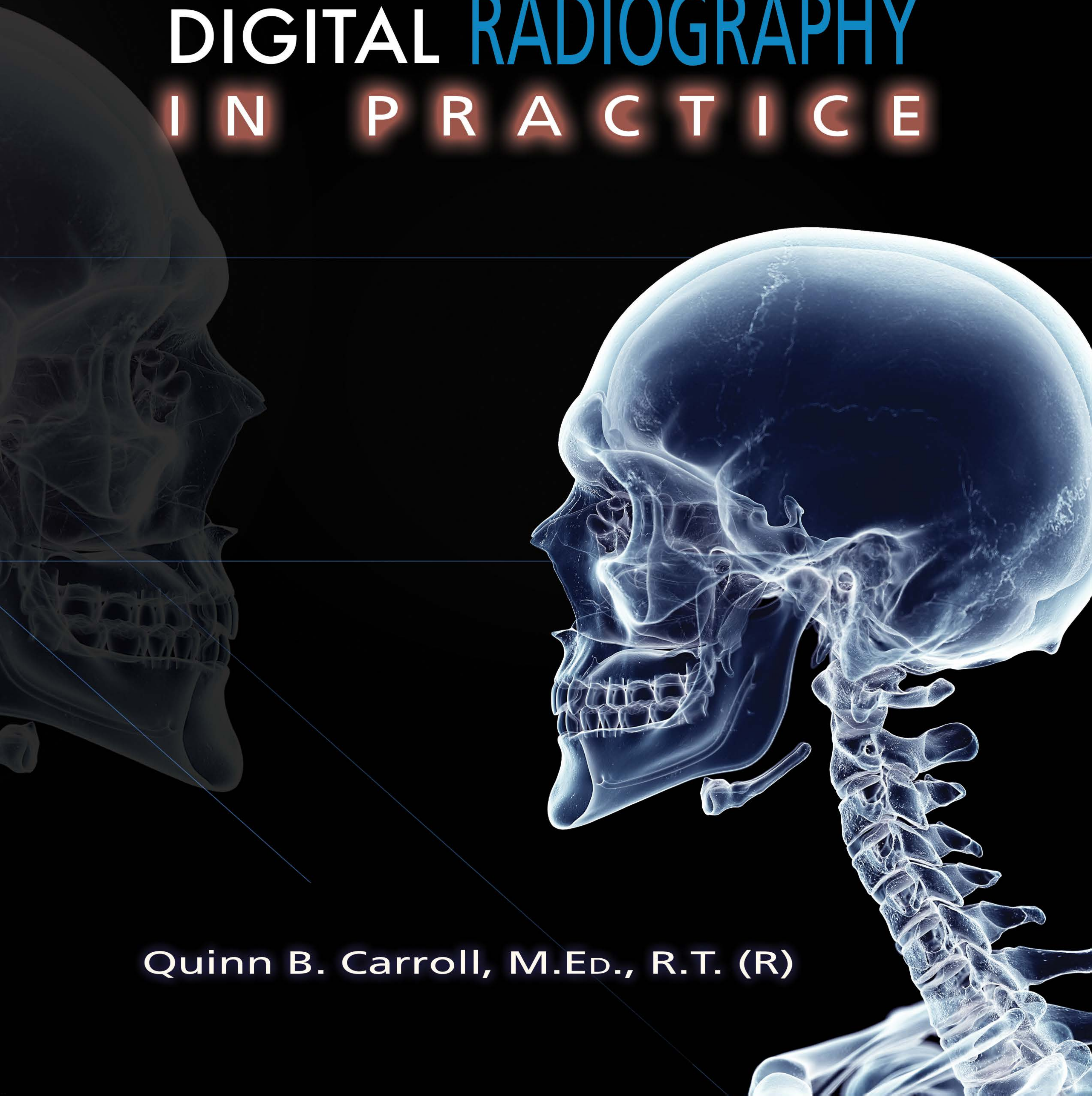
SECOND EDITION

STUDENT WORKBOOK FOR DIGITAL RADIOGRAPHY IN PRACTICE



Quinn B. Carroll, M.Ed., R.T. (R)

