

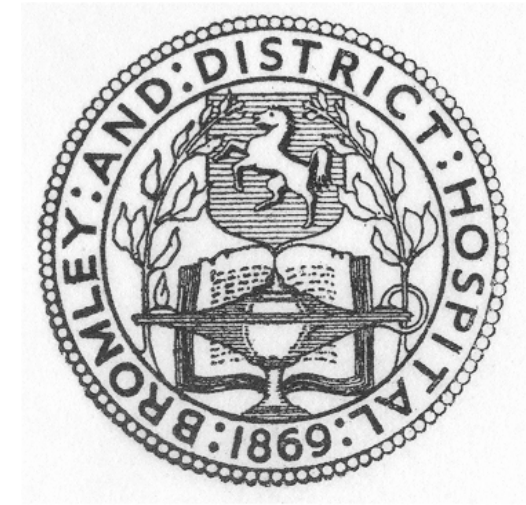
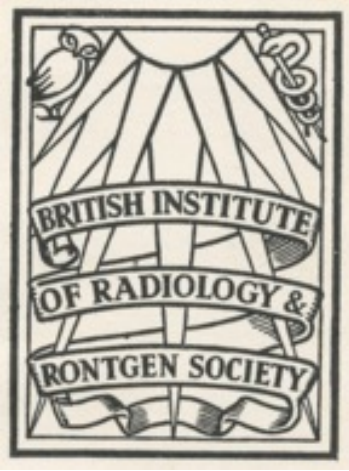
RHINOCERON



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# 2022-2023 DHMSA: Radiology and Imaging Part II

Adrian Thomas

Visiting Professor

Canterbury Christ Church University

1st April 2023



# Dr Thomas Henry (Tom) Hills 1911-1983

- Director of X-ray Department Guy's Hospital 1949-1974.
- Paper at conference "New Trends in Radiography", 8-9 December 1971 at the Royal Photographic Society in London.
- "A Radiologists Thoughts on Future Developments on Radiography."
- The Journal of Photographic Society, 19, 140-142.



# Hills: New Trends in Radiography (1).

- “If you want to introduce something really new into the science of radiography you must get right away from attempts to improve on the systems and methods that we use today.
- If you go to any existing X-ray department and just study their methods you will probably learn nothing.”

## Hills: New Trends in Radiography (2).

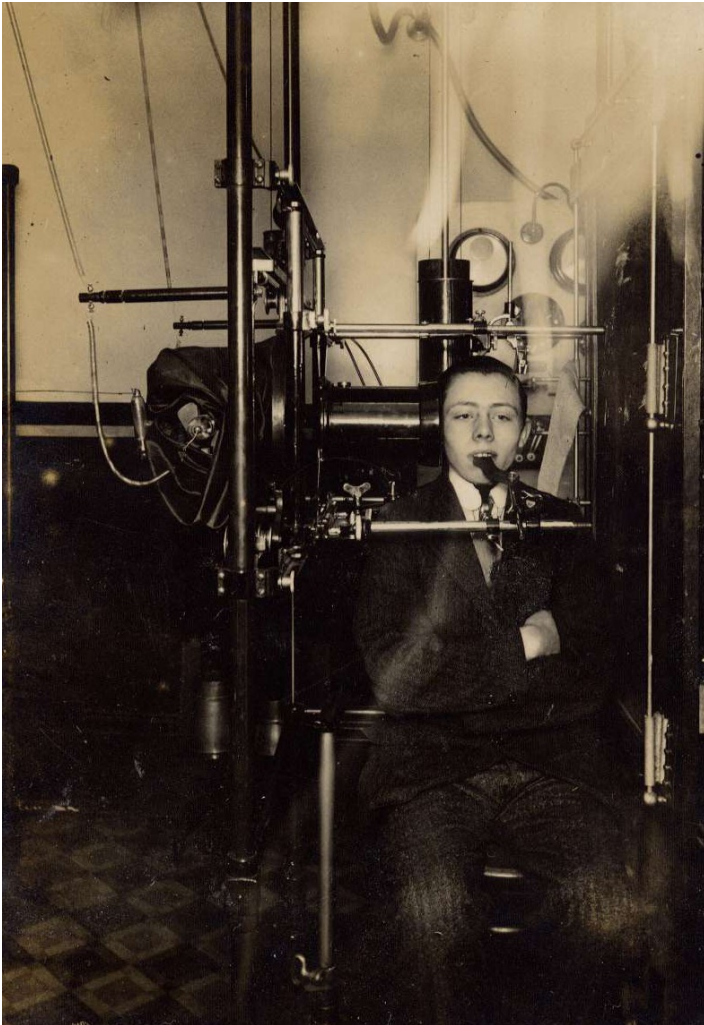
- “In planning a new X-ray department for my hospital (*Guy’s tower opened 1974*) I have succeeded in adding two X-ray rooms to our obvious requirements both with rather strange sounding names on the plans.
- I have managed to avoid telling anyone what they are wanted for, for the simple reason that I do not know.
- But judging by past experience it is certain that within the next decade they will be fully operative with some type of diagnostic procedure that we know nothing about today.”

# Hills: New Trends in Radiography (3).

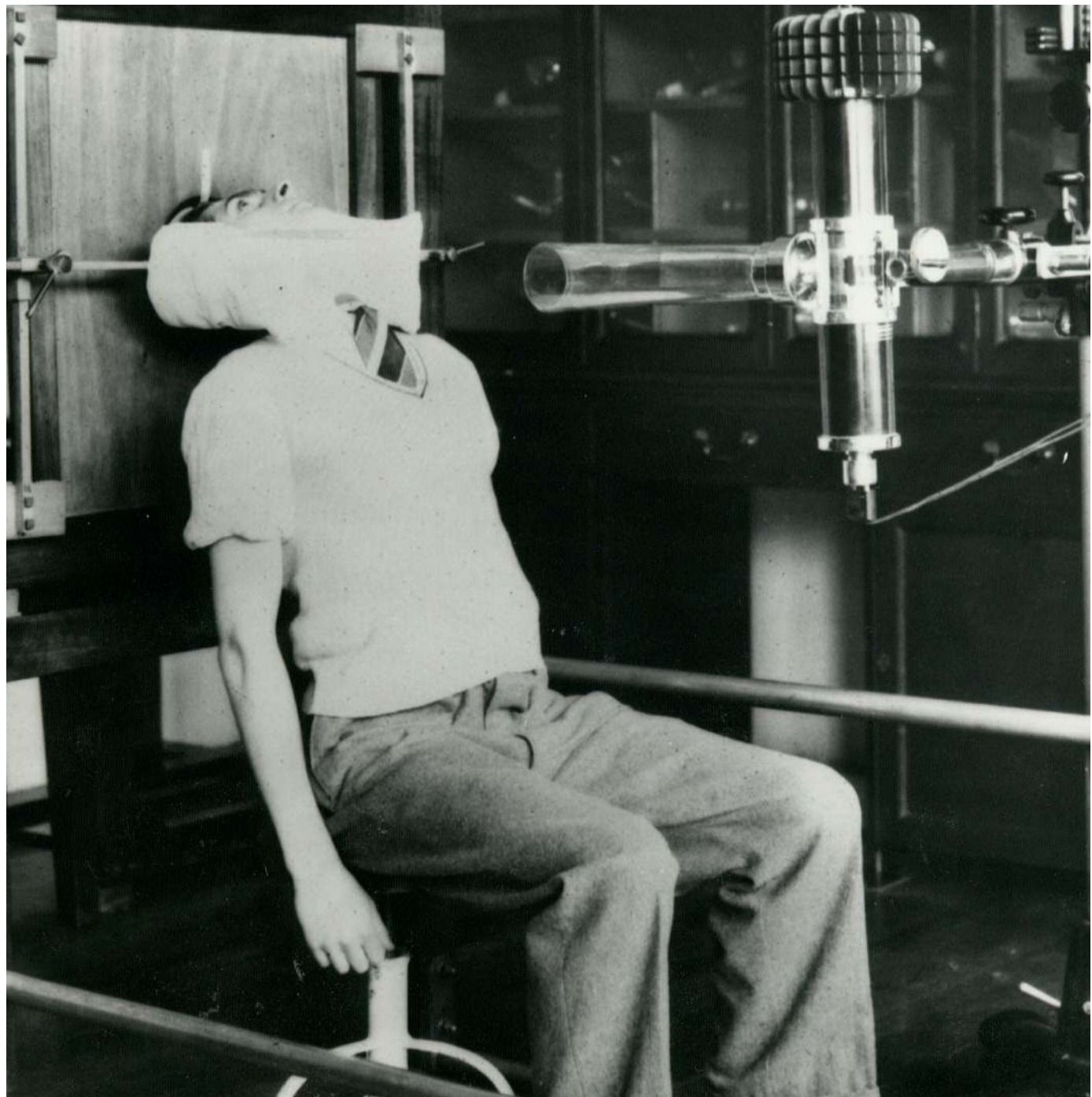
- “I think that it is a general feeling amongst those most deeply involved with any subject to believe that they know all there is to know and cannot understand how further progress can be made.
- But time and again new techniques and skills are evolved usually to meet some demand from our clinical colleagues.
- On the other hand it is essential to keep a close watch on any developments in completely remote fields of engineering in the hope that they may have an application of use to us.”



# Pituitary Radiography (1918).



Skull  
radiography  
at  
Hammersmith  
Hospital  
1930s.





# Walter E Dandy (1886-1946).

- Protégé of Harvey Cushing at Johns Hopkins Hospital.
- 1918: Ventriculography.
- 1919: Encephalography by introduction of air via lumbar theca.



# Walter E Dandy (1886-1946)

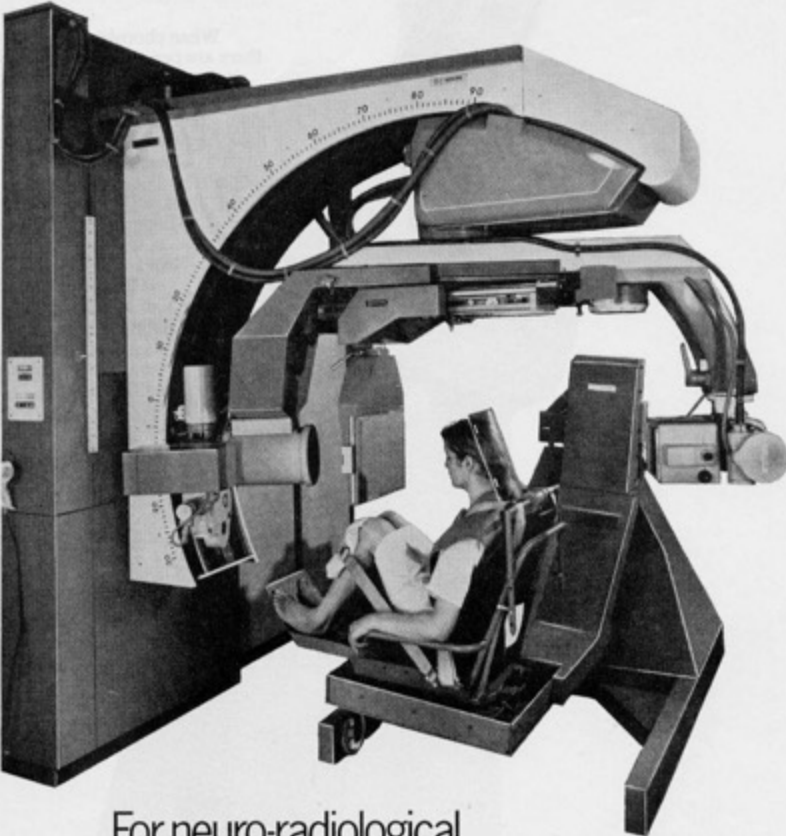
- “.....the possibility of filling the cerebral ventricles with a medium that will produce a shadow in the roentgenogram.
- If this could be done, an accurate outline of the cerebral ventricles could be photographed with roentgen-rays, and since most neoplasms either directly or indirectly modify the size or shape of the ventricles, we should then possess an early and accurate aid to the localisation of intracranial affections.” (1918)

# Ventriculography.

“The procedure is dangerous and complicated, but in competent hands it should not be nearly so dangerous as an exploratory craniotomy and it frequently yields more information than the latter operation.”

J.W. Pierson 1925

# Isocentric Chair 1971



For neuro-radiological  
examinations  
**PHILIPS DIAGNOST N**  
now with the new isocentric chair (1971)

Philips introduced this unique combination at the 12th International Radiological Congress in Tokyo.  
The isocentric chair is so called because the construction is such that in combination with the Diagnost N the object under investigation remains centred in the X-Ray beam during tilting and/or turning of the chair with patient. This combination guarantees a rapid, efficient course of the pneumo-encephalography with minimum discomfort to the patient, and considerable diagnostic scope for the radiologist.

Philips Medical Systems Ltd.,  
45 Nightingale Lane,  
London, S.W.12.  
Tel: 01-673 7766.

**PHILIPS**



Mavis Reynolds.



