EVER EXPANDING HORIZONS

Rethinking Approaches to Maintenance Outage Planning and Operations

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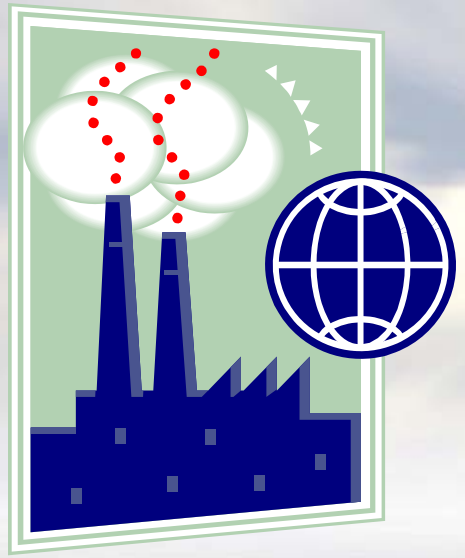
Curtiss-Wright Flow Control
January 15, 2009

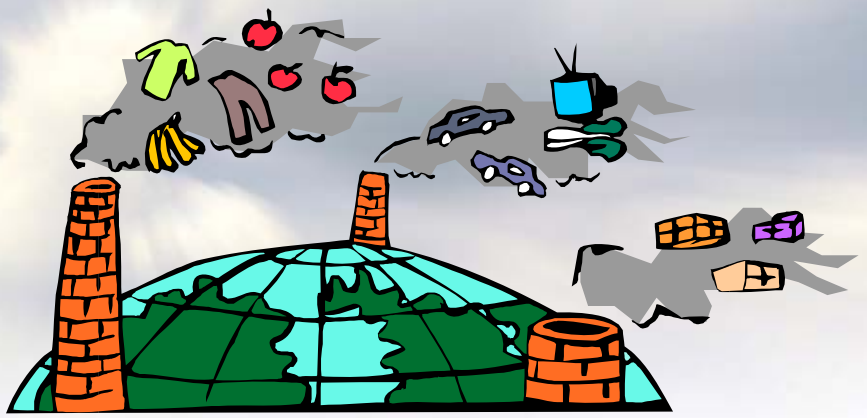
DOWN TO EARTH THINKING

Current cost structure requires maximum efficiency!

- Uncertain or rising fuel prices limit dispatch flexibility
- Limited system reserve capacity requires higher unit run time per year
- Pre-planning for outages getting more complicated

New and existing Environmental requirements will continue to limit operational flexibility





Our Staff is getting older!

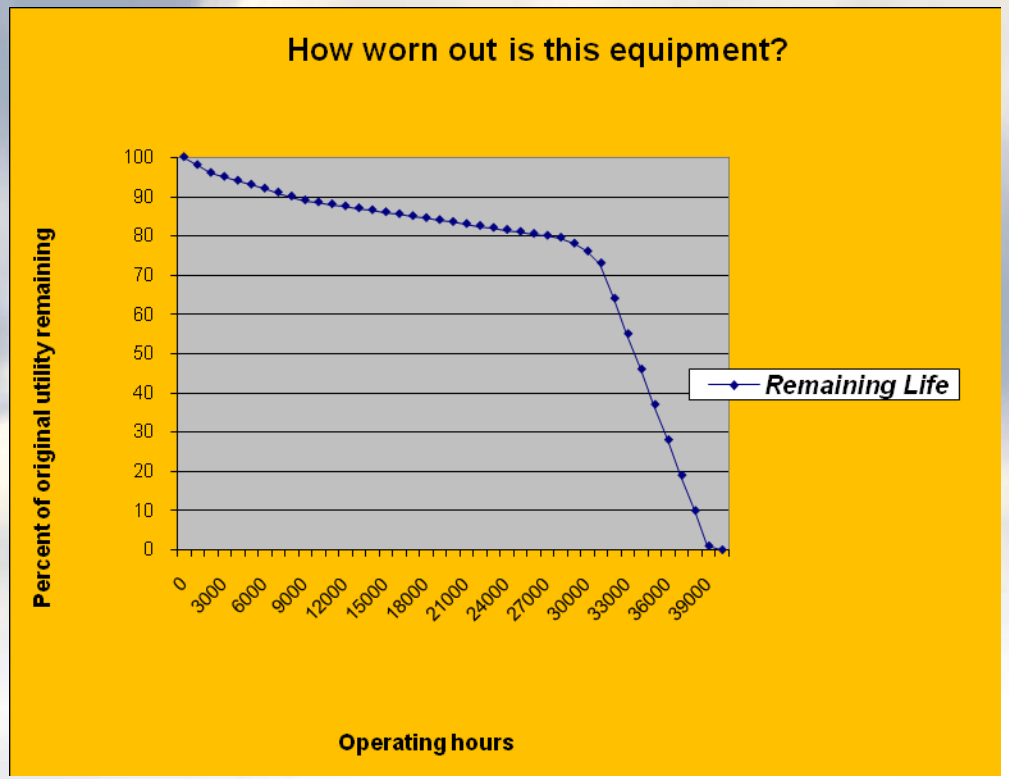
- Limited new entry by younger staff.
- Retirement of experience staff leading to reduced in-house labor pool.
- Need to capture expertise for future.

Is our Staff *Really* operating in the optimal configuration?

- What “real time” data do you have that shows the impact of operating decisions on the life of plant equipment?
- Is there a feed back process to show the “hands on” operators what they are doing to each piece of operating equipment as they change load settings and operating configurations?