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Second Edition

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By

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INTRODUCTION

How to Use this Student Workbook

The **Workbook** is entirely organized in a "fill-in-the-blank" format. The wording of each question almost exactly matches the lecture slide series Digital Radiography in Practice: Instructor PowerPoint™ Slides, and closely matches the progression of concepts in the textbook. The guiding philosophy is to provide immediate or short-term reinforcement of lecture and reading material by focusing on keywords. The **Workbook** should therefore be used on a *daily basis*, not as a self-test or review after whole units have been covered. Following are specific recommendations on how the student (and instructor) can most fully benefit from the **Workbook** and other ancillaries to *Digital Radiography in Practice*:

1. IN-CLASS USE (RECOMMENDED):

   This is the most recommended method, for use with the **Digital Radiography in Practice Instructor PowerPoint Slides**. The workbook and slides are designed to work in tandem with each other to *actively engage* the student in classroom learning while at the same time minimizing the amount of notetaking so that the student is allowed to concentrate on the lecture. The sequence and wording of questions almost exactly matches the slides, using a fill-in-the-blank approach connected to highlighted *keywords on the slides.*

   Instructors may elect to require this type of classroom participation and award points for completion of each unit.

2. HOMEWORK USE:

   If the **Workbook** is used as a reinforcement tool for *homework*, it is strongly recommended that the student answer the corresponding questions after reading *each major section* of a chapter. If you wait until completing an entire chapter, you may have trouble recalling the *keywords* elicited by each question and are more likely to confuse different concepts. To facilitate this, the major unit subheadings are included in the **Workbook** to match the textbook.

3. UNIT REVIEW AND SELF-TESTING:

   For the purposes of review, self-testing or preparation immediately prior to a test, ***Chapter Review Questions*** are provided at the end of each chapter in the textbook. Answer keys to these questions may be made available from your instructor. These are better suited to unit review and test preparation than the workbook material.

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Chapter 1

NATURE OF THE DIGITAL RADIOGRAPH

Development of Digital Radiography

1. 1979 – First application of digital tech: Digital _________________ unit.
2. 1982 – PACS and ____________________.
3. 1980s – Computed radiography (CR): Initially led to a ____________ of exposure.
4. 1996 – Digital radiography (DR): Advanced miniaturization of ______________ elements.
5. For CR, x-ray energy stored by a phosphor is emitted as ________ when stimulated by a laser beam.
6. For direct-conversion DR, x-ray energy is converted directly into stored _________ charge.
7. For indirect-conversion DR, a __________ first converts x-rays to light, then the light is converted into electrical charge.
8. Both direct-conversion and indirect-conversion systems use an _________ ___________ _________ of miniature detectors.
9. All CR and DR systems ultimately produce an ____________ image signal that is “fed” into a computer for processing.

Nature of the Digital Image

10. All forms of digital image acquisition result in an image ___________.

11. Each ________ (picture element) is a single location designated by its column and row.

12. Each pixel is assigned a pixel value that will become its _____________ upon display.

13. Light images enter a camera, and x-rays enter a detector, in _____________ form.

14. To manipulate these images with a computer, they must first be converted into __________ form.

15. Analog: Continuous, and infinitely ______________, like the rails of a railroad track.

16. Digital: Discrete (separated into ____________ units), limited in subdivision and in scale, like the wooden ties of a railroad track.

17. Mathematically, digitization means ______________ all measurements to the nearest available digital value in a pre-set scale.

18. This rounding out makes digital information *inherently* less ______________ than analog information.

19. However, as long as the discrete units for a digital computer are smaller than the human eye can detect, digitizing the information improves ______________ accuracy.

20. This is why ___________ equipment is used to clock the winner of a race in the Olympics.

21. Rounding these input values (A) out to the nearest allowable discrete unit (B) so the computer can manage them is the function of an ___________-to-___________ converter (ADC).

