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AUTOMATING THE RADIOGRAPHIC NDT PROCESS

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"Automating the Radiographic NDT Process"

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Background

Automation is a production method with considerable worldwide publicity and interest. By automation we mean those means by which we seek to remove the human element from the manufacturing (inspection) process. In the U.S., while some NDT modalities have a high percentage of total tests done on automated systems, film radiographic NDT has remained manual. Much radiography is done the way it was 50 years ago. While some progress in automation is seen in real time radiation imaging systems, the parts handling portions have not been used in film systems. Real time is a growing and viable field for the NDT practitioner and where appropriate the growth will continue. Automation, though is needed in the film systems.

There are two main reasons to automate: "Reliability" (reproducibility) and "Productivity". In lower labor cost areas "productivity" increases would need to be larger to economical justify the use of automated system. Reliability though, in establishing technique, handling parts and film, processing film and in interpretation could form a justification base for an automated system (or portions of a system).

One could ask, "Why include film in the automated system of the future?" The complete technical background can be found in reference no. 4 but, succintly put, it is the image capture (sensing) and information recording capability of film. Figure 1 shows the content for one film type. The pixels (picture units) formed are 0.0055mm square.

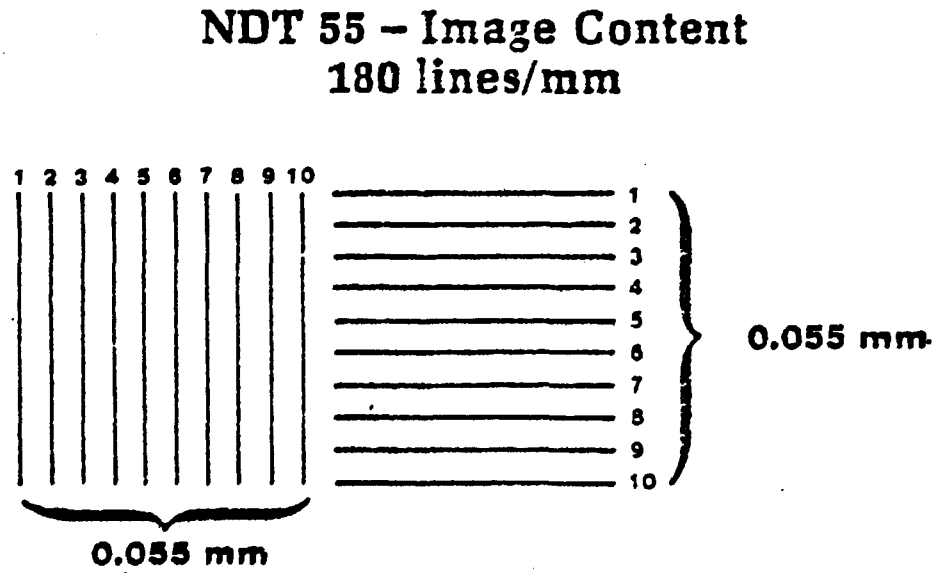
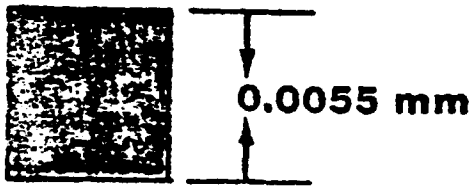


Figure 1

Each pixel may have as many as 300 density steps (Figure 2).

NDT 55 – Image Content (contd.)

One pixel = 0.0055 × 0.0055 mm



150 - 0.02 density steps from 1.0 - 4.0

300 - 0.01 density steps from 1.0 - 4.0

Figure 2

The total digitized information from resolution and the density steps is a maximum 8,400,000,000 bits in a 14 x 17 film (Figure 3).

NDT 55 – Image Content (contd.)

Total Digital Content of 14 × 17

14 × 25.4 × 17 × 25.4 ÷ 0.0055 =

28 mm (pixels) × 300 steps =

8,400,000,000 bits = 2200 floppy discs

Figure 3

This would take 2200 floppy discs or 2.2 optical discs <u>if</u> all this information were recorded.

