MIRION Connect 21

Annual Users' Conference

Imaging Technology Benefits and Tradeoffs

David Stewart
Director, PLM: Military, HLS, and Imaging
Frank Witzel
Application Support Manager

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Imaging Technology – Benefits and Tradeoffs

Cameras are often used (and mis-used) in both process monitoring applications as well as inspection applications. In order to be successful, it is important to understand the benefits and tradeoffs of various imaging technologies; whether from the standpoint of radiation tolerance, size, color, optics, connectivity, or other key attributes. In addition, how you choose to integrate cameras and camera software into your workflow can make the difference between success and frustration. We describe, utilizing straightforward real-world examples, the best practices and considerations one should employ to ensure success. An open discussion will be held at the end of the session to discuss specific challenges and answer questions attendees face in their applications today.

Is this the correct session for you?

Who we are: David Stewart

- With Mirion for 20+ years
- Various leadership, technical, and product roles
- Field time
  - Site-based system design
  - Reactor outage support
  - Installation oversight
- Director, PLM: Military, Homeland Security, and Imaging

Who we are: Frank Witzel

Education and previous experience

BBA-Marketing, St. Bonaventure U -1985

30+ Years in Nuclear Camera Sales and Sales Management

Imaging & Sensing Technology Corp (1988-2007)

Mirion Technologies (2007-2021)

Application Support Manager July 2021 - present

Application expertise and skills

- Radiation Tolerant CCTV Camera Systems
- Suppliers: IST, ist-rees, Rees Instruments, Mirion

Legal Statement

- Images have been taken from public sources where possible
- All images remain the property of their respective authors and copyright holders
- Images shown are strictly for the purposes of demonstrating examples
  - Protected information about specific applications and locations cannot be discussed
- Where customer-specific images are utilized, site identifiable information has been removed

Introduction

AGENDA

- (Brief) Technology Overview
- Understanding the importance of Workflow
- Real World Examples
- Alternate Choices to Imaging
- Open Discussion

- Start off with some technical, but not focus of today's session
- Focus on real world examples
- Emphasize what works and what can be improved

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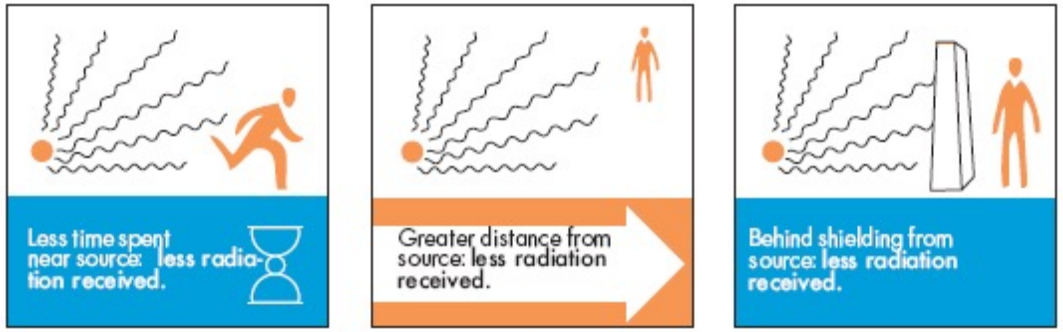
Radiation Tolerance

	DOTCAM	MINIPTZ MK2	C981	ALLRAD MK2	HD-RAD		DOTCAM - HR	SC985	SC985 HR	ALLRAD	R981 COMPACT	HYPERION	HYPERION COMPACT	R93	R941	R942
																