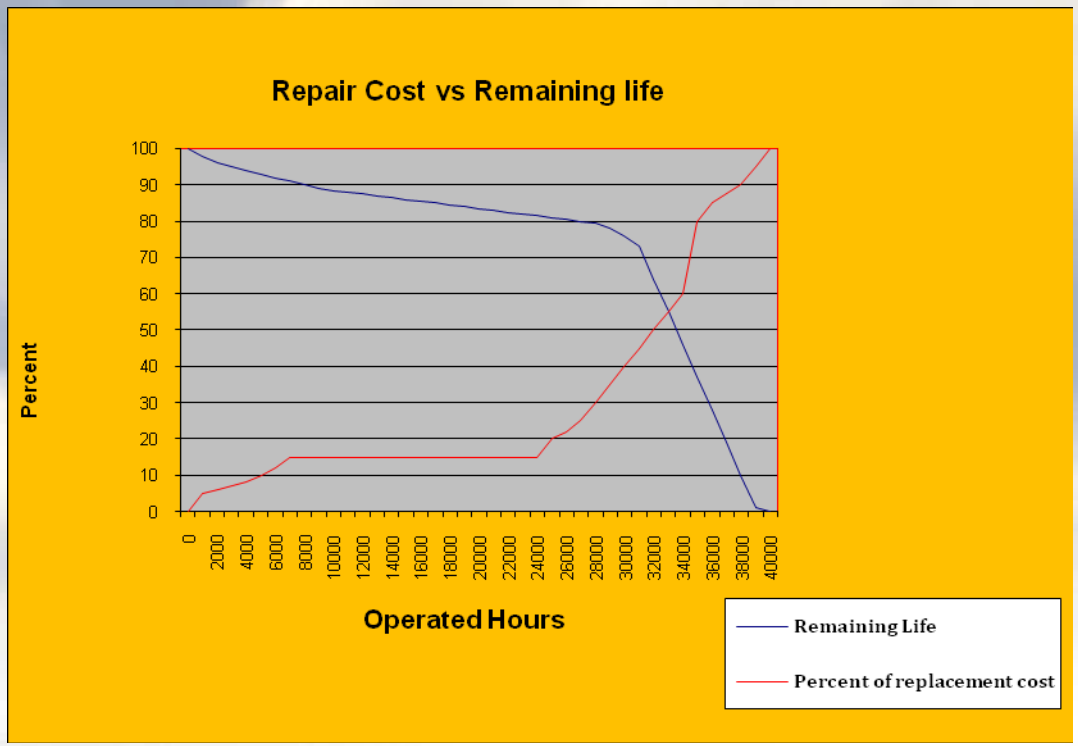
What are we working toward?

- How do we find the best wear point to perform maintenance?



How do we justify the cost?

- Is the optimal cost point the same as the wear point?
- How do we know how much wear exist without shutting down?



How does staff decide on the best maintenance approach

- Where does the information for this decision come from?
- Is there “real time” data or is it developed by looking at history and post removal inspection information?
- How does staff experience get incorporated into the mix?

Wouldn't it be great to have better operating and planning data!

It's time to rethink our approach…

Active Real Time
Asset Condition Monitoring Contributing to Optimizing Fleet Management

SWANtech™

The Next Wave in Condition Monitoring

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Flow Control Corporation

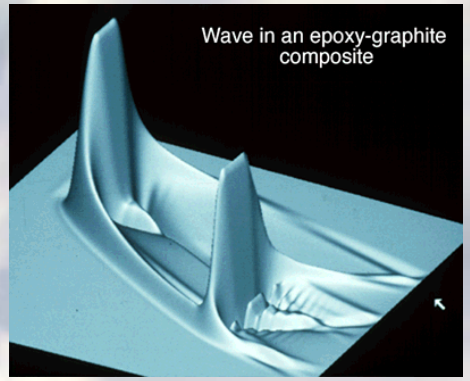
An Asset Condition Monitoring Solution should…

- Provide insight and advantage to maximize operational readiness and availability
- Allow you to understand the impact of operational decisions on remaining useful life
- Make it possible to maintain the right assets at the right times
- Eliminate unscheduled shutdowns
- Allow you to Stay Ahead and in Control

Stress Wave ANalysis Measures Friction

All moving things (solids, liquids and gases) produce friction

Friction (and impact events) produces stress waves



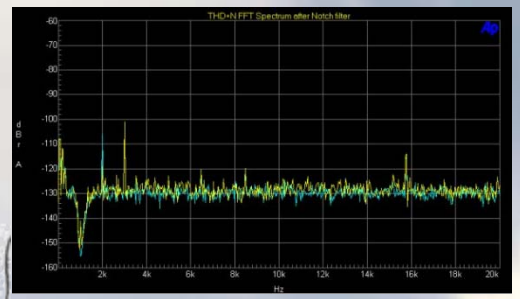
Stress Wave Visualization – Virginia Tech

Stress waves are energy sound waves that move through a solid.

…We "listen for friction"

SWAN = Health Care + Condition Monitoring

Condition Alone Isn't Enough…Understanding Health is Important



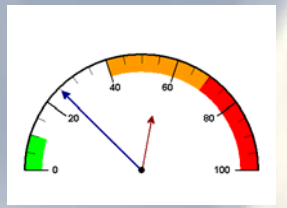
You can be healthy and yet experience different levels of stress, depending on how hard you are working (or how fast you are running).

If you **know** the operating conditions and environmental conditions, you can understand if the stress levels you see are appropriate (or not).

If you **know** the stress levels are not appropriate then you have a condition that needs to managed before it becomes too late.

