

# Technologies supporting reliable examinations



**Greg Selby**  
Senior Technical Executive, NDE

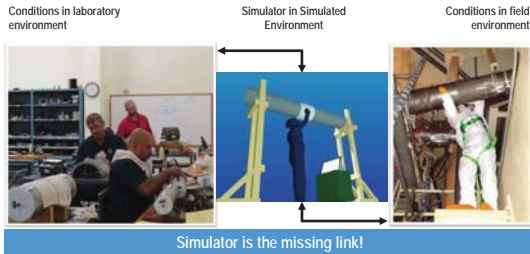
NRC RIC  
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## Two topics today

- UT simulator and virtual mockups
  - Start with recorded data from existing mockups
  - Use cut-and-paste (not as easy as it sounds) to add, delete, move or modify flaw responses
  - Training and practice for manual examiners
- Full matrix capture and the total focusing method
  - High lateral resolution at all depths
  - The future of high-end UT

## UT Simulator and Virtual Mockups

## Simulator in Simulated Environment



## Practical Benefits of Virtual NDE

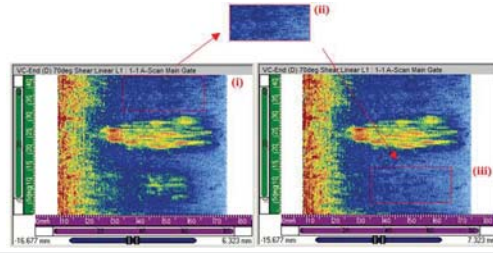
PHYSICAL		VIRTUAL
Limited Often non-specific Often unavailable for education	<b>INVENTORY</b>	Unlimited Can be specific Available for education
Specific locations Inconvenient	<b>ACCESS</b>	Virtual library At your convenience
Limited opportunities Often disruptive to work schedule Limited training elements	<b>TRAINING/PRACTICE</b>	Diversified opportunities Minimal disruption to work schedule Additional training elements
Difficult to share Limited incorporation into training	<b>OPERATIONAL EXPERIENCE</b>	Easy to share Enhanced incorporation into training

Virtual does not fully replace physical, but it extends its mileage

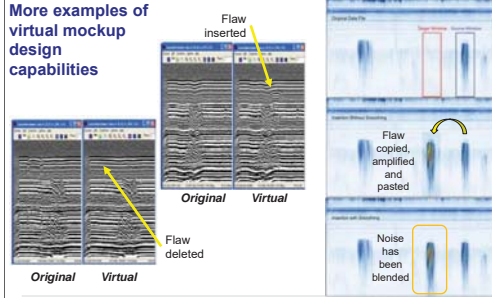
## Virtual mockups

- The UT simulator requires input data
  - Encoded data acquired from robotic (usually) scans of physical mockups
  - Resource limitations
    - Physical mockups are expensive
    - Inventory is limited
    - Robotic scanning is expensive
- Virtual mockups
  - Use the recorded data from existing mockups
  - “Cut-and-paste” the flaws to create unlimited virtual mockups

### Basic process for removing a flaw from a data set

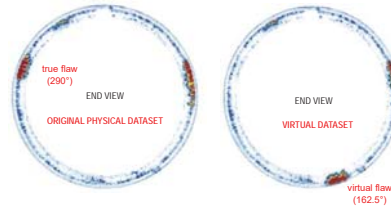


### More examples of virtual mockup design capabilities



### Summary – simulator and virtual mockups

- Simulators extend the applicability of virtual mockups to manual scans
- Specimen inventory becomes practically limitless



## Full Matrix Capture and the Total Focusing Method

### What is FMC and TFM?

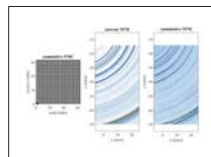
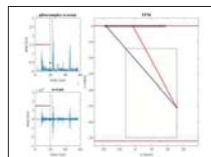
- Full Matrix Capture (FMC):
  - FMC is a technique for ultrasonic **data collection** from multi-element transducers
  - One array element pulses at a time; all elements receive independently
- Total Focusing Method (TFM):
  - TFM is an **image reconstruction** technique using FMC or other data
  - The value of each constituent datum (pixel) of the image results from ultrasound that may be focused on both transmission and reception

### TFM image formulation from FMC data

- TFM image of experimental data from PA block
- The image formulation is repeated for all possible send-receive combinations



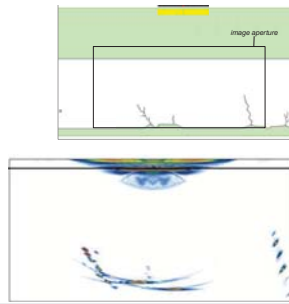
• TFM image resulting from every send-receive combination



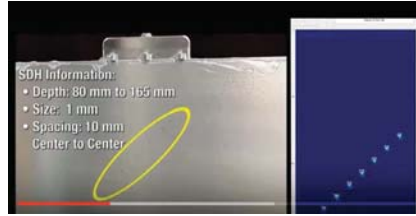
FMC – full matrix capture  
TFM – total focusing method

### High lateral resolution

- Image features are sharp, not smeared – in focus at all depths
- Confident interpretation of the images

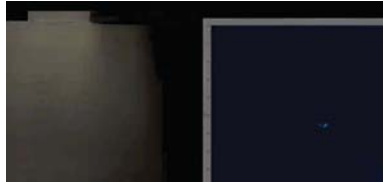


### Advanced TFM in real time



This is "Advanced TFM", a feature of TFM equipment produced by Advanced OEM Systems  
video by permission of The Phased Array Company; full video at [https://www.youtube.com/watch?v=0FwPw\\_06008](https://www.youtube.com/watch?v=0FwPw_06008)

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### Summary – TFM pros and cons vs. phased array

#### TFM pros

- Greater flexibility in data processing
- Focusing not limited to a single depth
- Greater spatial resolution
- The maximum possible data is extracted from the probe and scan

#### TFM cons

- Very large FMC data sets
- Computationally intensive
- Few systems currently are capable of real-time scanning
  - FMC using large arrays

### discussion



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