Spokane Industries’ Computed Radiography Implementation Experience

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Background

- Spokane Industries Castings Divisions is a producer of steel and high chrome iron castings for commercial customers and the aggregate (rock-crushing) industry
- Castings range from investment castings weighing a few ounces to sand molded casting >5000lbs
- Customer requirement for soundness verification for samples and production
- Our own requirement for soundness verification
- We perform our RT on castings up to 6” thick, contracting out the RT for thicker castings
– Our RT lab is located in a separate building from the main facility
Background Continued

– Film-based, using a Kodak Processor

– One Level II RT employee full-time, one Level II part-time (other responsibilities). Level III contracted.
Our Decision for Computed Radiography

In 2011 we started to focus on improvements we needed in RT

- Our Kodak processor was having increased maintenance downtime
- Increased speed to help address customer demand
- Ease of use for single-operator environment
- More time on analysis of results, not operational issues
- Quickest possible learning curve
- Interface easily with our gamma sources
- Improved communication within the company on RT results, and with external customers
- Reasonable cost to purchase and operate
Our Decision for Computed Radiography

- Computed Radiography (CR) vs Digital Radiography (DR)
  - First option was to replace our Kodak with a new film processor – but some of our concerns would not be addressed with film.
  - Research was done to better understand available technologies that could interface with our current gamma sources (Iridium 192 and Cobalt 60).
  - Both DR and CR systems were considered.
  - Both systems display digital images on a computer monitor.
  - Both systems are significantly faster than film-based processing.
  - Both systems use reusable imaging plates, unlike film’s single use.
Our Decision for Computed Radiography

- Computed Radiography (CR) vs Digital Radiography (DR)
  - DR systems use a rigid, digital plate in place of film.
  - This digital plate interfaces directly with a computer to generate the radiographic image in a few seconds.
  - DR plates are relatively high-cost (> $50,000). For us, our concern was damage to the plates – they can crack.
  - Because of this risk to damage to the plates in our environment we decided against DR systems.
Our Decision for Computed Radiography

- **Computed Radiography (CR) vs Digital Radiography (DR)**
  - CR systems use a thin (<.020), flexible phosphor imaging plate in place of film.
  - CR imaging plates can be cut to size and wrapped around a curve.
  - Unlike DR systems, the CR imaging plate must be “processed” through a separate scanner to “read” the plate before the image is displayed on the computer.
  - The imaging process time (time to display) of the CR plate is longer than DR systems, but still very short at about 90 seconds.
  - The CR imaging plates are reusable and in theory, do not wear out, but with handling they can be scratched/damaged affecting image quality.
Our Decision for Computed Radiography

- Computed Radiography (CR) vs Digital Radiography (DR)
  - The CR imaging plates are <$1,000 for 14x17” (our typical size).
  - The CR scanner is small – about the size of a desktop laser printer.
  - Seeing is believing and once we had an onsite demonstration we were convinced this was the best option for us.
  - We purchased the Carestream HPX-1 system in December 2011 and have basically not used film since.
Implementation of the CR system

- The CR scanner and monitor are located in our RT lab office on a standard office desk.
- The monitor is a higher resolution monitor – we use the full color 2048x1536 pixel (medical-grade) offered with the system.
- Computer is networked – with file backup and redundant archival DVD backup as well.
Implementation of the CR system

- Lighting is subdued to ease eyestrain from viewing the monitor and to help minimize fade of the imaging plates during loading into the scanner.
  - The phosphor imaging plates are erased in the scanner by bright halogen lights once the image has been read. Bright overhead lighting can reduce the image quality during loading of unprotected plates into the scanner.
- The scanner boots up and is ready as quickly as the computer.
- The scanner requires no maintenance except for the air filter cleaning/replacement, about twice yearly, and replacement of the halogen bulbs as needed (not required yet in over 2½ years).
Implementation of the CR system

– We use the CR imaging plates in the same sleeves that we use for film
  • Cassettes can also be used, but the image quality was degraded
Implementation of the CR system