<u>Automating the Film Radiographic System</u>

The automation of the radiographic NDT System will require these modules.

- Parts handling
- Film handling
- Computed techniques
- Automatic processing
- Computer aided interpretation

In this short treatment it is not possible to cover each of these automatic system module in detail. In fact, a total system incorporating all these machines does not exist. As the title suggests we are talking here about the <u>process</u> of automating, rather than a finished project.

Parts handling is done for a variety of industries (and NDT inspection methods). Robotics are becoming more common in many countries. This operation of moving parts is only mentioned briefly here as the techniques are common to many industries and well known.

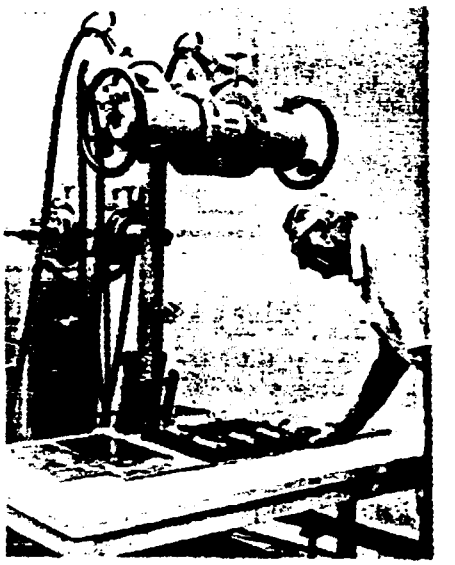
Film handling is something we have 14 years experience with and is more specific to radiography. Figures 4 - 7 show the process for automating the handling of film without a darkroom.

NDT Modular Film Dispenser

Four easy steps to quality radiographs in room light:
1. Loading.

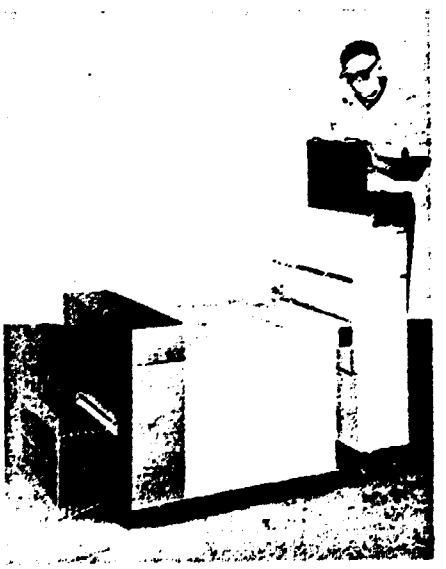
Figure 4

NDT Daylight Cassette



2. Exposing.

Figure 5



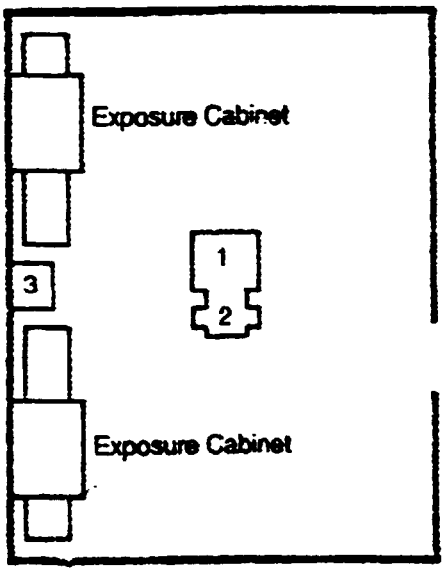
3. Unloading and Processing.

Figure 6

4. Viewing.

Figure 7

One can visualize the use of robotics to move the cassette to the part and then (after exposure) to the processor. (See Figure 8 or layout.)