Total Dose	100 Gy (1 x 10^4 rad)	100 Gy (1 x 10^4 rad)	100 Gy (1 x 10^4 rad)	100 Gy (1 x 10^4 rad)	500 Gy (5 x 10^4 rad)	500 Gy (5 x 10^4 rad)	1k Gy (1 x 10^5 rad)	10kGy (1 Mrad) [^{137}Cs]	50kGy (5 Mrad) [^{137}Cs]	1 MGy (1 x 10^8 rad)	1 MGy (1 x 10^8 rad)	1 MGy (1 x 10^8 rad)	1 MGy (1 x 10^8 rad) Cobalt-60	2 MGy [60Co] (2 x 10^8 rads) Cobalt-60	2 MGy [60Co] (2 x 10^8 rads) Cobalt-60	2 MGy [60Co] (2 x 10^8 rads) Cobalt-60
Dose Rate	100 Gy/h (1 x 10^4 rad/h)	100 Gy/h (1 x 10^4 rad/h)	100 Gy/h (1 x 10^4 rad/h)	100 Gy/h (1 x 10^4 rad/h)	100 Gy/h (1 x 10^4 rad/h)	100 Gy/h (1 x 10^4 rad/h)	300 Gy/h (3 x 10^4 rad/hr)	1kGy/h (100k rad/h)	1kGy/h (100k rad/h)	1 kGy/h (1 x 10^5 rad/h) Chalnicon	1 kGy/h (1 x 10^5 rad/h) Chalnicon	1 kGy/h (1 x 10^5 rad/h) Digital	1 kGy/h (1 x 10^5 rad/h)	1 kGy/h (1 x 10^5 rad/h) Chalnicon	1 kGy/h (1 x 10^5 rad/h) Chalnicon	1 kGy/h (1 x 10^5 rad/h) Chalnicon
On-Board Lighting	6 x LED Ring (internal)	LED - 4 x Wide & 4 x Spot (internal)	Optional (external)	LED - 2 x Wide & 2 x Spot (internal)	4 x LED (internal)	2 x LED (external)	6 x LED Ring (internal)	Optional (external)	Optional (external)	LED - 2 x Wide, 2 x Wide	Optional (external)	No	Optional (external)	Optional	No	No
Optional Lights/Audio	Variable Lighting	• 1 x 20 W (in air) • 1 x 50 W (underwater)	• 100 W (in air) • 300 W (underwater) • High Power LED • Microphone	Optional 2 x 35 W (underwater)	None	None	Variable Lighting	Optional Variable LED Lighting	Optional Variable LED Lighting	Optional 2 x 35 W	• 100 W (in air) • 300 W (underwater) • High Power LED • Microphone	No	2 x 50 W	Optional Lighting Heads	No	No
Operating U/W Depth	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	60 m (200 feet)	50 m (165 feet)	50 m (165 feet)
Max Temperature	• 50 °C (122 °F) underwater • 40 °C (104°F) in air	• 50 °C (122 °F) underwater • 40 °C (104°F) in air	• 50 °C (122°F) underwater • 40 °C (104°F) in air	• 50 °C (122°F) underwater • 40 °C (104°F) in air	40 °C (104 °F) underwater only	• 45 °C (113 °F) in air • 50 °C (122 °F) underwater	• 60 °C (140°F) underwater • 50 °C (122°F) in air	55 °C	55 °C	• 70 °C (158 °F) underwater • 50 °C (122 °F) in air	• 70 °C (158°F) underwater • 50 °C (122°F) in air	• 70 °C (158°F) underwater • 60 °C (140°F) in air	• 0-62.5°C (without lights) • 0-55°C (with lights)	• 70 °C (158 °F) underwater • 55 °C (131 °F) in air	• 70 °C (158 °F) underwater • 55 °C (131 °F) in air	• 70 °C (158 °F) underwater • 55 °C (131 °F) in air
CCD/Solid State	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	No	No
Pan & Tilt	No	Yes	Yes (optional)	Yes	Yes	Yes	No	Yes	Yes	Yes	Optional	Yes	Yes	No	No	Compatible with pan and tilt unit
Lens Options	• 1.9 mm (no LED lights) • 3 mm, 3.7 mm, 4.3 mm • 8 mm, 12 mm, 16 mm	10 x Optical Zoom (4 x Digital Zoom)	18 x Optical Zoom (4 x Digital Zoom)	18 x Optical Zoom (4 x Digital Zoom)	10 x Optical Zoom (4 x Digital Zoom)	10 x Optical Zoom (4 x Digital Zoom)	• 3.9 mm f/2.8 • 3.0 mm f/2 • 6 mm f/2.8	6.5 - 65 mm f/2 Non browning zoom	6.5 - 65 mm f/2 Non browning zoom	• 8 - 24 mm f/2.8 Non browning zoom • 6 mm, 9 mm, 25 mm fixed non browning	• 12-72 mm f/1.8 Non browning zoom • 24-144 mm f/3.6 Non browning zoom	17.5 - 105mm f/2.4 Non browning zoom	17.5 - 105 mm f/2.4-f/16 Non browning zoom	• 6 mm, 9 mm, 25 mm Fixed Non browning • 8-24 mm f/2.8 Non browning zoom	8 - 24 mm f/2.8 Non browning zoom	• 12 - 72 mm f/1.8 Non browning zoom • 24 - 144 mm f/3.6 Non browning zoom
Overall Size	29 mm diameter x 109 mm long (1.14 x 4.3 inches)	63.5 mm diameter x 371 mm long (2.50 x 14.6 inches)	162 mm wide x 221 mm high x 220 mm long (6.4 x 8.7 x 8.7 inches)	110 mm wide x 414 mm long (4.3 x 16.3 inches)	110 mm wide x 307 long (4.3 x 12 inches)	155 mm wide x 311 mm long (6.1 x 12.2 inches)	29 mm diameter x 79 mm long (1.14 x 3.1 inches)	206 mm wide x 292 mm high x 224 mm long (8.1 x 11.5 x 8.8 inches)	352 mm wide x 389 mm high x 255 mm long (13.9 x 15.3 x 10 inches)	110 mm wide x 414 mm long (4.3 x 16.3 inches)	162 mm wide x 229 mm high x 220 mm long (6.4 x 9 x 8.7 inches)	120 mm diameter x 342 mm long (4.7 x 13.5 inches)	172 mm wide x 267 mm long (with lights)	40.5 mm diameter x 250 mm long (1.6 x 9.8 inches)	55 mm diameter x 269 mm long (2.16 x 10.6 inches)	76.2 mm diameter x 390 mm long (3 x 15.4 inches)
Radiation Tolerance Level:	LOW				MEDIUM										HIGH	