Asset Monitoring Needs to Capture Different Operating Dynamics

Dynamic loading…



Flow

RPM

Torque

Wear…

Lubricate condition…

Failure process…

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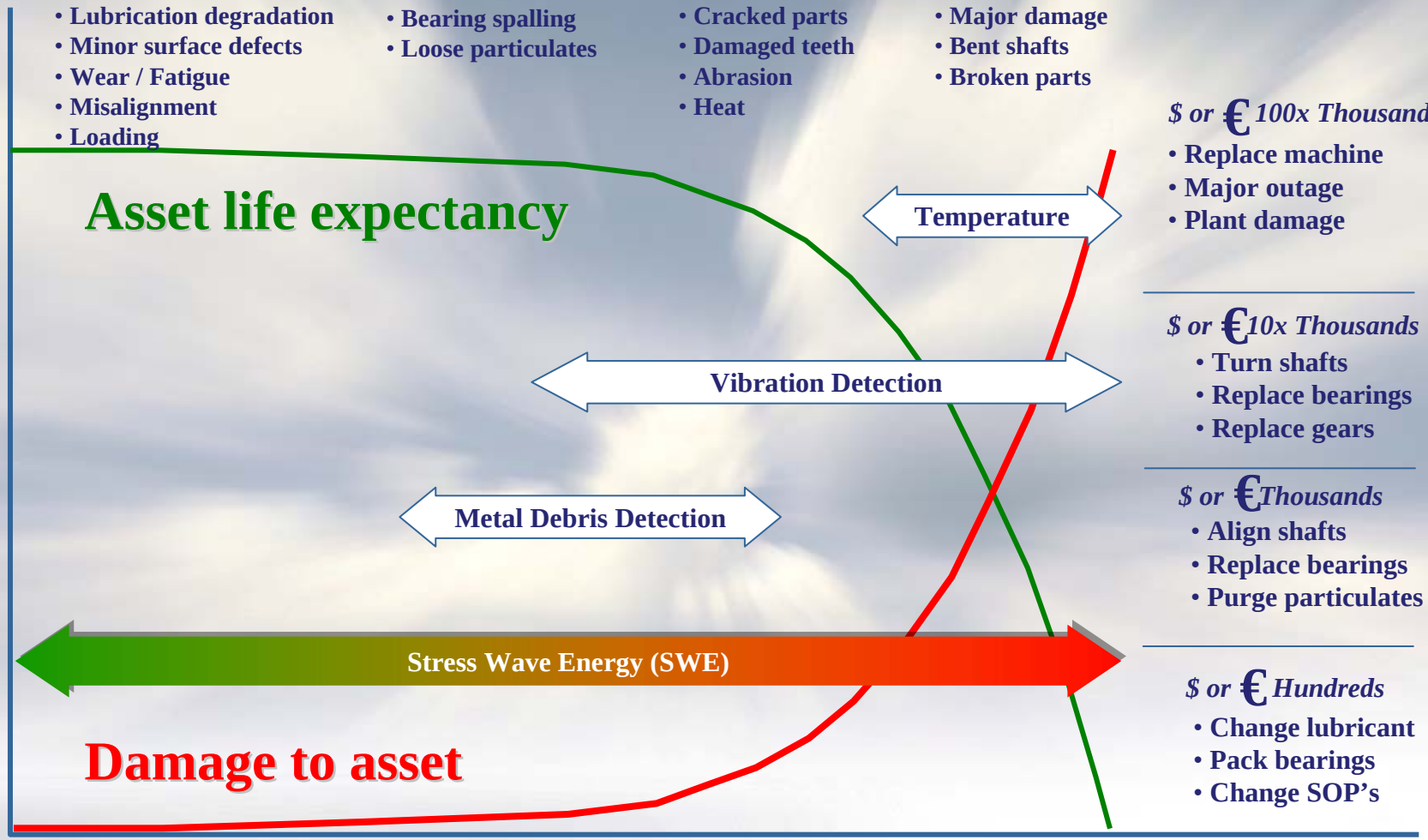
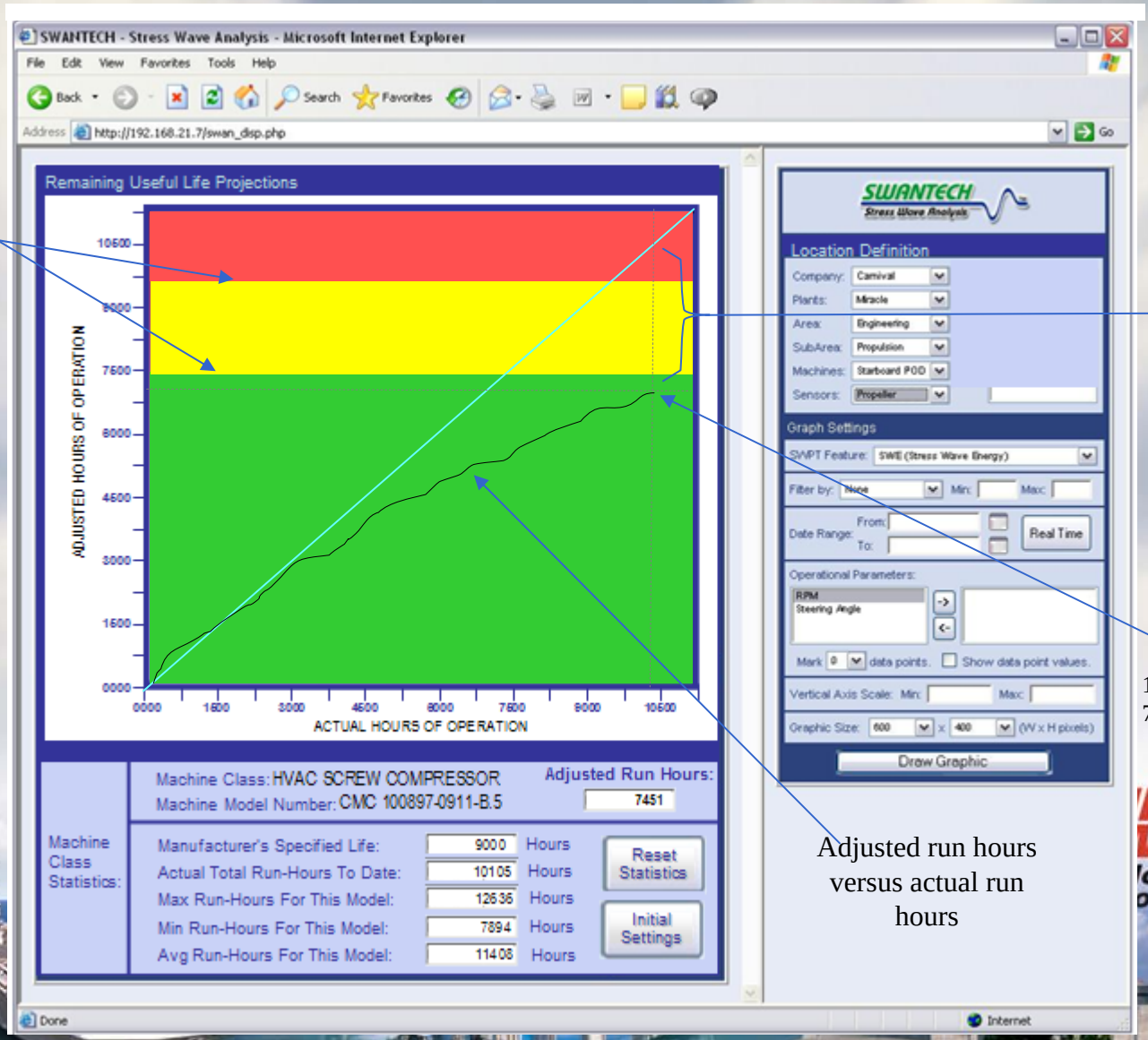
…Traditional temperature and vibration are second order responses to changes in friction

Stay Ahead and in Control



Life Remaining Index (LRI)

Adjustable GYR thresholds (adjusted run-time hours)



Difference between "pure" run-time and smart run-time

Right now:

