



# Technology, Productivity and Information on P&H Mining Equipment

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# Where are we coming from?

## A little over 5 years ago:

- **Analog electronic motion controls**
- **Simple PLC systems for logic and sequencing**
- **Simple fault message displays**
- **Only communications link: Dispatch<sup>®</sup> system to send truck from shovel**



# Today--after Technology Changes: Drives

- **Full microprocessor control on both armature and field, continuous interactive operation for optimal cycling**
- **Retrofit applications: between 2 and 6 second cycle time reductions**
- **New machines: move 115 tons in fastest available time**



# New Machine Digital Drive Control Cabinet



- Armature, field, and RPC controls
- PLC
- Built-in GUI for troubleshooting PLC and drives



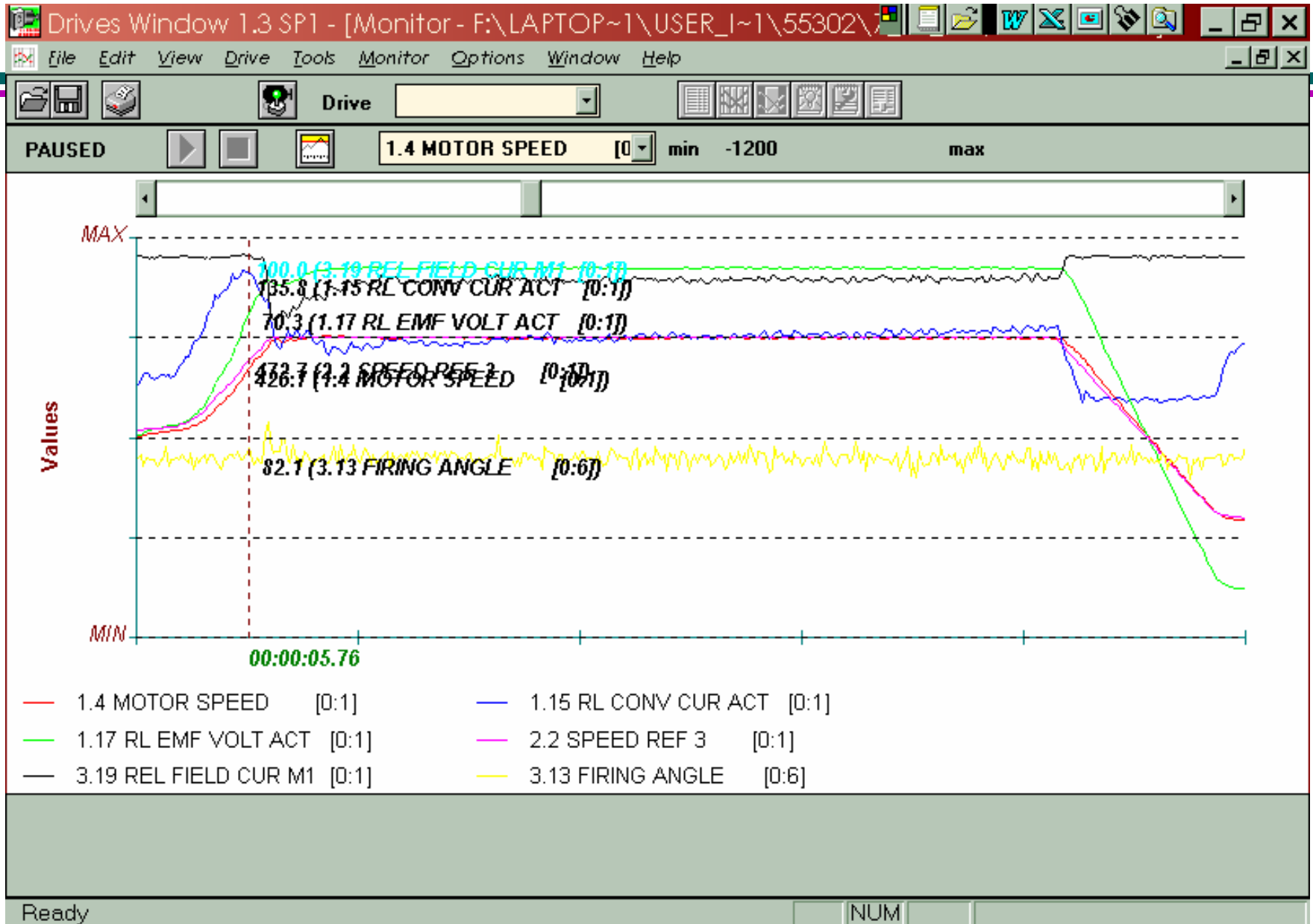
# Today--after Technology Changes

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- **PLCs with extensive machine limit systems and protectives**
- **Diagnostics available for temperatures**
- **Drive faults diagnostics built-in**
- **Color touch-screen operator and maintenance HMI units**
  - » **on-line help, built-in troubleshooting aids reduce downtime**