– During initial startup we ran the CR system side-by-side with the film system to compare functional use and image quality
  • We quickly determined that with the CR imaging plates we could reduce the exposure time by about 20-30% compared to film achieving similar image quality.
  • Image quality and system accuracy **should** be determined by confirmation of the monitor with a SMPTE test image (a “TV” test image), and with a CR phantom or comparable system test.
Implementation of the CR system

CR Phantom Test (Carestream’s Comparable Test Shown)

SMPTE Monitor Test Image (partial shown)
Implementation of the CR system

- We focused initially on the ability to see the 2T holes in the penetrators and a comparison of the CR images to our film images (side-by-side)
Implementation of the CR system

- Use of the CR system required updating our RT procedures
  - Appendix section added to address CR
  - ASTM E1742, Standard Practice for Radiographic Examination
  - ASTM E2033, Standard Practice for Computed Radiology
  - ASTM E2445, Practice for Qualification and Long Term Stability of Computed Radiology System
  - ASTM E2446, Practice for Classification of Computed Radiology Systems
  - ASME Section V, Article 2, Radiography
- Personnel Certification needed updating as well to cover CR/Digital RT
  - Outside class time (40 hrs) and certification
- Our contracted Level III performed the bulk of this updating, with CR class time provided by Carestream at their facility in New York
Same Gamma Sources – no functional changes in RT vault.

CR system does not need the daily maintenance and chemicals of the film developer.

Processing time

- CR imaging plates exposure time approximately 20% less than film – this is significant for the longer shots that are >30 minutes.
- 90 second image acquisition and display for CR vs 8 minutes for first film, each additional film output in 2-3 minutes if loaded in as a batch.
- This processing time reduction allows increased part inspection and more output.

Film is single use – CR imaging plates are lasting +500 exposures

- If CR imaging plate is scratched the scratch will show up on all images.
- Careful handling of the CR plates is needed.
Comparison of CR vs Film

– CR images, being digital, are easy to incorporate directly into reports.
– CR images do not require physical storage space of film, but do require the appropriate digital archiving and file security.
– CR images allow notation on the image – helpful to identify issues.
Comparison of CR vs Film

- CR images are easy to share
  - With customers in reports.
  - Internal on network – historically had to transport the images over to our main office to review with management.
  - Printed out and attached to parts to help map rejected indications for repair in the main foundry.
CR images are less expensive per exposure

- In 2013 we used 9 14x17” CR imaging plates.
- Each plate was exposed ~500 times.
- Each plates cost was $910.00 – or $8190.00 total, or $1.82 per exposure.
- With film at $5.16 per sheet the total cost for the same amount of exposures would have been $23,220.
- CR has another cost advantage that needs to be factored in – the CR imaging plate has a wider dynamic range possible than film. This allows us to capture varying thicknesses (densities) of a part with one exposure, vs multiple sheets of film with different speeds.
- Based on this, the $23,220 film cost would increase to $54,180 for the part mix we currently RT (an increase of $45,990 over CR).
Comparison of CR vs Film

CR images, one CR plate exposure showing different density ranges achieved
Comparison of CR vs Film

Same CR exposure from before, with digital edge enhancement – combining all densities into one image.
Comparison of CR vs Film

CR also allows additional digital effects, such as a zoom window as shown here. Magnification can be adjusted as needed.
Comparison of CR vs Film

Film images – requiring three sheets of film to achieve same density range as CR
Difficult to acquire these images – Photograph with camera while on viewer, download, import.
Customer Acceptance

• Sent emails to our major customers explaining the CR system
• Informed them we would be comparing the digital images to the standard ASTM reference radiographs
• Responses:
  – Will it be faster and will we see a price reduction? (Yes on faster, No on price reduction)
  – Did you compare the images to the same film images? (Yes)
  – Will we receive film? (No, but we can send the digital images, and the reports would have small images embedded)
• No real customer concern about calibration/ASTM standards
• Very positive reviews with on-site visits and RT reports
Summary

- CR system easy to integrate into an existing gamma RT lab
- Quick learning curve to adapt to the plates and digital software
- Increased overall speed and reduced maintenance time
- Decreased operation costs, although startup costs (equipment, training, procedural updating is needed)
- Two year ROI in our situation
- Vastly improved sharing of RT data, internally and with customers
- Commercial Customer acceptance was very positive
Thank You