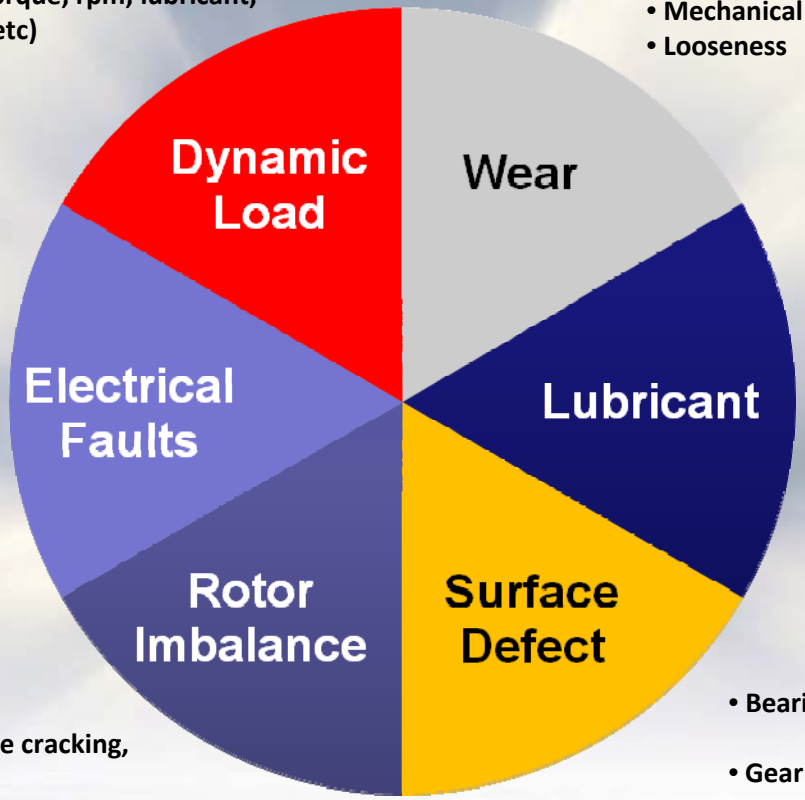
10,105 actual hours
7,451 adjusted hours

Adjusted run hours versus actual run hours

SWANtech Capabilities

- Stress Loads as a f(torque, rpm, lubricant, angular momentum, etc)

- Mechanical Wear
- Looseness



- Arcing, grounding, rub, electrical load imbalance

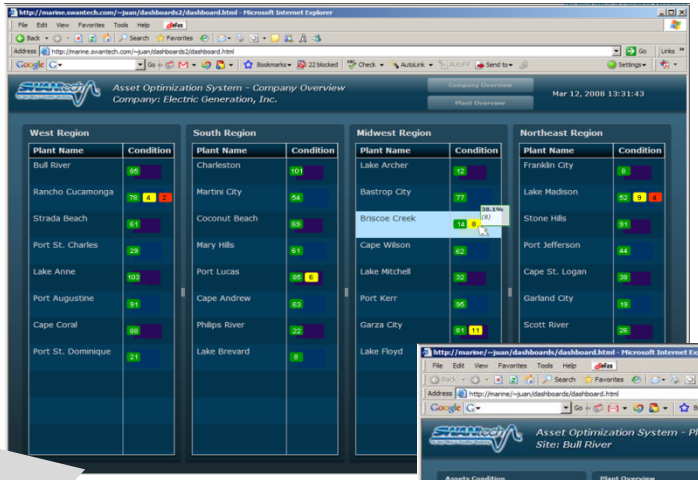
- Lubricant Condition (contamination, break-down)
- Lubricant Effectiveness (fluid film failure, flow, levels)

- Asymmetric pitch, blade cracking, imbalance
- Misalignment, eccentricity

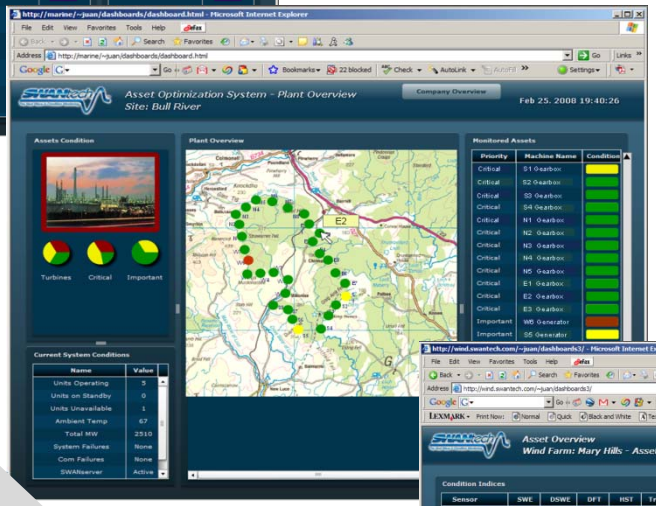
- Bearing Faults (location and isolation)
- Gear Faults (location and isolation)
- Shaft Faults (location and isolation)

Asset Dashboard Displays

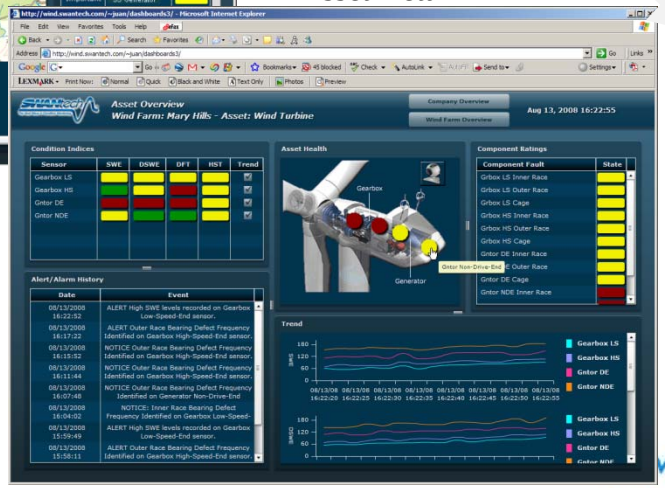
FLEET Overview



Site Overview



Asset Detail



Greater Detail

Greater Density

FLEET Overview:
Multiple user-defined regions
Unlimited sites per region
Unlimited assets per site
Huge asset density on one page

Site Overview:
User defined asset categories
Multiple user-defined sub-areas
Unlimited assets per site
All assets on one page if desired