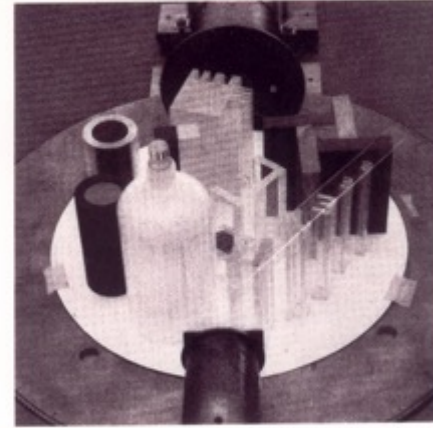
succession. At the end of a myelogram the radiologist counts the number of people flat out on the floor, this being in direct proportion to the success of the examination. (*see fig. above*)

Sir Godfrey  
Newbold  
Hounsfield  
(1919-2004)

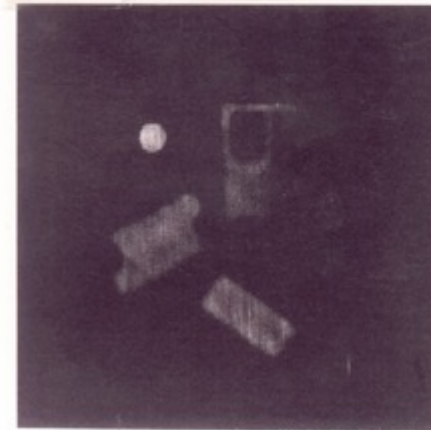


# Perspex Model.

Taking a picture of a complicated Perspex Model with Gamma Rays.  
The Gamma source is at the top of the picture the Scintillation counter is at the



A picture taken using Americium (a gamma ray source).  
Showing a picture of rectangular blocks in water.  
Readings were taken from a scintillation  
counter which counted the gamma ray photons.  
(it took a <sup>9 days</sup> week to take the picture and 15 minutes computing  
time to reconstruct the picture).



FIRST PICTURE  
EVER.

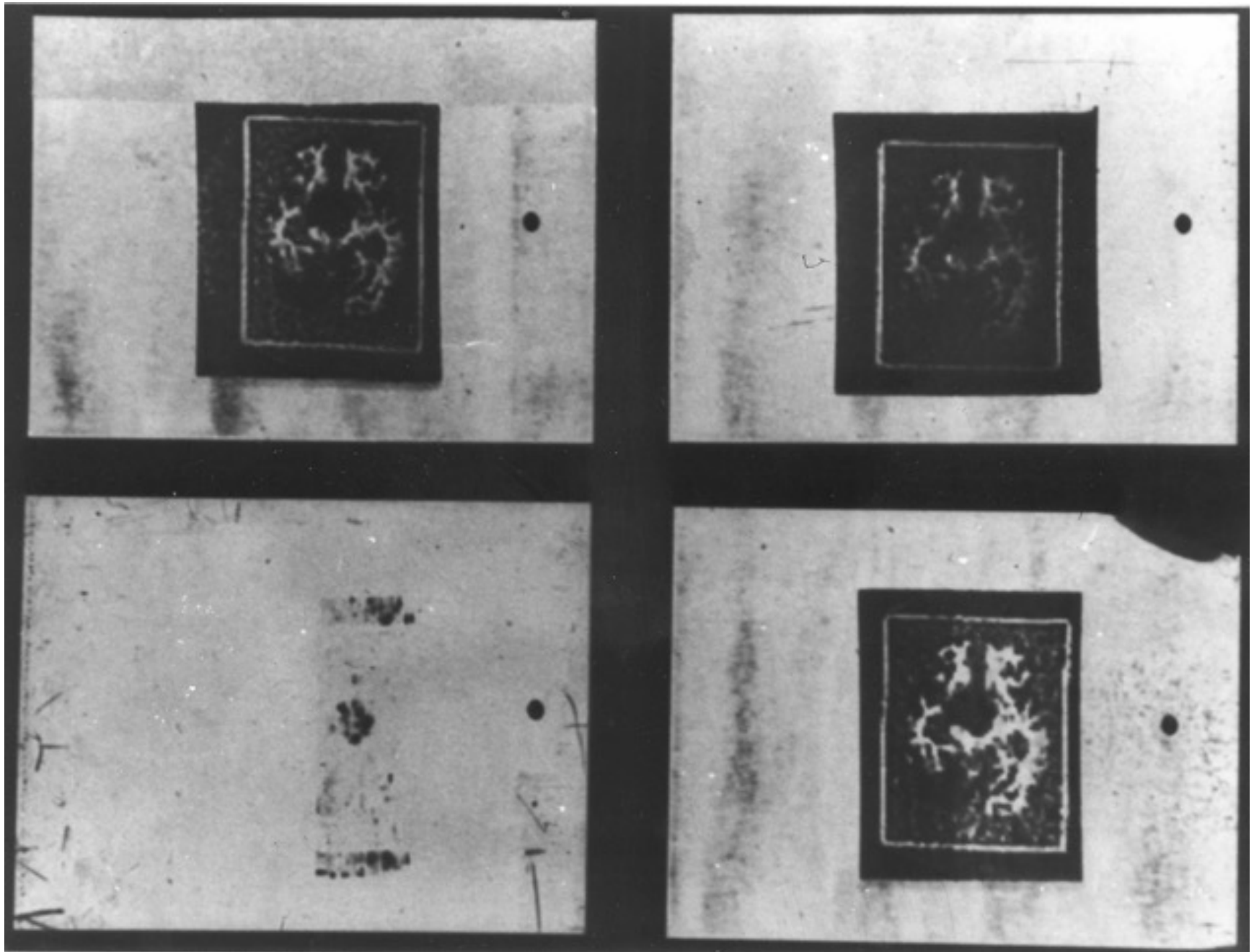


# Laboratory Lathe Bed



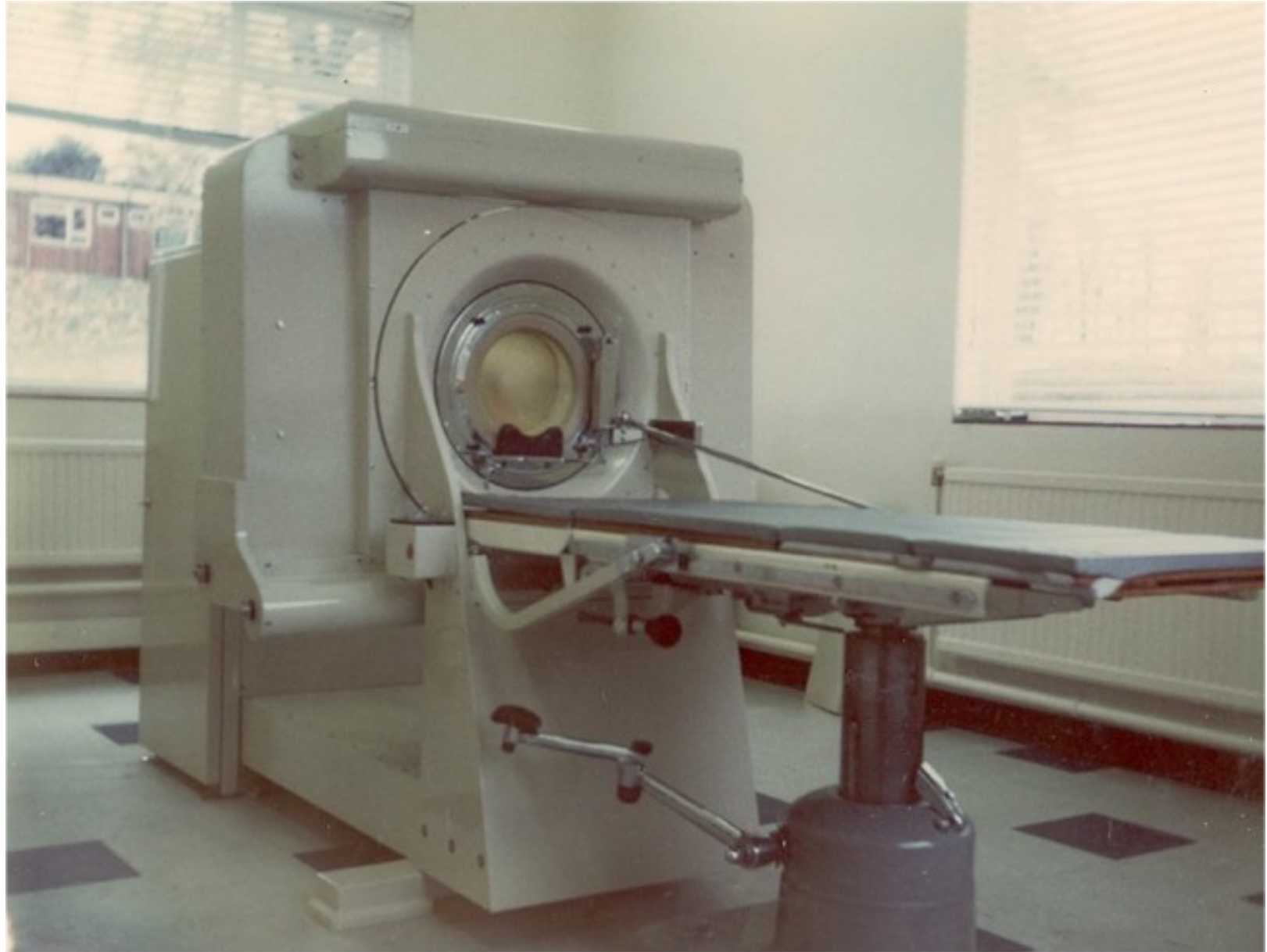


# Pickled Brain in a box

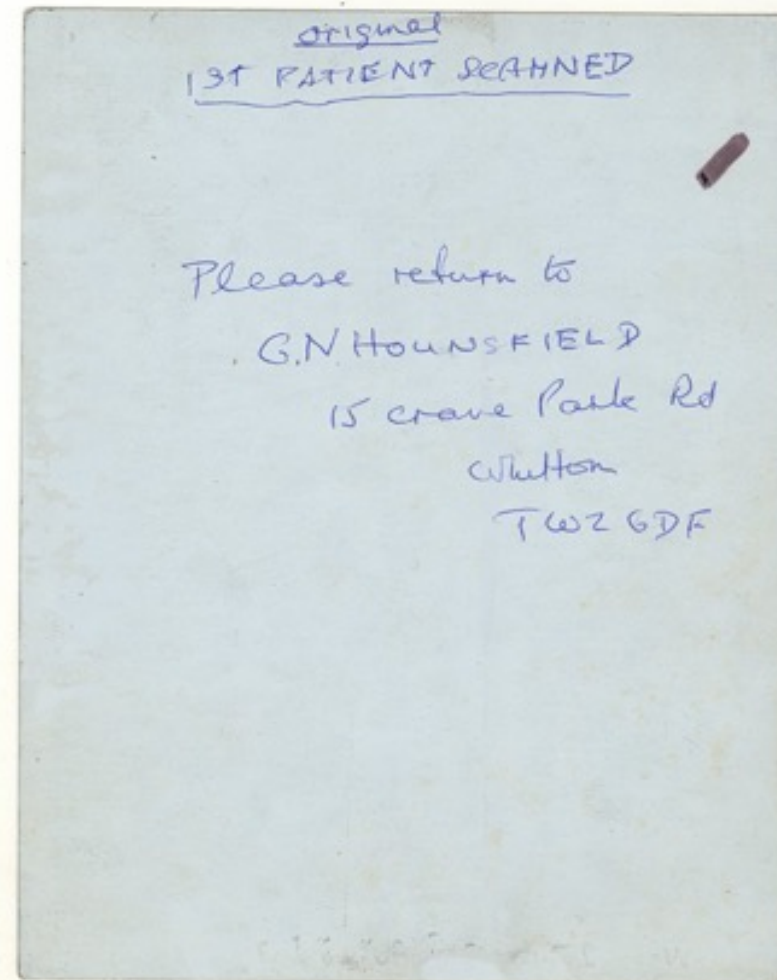
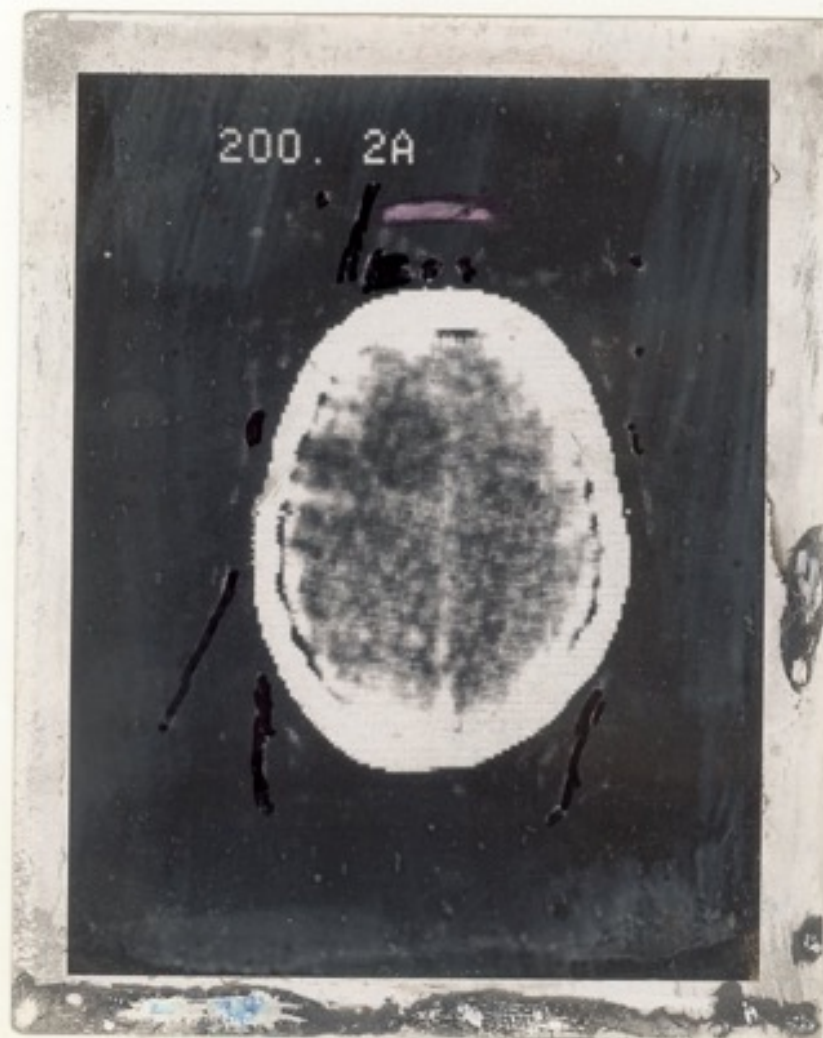