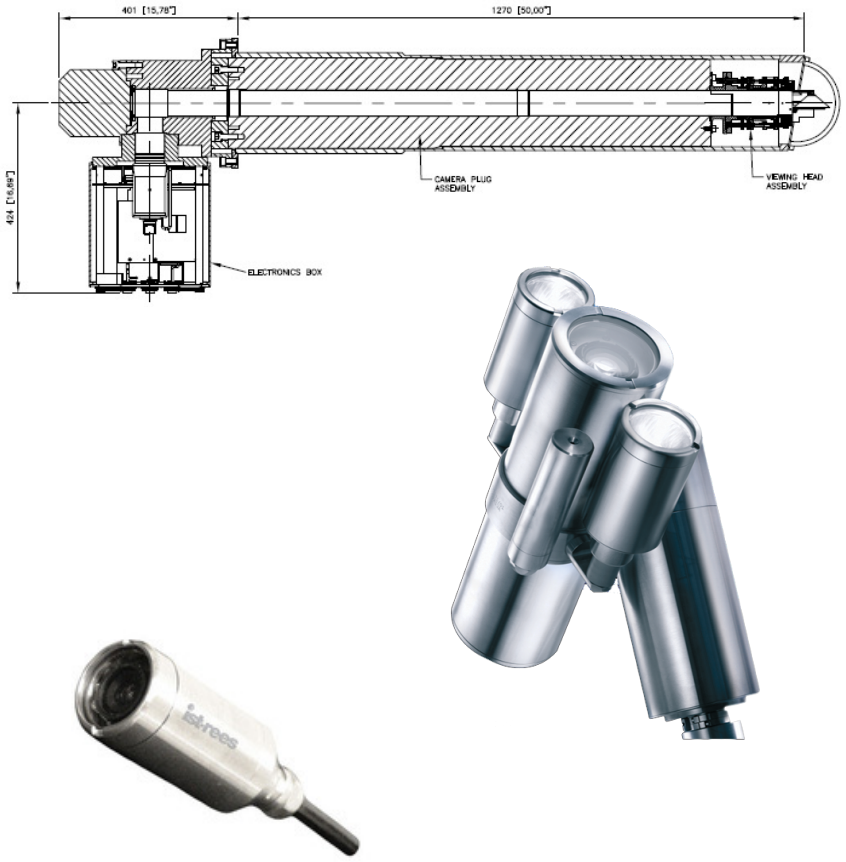
Radiation Tolerance



- Some things don't change:
  Time, Distance, and Shielding
- Must consider both cumulative dose and dynamic dose
- More importantly need to understand use and workflow

Size Matters – So Does Access

- Different cameras bring different features
- Throughwall – large and require planning, but significant maintenance reduction and minimal access
- Pan/Tilt Cameras – offer functional flexibility, but will require maintenance and access
- Inspection camera – much smaller/easier to deploy, but limited optics and self-mobility



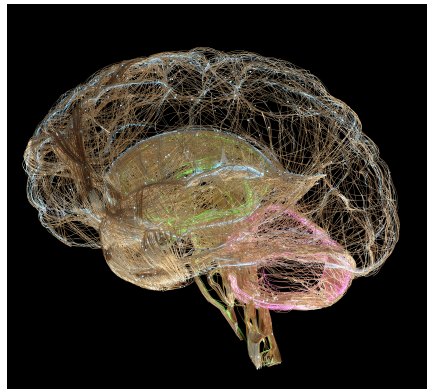
Color versus Monochrome

- Difficult in radiation
- Larger (mostly)
- $$$ (sort of)
- Greater cable/storage demands
- Lower resolution (rad tol)

- Established in radiation
- Smaller (mostly)
- $$ (sort of)
- Easier to transmit/distribute
- Higher resolution (rad tol)

Color versus Monochrome

BUT



Lenses

- Zoom: varifocal, tracking, motorized
- “Glass”: non-browning, clear, color corrected
- Focus Distance: close focus = short depth
- Lens Speed:
  - Fast = f/1.2 - f/1.8
  - Slow = >f/11
- Depth of Focus or Circle of Confusion

