Agenda

• Overview of Thermography
• Benefits of Thermography
• Who Uses Infrared Cameras?
  – Equipment Applications
  – Vertical Segments
  – Key Users
• Intro to Fluke Ti Product Family
Thermography then and now:

A few years ago:
- Avg. Price per unit > $20K
- Typical User – Professional
- Where Used – Larger customers, government

Now:
- Avg. Price per unit < $10K
- Typical User – Maintenance Tech
- Where Used – General Mfg, Bldg Science, Health Science

Overall improvement in the Return on Investment (ROI) for customers has dropped from “Years” to “Months”
Overview of Thermography

What is Thermography?

• Measurement of temperature remotely to indicate equipment health

• Thermography is the temperature measurement of several points and assigns a color based on the temperature:
  • Uses standard color palette: Red is hot/blue is cold
  • Brighter colors are warmer/darker colors are cooler

• Thermography cameras produce a picture that details this information in an easy to use format
  • Easier to use
  • More affordable
  • Finding more applications
Overview of Thermography

What is the Benefit?

- High heat is key indicator of equipment failure:
  - Find hot spot
  - Fix equipment before failure
  - Equipment operating efficiently

- Average cost of downtime for a given piece of equipment is greater than $20K/hour

- Enables Service/Installer/Maintenance technicians (YOU!) to stop fighting fires and fix problems before they result in large-scale losses

- Measurement is…
  - Non-contact
  - Obtained without disturbing production
  - Applies to all types of equipment
  - Reliable data
  - Quickly identifies specific location
  - Apply to most all conditions
# Average Downtime Costs: Lost Revenues

<table>
<thead>
<tr>
<th>Industry Sector</th>
<th>Revenue/Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>$704,101</td>
</tr>
<tr>
<td>Construction and engineering</td>
<td>$389,601</td>
</tr>
<tr>
<td>Electronics</td>
<td>$477,366</td>
</tr>
<tr>
<td>Energy</td>
<td>$2,817,846</td>
</tr>
<tr>
<td>Food/beverage processing</td>
<td>$804,192</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>$1,610,654</td>
</tr>
<tr>
<td>Metals/natural resources</td>
<td>$580,588</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>$1,082,252</td>
</tr>
<tr>
<td>Utilities</td>
<td>$643,250</td>
</tr>
</tbody>
</table>
Overview of Thermography

Locating problems before failure has high value

- Increased safety
- Improved reliability
- Reduced fire fighting
- Reduced unscheduled outages
- Reduced maintenance and repair costs
- Improved production rate and quality
- Better assurance of repairs and new installations
# Thermography – Uses and Users

<table>
<thead>
<tr>
<th>Where is Thermography Used?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Vertical markets: industrial, utilities, local &amp; state governments, petroleum/gas, construction/restoration, paper &amp; pulp mills, data centers, human &amp; animal medical, R &amp; D, etc.</td>
</tr>
<tr>
<td>• Equipment Applications: engines, drives, motors, Electric Motor Bearings and Windings, belts, electrical panels, switchgear, power lines, UPS systems</td>
</tr>
<tr>
<td>• Building Diagnostics: Furnaces, HVAC, Roofs, building envelopes including Water Restoration, Mold Remediation and Pest Control</td>
</tr>
</tbody>
</table>

Overall—Most of You will be able to use thermography right away and improve your facility’s uptime quickly.
Infrared Camera Applications
Industrial Equipment Applications
## Electrical systems

<table>
<thead>
<tr>
<th>Commonly inspected components</th>
<th>Typical reasons for temperature hotspots or deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3 phase) Power distribution</td>
<td>Unbalanced loads</td>
</tr>
<tr>
<td>Fuse boxes</td>
<td>Harmonics (3rd harmonic current in Neutral)</td>
</tr>
<tr>
<td>Cables &amp; connections</td>
<td>Overloaded systems/excessive current</td>
</tr>
<tr>
<td>Relays/Switches</td>
<td>Loose or corroded connections increased resistance in the circuit (typically one side of components heats up)</td>
</tr>
<tr>
<td>Insulators</td>
<td>Insulation failure</td>
</tr>
<tr>
<td>Capacitors</td>
<td>Component failure</td>
</tr>
<tr>
<td>Substations</td>
<td>Wiring mistakes</td>
</tr>
<tr>
<td>Circuit breakers</td>
<td>Underspecified components (like fuses) would heat up on both side of the fuse</td>
</tr>
<tr>
<td>Controllers</td>
<td></td>
</tr>
<tr>
<td>Transformers</td>
<td></td>
</tr>
<tr>
<td>Motors</td>
<td></td>
</tr>
<tr>
<td>Battery banks</td>
<td></td>
</tr>
</tbody>
</table>
Two lighting breakers are 35°F above ambient
Electrical
Near catastrophic failure! Found and managed until normal factory shut down.
Power lines and Sub-stations
## Electromechanical