First Clinical  
Head Machine:  
1<sup>st</sup> October  
1971

Atkinson  
Morley's  
Hospital



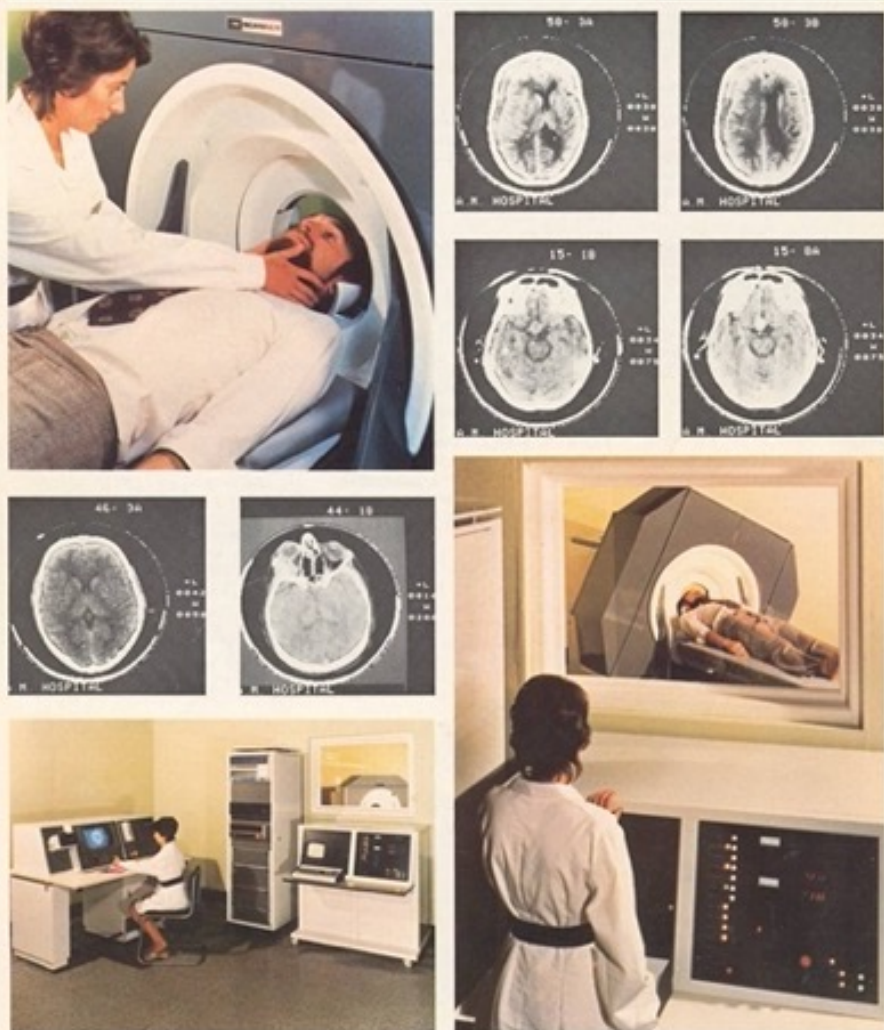
# First Patient Scanned





# EMI-Scanner CT1010

The most advanced diagnostic system for *Soddy House* neuroradiological examinations





# The EMI Scanner

Marks the paradigm shift!

“Until his discovery X-ray photography has not advanced fundamentally since RÖNTGEN X-rayed his wife’s hand in his laboratory in Würzburg in 1895.”

James W D Bull 1977

# CT Scanning.

“The result of HOUNSFIELD’S discovery  
has been to transform investigative  
medicine.”

James W D Bull 1977.

## *Embarass de richesse*

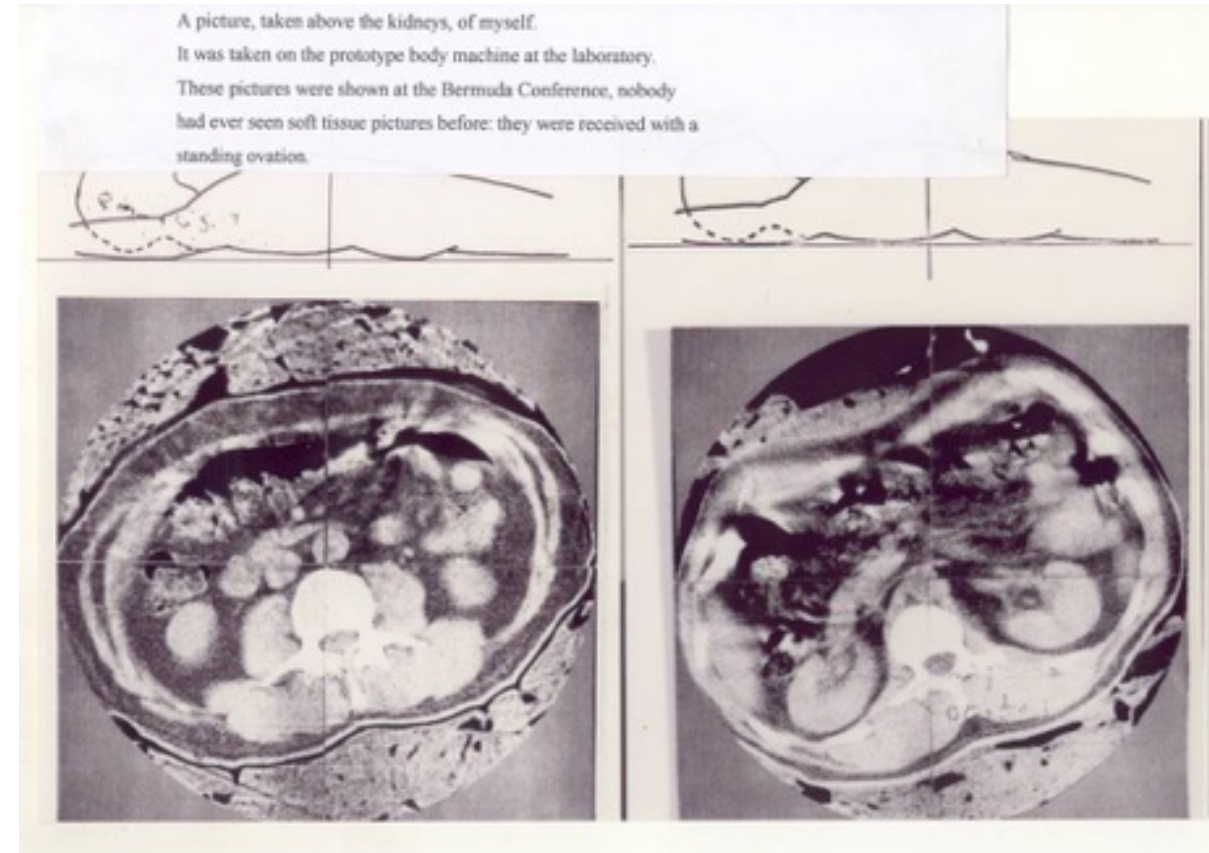
- The benefits of the scanner were so overwhelming as to be obvious.  
BMJ Editorial (1975) 2, 295-6.
- “No need for a randomised controlled trial to make sure that we could believe what we were seeing.”  
Brian Jennett 1984.
- However:
- In one centre no change in morbidity and mortality, fewer invasive tests, total costs for diagnosis increased.  
H Fienberg, AJR (1978) 131, 1-4.

# Head Injury.

- AMH 1976: Head Injuries: Replaced angiography and reduced burr holes. Mortality not reduced (Ambrose).
- Glasgow: CT often revealed clinically unsuspected haematoma. Still using long established criteria for transfer – clinical deterioration needs to have taken place. Changed referral guidelines in 1978.
- Conclusions in 1978: Some neurosurgeons advising that scanners should be placed in district hospitals: to avoid transfer to regional units (Bartlett, Neil-Dwyer & Benham 1978).

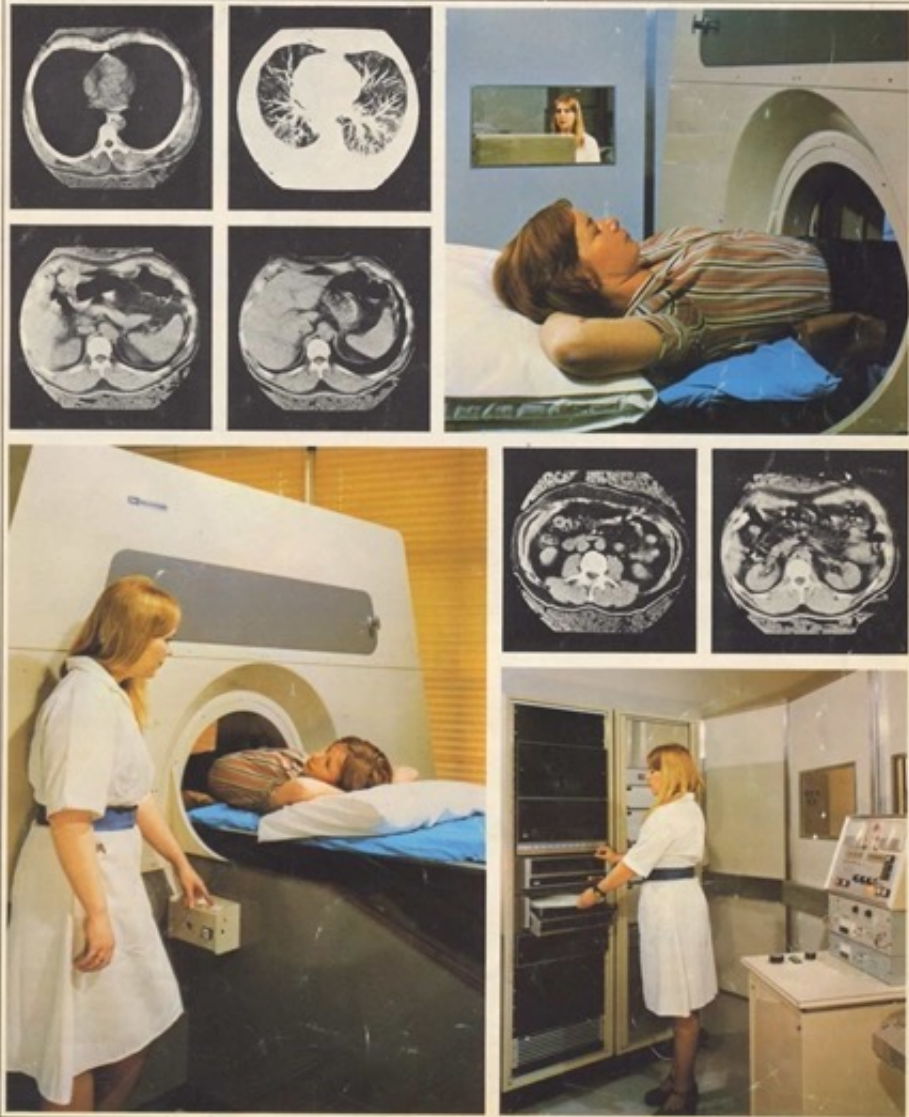


# Production Model Body Machine: high resolution 300 by 300 in 28sec. 1<sup>st</sup> International Conference on CT: Bermuda, March 1975.



# Emerald Body Scanner CT 5000

**EMI-Scanner CT5000** **EMI**  
A major advance in body tissue examination



The advertisement features a collage of images. The top row includes four small CT scan images showing cross-sections of the chest and abdomen, and a larger photograph of a patient lying on the scanner bed. The bottom row shows a technician in a white uniform operating the machine, and another photograph of the control console with a patient inside the scanner.



1979:  
“Exceptionally  
Difficult Year.”

# EMI

# MONEY & PEOPLE 1979

## ‘Exceptionally Difficult Year’

Report to Employees  
by Sir John Read, Chairman of the EMI  
Group



The financial year which ended on 30 June 1979, and which is reported in this issue of 'Money & People', was a tough one for EMI. The Group's worldwide sales of £869 million were marginally lower than the previous year, and

engineering delay in bringing the new advanced EMI-Scanner 7070 into production. Deliveries of the 7070 have now begun, however, and there are some 56 orders on hand.

While the results for the EMI Group were severely depressed by the combined effects of the problems in Music and Medical Electronics, I am glad to report that our other operations performed well.

Defence Electronics made a lower profit due to reduced exports, but built up a strong order book for the years ahead. EMI-MEC had a most successful year and EMI-Varian also succeeded in bettering its previous performance.

The companies and divisions comprising our Industrial Electronics operations reported mixed results, but the total figures for sales and profit were significantly better than last year – with AFA-Minerva and SE Labs doing particularly well.

Our Entertainment and Leisure businesses made a substantially higher total contribution to the Group's profit. Cinemas, film production and distribution, Elstree Studios and live entertainment were highlights on the Entertainment side, while Social Centres (bingo) were particularly successful among our varied Leisure activities.

Thames Television, which we jointly own with Rediffusion, had another successful year. Although the profit level was lower, due to

I should also like to pay particular tribute to Dr Godfrey Hounsfield, the inventor of the EMI-Scanner. His continuing work in the field of computed tomography (CT), which has made an outstanding contribution to medical science, was further recognised in October 1979 by the award of a Nobel Prize. Dr Hounsfield has been a member of EMI since 1951, and for much of the time he has worked as a senior research scientist in our Central Research Laboratories. His latest award is justly deserved and brings great credit to EMI and to Britain.

I must also commend the recognition given to other employees and artists for a number of specific achievements. In the United Kingdom, Nuclear Enterprises Limited gained a 1979 Queen's Award for Technological Achievement arising from their development of an advanced medical counter. Similarly, the efforts of our Central Research Laboratories were recognised by a United States 'IR-100' Award for their pioneering work on the secure magnetics tape 'watermarking' technique. Elsewhere in the world, notably in North America and Europe, our artists and employees secured further awards for the creation of distinguished recordings.