# Drive Monitor



# PLC Equipment

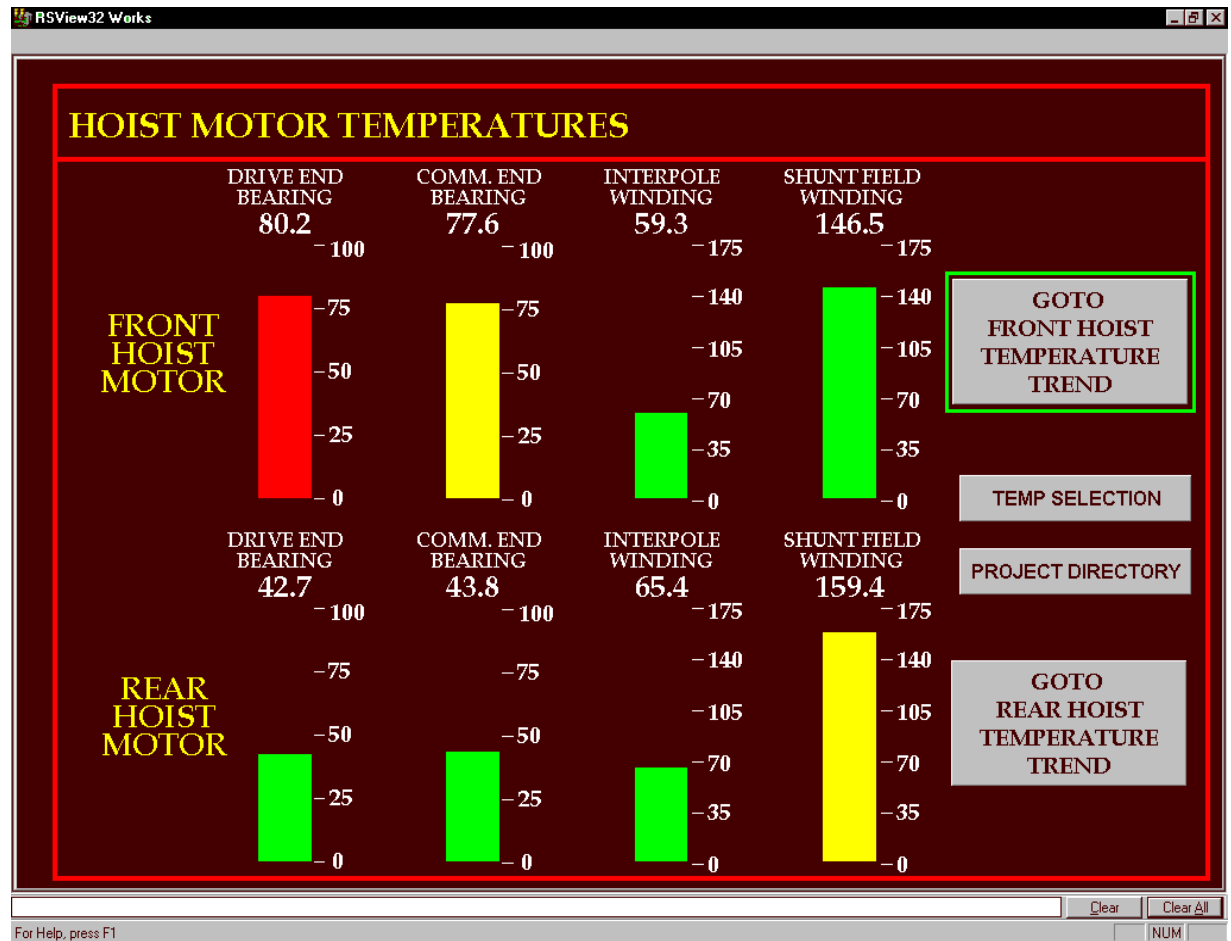


- **PLC processor**
- **Appropriate I/O--rack style or Flex**
- **Interface to drives**
- **Interface to OAP**