Lenses

- Why do I care???
- Lenses can be changed with relative ease
- Can be large price driver
- BUT make the biggest difference to address workflow challenges

Control Equipment

- Directly Impacts HMI experience
  - Joystick, pushbutton, mouse, touchscreen
- Large single monitor v. multiple small
- Connectivity to equipment
- Distributed operations v. centralized
- Data Storage
  - Encoding/impacts to size
  - Retrieval method(s)
  - Overwrite v. incident v. archive

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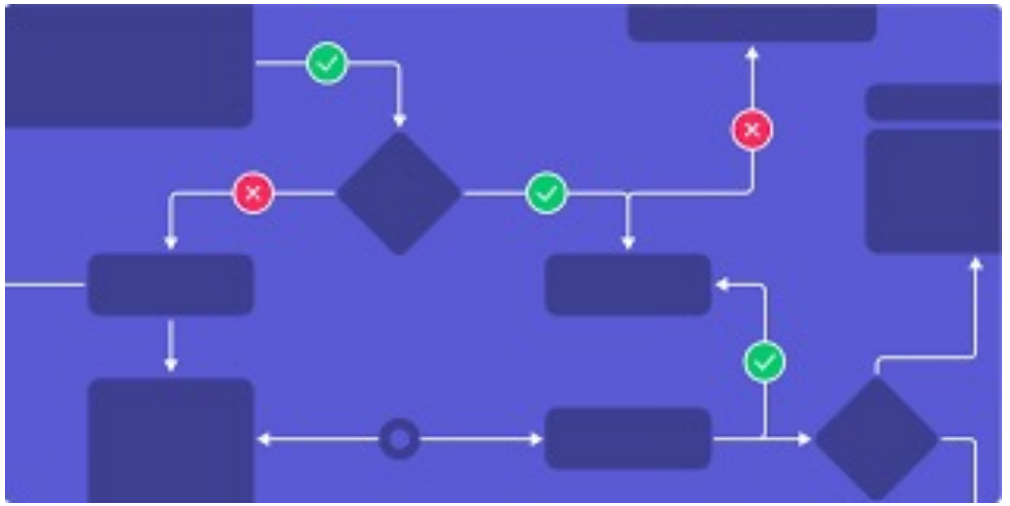
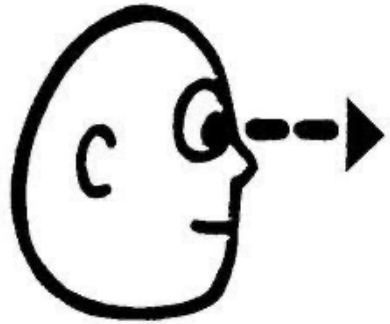
- Open Discussion



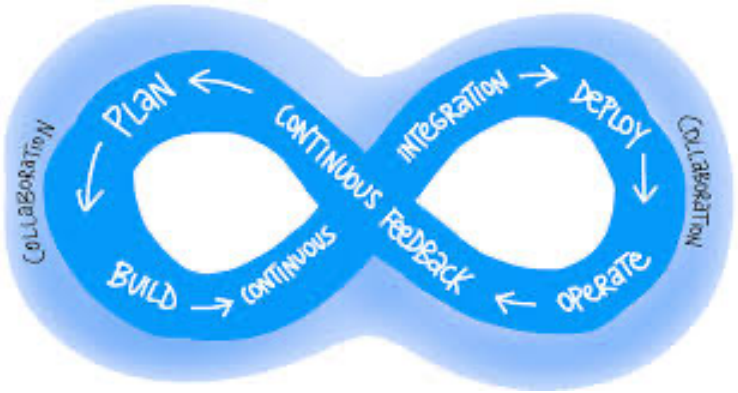
What do you want to see

- Why would operator efficiency improve
- How do they handle the process now
- When would they need to see
- What are “required” to see and “nice” to see
- Who all needs to see and/or control
- Where can cameras be located



How integrate with existing procedures

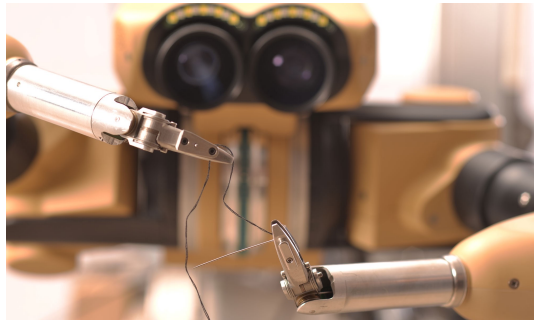
- What are the current processes and which processes would require a rewrite
- Who needs to approve process changes
- Will the process changes be “blocked” by some individuals/teams
- Do competing process changes provide a better solution
- What is the value proposition – who benefits