*John Read*

22 October 1979

# CAT scanner appeals:

- The appeal often funded only the machine.
- Issues with staffing and running costs.
- Issues with machine replacement (hospital were obliged to replace).
- However: They gave local people a sense of ownership (Voluntary Hospital v NHS).





# Willi A Kalender (1949-)



**Thoracic Radiology**

Willi A. Kalender, PhD • Wolfgang Seissler • Ernst Klotz, DiplPhys • Peter Vock, MD

**Spiral Volumetric CT with Single-Breath-Hold Technique, Continuous Transport, and Continuous Scanner Rotation<sup>1</sup>**

Continuous computed tomographic (CT) scanning of organ volumes during a single breath hold was studied. The authors modified the table feed mechanism of a continuously rotating CT scanner to allow patient transport at low, but accurately controlled, speeds (0.1–11.0 mm/sec) during continuous 1-second scanning. An algorithm was designed to reconstruct artifact-free images for arbitrary table positions from the helical data by interpolating between adjacent scans. Section sensitivity profiles were enlarged; the section width for a 10-mm section and a speed of 10.0 mm/sec was increased by a factor of 1.3, compared with the nominal value. Clinical examples were presented for studies of lung nodules and studies enhanced with contrast medium. Major advantages are the possibility of continuous scanning of extended volumes within a breath-hold period and retrospective, arbitrary selection of anatomic levels.

**Index terms:** Computed tomography (CT), image quality • Computed tomography (CT), physics • Computed tomography (CT), technology • Lung, CT, 60.1214

**Radiology 1990; 176:181–183**

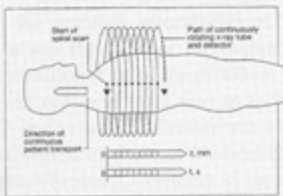


Figure 1. Sketch of the scanning geometry in spiral volumetric CT.  $t, \Delta$  = time in seconds,  $z$  = section position.

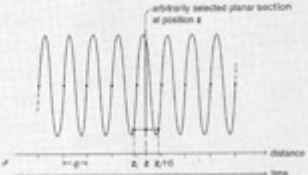


Figure 2. Principle of image reconstruction in spiral volumetric CT. Planar data for arbitrary table positions are calculated from the spiral data by means of linear interpolation.

In whole-body computed tomography (CT), inconsistent levels of inspiration from scan to scan or patient motion may cause omission of some anatomic levels or repeated scanning of others. These factors may jeopardize the success of an examination (eg, the search for and diagnosis of pulmonary nodules) (1–4). These inconsistencies will also disturb image quality in three-dimensional displays and in multiplanar reformations, in which discontinuities due to motion between scans are frequent. Also, respiration between scans prolongs examination times; in particular, contrast material-enhanced studies of extended volumes cannot be completed within the vascular enhancement phase (5, 7).

public of Germany) that produces up to 12 consecutive 1-second scans. Tube currents ranged from 250 mA for 5-second scanning to 170 mA for 12-second scanning; section thicknesses of 1, 2, 5, 8, and 10 mm were available. The x-ray tube has a storage capacity of 3.5 million heat units.

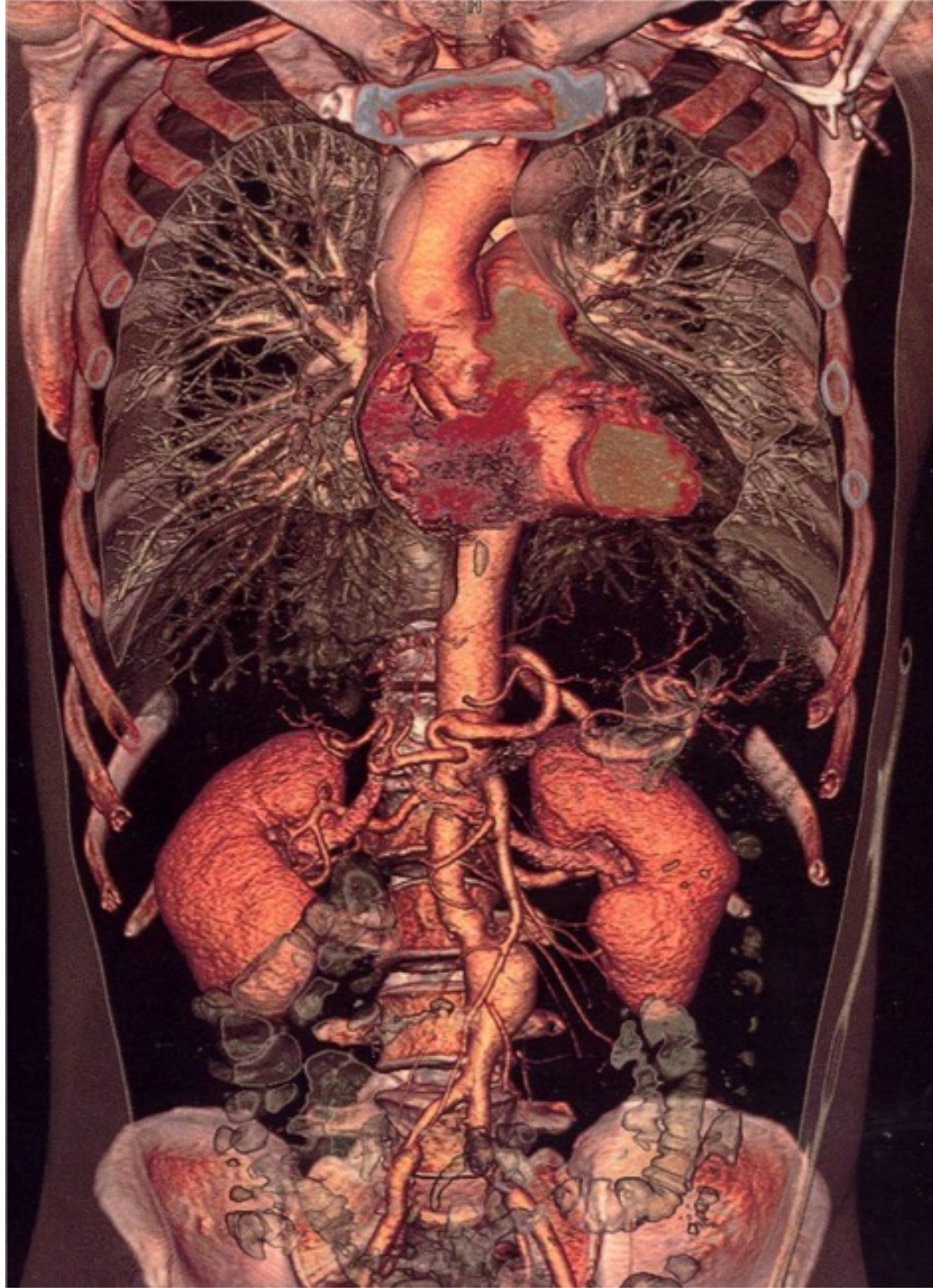
In an experimental modification of the table feed mechanism, we incorporated a stepper motor to allow continuous transport of the patient at low, but accurately controlled, speeds (0.1–11.0 mm/sec) during scanning.

**Scanning Geometry and Image Reconstruction**

In this type of scanning, the x-ray focus performs a spiral motion on a virtual cyl-



CTA: entire  
aorta.

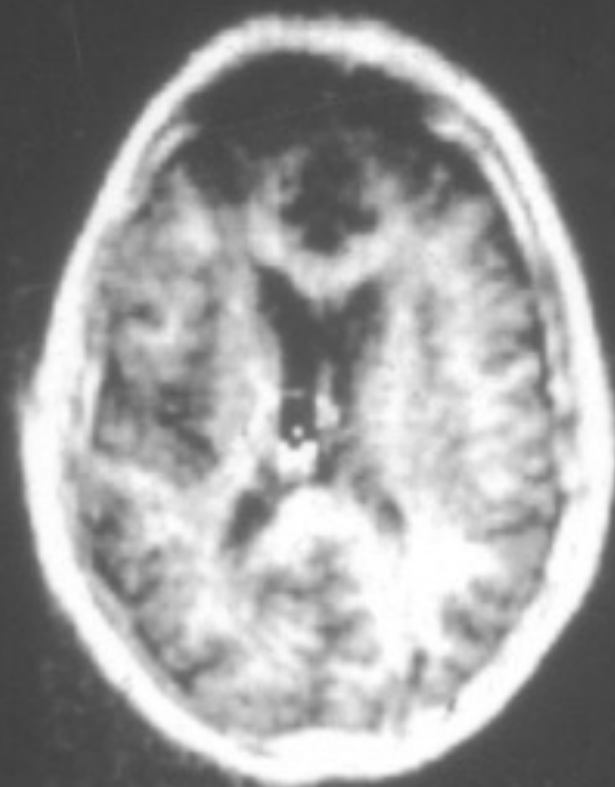


# NMR / MRI.

- Felix Bloch and Edward Purcell performed biological experiments in 1948.
- Advances in magnet technology in 1960s.
- Peter Mansfield and Grannell in Nottingham described NMR diffraction in solids in 1973.
- Paul Lauterbur in letter to Nature demonstrated a 2D image of two tubes of water in 1973.

# Development of NMR / MRI.

- First live human MR image cross-sectional proton image of a finger Mansfield and Maudsley in BJR 1976.
- First demonstration of intracranial pathology. Hawkes, Holland, Moore and Worthington 1980
- 1983 first commercial scanners installed.



N.M.R.

SCANNER

TEST  
PICTURE

AUTUMN  
1979

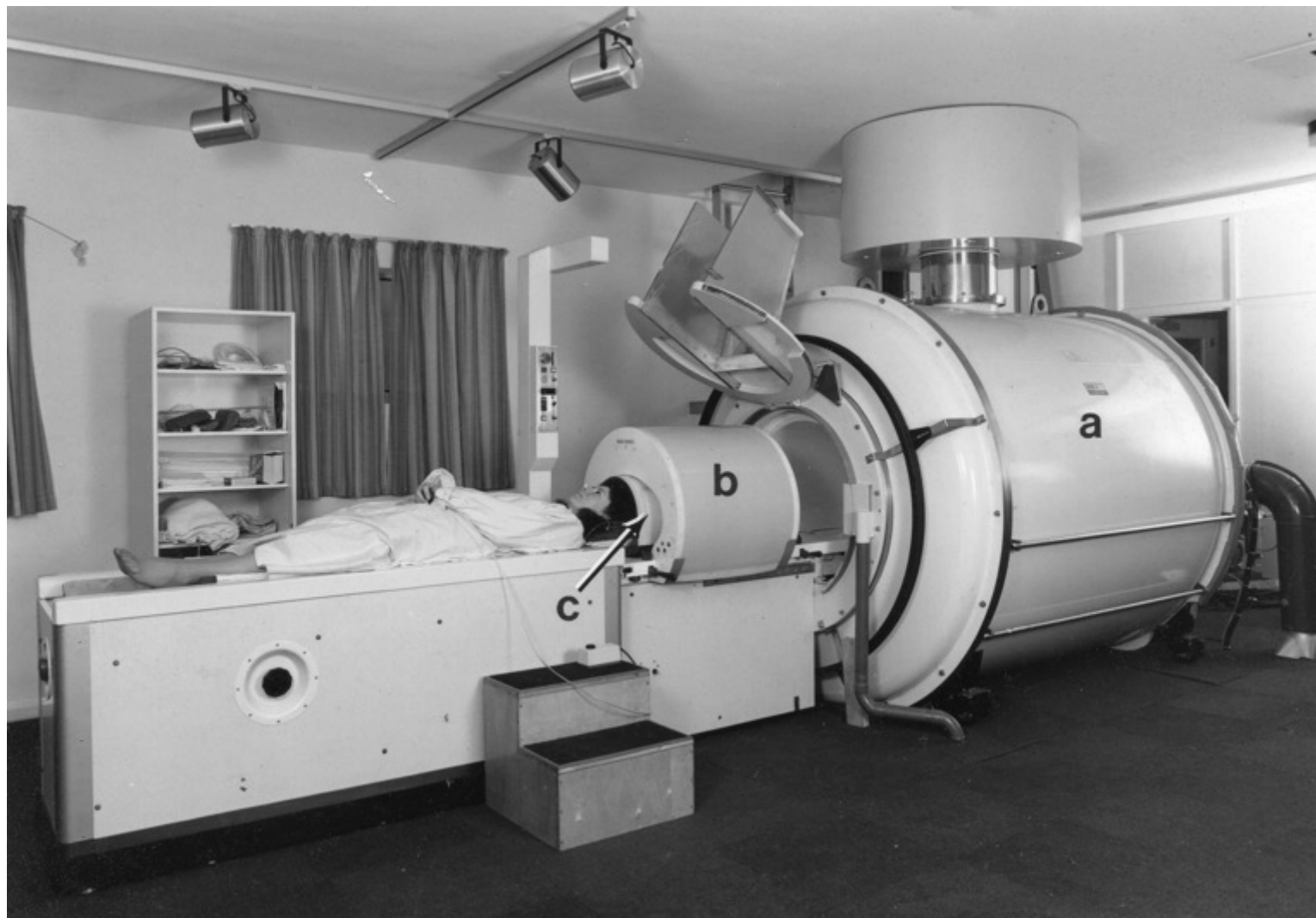
C.R.L.  
EMI LTD.  
HAYES  
MIDDX  
U.K.

