Underground Air Quality Monitoring

Maestro AirQuality Stations
Michael J. Gribbons
Increase Safety and Productivity

Maestro Vigilante AQS
Air Quality Station

More time at the Face.
Ultrasonic Transit Time Airflow Sensors

Increase Safety and Productivity
Ultrasonic Transit Time Airflow Sensors

Wall mounted applications
- Shaft
- Return or Fresh Air Raises
- Heater house

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Ultrasonic Transit Time Airflow Sensors

Primary fan applications
- Inlet ducting preference
More time at the Face.

Simple communications – analog or digital

Conventional Analog System

SCADA

PLC

Surface

U/G

Hardware configuration required at each level

I/O

Analog Inputs

Air Flow

CO

NO

Dry Bulb Temp

Wet Bulb Temp

Analog Outputs

Fan On/Off

Fan Speed

Downrate Control

Maestro Digital System

SCADA

PLC

Surface

U/G

Hardware configuration required at each level

I/O

Analog Inputs

Air Quality Station

Ethernet, Copper or Fiber Inputs

Maestro Marquee Display

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Digital Integration Example

Ventilation Management System - Schematics

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The path from “Project” to “Part Number”

Legacy Analog Air Quality Monitoring Station and I/O for louver controls

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Increase Safety and Productivity

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The path from “Project” to “Part Number”

• Order by part number
• No PLC required
• Simple configuration
• Same day integration
• 400 lbs reduced to 20 lbs
• Immediate delivery
• Single person installation
• No software upgrades

Current Technology
### The path from “Project” to “Part Number”

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Maestro Digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLC, Remote I/O, Cabinet, Wiring, Labour</td>
<td>$40,000.00</td>
<td>$0.00 (not required)</td>
</tr>
<tr>
<td>Engineering design, drawings</td>
<td>$60,000.00 (one time cost)</td>
<td>$0.00 to $3000.00</td>
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<tr>
<td>Air quantity and quality instruments</td>
<td>$16,000.00</td>
<td>$12,000.00</td>
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<tr>
<td>Installation costs</td>
<td>$20,000.00</td>
<td>$2000.00</td>
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<tr>
<td>Unit installed cost (1 ea.)</td>
<td>$136,000.00</td>
<td>$17,000.00</td>
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<tr>
<td>Unit installed cost (10 ea.)</td>
<td>$82,000.00</td>
<td>$14,300.00</td>
</tr>
<tr>
<td>Time from design to delivery</td>
<td>3 to 6 months</td>
<td>3-4 weeks</td>
</tr>
<tr>
<td>Installation, commissioning difficulty rating</td>
<td>6 out of 10</td>
<td>2 out of 10</td>
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<tr>
<td>Flexibility and Expandability</td>
<td>4 out of 10</td>
<td>8 out of 10</td>
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</tbody>
</table>
The path from “Project” to “Part Number”

- VAQS-DR-G002-G004-G008-AD4-MB-CT-BP-IM

Increase Safety and Productivity
The path from “Project” to “Part Number”

Legacy Analog Air Quality Monitoring Station

Order by part number
No PLC or PLC programming
Same day integration
400 lbs reduced to 20 lbs
Immediate delivery
Single person installation
No software upgrades

Current Technology

Increase Safety and Productivity
The path from “Project” to “Part Number”

- 50 lbs
- Two person installation
- No software upgrades
- Airflow, wet and dry bulb, CO & NO2

- 10 lbs
- Single person

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Web page configuration

Increase Safety and Productivity
Increase Safety and Productivity

Vale Nickel – Creighton Mine – Ontario, Canada

Allen Bradley Screen Shot
- Drift airflow
- CO
- Modbus TCP/IP Ethernet communications
- CISCO access points

More time at the Face.
More time at the Face.

Vale Nickel – Creighton Mine – Ontario, Canada

Real time based diagnostics
More time at the Face.

Barrick Gold – Cortez Mine – NV, USA
More time at the Face.

Airflow sensor dust build-up

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Maestro Gas Sensors

Increase Safety and Productivity
Sinter filter plugs before the sensor fails.
No possible way to clean.
Sintered Filter Replacement

Step 1:
Pull out calibration cup from gas sensor assembly.

Step 2:
Gently push a narrow and long instrument screw driver into the calibration cup until sintered filter element pops out.

Step 3:
Clean filter in an ultrasonic cleaning path or replace with new filter.

Step 4:
Apply a bead of silicon on outside edge of filter and press back into calibration cup.
More time at the Face.