Blocking considerations - Parallax

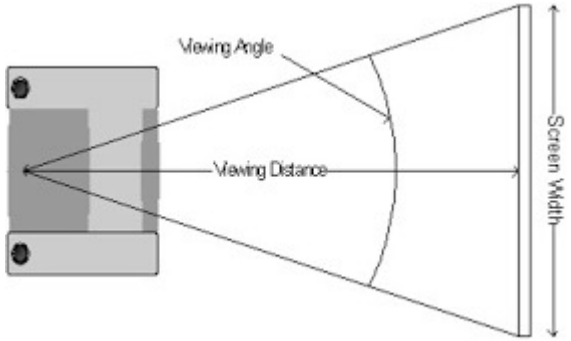
Parallax – apparent displacement of an object from differing points of view

- Important for relative alignment of two objects
- Usually achieved by more than one camera
- Will the process “block” the camera view(s) at different times – does it matter
- Do some process steps require “close up” confirmation from one or more cameras



Blocking considerations – Angle of View

- How “big” does the object appear on screen
- Optics versus distance
- Consider radiation versus replacement
- Cost of optics
- Why it’s critical to first understand what is needed to be seen as a first step
- Radiation requires understanding of workflow



Blocking considerations - lighting

- Is there light where it is needed
- Will process steps “block” the light at different times – does it matter
- Coincident lighting with camera versus secondary lighting
- Is intensity control required/desired
- What reflective surfaces should be considered

IT and Workflow

- Information Technology (IT) is of growing importance
- Digital or Analog images often are stored/archived
- HMI Control interfaces are migrating to networks
- Even if CCTV is “air-gapped” may still require review
- Site requirements often address images, law addresses audio
- IT often required for rights, control, and justification

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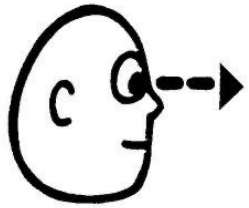
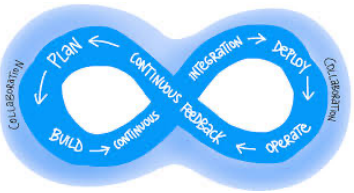
General “real world” Considerations

- Equipment access
  - Service
  - Protection
  - Operations
- Signal access
  - Cabling (often multiple signals)
  - Penetrations
  - Wireless
- Radiation
  - Dyanamic Dose
  - Cumulative Dose