WM 400  
WL+0218

PIC-26 PATIENT-IAN

RRC.: T1







11/01/1967  
Head  
INS742322

S

TE: 100ms  
Flip: 150

A

P

HEAD WITH CONTRAST  
Im: 11

I



# Ultrasound.

- Many interested in many centres over the world.
- Paul Langevin developed non-medical uses.
- In the UK the pioneer was Ian Donald. On 21<sup>st</sup> July 1955 Donald Visited the Research Department of the boilermakers Babcock & Wilcox at Renfrew on the invitation of one of the directors, who was the husband of a grateful patient.
- Later he formed a link with the Kelvin & Hughes Scientific Instrument Company, and with a young technician Tom Brown.

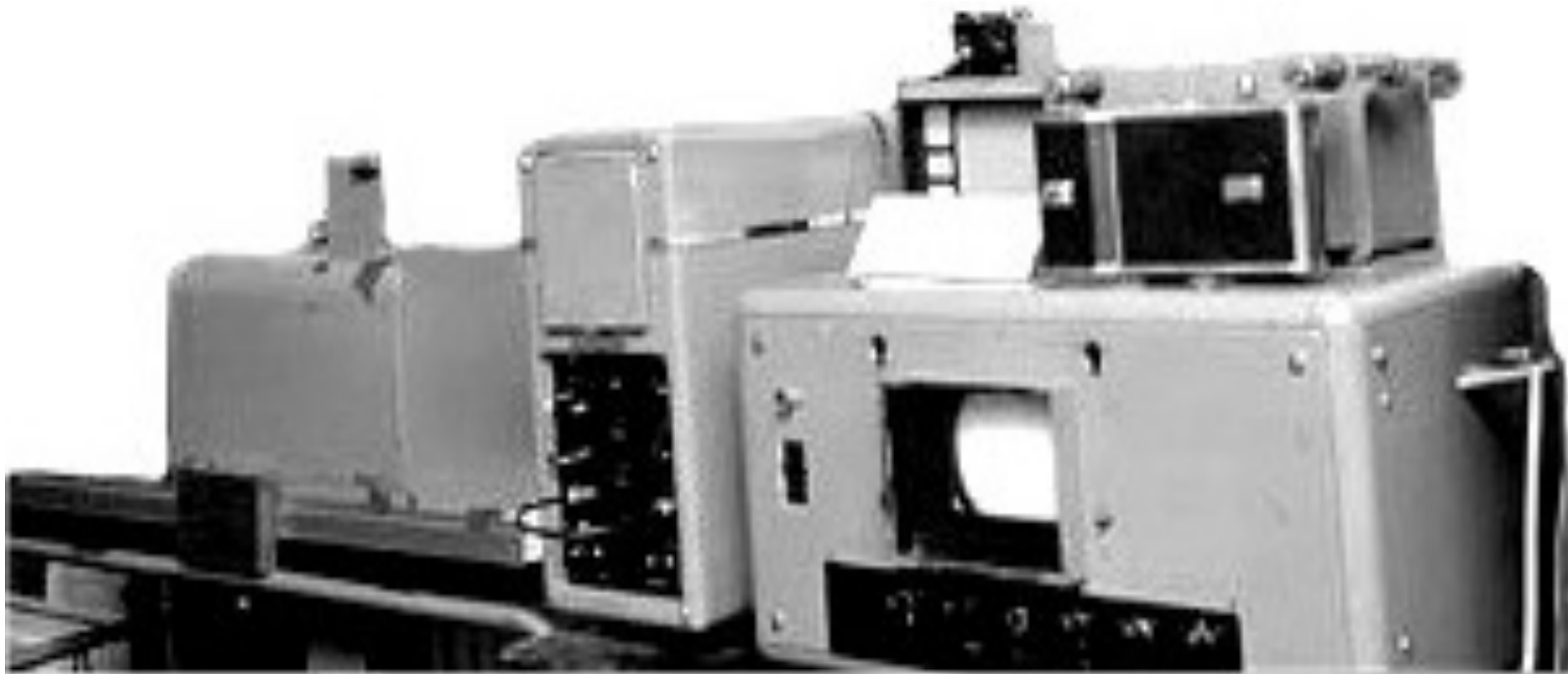
# Ultrasound flaw detector.

- Sergei Y. Sokolov, in Leningrad in 1928 proposed and then demonstrated a transmission technique for flaw detection in metals.
- He suggested that the technique could be used to detect irregularities in solids.
- The work was later taken up by others.



# Prototype Scanner 1957.

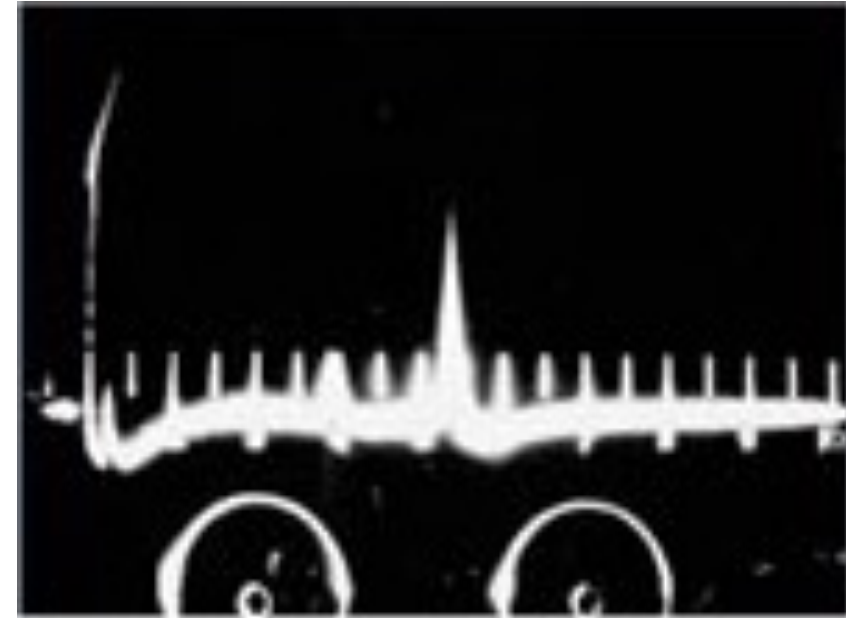
- Scanner gantry on left, in the middle is the “Mark IV” and on the right the extra screen from the Mark IIb.





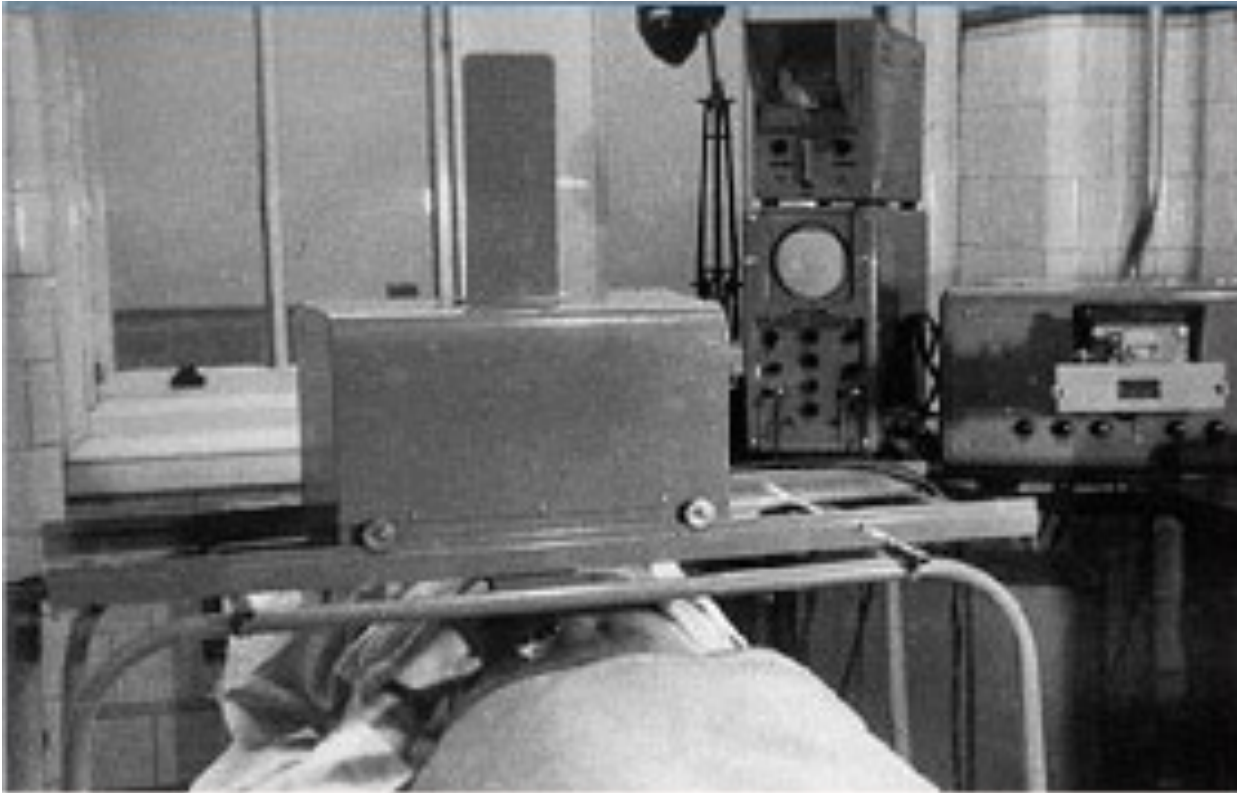
# Development.

- Early results were disappointing
- US greeted with scepticism and ridicule.
- However - ultrasound saved a patient's life by diagnosing a huge, easily removable, ovarian cyst in a woman who had been diagnosed as having inoperable cancer of the stomach, made people take the technique seriously.
- 'From this point', Ian Donald wrote, 'there could be no turning back.'

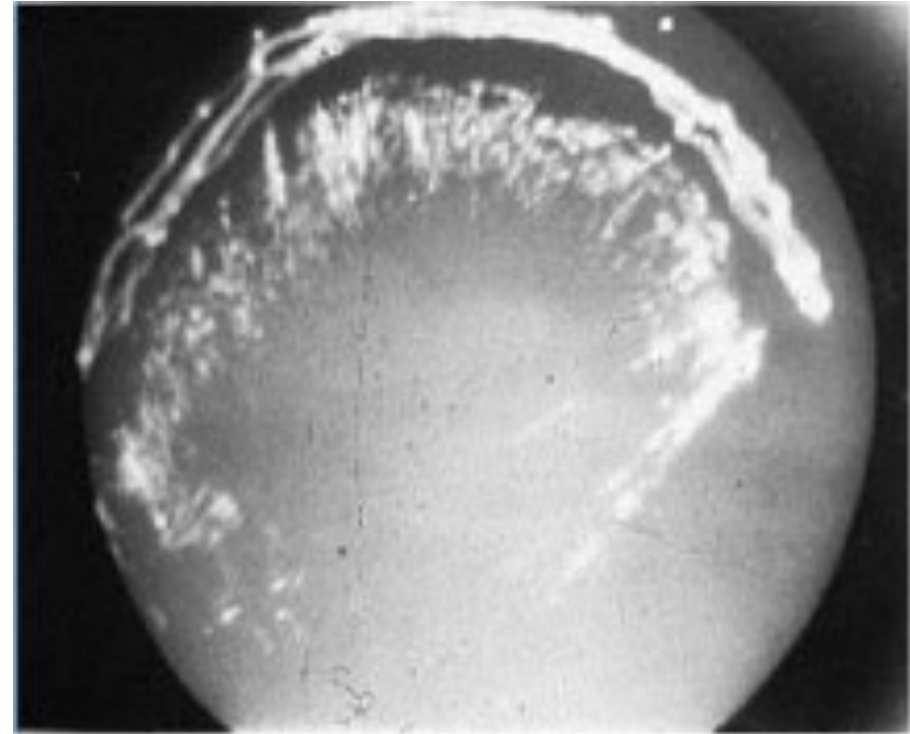


# Early US: 1957.

- Prototype Scanner: Donald & Brown 1957: the “bed table scanner.”

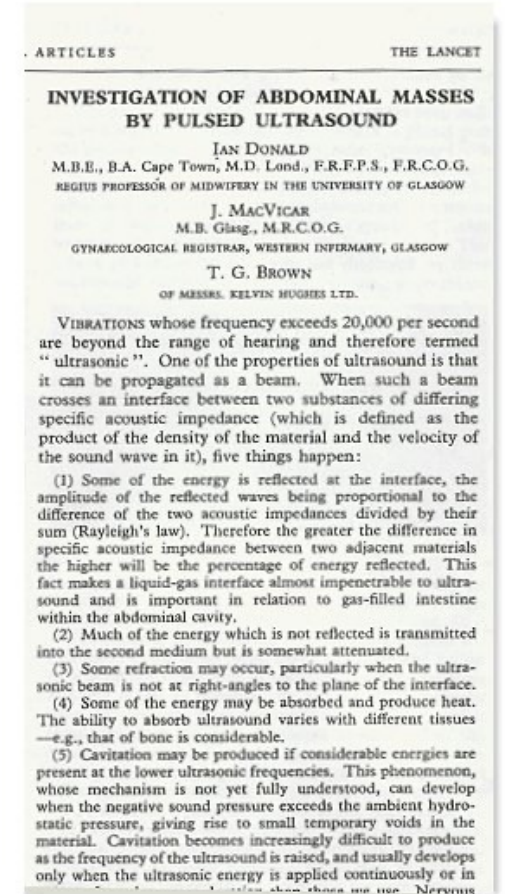


- Abdominal scan.



# Investigation of Abdominal Masses by Pulsed Ultrasound: Lancet 1958.

- The most important paper on O&G ultrasound ever written.
- Over 9 pages it described the experience of 100 patients.
- 12 illustrations of B-mode sonograms of the gravid uterus: ovarian cysts, fibroids, ascites & normal and pathological conditions.
- Depicted the prototype B-mode scanner gantry and probe and the Mark 4 flaw detector with which images were made.
- The safety of diagnostic ultrasound was also discussed.





