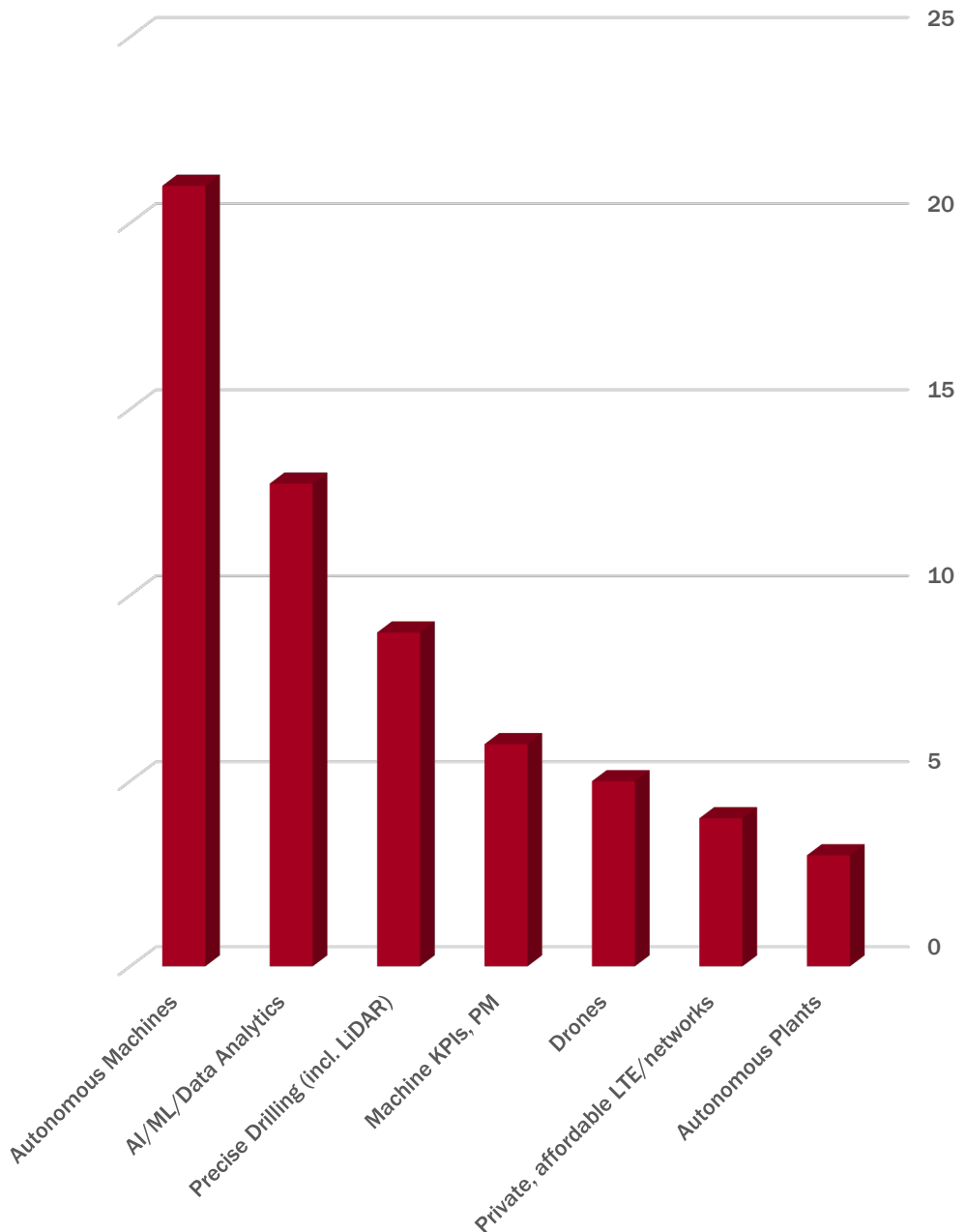
MANUFACTURING
AEROSPACE
PROCESSING

including "brewing"