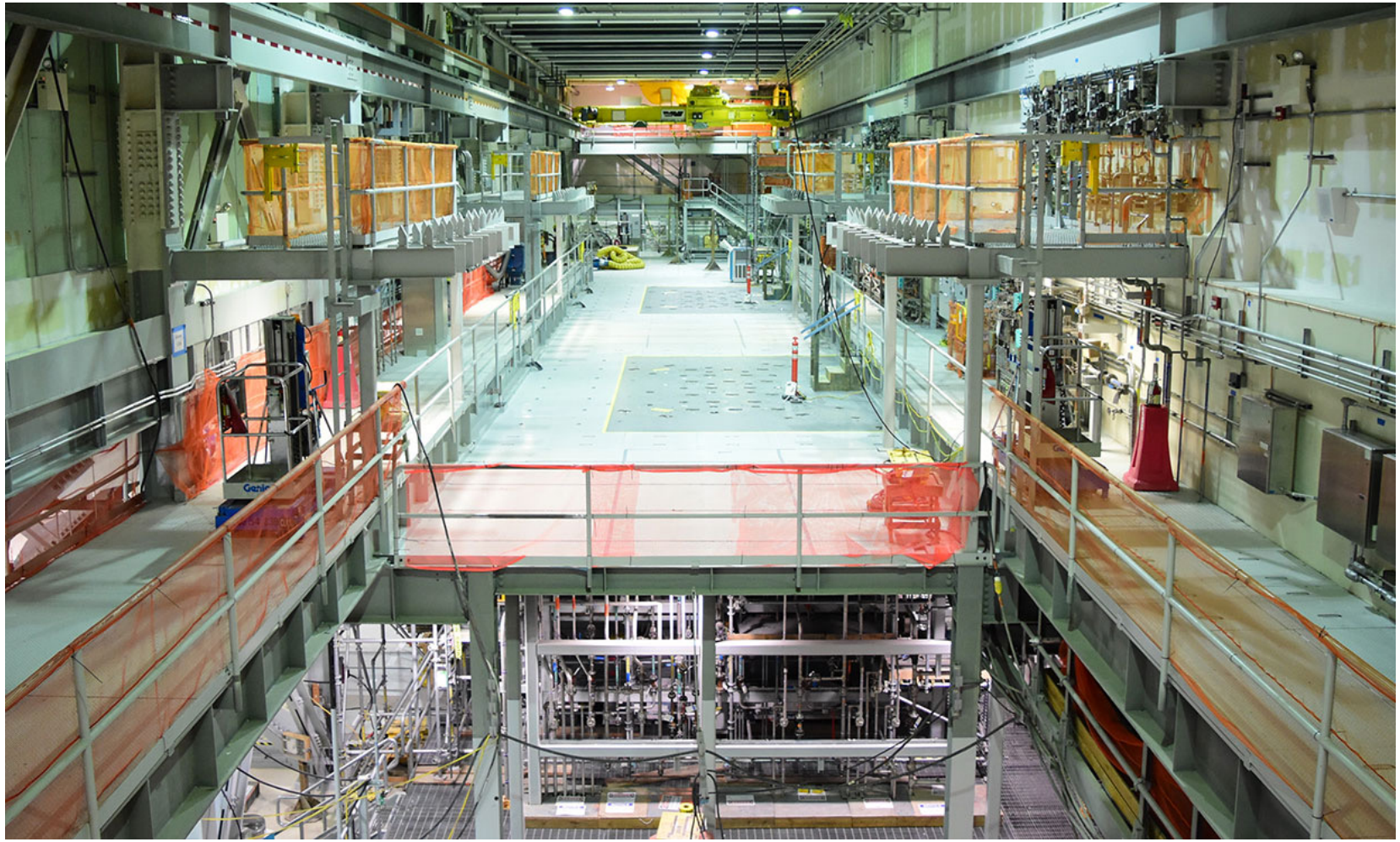
Large Area

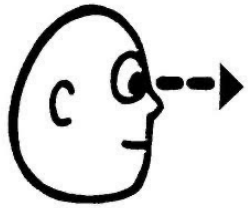


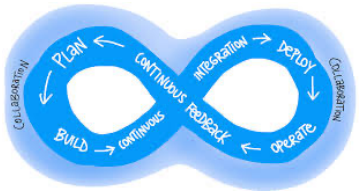

PLAN
CONTINUOUS
INTEGRATION
DEPLOY
BUILD
CONTINUOUS
FEEDBACK
OPERATE


Support

“Canyon”



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INTEGRATION
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FEEDBACK
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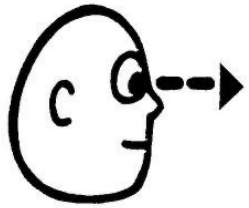
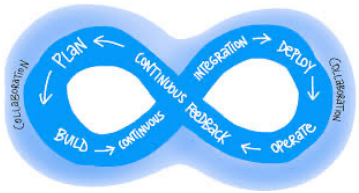
Support

Hot Cell




PLAN
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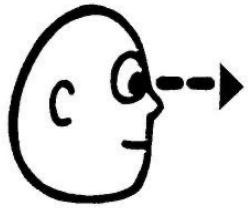
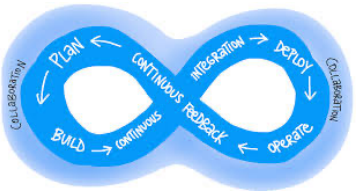
BUILD
CONTINUOUS FEEDBACK
OPERATE