# Temperature Display

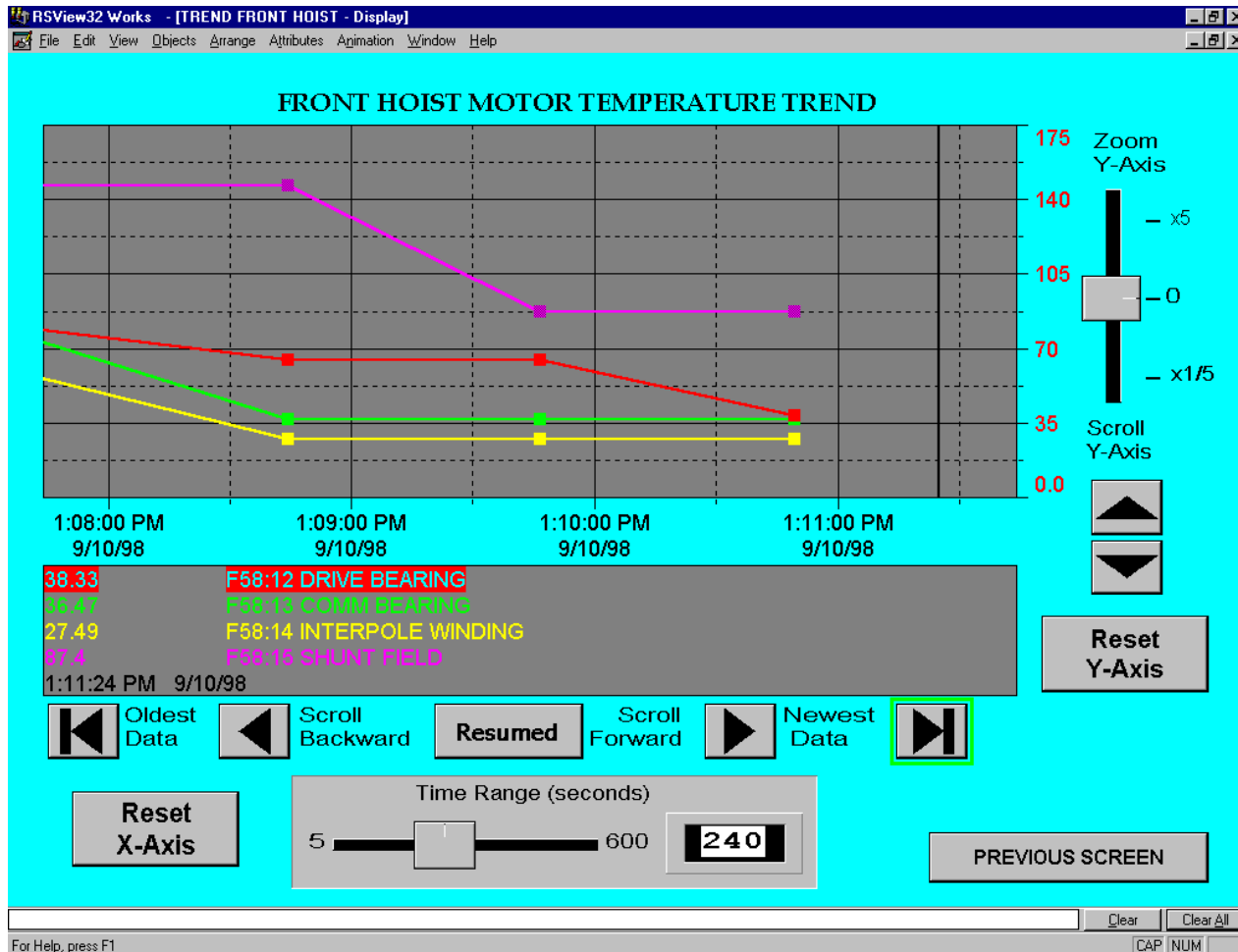
- All new motors equipped with four RTDs
  - » Drive End Bearing
  - » Opposite Drive End Bearing
  - » Main Field coil
  - » Interpole