# Vscan Air™

See more. Treat faster.

## First Impressions

All clinicians featured used Vscan Air within their clinical practice for a period of several months as part of an early user evaluation program.

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**See first impressions**

En savoir plus

18,176 vues

 J'aime

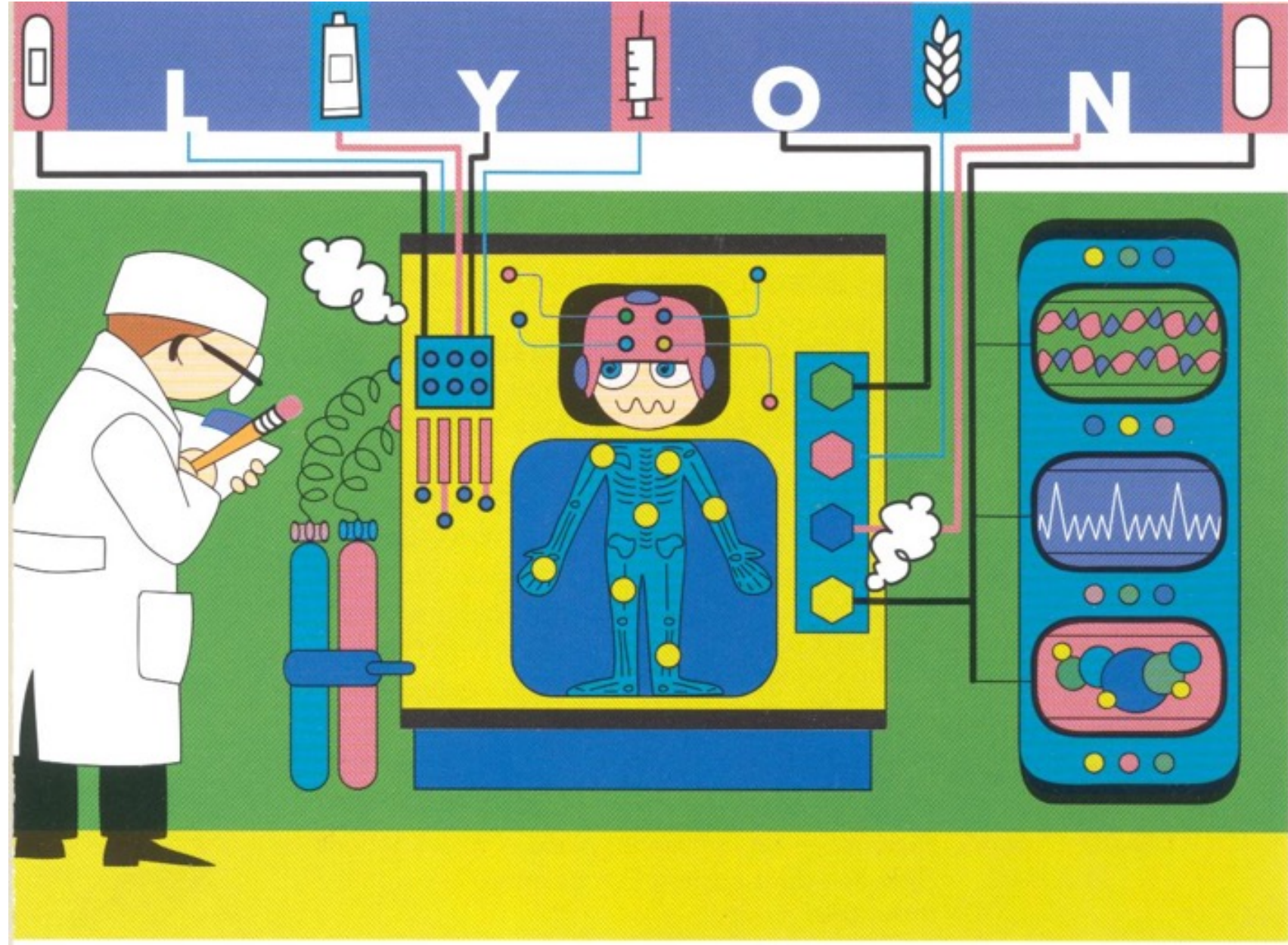
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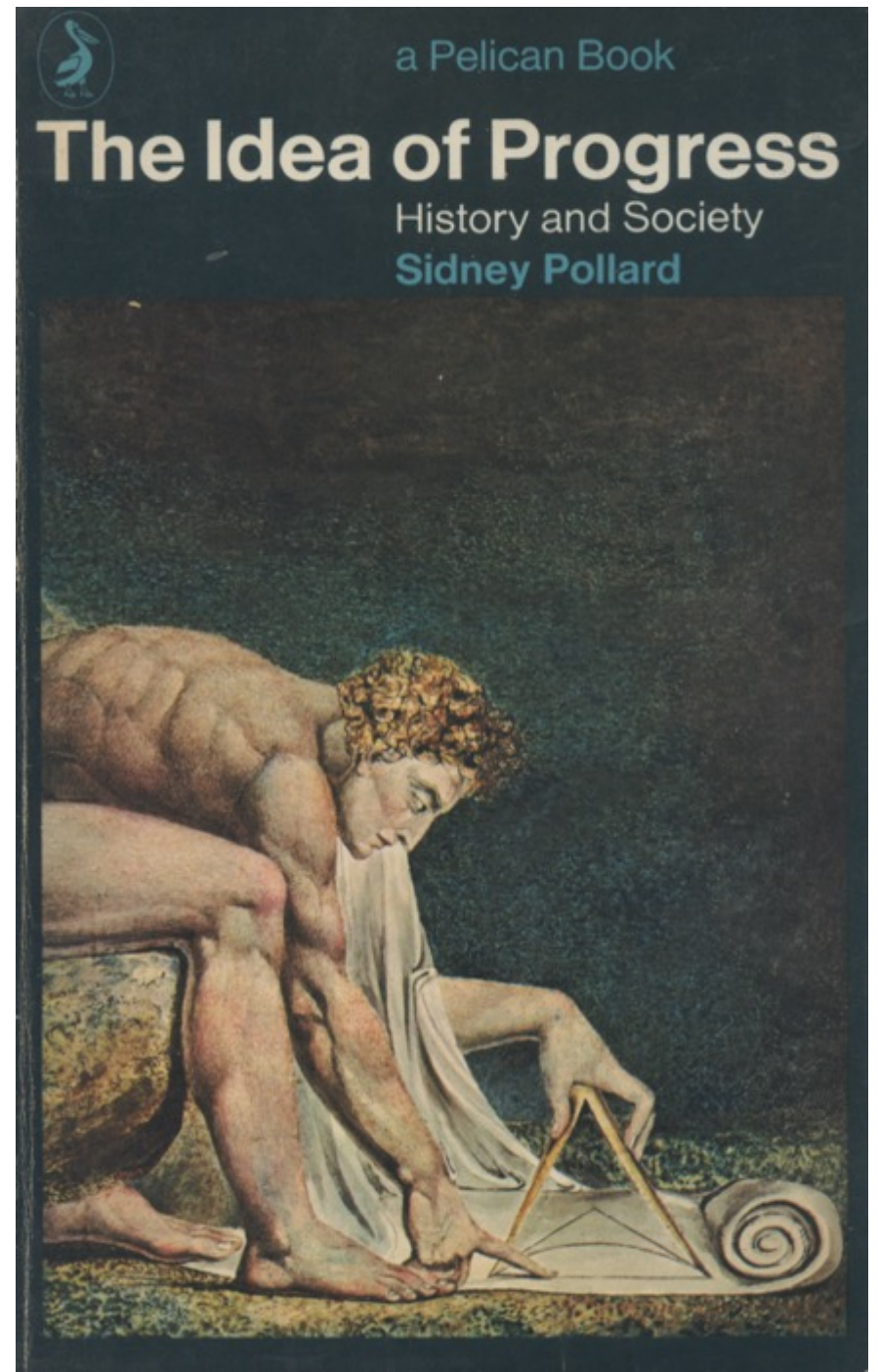
The Future.



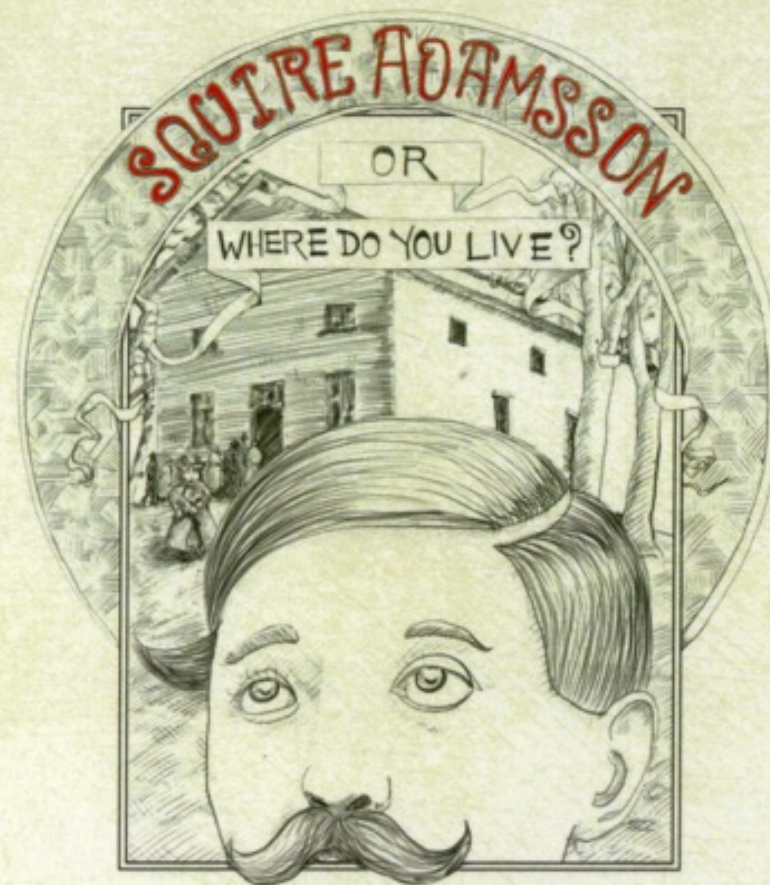
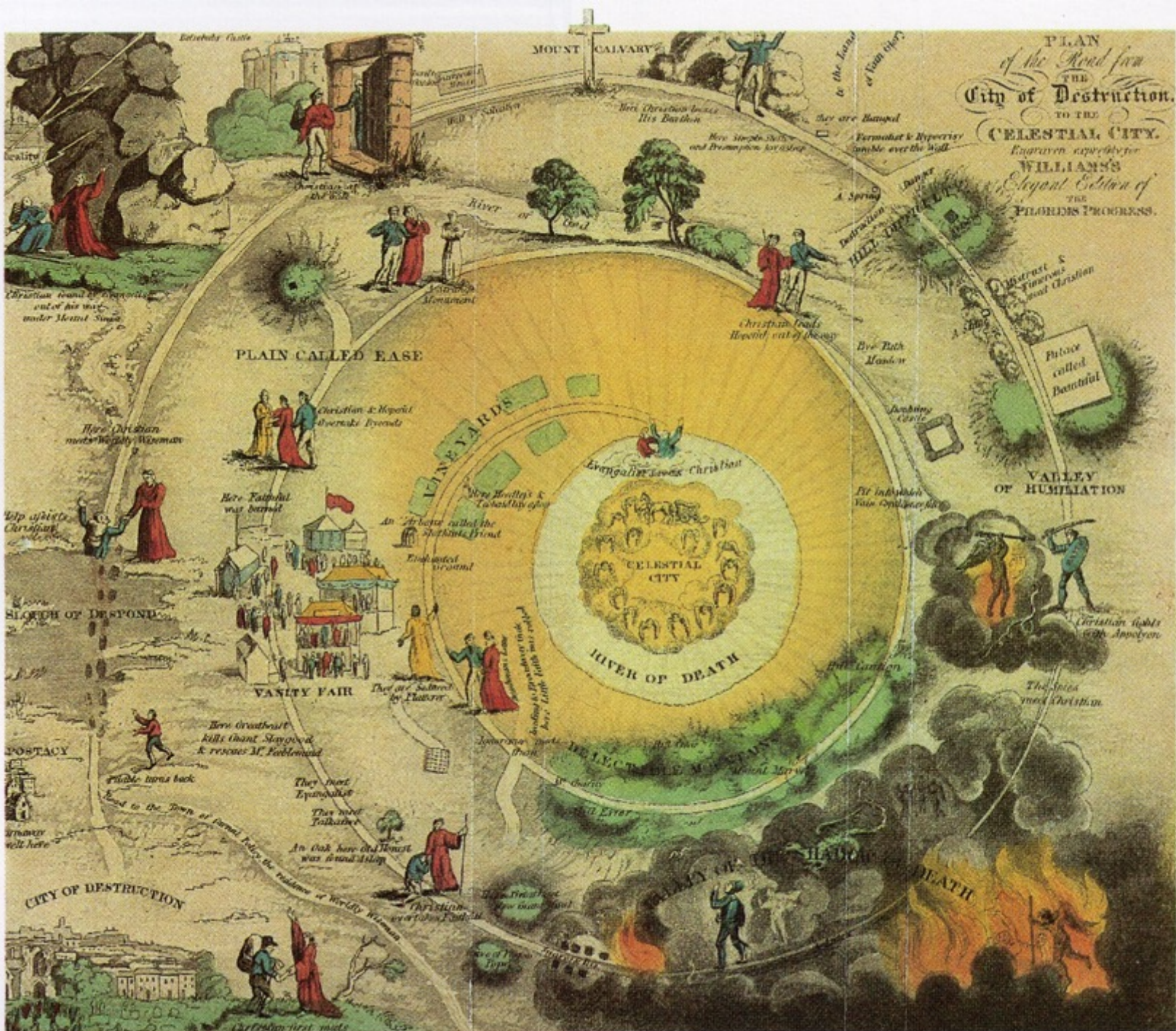
# Progress.