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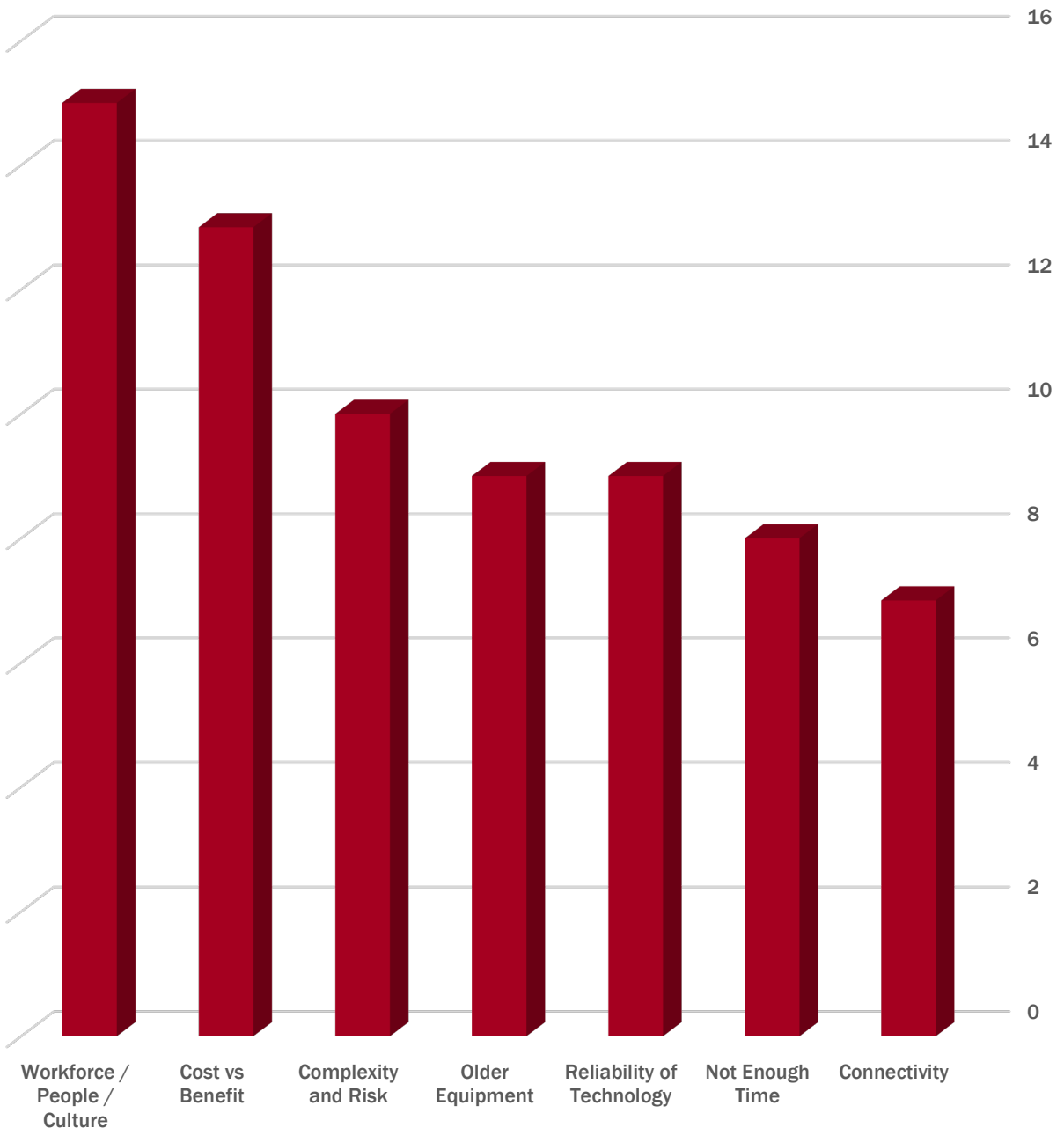
What Current Technologies Excite You Most?