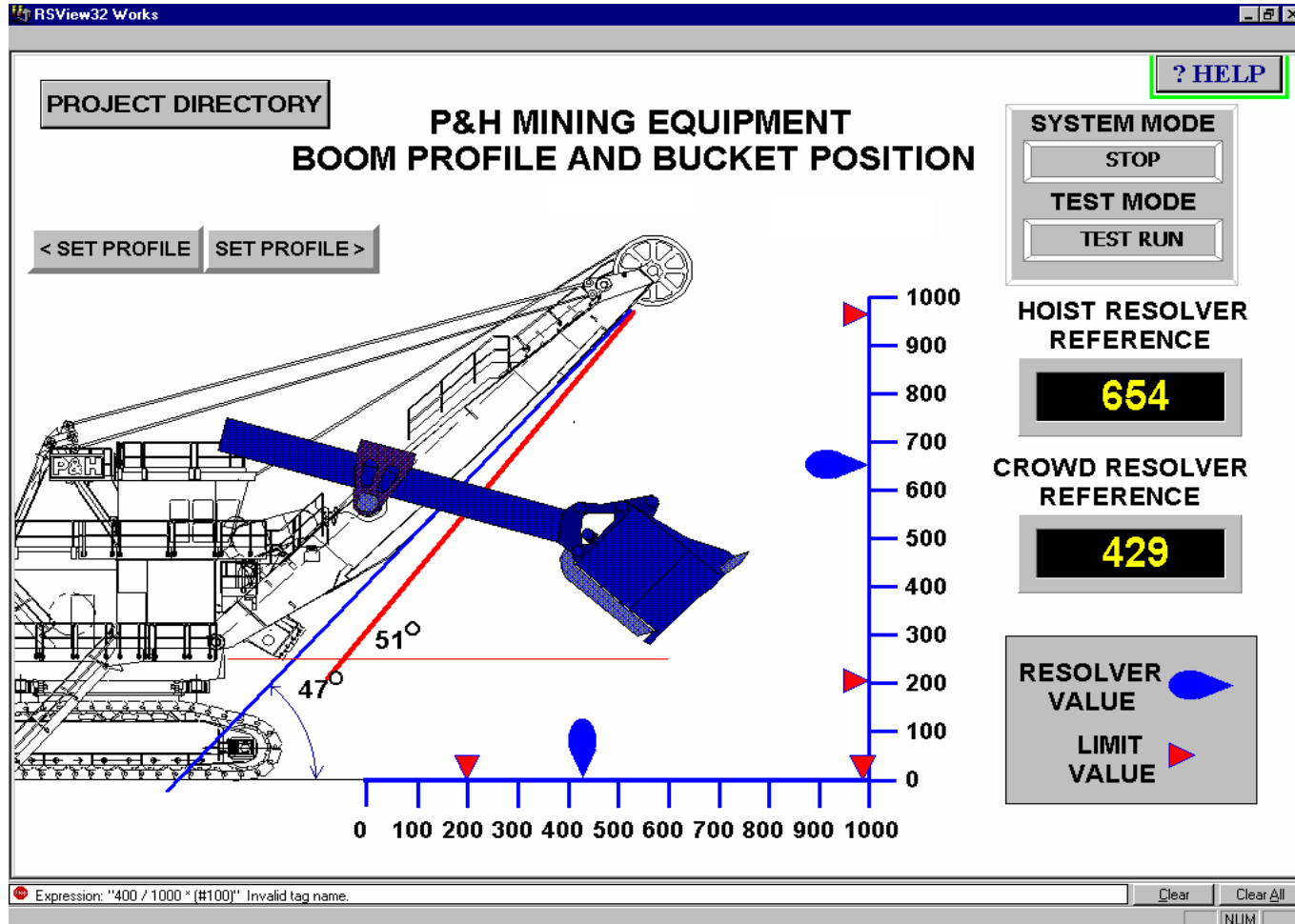


# Temperature Trending

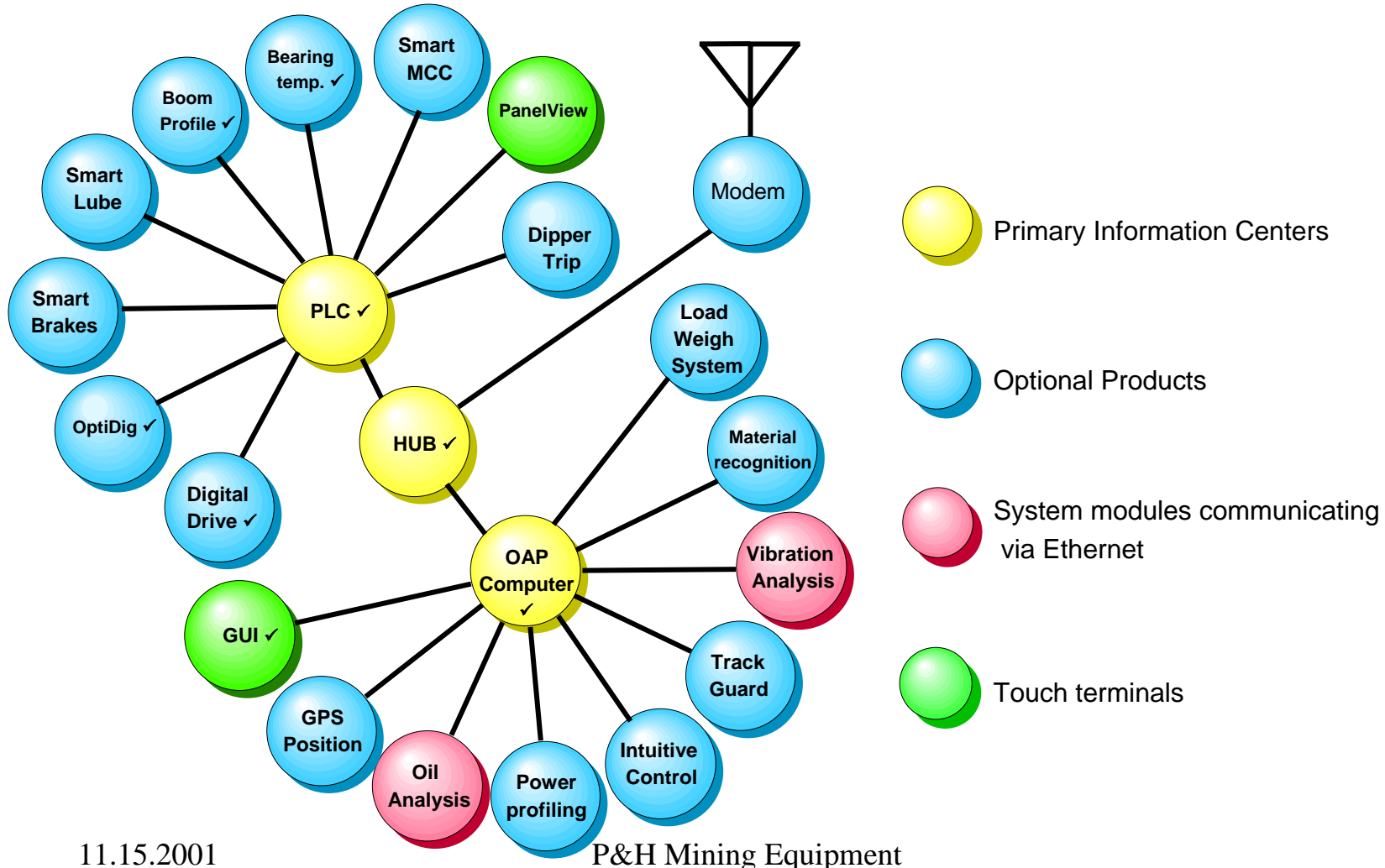




# Motion Limits and Boom Protection



# Integrating Technology





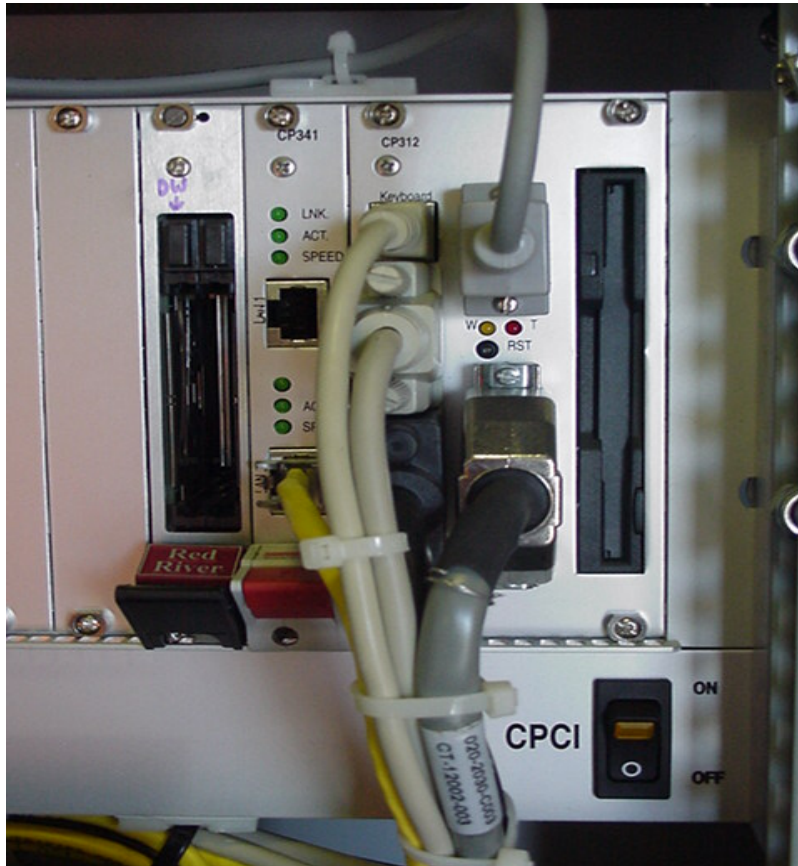
# Today--after Technology Changes

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- ◆ **Open Architecture Processor (OAP) for data**
  - » adds pre-processing and data collection ability
- ◆ **On-board, on-the-fly payload weighing**
- ◆ **Ability to send data off-board**
  - ◆ = *optional*



# Open Architecture Processor



- Allows high speed data processing independent of critical machine control
- Access to other mine systems via ethernet connection



# Replacing

## “on-off” sensors with transducers

- **Allows more flexible response to changing conditions**
- **Resistance Temperature Detectors (RTDs) vs. temperature switches**
- **Pressure transducers vs. switches for air and lube pressure**
- **Resolvers vs. limit switches for position, e.g. Automatic Boom Soft Setdown (ABSS)**
- **Transducer vs. no sensor for Lube Level**



# Lube level transducers







# Transducers generate more data flow

- **Transducers vs. on-off switches**
  - » *words of data* vs. one single bit
  - » trending and histories mean *files of words* vs. one single bit
- **What do we do with all this data?**
- **Storing it and transmitting it both have downsides**





# More Data

- **Digital Drives and additional PLC functions provide increased information when an alarm or fault occurs**
  - » on-line diagnostics shorten MTTR, but generate more data
- **Additional functionality to assist productivity, e.g. OptiDig<sup>tm</sup> stall prevention**