- “Whether progress is an illusion or a reality, this recent concept of mankind’s is certainly the most universal religion of the modern world”

(1968)







An Allegorical Tale from the Swedish Awakening

by Paul Peter Waldenström

Translation with Introduction and Notes

by Mark Safstrom



# BMJ

344:1-52 No 7859 Clinical research ISSN 0959-8138  
2 June 2012 | bmj.com

Maintenance drugs for opioid dependence  
How to deliver a consultant led service  
BMJ Group Awards: the winners  
Managing ventilator assisted pneumonia

**JOBS, COURSES, AND CAREERS**



OVERDIAGNOSIS  
Harming the healthy

# BMJ

347:1-38 No 7915 Clinical research ISSN 0959-8138  
6 July 2013 | bmj.com

Helping patients to die at home  
Chronic hepatitis B: NICE guidance  
Post-traumatic stress after intensive care  
Meet the new masters of public health

**JOBS, COURSES, AND CAREERS**



**Overdiagnosing pulmonary embolism**  
NEW SERIES ON UNNECESSARY CARE



Streather, J.  
2019.

## *Is Medicine Still Good for Us? A Primer for the 21st Century.*



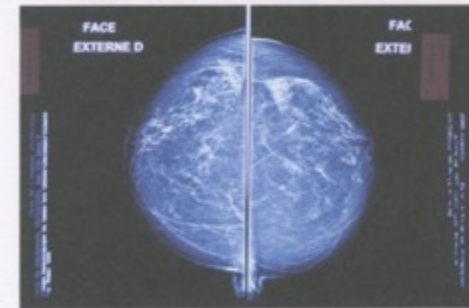
### Increased medical activity with no health gain is the definition of too much medicine.

A classic case of over-diagnosis and over-treatment is thyroid cancer. In a deft research article from 2013, US health care researcher Juan Brito and colleagues showed how the use of increasingly sophisticated diagnostic techniques led to a threefold increase in the detection of papillary thyroid cancer in the past 30 years, with absolutely no corresponding change in mortality.

**DNA sequencing** The identification of the precise order of the four chemical building blocks in a DNA molecule. Provides information about the genetic information carried in a particular strand or segment of DNA.

**A** Entrepreneur Jared Rosenthal set up a mobile DNA testing van in 2010. The explosion in direct-to-consumer diagnostics means we can find out more about our underlying health state. How much of this information can be translated into meaningful clinical findings is less certain.

**B** It is possible that the information disclosed by these home DNA testing kits would need careful medical interpretation and explanation. More information is not always better. Testing can lead to over-diagnosis and costly, unnecessary treatment.



**Randomized controlled trial (RCT)** A study in which a number of people are randomly assigned to two or more groups to test an intervention. One group has the intervention; the other, known as the comparison or control group, has an alternative intervention, a placebo or no intervention at all. RCTs are said to be the 'gold standard' for clinical trials of drugs or other medical intervention.

**Embolism** An obstruction in an artery, usually caused by a blood clot or a bubble. If an embolism obstructs the flow of blood to a major organ it can result in serious morbidity or death.

Commercial players such as drug companies and manufacturers of medical devices have a strong interest in expanding disease categories. In 2014, Australian health journalist Ray Moynihan and colleagues studied 16 publications from national and international guideline panels defining diagnostic criteria for 12 common conditions in the USA. Out of 16 published between 2000 and 2013, ten widened the definition, one restricted it and in five the impact was uncertain. An average of 75% of panel members had ties to industry and twelve of the panels were chaired by people with corporate links.

Population screening can also drive over-diagnosis and unnecessary treatment. Screening involves the *systematic testing of a defined and usually asymptomatic population* for a specific disorder. It can identify people at risk of serious diseases, such as cancer, who are not yet symptomatic. But there are downsides. Screening



# Current Issues.

- Increasing call for medical intervention.
- Relentless increase in demand. The Jevons' paradox.
- Scans to “rule out”.
- CT brain is now part of “confusion screen.”
- Multiple investigations, duplications.
- CT/MRI/US duplication.
- Radiologists increasing separated from patients (many prefer to work from home).
- Increasing criticism of medicine: Vernon Coleman, Ivan Illich, James Le Fanu.
- Staff Burn-Out.

# Medical Nemesis.

- The name of Nemesis also has a meaning of 'distribute, allot, apportion one's due' and 'just indignation, righteous anger'. Medical nemesis then becomes a direct result of medical hubris. Hubris can be seen as a condition of excessive pride or one of a dangerous overconfidence, and primarily one of acting against the natural order of the world. Medical pride carries with it the seeds of its own failure, and at least a failure to live up to the expectations that the public has been promised.
- Streather, whilst noting that modern medicine does the most remarkable things, holds that for all of its wonders that there is a gathering sense that medicine is heading in the wrong direction.

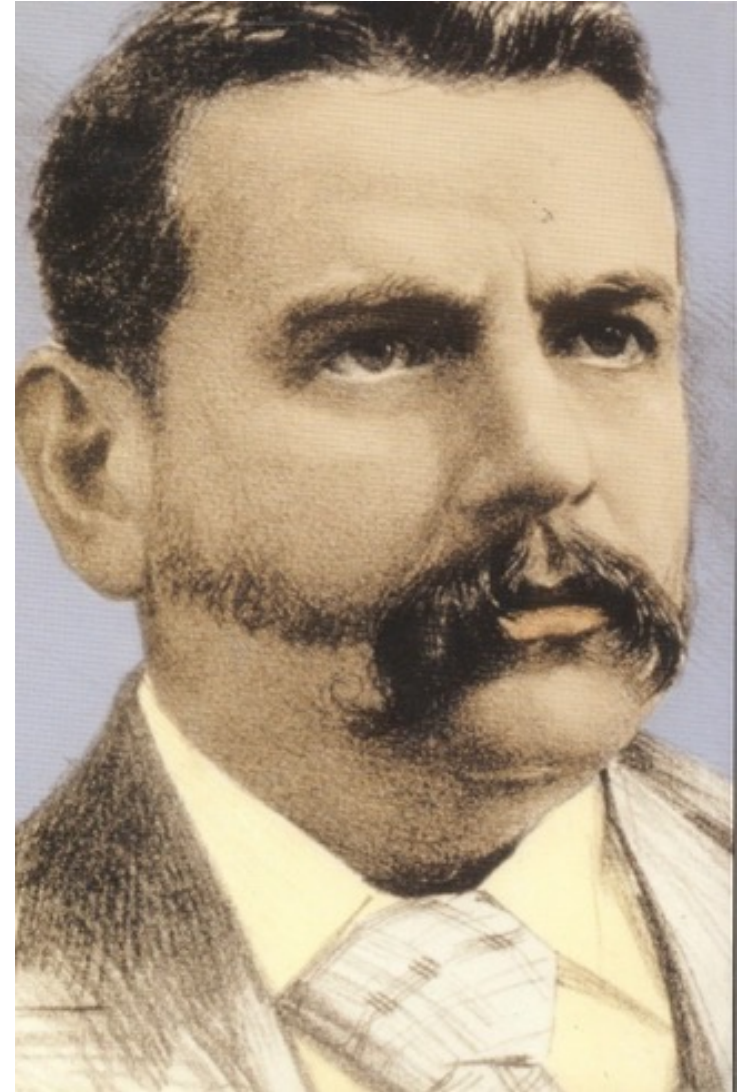
That the new building and apparatus were required is shown by the fact that already the staff has had to be increased, and even now it takes the whole accommodation to get through the large number of cases attending for all kinds of medical and surgical work.

Notwithstanding that the pavilion was made as large as the space at our disposal permitted, it is already evident that the demands upon it are far in excess of what can be accomplished. Two medical officers are daily engaged in the work, also an unqualified assistant and a staff of nurses. Over two thousand photographs, apart from the examination on the fluorescent screen, are being taken yearly. The most important addition to the work, however, has been in the electro-therapeutic department.

At the present moment the managers are engaged in a great scheme for rebuilding the whole hospital; and it is hoped, when the time comes, that still greater facilities will be placed at the disposal of the staff. Meantime, the present building is serving the purpose of showing the managers and staff, to some extent, what is required.

..... The words of John Macintyre in 1903.

- Glasgow Electrical Pavillion.
- President of the Röntgen Society (forerunner of the British Institute of Radiology) in 1901.





K

TELEPHONE: ROYSTON 9.  
KNESWORTH HALL,  
ROYSTON,  
HERTS.

1.12.22.

Dear W. Gilman Scott

I very much regret that it is impossible for us to carry out your scheme for having a fully equipped R Ray Dept at the London. But with £70000 owing to our Bankers, we are quite unable to embark on any capital expenditure.

It does seem utterly wrong that the

K

TELEPHONE: FRANKLIN 6134.  
29, CHESHAM PLACE,  
S.W.1.

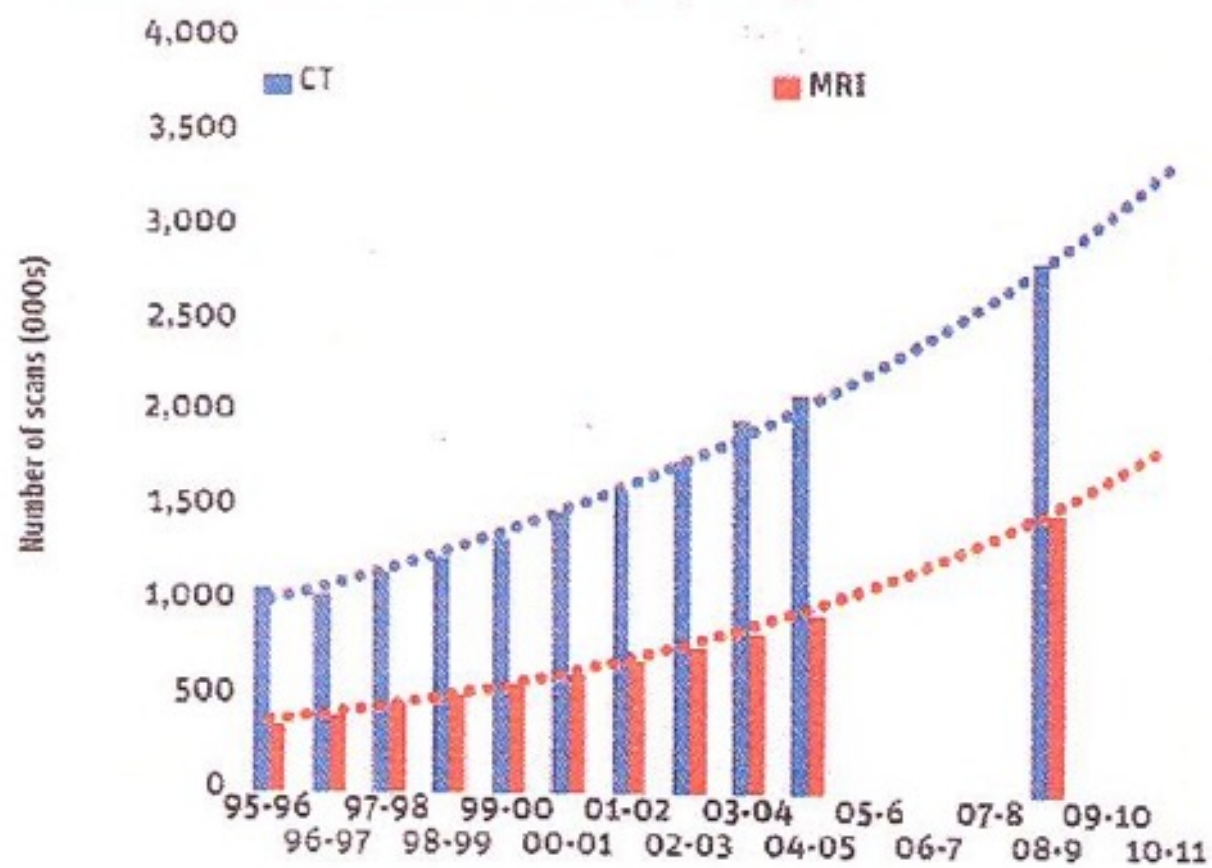
26.1.27.

