

# RADIOGRAPHIC IMAGING

D N and M O Chesney

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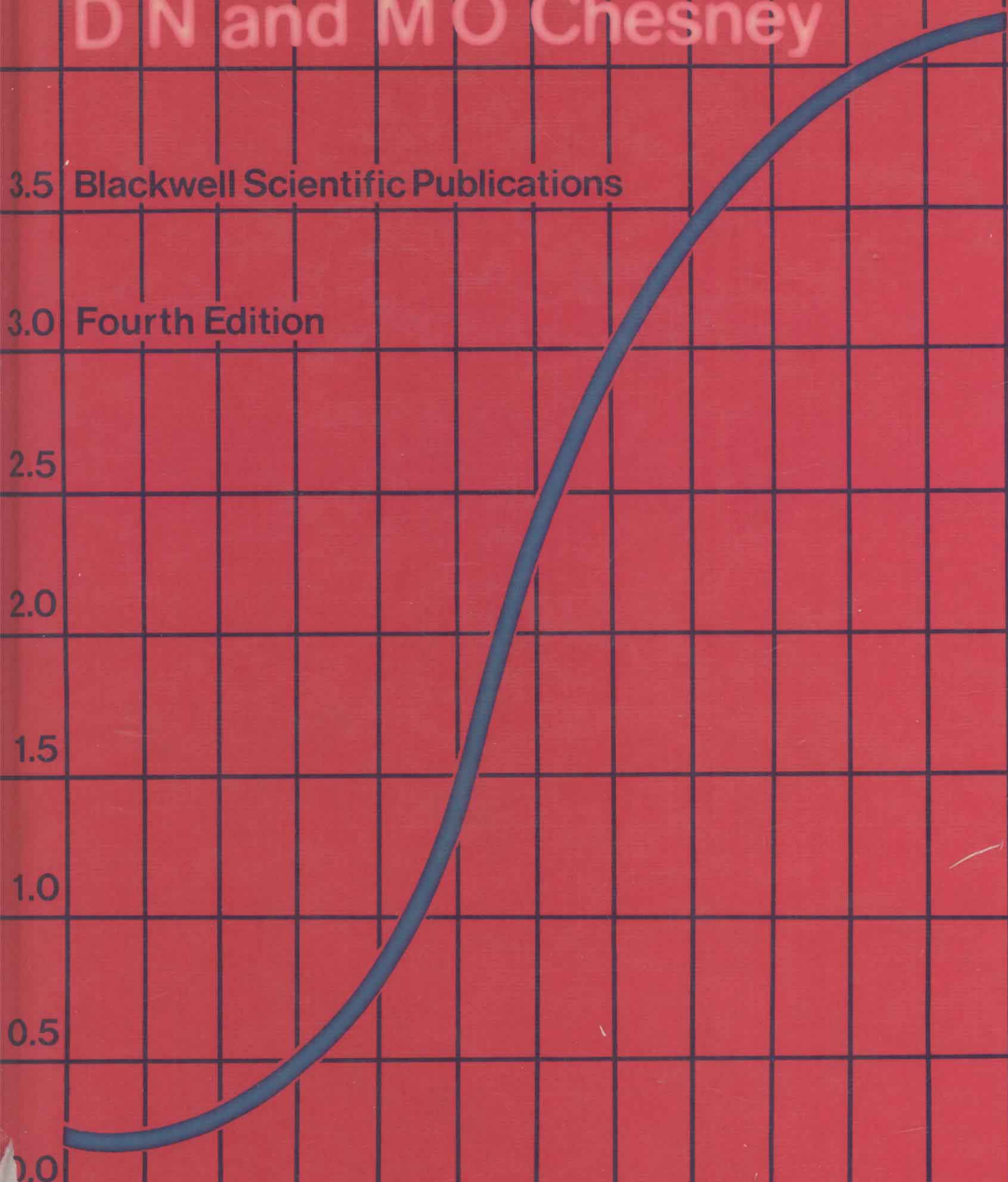
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# *Radiographic Imaging*

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To those whose book this really is:  
who gave us the straw for the bricks  
and afterwards advised us to remove  
some of them.

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## *Preface to Fourth Edition*

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A funny thing happened to *Radiographic Photography* on its way to the publisher. The book's journey was slow, from a distant past in the heads of its authors to a terminus at the premises of Blackwell Scientific Publications, beside the river in Osney Mead, Oxford. Somewhere, along some 60 miles of road and the uncountable reaches of our cerebral pathways, *Radiographic Photography* became a different book.