# Future Directions

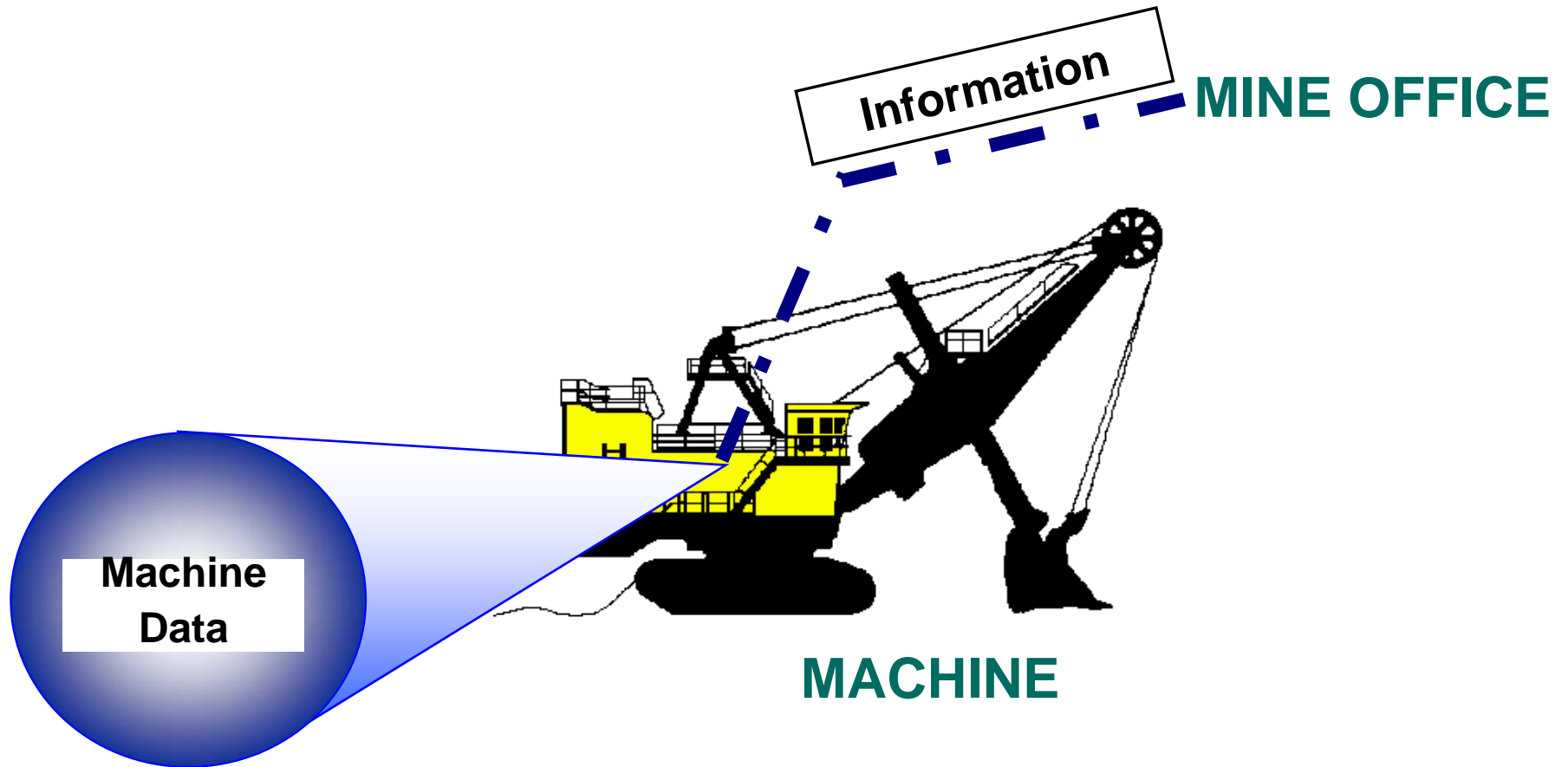
- **Continued work toward on-line predictive diagnostics (vibration data, oil analysis)**
- **More monitoring of machine/operator aspects to balance maximum productivity against increased maintenance, e.g. OptiDig<sup>tm</sup>, Track Guard<sup>tm</sup>**
- **Work on Smart Brakes and Smart Motor Control Centers**