<table>
<thead>
<tr>
<th>Commonly inspected components</th>
<th>Typical reasons for temperature hotspots or deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Motors</td>
<td>• Bad cooling- due to reduced airflow</td>
</tr>
<tr>
<td>• Pumps</td>
<td>• PQ problems like unbalance, overload or 5th harmonic (voltage) will cause heat dissipation</td>
</tr>
<tr>
<td>• Heat exchangers</td>
<td>• Bad alignment</td>
</tr>
<tr>
<td></td>
<td>• Insulation problems with motor windings</td>
</tr>
<tr>
<td></td>
<td>• Bearing problems – lubrication, wear, etc.</td>
</tr>
</tbody>
</table>
High Resistance Connection

3-Phase Connector Before Repair

3-Phase Connector After Repair

150 HP Motor
## Mechanical systems

<table>
<thead>
<tr>
<th>Commonly inspected components</th>
<th>Typical reasons for temperature hotspots or deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bearings</td>
<td>• Friction due to wear, misalignment or inadequate lubrication</td>
</tr>
<tr>
<td>• Gearboxes</td>
<td></td>
</tr>
<tr>
<td>• Drive belts</td>
<td></td>
</tr>
</tbody>
</table>

Fluke Thermography
# Process installations

<table>
<thead>
<tr>
<th>Commonly inspected components</th>
<th>Typical reasons for temperature hotspots or deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Refractory insulation</td>
<td>• Damaged structures caused by worn pipes etc</td>
</tr>
<tr>
<td>• Tanks and vessels</td>
<td>• Abnormal heat flow/heat gradients</td>
</tr>
<tr>
<td>• Steam systems/traps</td>
<td>• Gas or steam leakage</td>
</tr>
<tr>
<td>• Pipes and valves</td>
<td></td>
</tr>
<tr>
<td>• Heaters/Furnaces</td>
<td></td>
</tr>
<tr>
<td>• Manufacturing equipment</td>
<td></td>
</tr>
<tr>
<td>• Plastics Industry (Molding)</td>
<td></td>
</tr>
<tr>
<td>• Pulp &amp; Paper (Rollers, handling equipment, etc)</td>
<td></td>
</tr>
<tr>
<td>• Metal Foundry</td>
<td></td>
</tr>
<tr>
<td>• Boilers and Reactors</td>
<td></td>
</tr>
<tr>
<td>• Research &amp; Development</td>
<td></td>
</tr>
</tbody>
</table>
## Compressor for in Store Freezing Units

<table>
<thead>
<tr>
<th>Label</th>
<th>Emis</th>
<th>BG</th>
<th>Ave</th>
<th>SD</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>L0</td>
<td>0.95</td>
<td>68.0</td>
<td>235.10</td>
<td>1.90</td>
<td>238.2</td>
<td>230.9</td>
</tr>
<tr>
<td>P1</td>
<td>0.95</td>
<td>68.0</td>
<td>252.61</td>
<td>0.00</td>
<td>252.6</td>
<td>252.6</td>
</tr>
<tr>
<td>P2</td>
<td>0.95</td>
<td>68.0</td>
<td>239.45</td>
<td>0.00</td>
<td>239.5</td>
<td>239.5</td>
</tr>
<tr>
<td>P3</td>
<td>0.95</td>
<td>68.0</td>
<td>189.05</td>
<td>0.00</td>
<td>189.1</td>
<td>189.1</td>
</tr>
<tr>
<td>P4</td>
<td>0.95</td>
<td>68.0</td>
<td>109.18</td>
<td>0.00</td>
<td>109.2</td>
<td>109.2</td>
</tr>
</tbody>
</table>

Problems here!