When its 3rd printing ran out, the third edition of *Radiographic Photography* was almost 10 years old. This—in its authors' sight, as no doubt in others'—made it overdue for retirement, since if a textbook is advanced in years it cannot be advanced; it enters that unacceptable era when it possesses neither the truth of authenticity nor the tranquil appeal of antiquity.

During the decade since we wrote the third edition, radiographers and their patients have not changed: radiographers have remained—and will remain—caring makers of images. What have changed are the materials and equipments available for the practice of our profession; and indeed our very thinking about radiographic images and the recurrent assessments which we make of them within our schools of radiography and radiodiagnostic departments. In *Radiographic Imaging* we have attempted to salute these changes. Much of the book is fresh and we believe that it deserves a fresh title.

New chapters in this book include one on the storage of unexposed and exposed materials and another on daylight film-handling systems. Extensive revisions have been made to the chapters on intensifying screens and film now in use in radiodiagnostic departments. Chapter 17 has been re-written entirely, in order to include xeroradiography and modern materials for radiographic duplicating and subtraction.

What used to be the darkroom is now considered as part of a larger concept, the dispensing/processing/viewing area. Processing theory and practice, methods of silver recovery and evaluations of the radiographic image all have new faces and have been extensively up-dated. We have

also described systematic tests for product control in a radiodiagnostic department.

Recognising changes in the syllabuses of the College of Radiographers, we have shortened the parts of the book concerned with optics and the camera; and we have made a new approach to fluorography which includes techniques for image storage and which we hope will have revitalised the subject.

This book may be different from its predecessor but it is the same in two fundamental respects. The first of these is our 'non-mathematical' attitude. Radiographic imaging unquestionably is an applied science; but its practitioners in medical diagnosis generally are not scientists, nor conversant with chemical, electronic and mathematical languages. We have tried to make this book consistently comprehensible to those who are likely to consult it and hope that the readers of *Radiographic Photography* will not now hesitate to open our new pages, because of possibly 'difficult bits'. We assure you that there are none.

Secondly, *Radiographic Imaging* shares fully with its predecessor the indebtedness of its authors to a number of people, without whose co-operation the book's journey to its publisher could not have begun with any confidence in its success. It is a pleasure now to give outlet to our overflowing appreciation to the following: Mr R. F. Farr, of the Central Birmingham Health District, who read and commented upon part of Chapter 12; Mr Fraser Sanders, of Du Pont (UK) Ltd, who gave us generously of his knowledge and time in support of Chapter 13; and Mr Alan Waller, of Ilford Ltd, who likewise made journeys in order to educate us and gave skilled attention to Chapter 5.

Our thanks are extended to others, too, who have been interested agents on our behalf and instrumental in making available to us either current information or their companies' permission to use certain material. We are happily grateful to the following of our friends for their active concern: Du Pont's Chris Nathan and Peter Ranger; Ilford's John Hale; Kodak's John Bennett, Keith Dandy and Don Martin; 3M's Brian Brandon; Medical X-ray Supplies' Bill Mead; and Siemens' Ernie Orme.

We are pleased to acknowledge the courtesy of the following organisations in allowing us to reproduce certain illustrations of which they hold the copyright: Du Pont (UK) Ltd; GEC Medical Equipment Ltd; Ilford Ltd; Kodak Ltd; 3M United Kingdom Ltd; Radiation Measurements Inc.; Siemens Ltd; Wardray Products (Clerkenwell) Ltd.

Finally, we offer appreciation to the Department of Medical Illustration of Birmingham Dental Hospital for successfully undertaking

another 'rush job' on 4 of our diagrams ; and not least we say 'Thank you' to Mr Per Saugman of Blackwell Scientific Publications who has displayed patience whilst waiting for this book to be written.

1981

D.N.C.

M.O.C.

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## *Preface to First Edition*

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This book is not about photography; it is about a number of subjects which are grouped together under the title Radiographic Photography in the syllabus of training for the Membership Diploma of the Society of Radiographers. The word camera appears in this book comparatively seldom and those who would seek in its pages for light on their studio lighting must remain perpetually unilluminated.

In the first and last analyses, we should recognize that good radiography, though it may depend upon a knowledge of theoretical concepts, in fact is a practical skill. The subjects in their syllabus of training, summarized in the term radiographic photography, are important to radiographers because they are realistic subjects: knowledge and appreciation of them significantly affect the quality of the end-product—the radiograph. It seems strange that no textbook has yet been written for radiographers about radiographic photography and that their teachers must build courses of instruction on manufacturers' pamphlets and photographic manuals in a wider category. The authors hope that this book may fill what appears to be a gap among the aids to those who must learn and the tools of those who must teach.