# Future Directions - cont'd

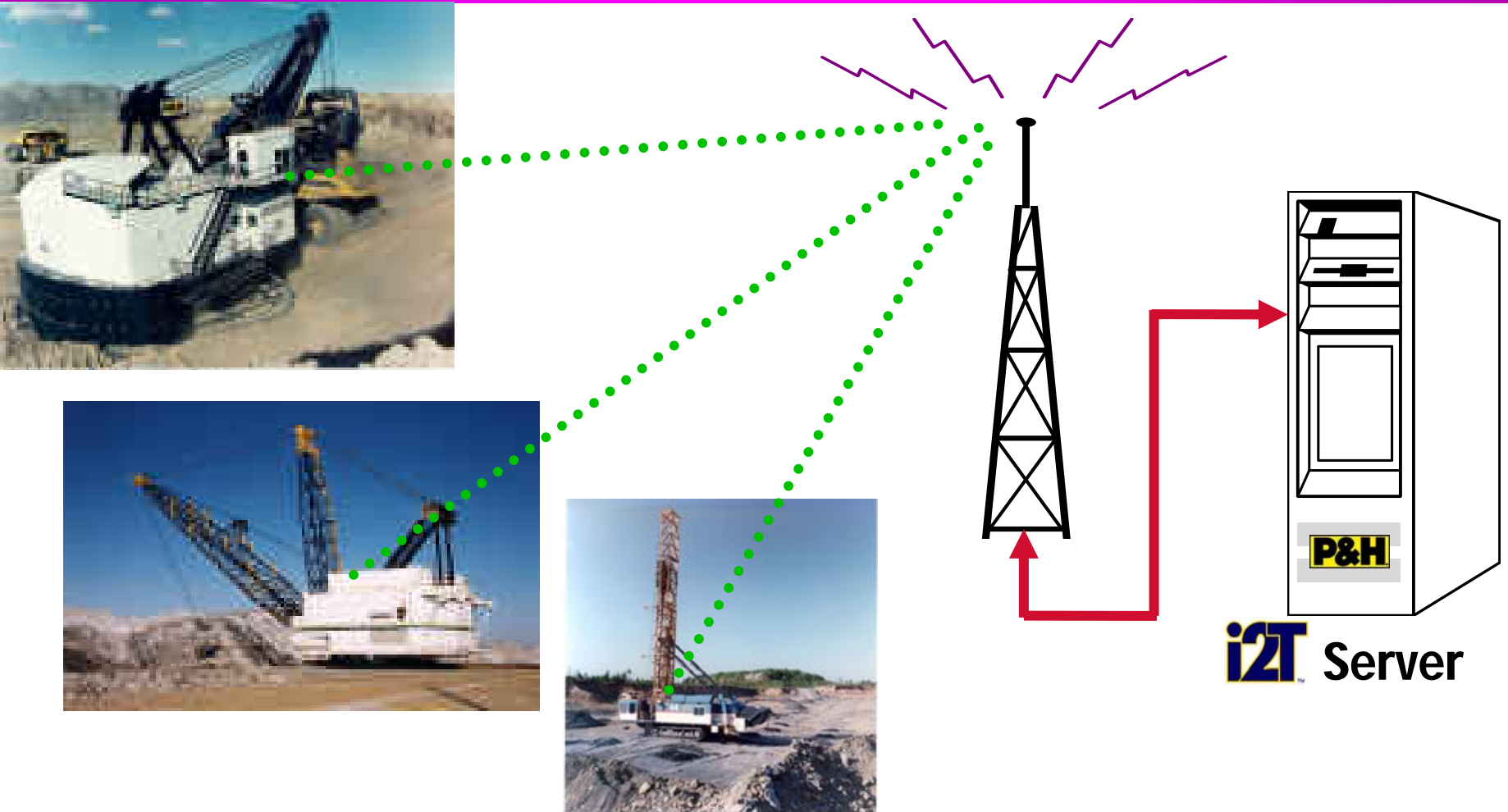
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- **Work on adaptive controls for drives taking into account :**
  - » power system conditions
  - » material changes
- **All of these have data flow implications!**

# Remote Communications



# Link to Server



# Integrating Information

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- Linking information - - i2T Remote Communications
  - ✦ Internal to machine
  - ✦ Machine to Mine Office
  - ✦ Mine Office to internal LAN, P&H, . . .
- Common platform for:
  - ✦ Multiple options (LWS, Remote Communications, . . .)
  - ✦ Universal solution to Shovels, Draglines, Drills



# How do we move data off-board?



## “Push” vs. “Pull”

- **P&H i2T approach has been to “pull” data off-board from on-board**
- **Only transmit specifically requested data**
- **Requires person at off-board side to request data**
- **Requires separate radio channels due to bandwidth/size of data stream**

# “Push” vs. “Pull” (continued)

- **Why not “push” commonly desired data into an off-board database?**
  - » Requires on-board pre-processing
  - » requires a communication pipeline with capacity
- **“Pull” makes sense when dealing with long streams of data**
  - » example: motor currents and voltages, temperature logs, fault information





# Mining Information for Multiple Users



- **Management**
- **Production**
- **Mine Planning**
- **Maintenance**
- **P&H (MinePro, Engineering,  
Service, Management,...)**
- **...**

# Information Challenges

- **Mobile equipment - stationary office**
- **Global communications disparities**
- **Remote locations**
- **Insufficient qualified personnel**
- **Mines do not want several different communications systems--one network should service all pit equipment**

# Collaboration

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- **Need Industry consensus on data file format.**
- **Mine-specific requirements identified and variations minimized.**
- **Trust.**

# Conclusion

- P&H wants to be part of the solution.
- In-pit radio systems are not a P&H core competency.
- i2T Products are a start toward better information management.
- The Industry (Miners, OEM's, 3rd Parties) need to collaborate toward mine-wide integration.
- Mines, however, need to be the drivers!



Tell us what YOU want.