- Caused this problem

![Thermal Image]
Steam Traps

Working
Delta T = 63°F

Failed
< 1°F
Tank Levels
## Buildings

<table>
<thead>
<tr>
<th>Commonly inspected components</th>
<th>Typical reasons for temperature hotspots or deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Walls</td>
<td>• Insulation verification like improperly installed or missing insulation</td>
</tr>
<tr>
<td>• Roofs</td>
<td>• Roof inspections; leaks cause water to enter to insulation</td>
</tr>
<tr>
<td>• Windows</td>
<td>• Construction evaluation</td>
</tr>
<tr>
<td>• Doors</td>
<td>• Locate air leakage</td>
</tr>
<tr>
<td>• HVAC</td>
<td>• Moisture intrusion; damage to insulation and building materials</td>
</tr>
<tr>
<td>• Insulation</td>
<td>• Mold detection</td>
</tr>
<tr>
<td>• Floor heating</td>
<td>• Thermal bridging in joints between walls</td>
</tr>
<tr>
<td></td>
<td>• Heat loss through damaged seals in multi-plane windows</td>
</tr>
<tr>
<td></td>
<td>• Damaged heat ducks/leakage of buried steam lines</td>
</tr>
</tbody>
</table>
Roof Inspection

Wet spots under roof membrane
Building Envelope

Moisture and air infiltration

• Moisture behind sheet rock
• Air infiltration around door
• Water drops 3 hrs after a shower
Bridge Deck / In-Floor Heating

- Hwy bridge deck with ground water heating
- In-floor hot water heating
## Electronics

<table>
<thead>
<tr>
<th>Commonly inspected components</th>
<th>Typical reasons for temperature hotspots or deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Electrical components and sub assemblies</td>
<td>- Under designed components</td>
</tr>
<tr>
<td>- Circuit boards Assemblies</td>
<td>- Component failure</td>
</tr>
<tr>
<td></td>
<td>- Improper soldering</td>
</tr>
<tr>
<td></td>
<td>- Broken traces</td>
</tr>
<tr>
<td></td>
<td>- Reversed polarity</td>
</tr>
</tbody>
</table>
Printed circuit board testing can find either poorly specified components at the design phase or failing components in the field.
The new face of thermal imaging
Leading innovation

• Ti30: first fully radiometric unit under $10K

• Ti20: breakthrough price-to-performance

• FlexCam Series (Ti40/50): leading image capability combined with ergonomic usage

• Fusion: breakthrough visual light-thermography image management

• Ease of use: all of our products are intuitive
Rounding out the Ti Line

<table>
<thead>
<tr>
<th>Segmentation</th>
<th>Ti10</th>
<th>Ti20</th>
<th>Ti25</th>
<th>Ti40 series</th>
<th>Ti50 series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close up circuit board analysis, distant power distribution scans, fast moving equipment</td>
<td>4.5k</td>
<td>6.5k</td>
<td>7.5k</td>
<td>12-20k</td>
<td>20-26k</td>
</tr>
<tr>
<td>High Temperature Process/Product R&amp;D and field diagnosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic motors, pumps and electrical panels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PdM routes on the factory floor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finding Hot Spots</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Rounding out the Ti Line

<table>
<thead>
<tr>
<th></th>
<th>New users</th>
<th>Experienced users/specialists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imaging</td>
<td>Mostly qualitative imaging</td>
<td>Qualitative &amp; quantitative imaging</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Industrial &amp; building diagnostics</td>
<td>Ind, BD, utilities, electronics</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Troubleshooting, (preventive) maintenance</td>
<td>Predictive maintenance</td>
</tr>
<tr>
<td>In depth analysis</td>
<td>In depth analysis</td>
<td></td>
</tr>
</tbody>
</table>

*Fluke Thermography*
Ti4X & Ti5X Series
Ti 4X & Ti5X Families

• Full frame radiometric video, 14Bit A to D
• 512MB memory card stores
  – 3,000 images IR images or 200 Fused images
• Sun readable 5” color display
• Articulating lens
• 2 - 3 hour Li-ion battery
• Annotate images
• Easy interface features
  – Window CE compatible
• Full function PC software
  – License Free
Breakthrough technology
180° articulating lens

• A sharp image in every situation
  – The display remains visible while viewing over high objects, under a machine or around immoveable obstructions
Easy to use instrument

- **AutoCapture**
  - The instrument is easily set up to automatically capture only those images where a temperature limit is exceeded
  - Troubleshoot Intermittent problems

- **SmartFocus**
  - No need to take your hand off the instrument to turn a focus ring

- **Windows CE based menu structure**
  - Intuitive easy to use menu, just like on any PC