In attempting to meet the needs of student radiographers, as we believe that they are not scientists and may have only irregular knowledge of chemistry, we have kept to a minimum the appearance of mathematical expressions and have avoided chemical formulae. Of great convenience to those in the know, such shorthand can be only profoundly baffling to those who are not. We hope that we have made to radiographic photography the practical approach which its character deserves.

The syllabus of training for the M.S.R. Diploma has directed the selection of material for this book. While it has been written for the education of student radiographers, we know that in some places greater detail is given than may be required for the M.S.R. course. It seems a proper principle to include in a textbook something more than the minimum demanded by a particular course of study; perhaps especially

so in a field of knowledge which is fertile of development. This aspect of the book may attract at least some post-graduate readers who wish to prepare for the Higher Examination of the Society of Radiographers.

From inclusions to an omission. This book has given no space to the reproduction of photographic faults in radiographs. Possibly this may appear a serious defect to its critics. However, it must be evident to radiographers of experience that if the catalogue of such errors is to be usefully extensive, apart from any attempt to make it complete, a large number of illustrations is necessarily required: even then it is certain that someone at some time would be confronted in the viewing room with a bizarre radiographic appearance for which no reference here would enable the radiographer to account. Reproduction on paper of certain classic faults is much less satisfactory than their visualization on original films. We would suggest that for student radiographers a more useful exercise than looking at such copies is always the handling and examination of the real material. Why should they not be permitted some limited experiment from which to form their own library of malpractices in handling radiographs?

No man is an island and, perhaps more than many others, authors of textbooks are dependent on links with certain mainlands of learning and material. We are aware that the substance of this book has been strengthened because a number of people each have given to us generous measures of their knowledge, ability and not least of their time. We are glad of an opportunity to offer to them an expression of our thanks, though the small gesture is incommensurate with the gift received.

We are grateful to Dr D. M. Alexander, consultant radiologist at the Coventry and Warwickshire Hospital, for reading Chapter 14 and discussing it with us; and to Miss A. L. Hebden, medical photographer at the same hospital, who took photographs, with most welcome expedition, of a step-wedge and of parts of the Odelca and Hansen equipment. Dr J. F. K. Hutton, consultant radiologist at the General Hospital, Birmingham, receives our thanks for kindly reading Chapters 12 and 13 and giving his comments. Mr W. Hurt, medical photographer at the Birmingham Children's Hospital, came to our aid at very short notice and provided illustrations to show the appearance of a granular pattern at different degrees of photographic enlargement.

From Mr K. W. Goddard we have had the stimulus of early interest in the project and we appreciate his help in reading the MS of Chapters 11, 6 and 7 and in mobilizing for us some of the resources of Kodak Ltd who have loaned many illustrations and supplied other material. With Kodak we must associate Mr Sydney Marshall who has been most helpful as informant, reader and commentator.

We would like to thank Mr John Bennett and Mr R. Greenway, each of whom supplied a personal communication of immeasurable value on automatic processing and respectively read Chapters 6, 7 and 8, and 9. We are grateful also to Mr R. J. Hercock for his kindness in giving close attention to nearly a third of the manuscript and to us so much of his time.

It has been necessary in some parts of this book to provide working descriptions of certain equipment. In the absence of practical contact with the apparatus concerned such accounts may be troublesome to follow, but they are no less than impossible to write. With this problem we have appreciated energetic help from Mr C. W. Mead who has made available opportunities to examine certain fluorographic equipment, supplied technical data and given useful commentary on the resultant chapters of the ms. We are grateful too to Mr P. Spencer for having so willingly put us on similar good terms with a Ken-X processor and for freely loaning relevant material. Finally we owe to the knowledge and helpfulness of Dr George Parker, who read Chapters 15 and 16, the reassurance that our own pristine ignorance of some photographic optics has been successfully eliminated.