Digitizing the Analog Image

22. Three Steps to Digitizing the Image:

    1. _________________
    2. _________________
    3. _________________

23. Scanning: Image is divided up into a(n) ___________ of pixel cells.

24. Sampling: _______________ of light (or x-rays) is measured for each cell.

25. Scanning: In CR, the reader (processor) is set to scan the PSP plate in a pre-designated number of _______, and samplings per ______.

26. In DR (and DF using CCDs), since the number of available pixels is the number of detector elements (dels) embedded in the image receptor plate, collimation of the x-ray beam is analogous to _____________.

27. Sampling Aperture: Opening through which ____________________ are taken.

28. DR: Sampling aperture determined by _____________ ______________ (dels) in the IR, which are square in shape and do not overlap adjacent samplings.

29. CR: Sampling aperture determined by reading __________ beam in CR reader, which is circular in shape, overlapping adjacent samplings that must then be "cropped."

30. Quantizing: Discrete numerical value is assigned to each cell from a pre-designated _______ _________.

Bit Depth, Dynamic Range, and Gray Scale

31. The terms bit depth and dynamic range are often used interchangeably by physicists and _______________________, which can be confusing for the student. For clarity, we will define them according to their most dominant use by experts.

32. Bit Depth: The maximum range of pixel values a computer, display monitor, DR detector or other _________________ device can store, expressed as an exponent of base 2.

    "6 bits deep" = 2__ = 64 values
    "7 bits deep" = 2__ = 128 values
    "8 bits deep" = 28 = ____ values

33. The human eye can only discern about 2__ = ___ shades of gray or levels of brightness (a bit depth of __).

34. By not using the full range of bit depth of the computer, image processing ________ can be accelerated.

35. Dynamic range compression ________ off the extreme ends of the bit depth that are not needed to construct images, to save processing speed. This does not affect the displayed image.

36. Dynamic Range: The range of pixel values (from the bit depth) that the entire system makes _______________ to build up images.

37. Dynamic range is determined by _______________ as well as hardware.

38. Dynamic range is also the number of gray shades with which each _________ can be represented by the system.

39. Gray Scale: The range of pixel values actually present in a ______________ image.

40. Dynamic range is a ____________ of Bit Depth. Gray Scale is a subset of ____________ __________.

41. The greater the dynamic range, the ___________ the gray scale in the displayed image.

42. The longer the gray scale, the more ___________ can be represented in the image.

43. Excessive dynamic range _________ down image processing time. Insufficient dynamic range causes loss of image ___________.

44. Insufficient dynamic range prevents full post ________________ capabilities for the image:

45. We must be able to double or cut in half both the brightness and contrast of the image _____________ times without running out of dynamic range (data clipping). Complex features such as subtraction require still more.

46. The dynamic range of the remnant x-ray beam is approximately 2___.

47. The enhanced contrast resolution and processing features of CT and MRI systems require a ____-bit deep range.

48. Most digital imaging systems have dynamic ranges set at 2^8 = 256, 2^{10} = 1024 (___ and ___), or 2^{12} = 4048.

What is a Pixel?

49. To a computer expert, a pixel has no particular shape or dimensions - It is a point location or ______________ which has been assigned a numerical value.

50. For displayed medical images, however, we define a pixel as the ____________ screen element which can represent all gray levels within the dynamic range of the imaging system.

51. These elements do have both a shape and an area _______.

52. For the radiographer, it is best to visualize pixels as generally __________ in shape and having a set size.

53. For an LCD display monitor, each hardware pixel is formed by the __________________ of two flat, transparent wires. Their dimensions are typically ____mm square.

Voxels, Dels and Pixels

54. Attenuation Coefficient: The ________ or __________________ of original x-ray beam intensity absorbed by a particular tissue area in the patient.

55. The attenuation coefficient is determined by data acquired from 3-dimensional volumes of tissue within the patient called __________, an acronym for "______________-elements."