Dear Gilman Scott

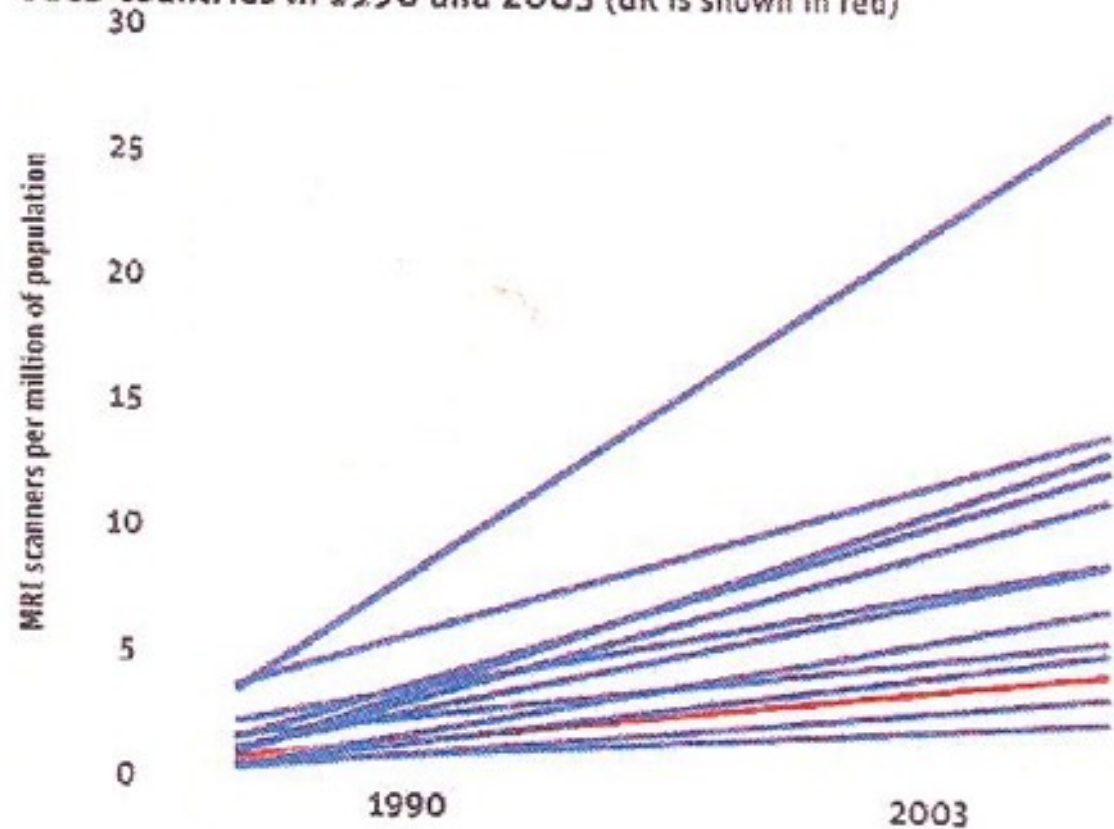
You have an unanswerable case & that matter is almost unbearable to me to have to say that I do not see how the London can possibly do the work it OUGHT to do. In 30 yrs I have never refused to do any work & we have advanced as no other Hospital has, but now the resiliency has gone out of me. We are nearly £100000 in debt

## DIAGNOSTIC TRENDS

### Current trends in MRI and CT imaging in England



The number of MRI scanners per million of population in selected OECD countries in 1990 and 2003 (UK is shown in red)





**April 2022**



## **Engineering-Based Medical Training: The Catalyst for a Health Care Revolution**

With the cost of health care accounting for 19% of GDP in the U.S., and an aging population with increasing need, solutions are required to revolutionize healthcare. Through strategic collaboration, medical and engineering professionals can develop solutions to reduce costs, improve quality and increase health care equity and accessibility.

SuperSonic<sup>®</sup> MACH<sup>™</sup> Ultrasound Series

**Turning Technical Experience Into Clinical Value**

**HOLOGIC<sup>®</sup>**

- It's easy to jump on a bandwagon.....





Can we provide a service that is high quality,  
for everyone, immediate (24/7) and cheap?



# Image and Reality: What is real?



Cinematic Rendering  
Co-Creation in an agile clinical environment



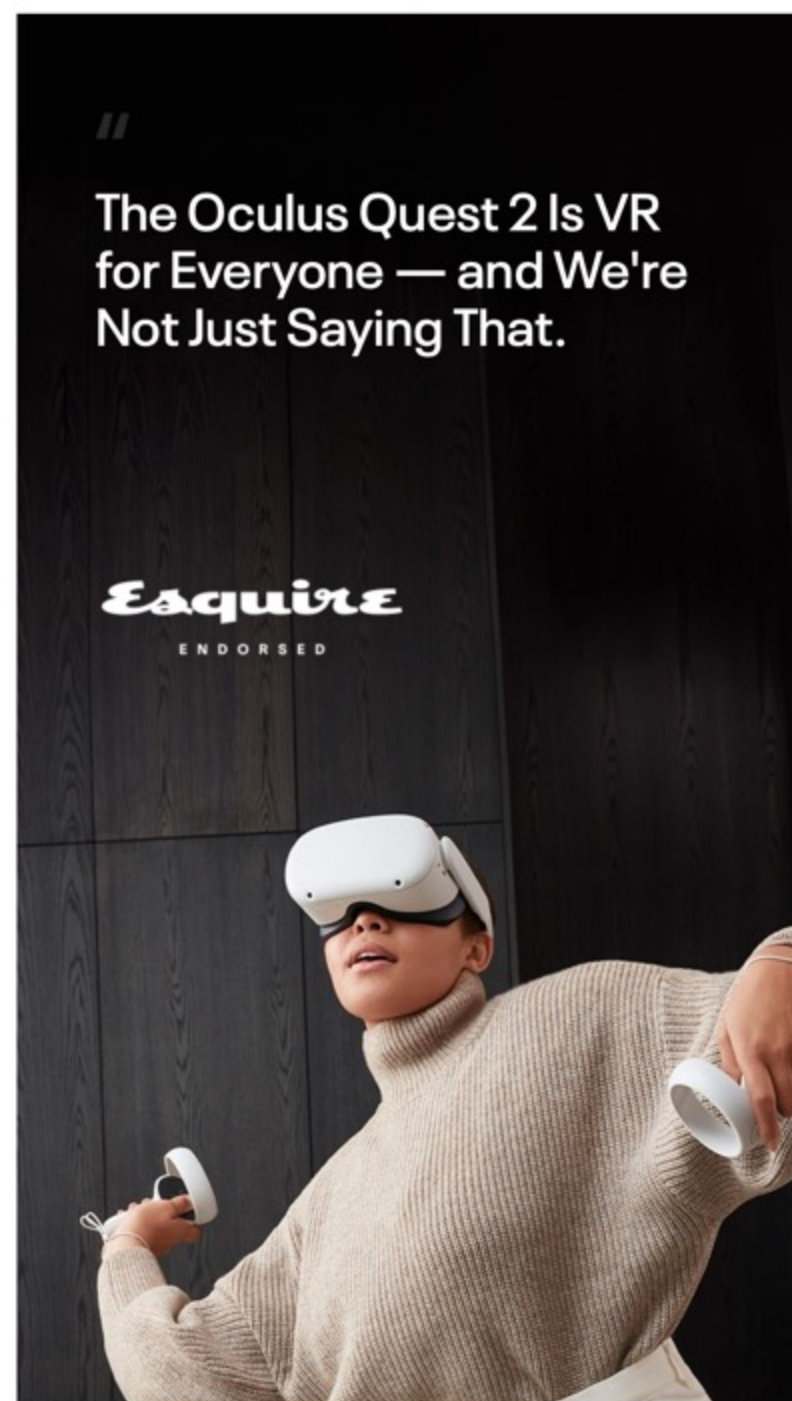
Target vision of collaboration  
Every **radiologist** will be  
able to create **meaningful**  
Cinematic Renderings  
in **less than 30 seconds**.



9  
Unrestricted © Siemens Healthineers, 2021









# The modern world:

- Environmental impact of radiology.
- Access to imaging.
- Artificial Intelligence.
- Virtual Reality.
- Modern emphasis on wellness / anxiety / depression / burn-out.
- Atomised individuals / home working / teleradiology.

# The question why?

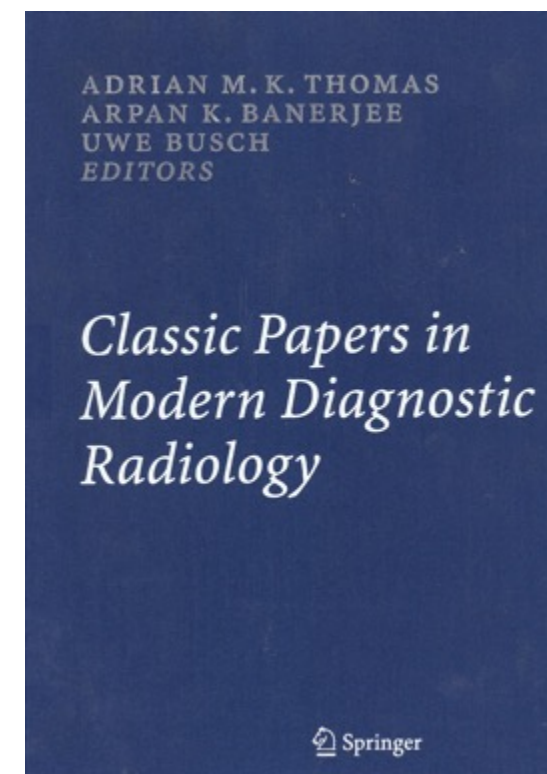
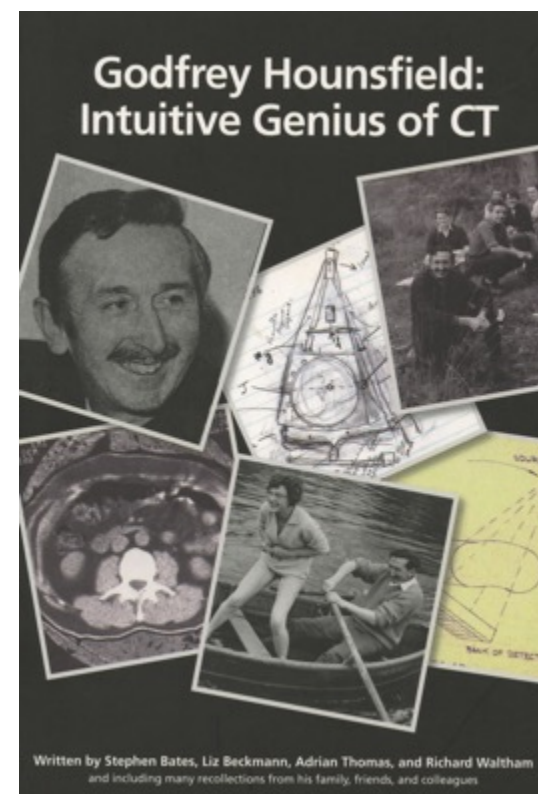
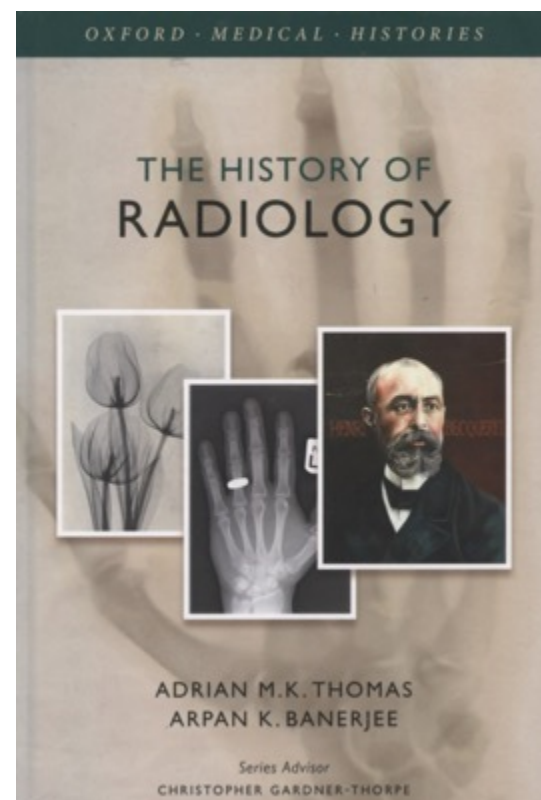
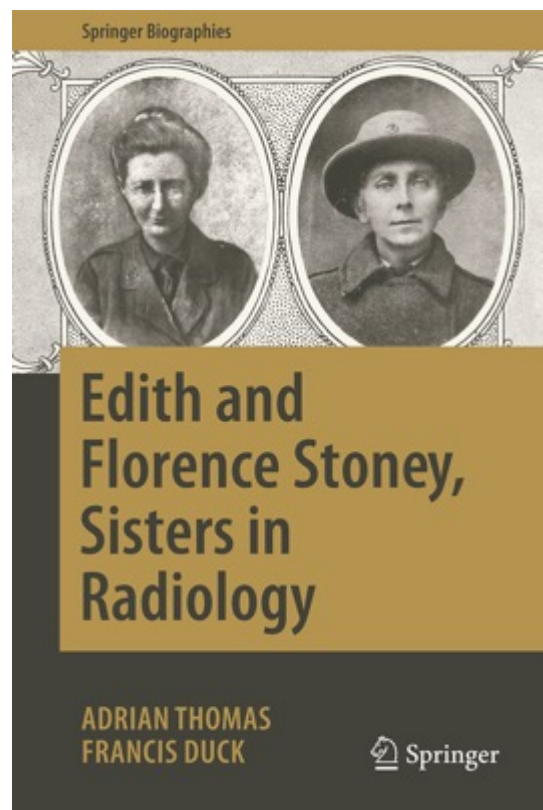
- The skull X-rays was performed by one of the “crisply permed, white-coated young women who were jauntily self assured” and who deferred to no one. Edwin’s grinning skull was recorded and he commented to the radiographer that the poet Webster “saw the skull beneath the skin.” These words were from *Whispers of Immortality* by T S Eliot (1885-1965), who wrote “Webster was much possessed by death, And saw the skull beneath the skin; And breastless creatures under ground, Leaned backward with a lipless grin.” The young woman thought it better to be a radiographer than a poet, since radiographers “save lives, don’t we?” Edwin wondered what was the purpose of saving lives, and what did she want people to live for? The radiographer replied that it was no concern of hers, and that anyway “That didn’t come into my course.”
- The Doctor is sick, Anthony Burgess (1960)

# Phronesis.

- *Phronesis* φρόνησις can be seen as the supreme intellectual virtue, and is practical wisdom, which is reasoned, and is capable of action with regard to the things that are good or bad for us.
- *Phronesis* is about living well, that is living the good life, and in harmony with our environment. It is a skilled deliberation, and has an ethical significance. With a combination of theoretical and practical wisdom radiology can have a confident future.







# Thank You.

- *Invisible Light, The Remarkable Story of Radiology.* (2022)  
Thomas, Adrian. Boca Raton: CRC Press (Taylor and Francis Group). A fully referenced account of the development of radiology.

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