Typical Layout for Daylight System
1. Processor
2. Unloader
3. Film Dispenser

Figure 8

Roller automatic film processing in NDT has been around for close to 20 years. The ability to load the processor "on line" in daylight for 6 - 10 years. Much has been written about these machines and to a great extent they "eliminate the human factor" from film processing.

Daylight NDT Systems offer the possibility to fully automate the process. Their use, as with many systems, must be justified by cost. Figure 9 shows but one such justification of a daylight system for a U.S. based business.

. Capital Investment, Operating Expense, Payback and ROI for the NDT Daylight Module

	Conventional Darkroom Operation	NDT Daylight Module Operation	Savings
Capital Investment			
Darkroom Construction	$ 4 500	—	
Darkroom Furnishings (Including Automatic Processor)	13 000	—	
NDT Daylight Module	—	$ 30,000	
Investment Tax Credit	(1 040)	(2 400)	
Total Capital Investment	16 260	27 600	$11 340
Operating Expenses			
Labor (Two Person Years)	42 240	36 940	
Film (50M Sq. Ft. Annual Usage)	125 000	122 500	
Total Operating Expenses	167 240	159 440	7 800
Payback: 1.5 Years			
Return on Investment: 26% (A Comparison of Cols. 1 And 2)			

Figure 9

Computed x-ray techniques (or automatic exposure control) are available. This form of automation reduces human factors in setting up the x-ray exposure unit and improves reproducibility. It can be brought into the field exposure work by the TRS-80 Radio Shack portable computer.

To us one of the most exciting possibilities for automation lies in a recent innovation that uses a laser scanner to digitize film imaged information. Figure 10 is a schematic of how this works and figure 11 a picture of the prototype unit.