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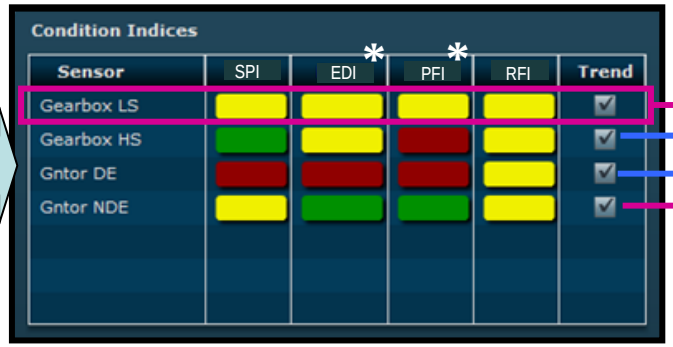
Condition Aggregation Simplifies Operations

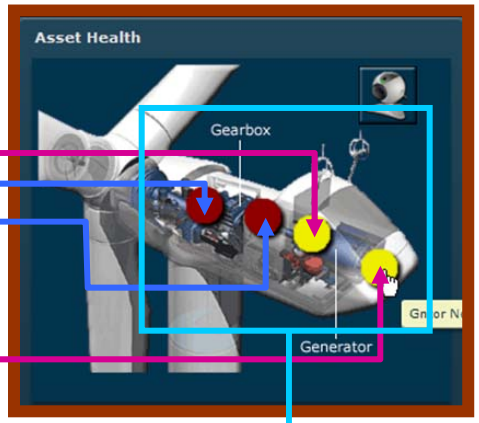
Condition Index "sets" aggregate to a **sensor condition** (one per sensor) that is expressed as a code: G,Y or R

Sensor Condition Indicators

SWANserver-based logic and calculations

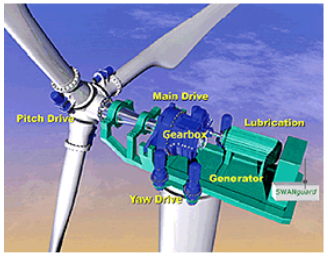
- Triggered DRs
- SWE history
- OpParameters
- CI calculations



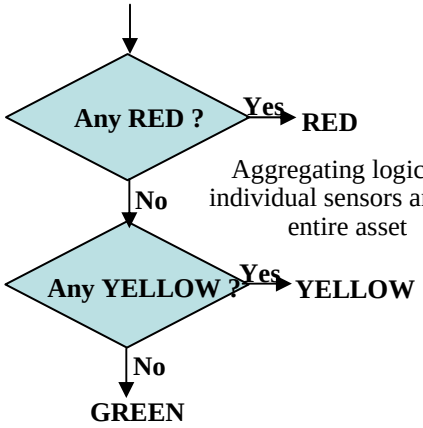


* The available CIs will depend on specific factors such as having RPM or a common shaft

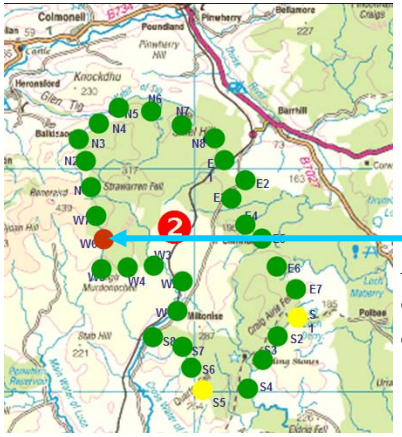
Sensors associated with this asset



Asset being monitored



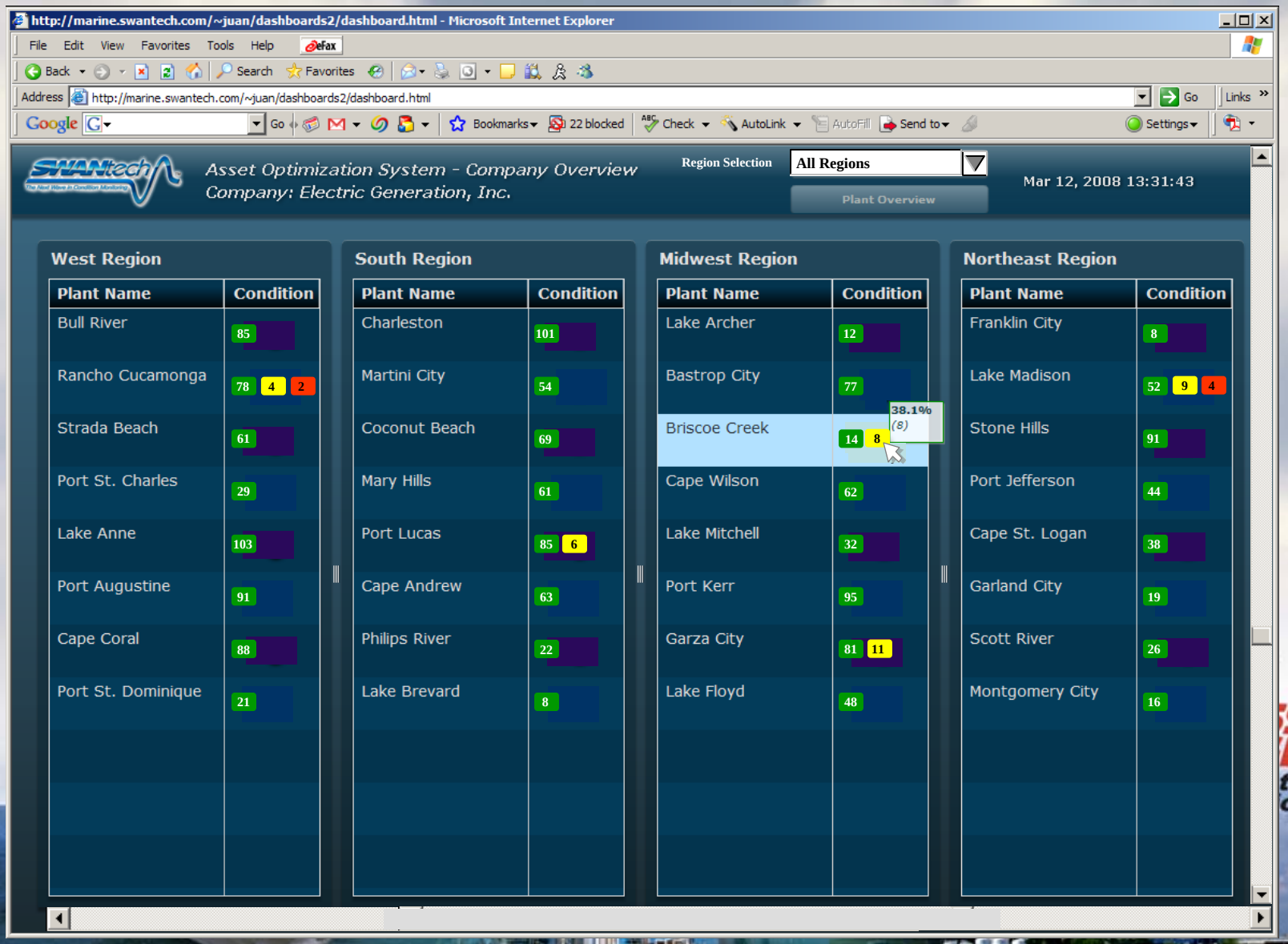
Aggregating logic for individual sensors and for entire asset