- **Compact flash memory cards**
  - 512 MB card standard to save over 3000 IR images & 200 Fused images
Industry leading image quality

• 5” high resolution, high contrast display
  – The biggest display in the industry

• Superior thermal sensitivity (up to 0.07 °C using low noise VOx technology)
  – The sharpest images showing the smallest temperature difference

• Choice of 320x240 or 160x120 models
Level and Span
“Scaling Palette Temperatures”

• Cameras can be set for “auto” or “manual” rescaling

• Auto rescaling adjusts image to highest and lowest temp in FOV

• Taking advantage of the manual level and scale adjustment can give you better thermal resolution within the FOV
Level and Span

Manually adjusted

Auto Scaled
The “Annotation” tool allows the user to create routes with as much detail as needed, including:
- Location
- Equipment types including ID tag info
- List suspected problems
- Define severity
- Recommended fix
- No limit on categories

- Reduces typing
- Reduces report time
The Fluke Ti4X and Ti5X IR FlexCam® Series Thermal Imagers

1. Unique innovative technology
2. Industry leading image quality
3. Powerful analysis and reporting capabilities
4. Easy to use instruments
5. And ......

The thermal imagers for PdM experts and consultants looking for the best thermal imager around
Innovative technology
IR-Fusion™

• Infrared and visible light images fused together on one display
• IR-Fusion reveals more detail and pinpoints trouble areas quicker by automatically relating thermal images with the real world
  – Allows for first time right repair by reducing the risk of replacing “good” components
Innovative technology
**IR-Fusion™** (on FT models)

- Five viewing modes

- Full IR
- Full Visible Light
- Picture in Picture
- Alpha Blending
- IR/Visible Alarms

Fluke Thermography
Blending Example

Infrared Image

Visible Image

Blended Image
Can Read Infrared Temperatures in Visible Image
Innovative technology
IR-Fusion™

- Read Infrared Temperatures in Visible Image
- Always a visual image available for better reporting
Picture in Picture Example

Visible Image

Infrared Image

Blended Image
Percent Blending

100

75

50

25

Fluke Thermography
Color Alarm Example
Laser Pointer Spot Seen in Visible and Blended Image
Powerful analysis and reporting software
SmartView™ software

• Included with each IR FlexCam Thermal Imager
Powerful analysis and reporting software

SmartView™ software

• Image viewing and editing
  – Changes level and span settings
• Extensive annotation possibilities
• Detailed analysis and total image control
  – Same 5 viewing modes as on the instrument
Powerful analysis and reporting software
SmartView™ software

• Simplified report generation
  – Allows for full user customization of report
• Standard up to 600 °C (with option of 1200 °C)
• All models fully radiometric
• Interchangeable lenses
  – Choice of 3 high quality germanium lenses
  – Standard 20 mm,
  – Wide angle 10.5 mm
  – Telephoto 54 mm
• Video output
• Rugged, battery-powered, IP54 rated
**Lens Options**

- **Wide Angle**
  - Long Distance – Telephoto – 54mm
  - Long distance
    - Power line insulators / transformers
    - Medium distance – small IFOVm objects
    - PC Board design & testing

- **Standard**
  - Standard – 20mm
    - Most industrial PdM
    - Most building Science applications

- **Long Distance**
  - Wide Angle – 10.4mm
    - Some Building Science apps
    - Close-up but where wide view area is required
Complete offering

• Heavy duty carrying case
• 2 rechargeable battery packs
• Battery charger
• AC adapter (for Ti45/Ti55 model only)
• Video cable
• 512 MB compact flash card
• Compact flash card reader and USB cable
• PCMCIA compact flash card reader
• Neck strap
• SmartView reporting and analysis software on CD
• User manual on CD
Introducing Fluke Ti10 and Ti25 thermal imagers
The new Fluke Ti10/25
One look and feel – 2 different products

• IR-Fusion® Technology
  – Infrared and visual images fused together makes Infrared easy to understand

• Delivers the clear, crisp images needed to find problems fast

• Rugged, easy to use
  – What you expect from Fluke

Models for almost any application and budget
  – Comes as one complete package including everything you need
The new Fluke Ti10/25
One look and feel – 2 different products
The new Fluke Ti10/25 with IR-Fusion® Technology

• Makes infrared easy to understand
  – Don’t need to be a specialist to see and understand what you are looking at

• Makes reporting much easier
  – The reference with the “real world” is always there