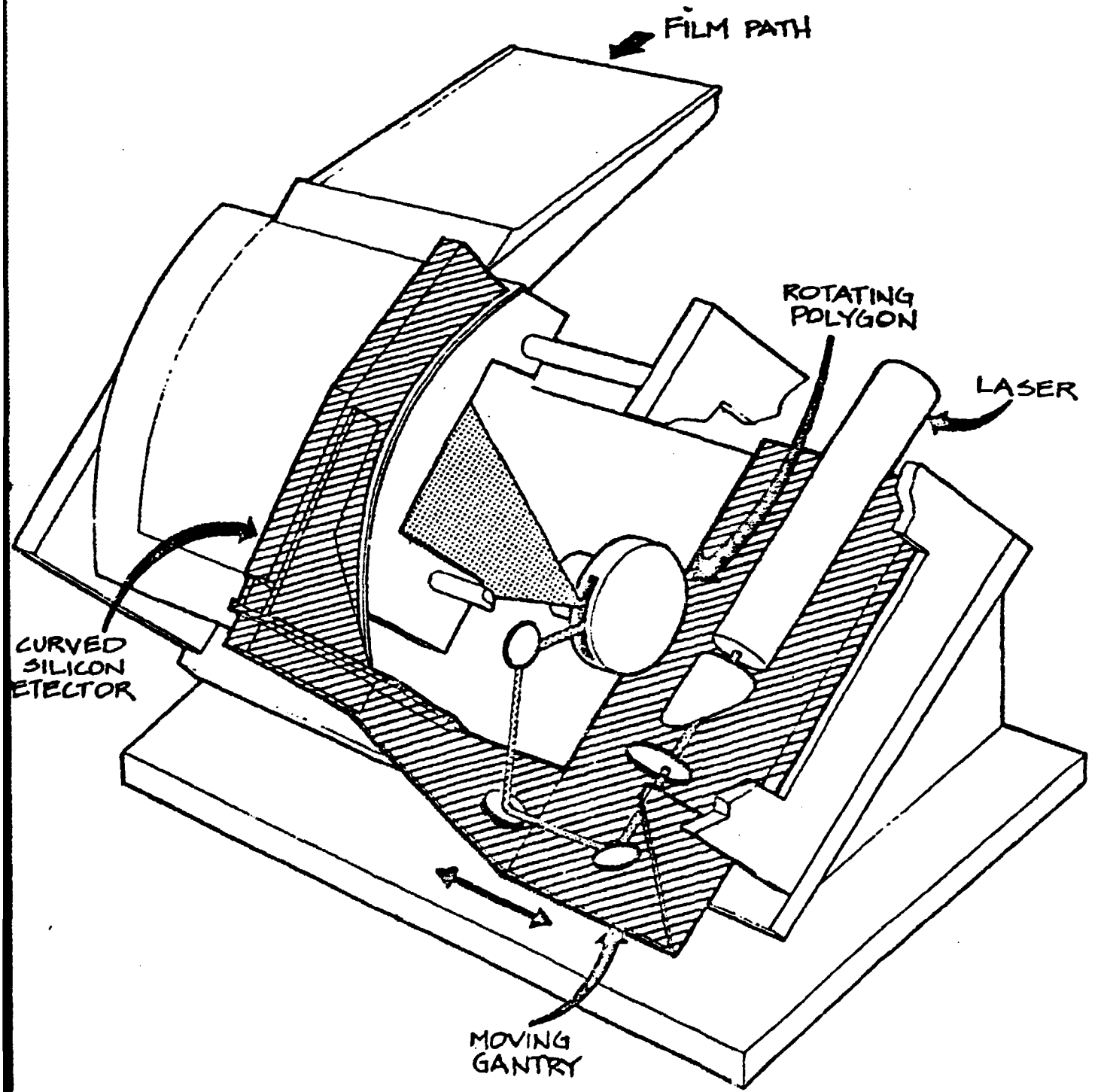
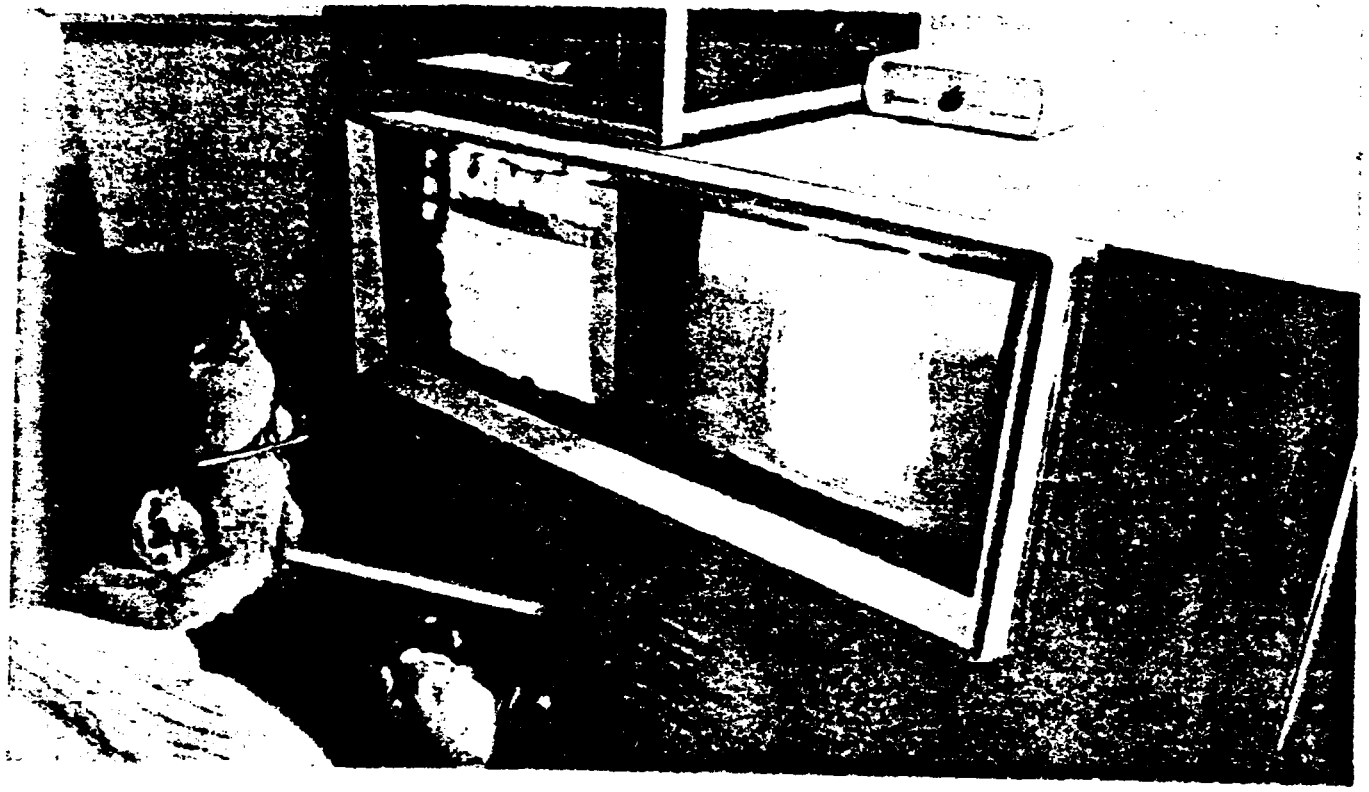