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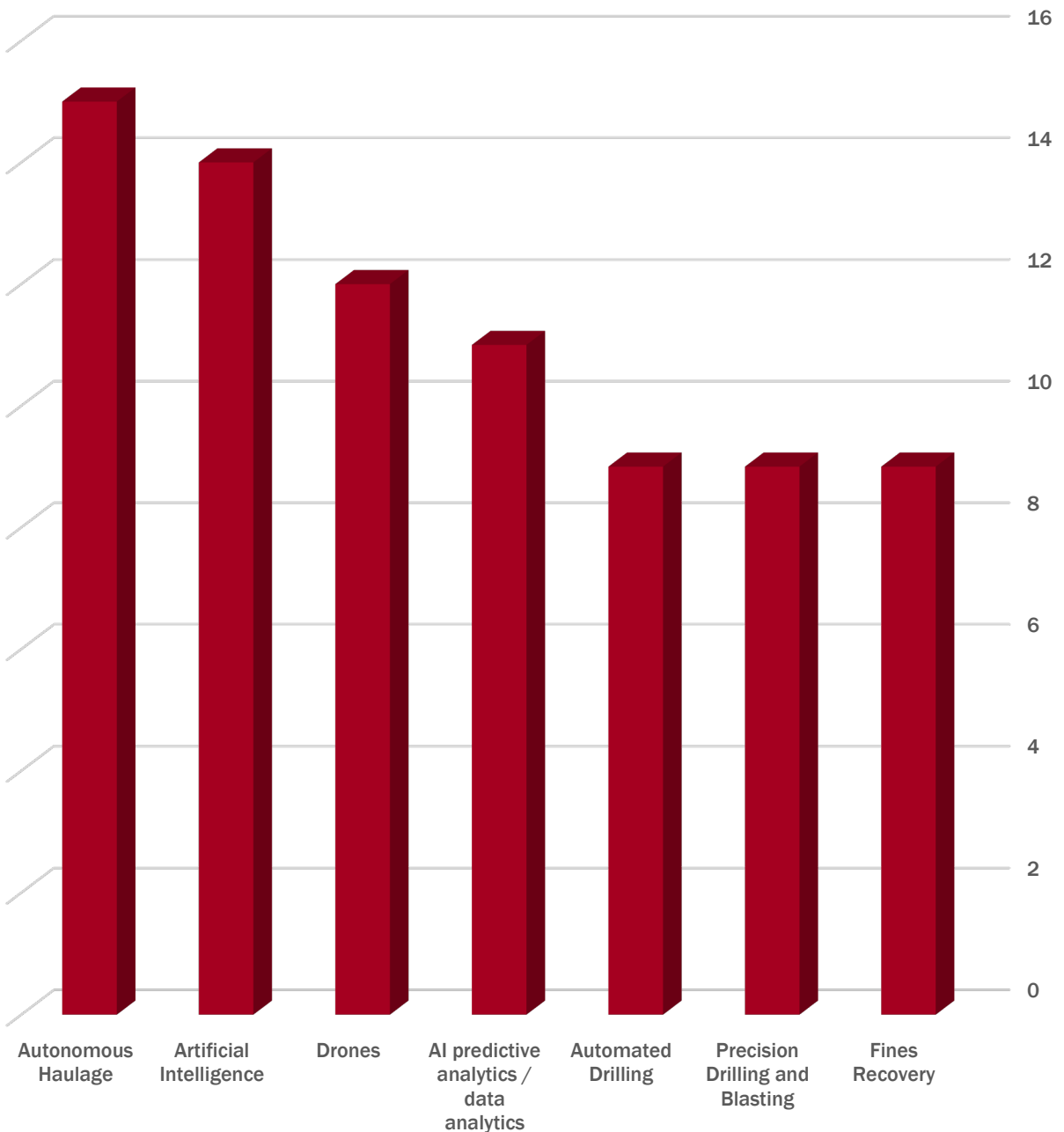
What Are the Top Barriers to Adopting New Technology?