DustMon haulage ramp dust monitor

Real time dust readings to optimize dust suppressant chemicals

Increase Safety and Productivity
## Product Communication Options

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>AirScout™ Airflow meter</td>
<td>Standard software selectable</td>
<td>Select EZ Node™ &amp; EZ Base™</td>
<td>Standard software selectable</td>
<td>Standard software selectable</td>
<td>Optional with protocol converter</td>
<td>Select EZ Node™ – p/n EZN-E</td>
</tr>
<tr>
<td>Vigilante AQS™ Air Quality Station</td>
<td>Select AD4™ Module</td>
<td>Select EZ Node™ &amp; EZ Base™</td>
<td>Standard software selectable</td>
<td>Standard software selectable</td>
<td>Optional with protocol converter</td>
<td>Select EZ Node™ – p/n EZN-E</td>
</tr>
<tr>
<td>FanMon™ Fan Monitoring System</td>
<td>Select AD4™ Module</td>
<td>Select EZ Node™ &amp; EZ Base™</td>
<td>Standard software selectable</td>
<td>Standard software selectable</td>
<td>Optional with protocol converter</td>
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</tr>
<tr>
<td>SuperBrite™ Marquee Display</td>
<td>N/A</td>
<td>Select EZ Node™ &amp; EZ Base™</td>
<td>Standard software selectable</td>
<td>Standard software selectable</td>
<td>Optional with protocol converter</td>
<td>Select EZ Node™ – p/n EZN-E</td>
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<tr>
<td>Ethernet/I/O™ Remote Ethernet I/O</td>
<td>N/A</td>
<td>Select EZ Node™ &amp; EZ Base™</td>
<td>Standard software selectable</td>
<td>Standard software selectable</td>
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<td>Select EZ Node™ – p/n EZN-E</td>
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More time at the Face.

Analog
Typical PLC based Analog Network Architecture

SCADA/HMI

Network Switch

Ethernet Fiber

SURFACE

Remote I/O

ControlNet

Under Ground

AirScout™
Airflow meter

Vigilante AQS™
Air Quality Station

RS-485 Serial Modbus

AD4™ Module
Analog output of gas, airflow, humidity values

Analog Signals

Ethernet

Level A

Level B

Increase Safety and Productivity
Digital Leaky Feeder
Radio Network Architecture

SCADA/HMI
RS-485 Serial Modbus

Network Switch
Ethernet Copper or Fiber

PC2
PC1

Mine Operation Center Head End

Terminator

Vigilante AQS™
Air Quality Station

AD4™ Module
control and monitor auxiliary fans, louvers or doors

Analog 4-20 mA & Relays

LF Amplifier

SuperBrite™
Marquee Display

EZ Base™
leaky feeder head end chassis c/w 2 protocol converters (PC1 & PC2)

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Digital RS-485 Serial Network Architecture

Increase Safety and Productivity

SCADA/HMI

Ethernet
Fiber

Vigilante AQS™ Air Quality Station
AD4™ Module control and monitor auxiliary fans, louvers or doors

SuperBrite™ Marquee Display

RS-485 Serial Modbus

Network Switch

Analog & Relays

RS-485 Modbus
Serial
Network

More time at the Face.
MST Ethernet Network Architecture

SCADA/HMI

Network Switch

Ethernet Fiber

SURFACE

Wireless Access Point

EZ Node™ Wireless 802.11 100 metre line of sight range

Vigilante AQS™ Air Quality Station

Modbus TCP/IP Copper PoE

AD4 Module Control and monitor auxiliary fans and doors

LEVEL A

LEVEL B

SuperBrite™ Marquee Display

Increase Safety and Productivity
Ventsim Integration
Network Architecture

MaestroLink™
LiveVIEW™
MS SQL Database

Vigilante AQS™
Air Quality Station

AirScout™
Airflow Meter

Ethernet Fiber

Maestro mine ventilation

Increase Safety and Productivity
Ventsim Visual LiveVIEW™ Integration

- Real time data on Ventsim PC
- Continuous model update
- Full diagnostic information on MaestroLink™
- Historical trending information on MaestroLink™
- No PLC, SCADA or HMI required
- No additional programming
- MaestroLink™ has no licenses and free upgrades for the life of mine

REQUIREMENTS
- LiveVIEW™ option
- MaestroLink™ - $1500.00
- Ethernet communications

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“From my standpoint, it’s a very good tool to validate the ventilation model and make the required adjustment if needed. Being able to read in the model, both live airflows and gas concentrations helps to react fast and take the appropriate measures when a problem occurs in the ventilation system. It also helps to ensure good air quality at any time.”
More time at the Face.

Real Time – Diagnostics – Gas Sensors
More time at the Face.

Real Time Diagnostics – Alignment

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Real Time Diagnostics – Sensor 1 Failure
More time at the Face.

Real Time Diagnostics – Vehicle in Path

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More time at the Face.

Why digital?

• Quickest to integrate
• Reduction of hardware
• Defined CAPEX + OPEX
• “Real time” data
• “Real time” diagnostics
• Maximum system uptime
• Specific maintenance mobilization
• Minimum amount of technical knowledge
• No special software and licenses
• Reliable data = quicker return to face