Figure 10



Prototype Film DRS Unit
Figure 11

The 14 x 17 film, using the Film DRS (Digital Radiography System), becomes an "optical rectangle" with resolution limited by scanning mechanism and the TV video system used to "play back" the digitally enhanced image. As stated earlier, the total information content to use is approximately 8 x 10^9 bits. The scanning operation can be done in as little as six seconds. The programming for this system is just beginning but the current specifications and some of the standard functions are shown in Figure 12.

- Data Matrix 2000x2000
- Pixel Depth 12 bits (Log)
- Scan time (14x17 inches) 60 seconds
- Soft Display 1050 Line Video
- Image Processing
  - Window and Level Controls
  - Magnification and Roam Controls
  - Unsharp masking
  - Edge enhancement
  - Tone scale reversal
  - Subtraction

Figure 12

Resolutions currently achieved are 200 and 100 micron with 50 micron (~16 lines/mm) planned.

Our purpose was to give an overview of the ongoing efforts to automate radiographic NDT. Hopefully some of the efforts are applicable to your operations.

References

1. Schwenker, R. P. "Film-Screen Digital Radiography", SPIE Vol. 486, Practical Applications of Conventional and New Imaging Technologies (1984).

2. McKinney, W. E. J., "Film Digital Radiography System", NDT Today, Fall 1985.

3. Graeme, W. A., "Automated Film Handling with NDT Daylight Module", NDT Today, Winter 1985.

4. Aman, J. K., "The Surprising Information Recording Capacity of Silver Halide Photosystems", NDT Today, Spring 1985.

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Summary:

Automation, the removal of the human element in inspection, has not been generally applied to film radiographic NDT. The justification for automating is not only productivity but also reliability of results.

Film remains in the automated system of the future because of its extremely high image content, approximately 8 x 10^9 bits per 14 x 17. This equivalent to 2200 computer floppy discs.

Parts handling systems and robotics applied for manufacturing and some NDT modalities, should now be applied to film radiographic NDT systems. Automatic film handling can be achieved with the daylight NDT film handling system. Automatic film processing is becoming the standard in industry and can be coupled to the daylight system. Robots offer the opportunity to automate fully the exposure step.

Finally, computer aided interpretation appears on the horizon. A unit which laser scans a 14 x 17 (inch) film in 6 - 8 seconds can digitize film information for further manipulation and possible automatic interrogations (computer aided interpretation). The system called FDRS (for Film Digital Radiography System) is moving toward 50 micron (~16 lines/mm) resolution. This is believed to meet the need of the majority of image content needs.

We expect the automated system to appear first in parts (modules) as certain operations are automated. The future will see it all come together in an automated film radiographic NDT system.

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