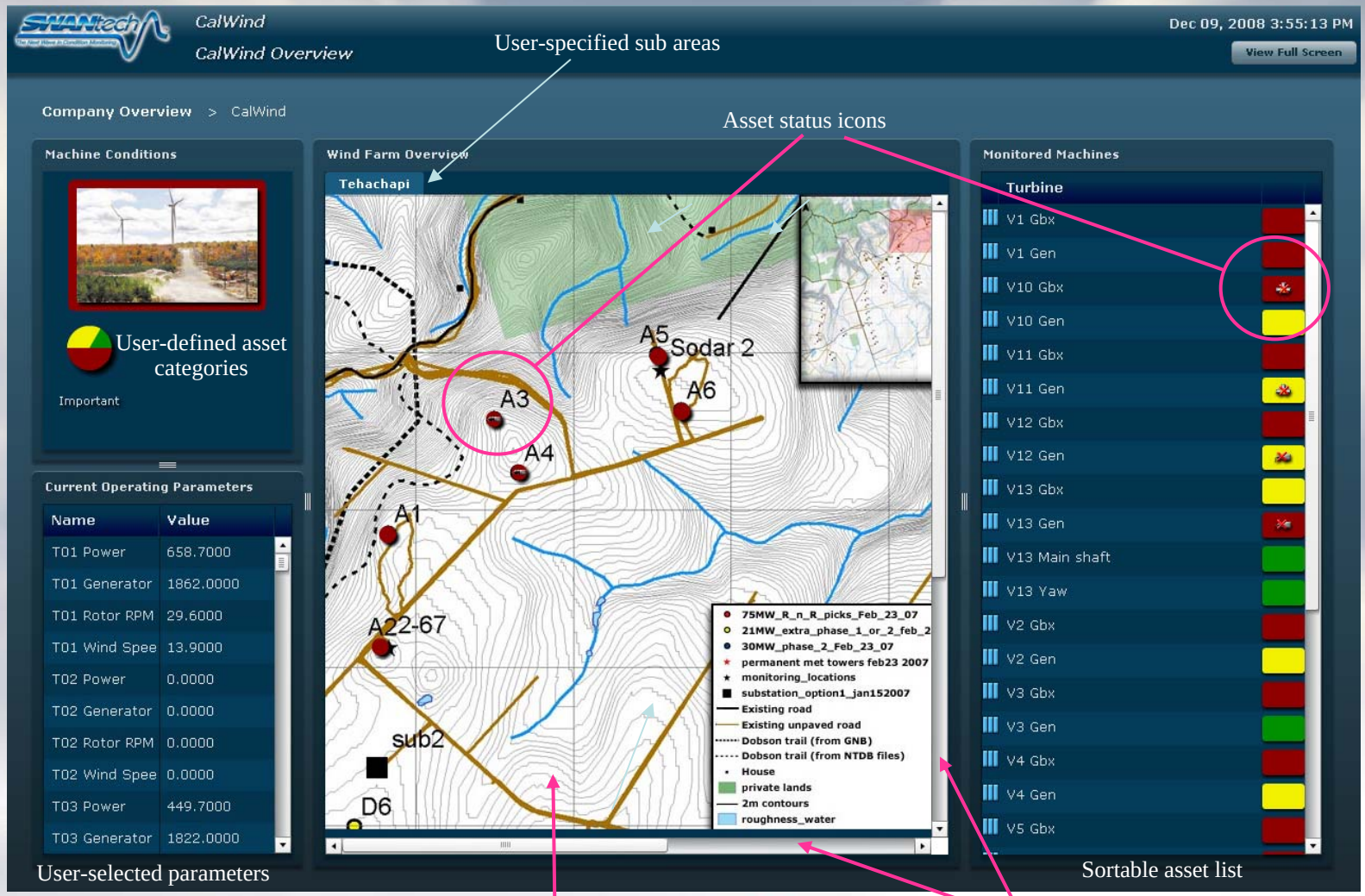
Asset Condition Indicators

Asset sensor conditions aggregate to an **asset condition** which is expressed as a code: G, Y or R