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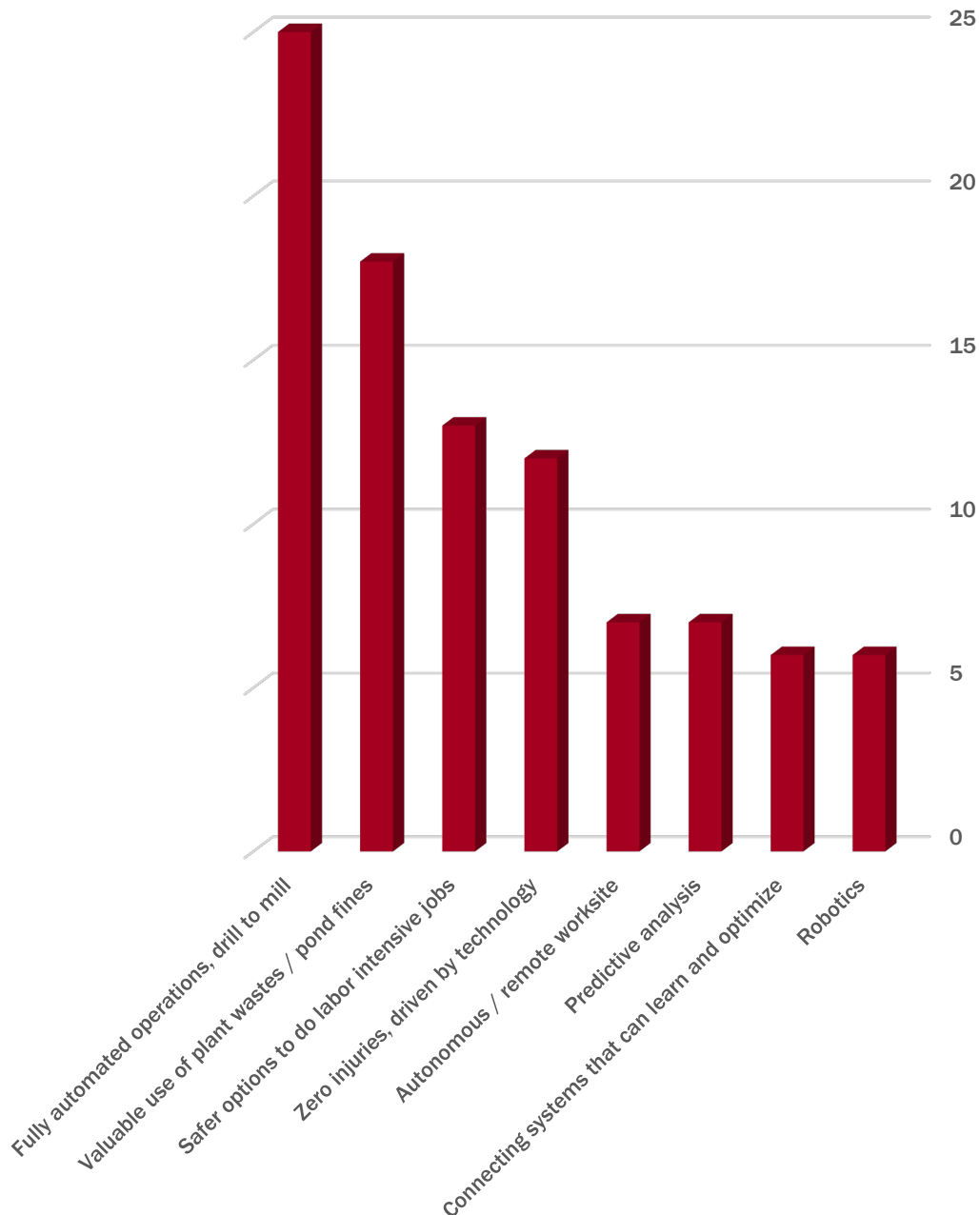
What Technologies do you Anticipate Being the New Normal in 10 Years?



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What Technologies do you Dream About for Our Industry?



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Conclusions

1. There is a clear interest in currently available technologies including autonomous equipment, AI/data analytics, and precision drilling.
2. However, there are several hurdles that exist to implementing these existing technologies. The key barriers include workforce/culture, payback period (including the need to update equipment), and risk/reliability.
3. Within the next 10 years, it is anticipated that autonomous haulage, the use of AI/data analytics, the use of drones, and automated precise drilling will be commonly used technologies within the crushed stone industry.
4. In the longer time frame, there is a strong desire to see the development of fully automated drill-to-mill operations, a profitable market for fines/dust, and continued improvement in safety due to increased use of technology.

The development and implementation of these technologies will be expedited by strong cooperation between producers, equipment manufacturers, universities, and other sectors of our industry.

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Built for the Mine is an educational partnership between mining industry leaders and the Virginia Tech Department of Mining and Minerals Engineering.

The mission of Built for the Mine is to “Develop the next generation of people and technology for the next generation of the aggregate industry.” This mission will be accomplished by establishing and growing a partnership between industry representatives and the Mining and Minerals Engineering Department at Virginia Tech.

The vision of Built for the Mine is to have an industry brand and be the recognized leader for developing talented graduates who are prepared to fill the growing knowledge gap within the aggregates industry created by the onset of the Fourth Industrial Revolution.

The program prepares students for careers in mining by enhancing goal-setting, improving interview and resume skills, developing professional paths, networking with industry leaders, and giving them access to internships and employment opportunities.

For more information,
Contact Dr. Erik Westman
ewestman@vt.edu

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