Support

Tank Farm




PLAN
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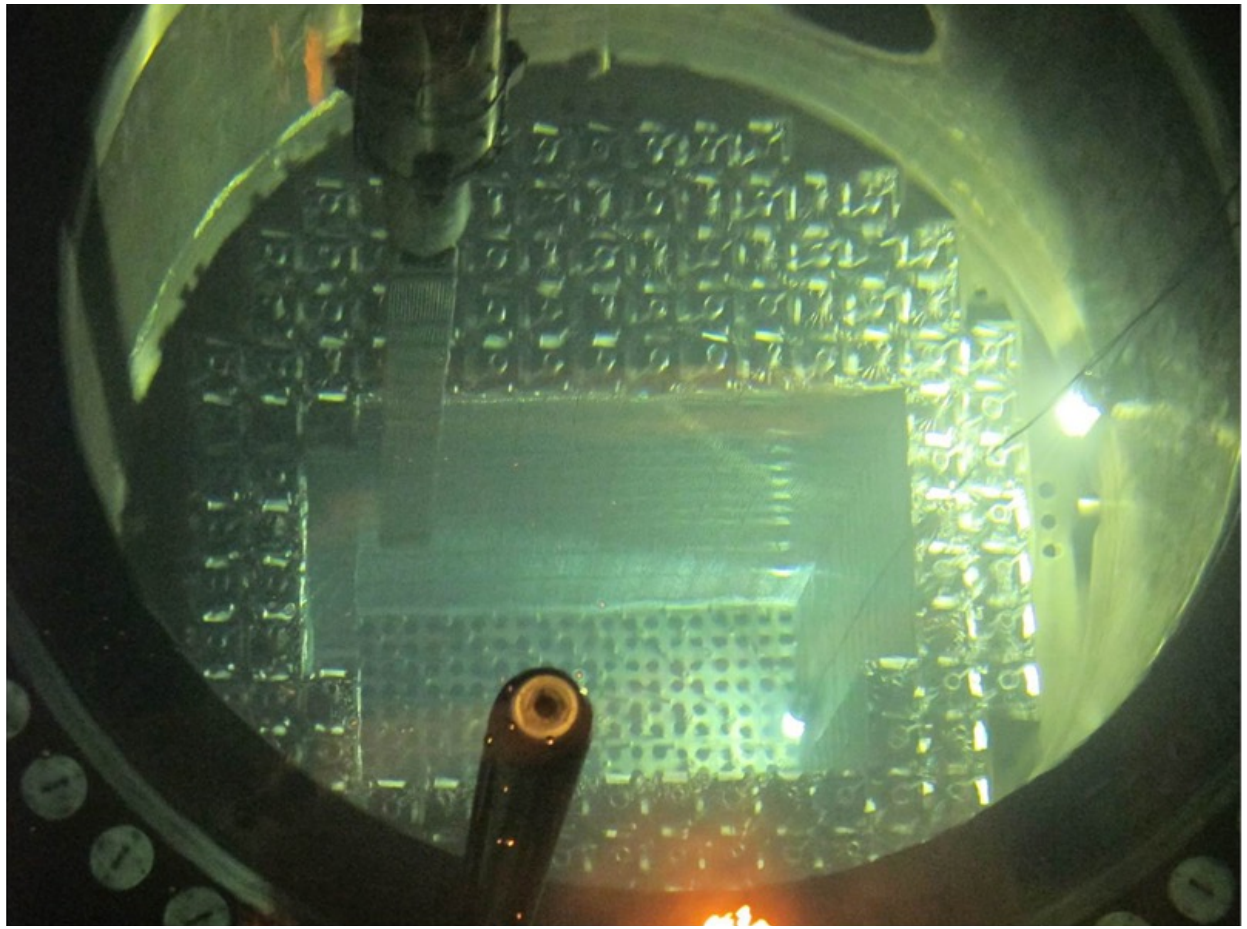
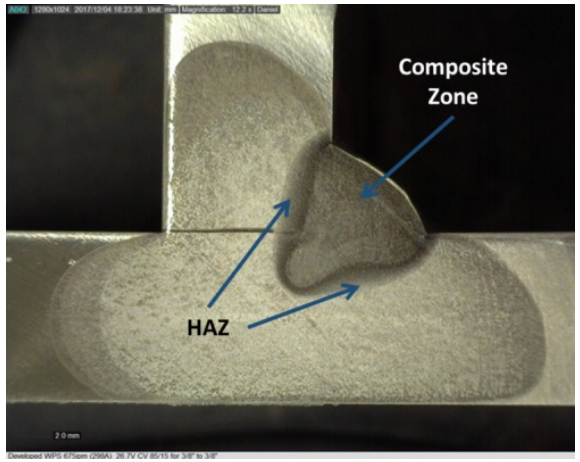
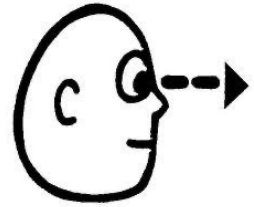
BUILD
CONTINUOUS FEEDBACK
OPERATE

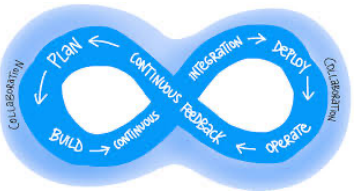

Support

Inspection




Composite
Zone
HAZ




PLAN
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INTEGRATION
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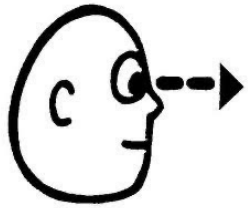
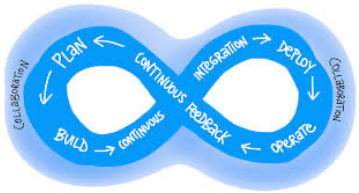
OPERATE