Plant Fleet Overview



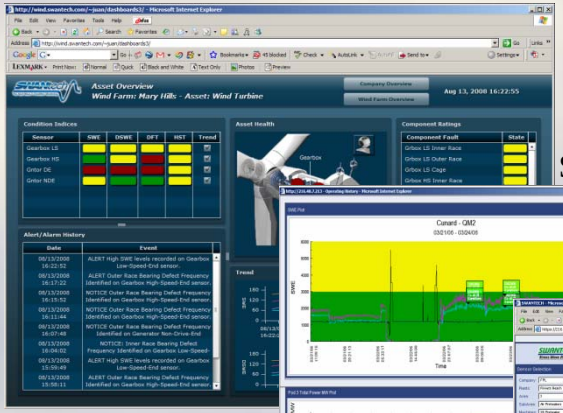
Site Display



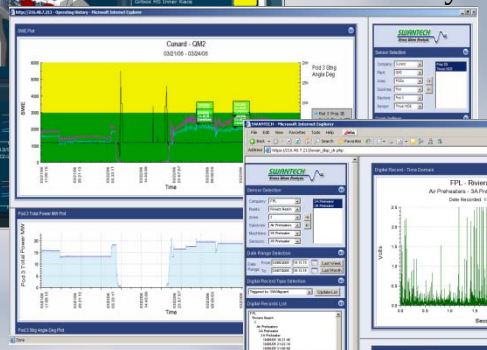
Asset Detail Display

Asset Detail & Analysis Displays

Asset Detail



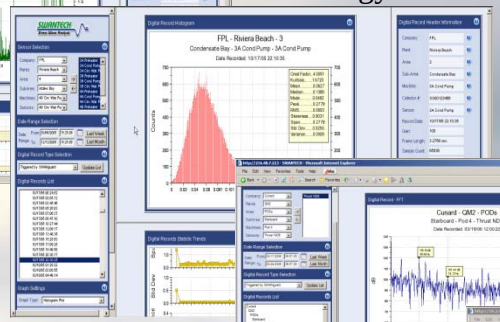
SWE History



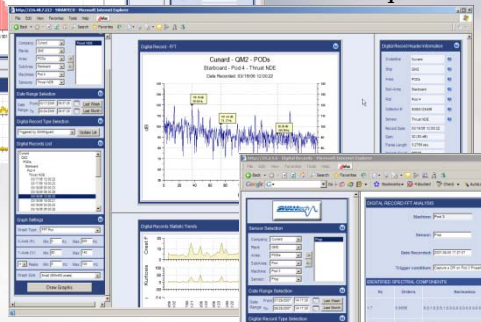
DR Time Domain

DR Analysis

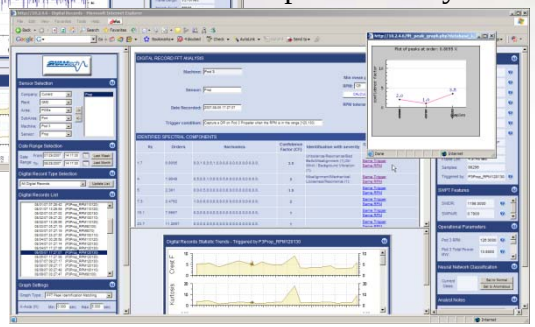
DR Energy Distribution



DR Freq Domain



Spectral Analysis



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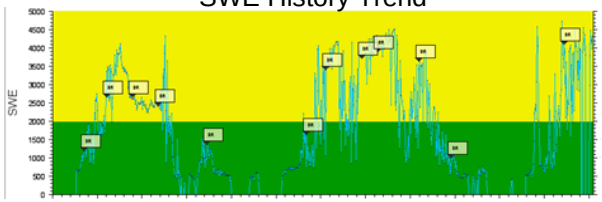
Condition Index Calculations

- **SWE Performance Index (SPI)**

SWE History Trend

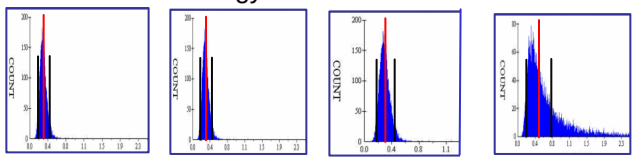


Statistical Data Reductions

CI Asset Ranking

- **Random Frequency Index (RFI)**

DR Energy Distribution Statistics

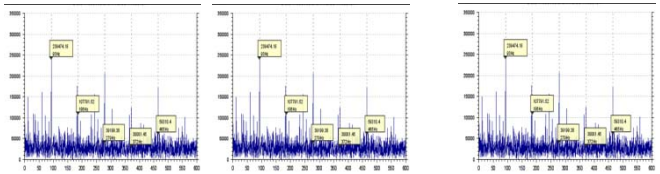


Statistical Data Reductions

CI Asset Ranking

- **Periodic Frequency Index (PFI)**

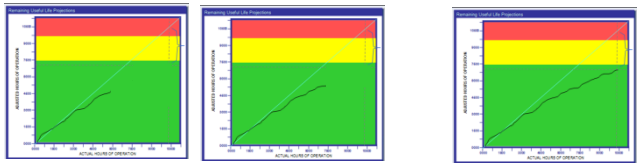
DR Frequency Component Statistics



Statistical Data Reductions

CI Asset Ranking

- **Life Remaining Index (LRI)**



Statistical Data Reductions

CI Asset Ranking

Aggregate Sensor Ranking

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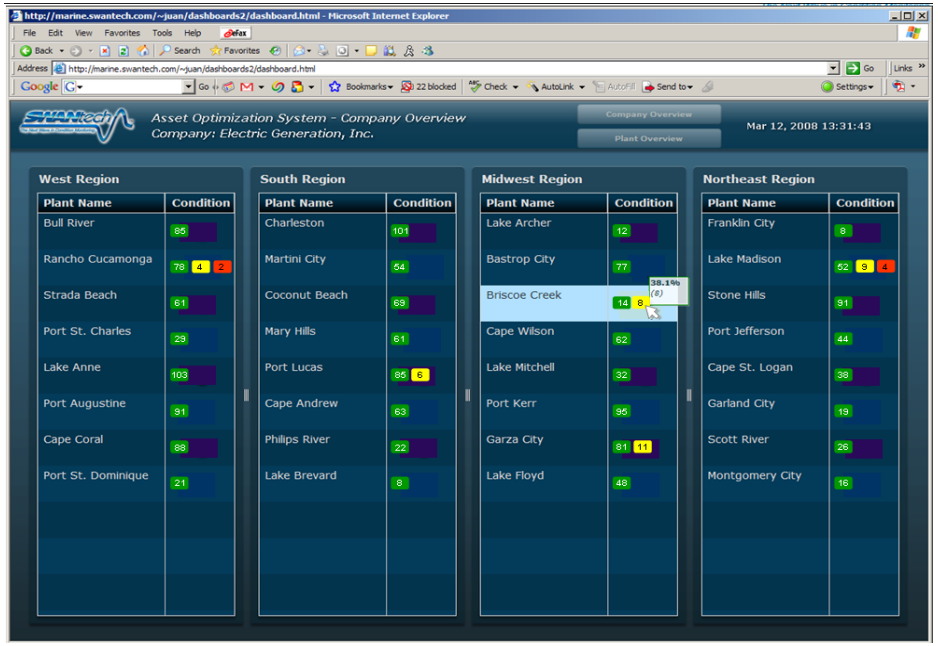
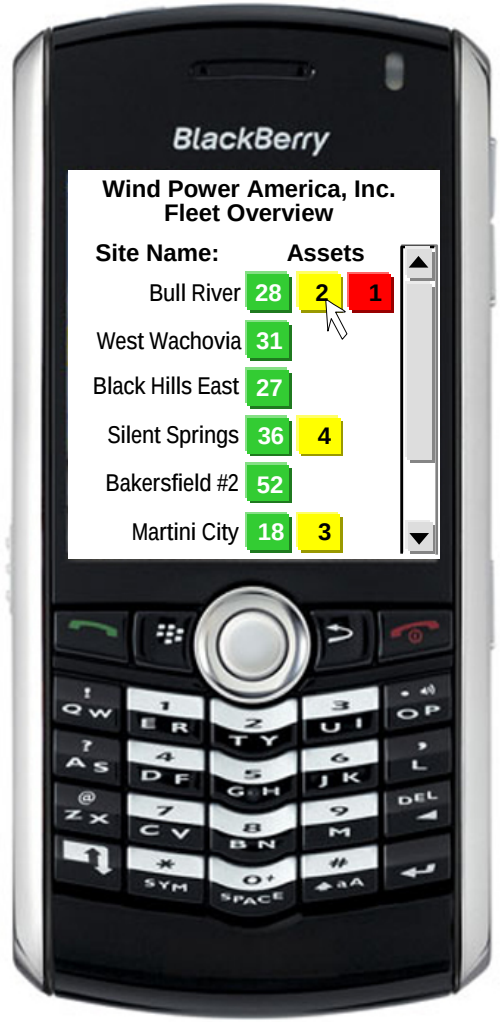
Customer Interfaces – “PDA version”