This book would have been poorly illustrated had it depended solely on the artistic ability of either of its authors. Nearly all the diagrams and photographs have been given to us through the courtesy of certain manufacturers, learned journals and publishers, and to these collectively we are most grateful for such practical assistance, in some cases on a very generous scale. We give sincere appreciation to the following: Cuthbert Andrews; The Fountain Press; Ilford Ltd, particularly Mr J. James of X-ray Sales and Mr D. H. O. John of the Techno-Commercial Dept (X-ray Division); the *Journal of Photographic Science*; Kodak Ltd, particularly Mr K. W. Goddard of the Medical Sales Division; N.V. Optische Industrie, De Oude Delft, Holland; Pako Corporation, Minneapolis, U.S.A.; D. Pennellier and Co Ltd; Philips Electrical Ltd; Philips Technical Library; *Radiography*, the Journal of the Society of Radiographers; Theratronics Ltd; Watson and Sons (Electro-Medical) Ltd, particularly Mr G. R. Woodall, Publicity Manager; X-ray Sales Division, Eastman Kodak Co, Rochester, New York.

D.N.C.  
M.O.C.

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# Chapter I

## *The Photographic Process*

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### VISIBLE LIGHT IMAGES

Photography is a record made by means of light. Three separate processes can be distinguished.

(i) The formation of an image. In general photography this is an optical image produced when *divergent* rays coming from a subject are made to *converge* by means of a lens. In radiography it is a shadow image produced when interposed objects attenuate an X-ray beam.

(ii) Recording the image. In the first instance the image exists as a hidden one within the material used for the record; this must be a substance which reacts to light.

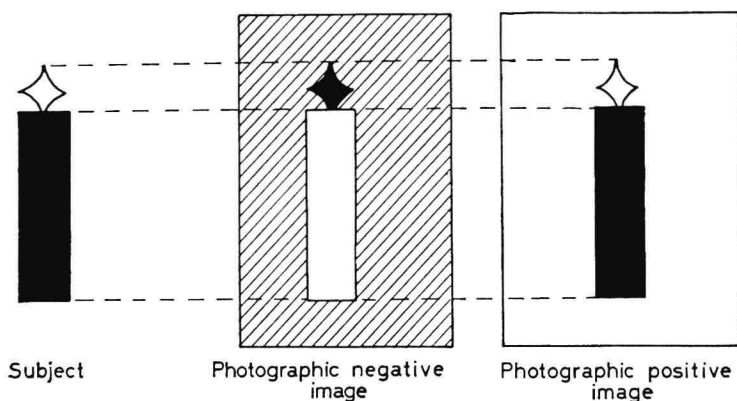
(iii) The production of the image in permanent form. This involves the action of a chemical agent to make the hidden image visible. This stage is known as *development*, and it is followed by further chemical processes which fix the image and make it into a permanent record.

Photographic history is the story of discovery of physical and chemical processes by which an image is formed, recorded, and made permanent. It has extended over a long period of time. The science of optics, for example, is a very old one, and the 'pinhole camera' which has pleased many of us in our schooldays is a device by no means new; Aristotle referred to pinhole images as long ago as 350 B.C. Yet it was not until the nineteenth century that real progress was made in obtaining permanent record for photographic images.

In the search for a means by which to make such records, the action of light on certain materials was noticed. That light can produce change is common knowledge to us all. Curtains and carpets fade under the action of sunlight; some human bodies turn agreeably brown. It is not within the intended scope of this book to recount the evolution of photographic processes, attractive though such by-ways may be. We are concerned at present with the light-sensitive materials encountered by radiographers in their work. These are materials which on exposure to

light are found, after chemical development, to have darkened where the light has reached them.

A photographic material recording an image receives more light from the brighter parts of the subject. If the material reacts to light by becoming *darker*, it follows that in the developed result those parts of the subject which were bright to the eye are dark in the recorded image. Those parts of the subject which are dark to the eye are light in the recorded image. This image with reversed tones constitutes a *photographic negative* (Fig. 1.1).



**Fig. 1.1.** The bright parts of the subject (e.g. the candle-flame) in the first photographic image (a negative one) are dark. From the negative, a positive can be made. The dark parts of the negative transmit less light, and in the positive these parts correspond in tone to the bright parts of the original subject.

From this negative another positive image can be made quite simply. If the negative image is on a transparent film or glass base, it will allow light to pass. Obviously the dark parts of the image will allow less light to pass than do the light parts of the image. The procedure then is to pass light through the negative image on to another piece of photographic material which, like the first, responds to light by becoming black after development. The two photographic materials may be in contact with each other, or the image may be projected from the one to the other. The light parts of the negative transmit more light to blacken the second piece of material than do the dark parts of the negative. The second image is therefore dark in areas corresponding to the dark parts of the subject, and light in areas corresponding to the light areas of the subject. The recorded image is therefore in the same tones (or it may be expressed that the