• Provides different viewing modes to better identify trouble areas
  – On camera or in the software

• Until now only available in > $10k priced imagers
The new Fluke Ti10/25 with IR-Fusion® Technology

Max IR (traditional thermal imaging)

Mid IR

Min IR

PIP Max IR

PIP Mid IR

PIP Min IR

Fluke Thermography
The new Fluke Ti
Large crisp images

• Large, widescreen full color LCD display shows all details

• Identify even small temperature differences with excellent thermal sensitivity (NETD)

• High performance, low noise sensor provides high-quality, stable image
The new Fluke Ti
Made for rough environments

- Engineered and tested to withstand 6.5 ft. drop
  - Not even Fluke DMMs are tested to this specification

- Withstands dust and water
  - IP54 rating

- Innovative protective lens cover protects lens when not in use

- Works in ambient temperatures as low as 14 °F and high as 122 °F and measures up to 662 °F (Ti25)
The new Fluke Ti
Easy to use

• Intuitive, three-button menu

• Single-handed operation

• Adjustable (left or right) hand strap makes imager convenient to hold

• Store more than 1200 IR-Fusion images on memory card for later analysis or reporting

• Supports 16 different languages
The new Fluke Ti
Thermal Imaging made affordable

- Priced between $4500 and $7500

- One complete package includes:
  - SmartView™ analysis and reporting software (with free upgrades)
  - Rugged hard case and portable soft case
  - Adjustable hand strap
  - 2 GB SD memory card
  - SD memory card reader
  - Internal rechargeable battery
  - AC charger/power supply
Introducing the Ti20 Thermal Imager
Introducing the Fluke Ti20

A thermal imager for Industrial use:

• Breakthrough price/performance
  – Analyze data and optimize images
  – Display high quality images
  – Easy to use
• Optimized for Industrial applications:
  – Professional Grade
  – Key measurement needs
• Great for predictive maintenance
• Complete offering
Breakthrough performance

Analyze Images

**Fully radiometric thermal Imager**
- For detailed temperature analysis and trending
- Easily identify problems by comparing temperature data
- Calibrated temperature points
- Stores images and the data behind the image

**Adjust key parameters in software afterwards**
- Emissivity, palette, reflective coefficient
- Saves time by avoiding second measurements
- No need to go back on the factory floor
**Breakthrough performance**

**Display high quality Images**

**High-resolution image**
- 128 x 96 resolution

**Large, bright LCD display**
- Uncluttered full size image with data and separate part of the screen
- For use under every lighting condition

**Separate display for picture and measurements:**
- Can always see the temperature, other key measurements, and equipment ID
- Not so for competitors (e.g. Flir)
Single handed point; shoot and image capture operation:
- Press the trigger to capture the image
- Compare with other images taken

Automatically adjusts temperature level and span to display an image without pressing any buttons:
- Manually adjust level and span to further optimize picture
- Clearly displayed level and range indicator

Simple menu structure for intuitive use and getting started faster:
- Only three menu button navigation
- Ideal for multiple users (common for industrial settings)
It’s a Fluke – rugged, battery powered unit

- Up to 6 hours battery life (using both rechargeable batteries supplied)
- Smart design protects lens for accidental drops etc
- Survives harsh industrial environment

IP54 rated

- Water and dust proof
- Connections protected for moisture and water

Measures up to 662°F (350°C)

- Covers broad industrial applications
Overview of controls

- Focus ring
- Lens
- Laser pointer
- Trigger to store image
- Large bright Display
- Menu Soft keys
- Battery compartment
- Tripod mount (under imager)
- AC adapter terminal
- Protection
Ideal for predictive maintenance

Supports inspection routing:
• Clear on camera instructions
• Anyone can do the job

Periodic inspections help to detect temperature changes:
• Establish baseline settings for equipment
• Early indications for potential problems

Compare images to ensure that the captured image is taken correctly:
• From the correct position and distance
• Increases quality and confidence in preventive maintenance program
• Reduces the need to go back and take additional pictures
• Before image stored
Fluke Ti20 Complete offering

**InsideIR software reporting and analysis software included:**
- Allowing unlimited use by your whole maintenance team with no additional cost
- Allows detailed analysis, storage and reporting.

**Comes complete with all necessary accessories to start using right out of the box**

**Includes Professional application training materials to ensure quick learning and a fast return on investment**
Training CD

Fluke Thermography