“Fleet” View





(Scheduled for product release in Q1-2009)

EVER EXPANDING HORIZONS

End of Presentation

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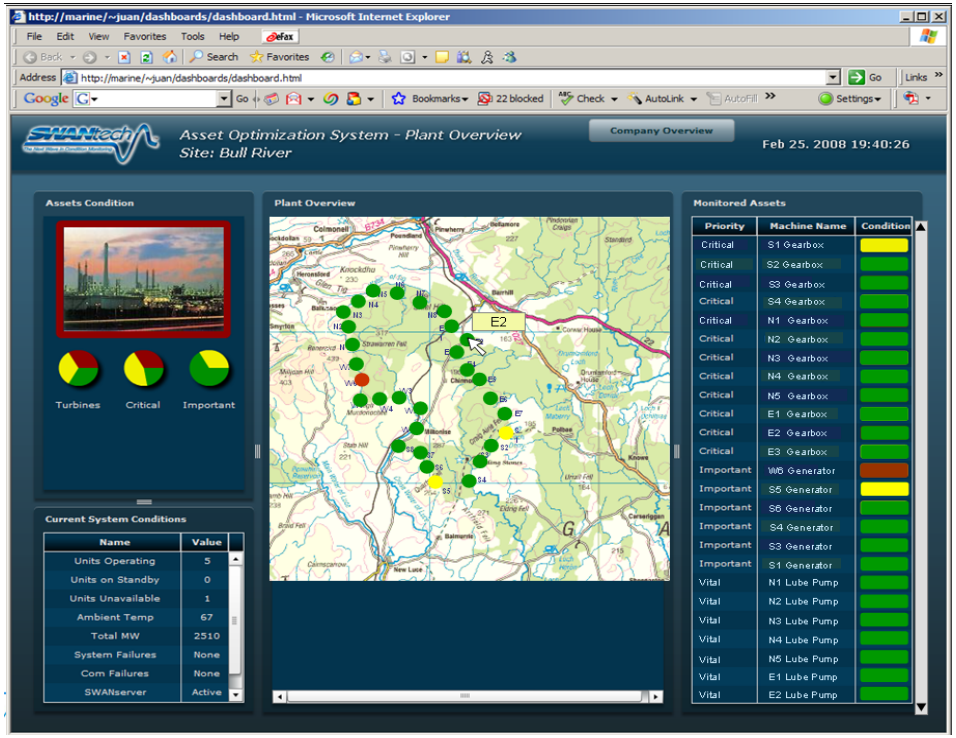
DOWN TO EARTH THINKING

Some Back up or Miscellanious slides

Customer Interfaces – “PDA version”

“Site” View



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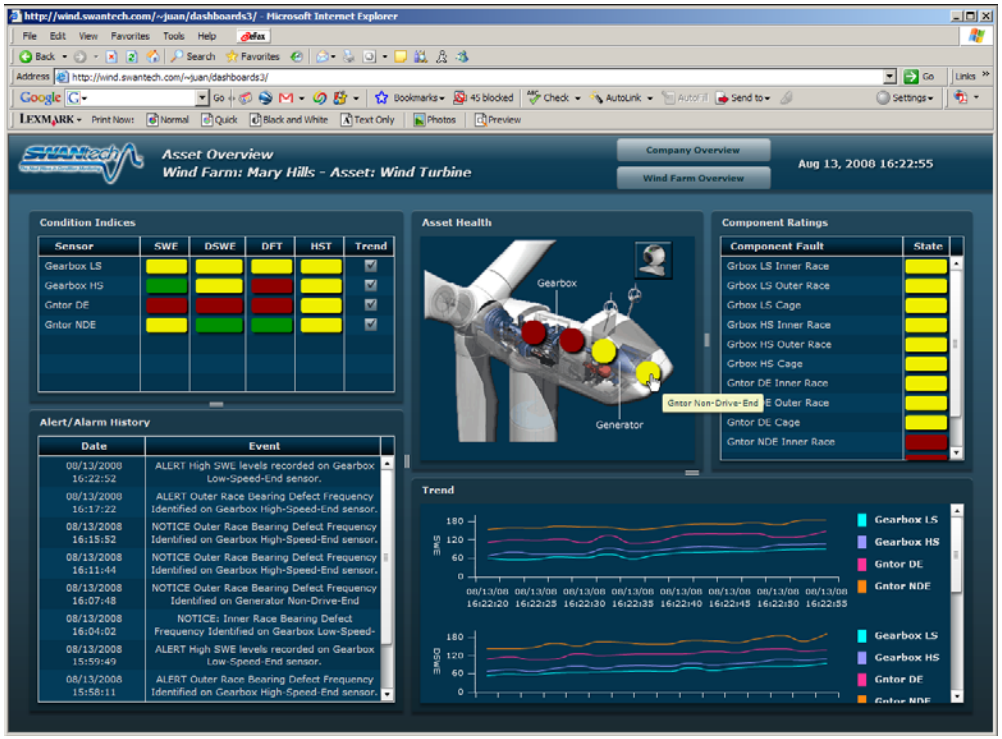
Customer Interfaces – “PDA version”

“Asset” View



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Customer Interfaces – “PDA version”