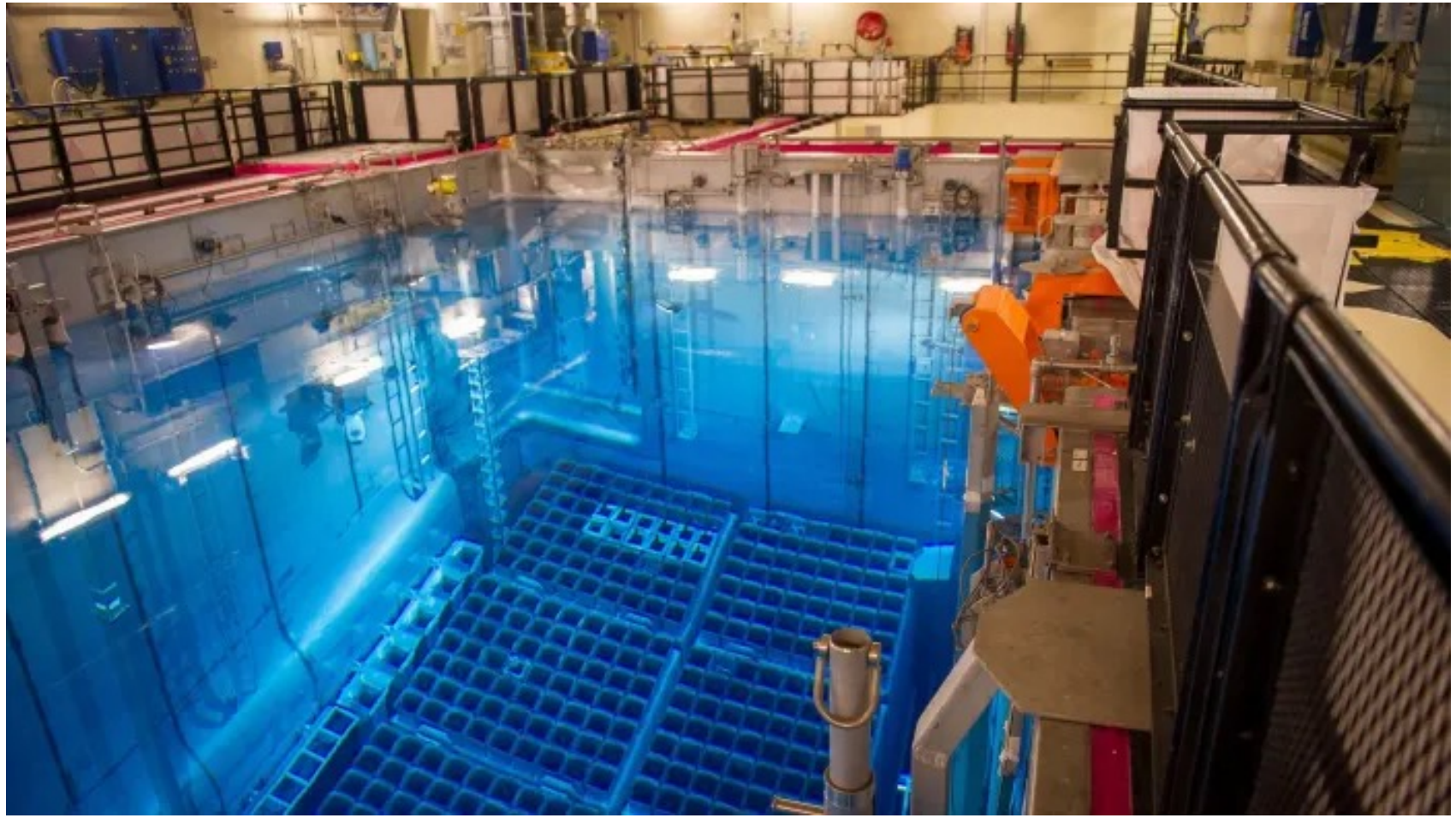

Support

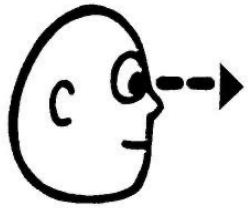
Process Monitoring

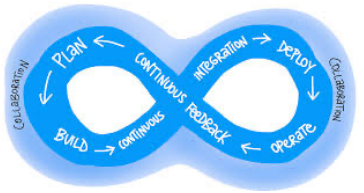




Robotic



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Support

Modes of Operation

- Multiple operating modes – irrespective of application
  - Requires greater planning, but
  - many benefits for multi-use
- Control Room v. Distributed Viewing on same system
- Safe Shutdown operations
  - Station Black Out considerations
  - Browns Ferry fire – 22 March 1975 – drove regulations

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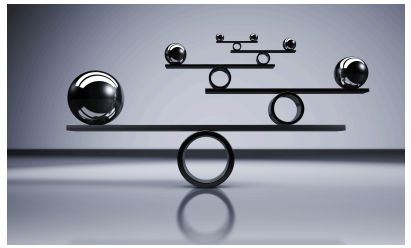
Alternate Choices

- Right camera for the job
- Instrumentation
- Shielded Windows
- Alternate Inspection Technology
- Direct observation/access
- Re-evaluate based on revised workflow
- Feeling of “disconnect” by operators
- Limited view with fixed distance
- Eddy current, ultrasonic, sampling…
- Periscope, dress out



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Alternate Choices

Thank you!

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