Ultrasonic Glasgow

A celebration of The Glasgow School of Art's contribution to the history and development of medical obstetrics ultrasound.

THE GLASGOW SCHOOL OF ART

Ultrasonic Glasgow

A celebration of The Glasgow School of Art's contribution to the history and development of medical obstetrics ultrasound.

THE GLASGOW SCHOOL OF ART

THE GLASGOW SCHOOL OF ART

Ultrasonic Glasgow was funded by a Royal Society of Edinburgh Arts and Humanities Small Grant and from The Glasgow School of Art's Research Development Fund.

Suggested citation for this report: Ultrasonic Glasgow: a celebration of The Glasgow School of Art's contribution to the history and development of medical obstetrics ultrasound. The Glasgow School of Art, 2019.

ISBN: 978-1-9999073-1-0

Design by Christine Jones
Printed by Gomer Press

Contents

Ultrasonic Glasgow: a story out of time

Arguably the most important technological development to affect the lives of women in the last 60 or so years has been diagnostic obstetric ultrasound. For a few short years in the late 1950s and early 1960s, Glasgow led the world in its development. A unique collaboration between clinical obstetrics, engineering, electronics and industrial design expertise created the very first prototypes and production models of ultrasound scanners for use in routine obstetrics scanning - anywhere in the world - for use in Glasgow hospitals.

The seminal 1958 Lancet paper by Donald, MacVicar and Brown[1] first alerted the medical profession to the possibilities of the use of pulsed ultrasound in obstetrics. Initially adapted from an industrial application for checking pressure vessels, the development of ultrasound devices for obstetrics purposes faced many challenges, e.g., how to adapt the existing technology for its new purpose, how to match the apparatus to the perceptual faculties of the human user, how best to image the developing foetus in its mother's womb, and how to ensure the design of the equipment was acceptable, usable and commercially viable for manufacture.

This publication accompanies the exhibition *Ultrasonic Glasgow* held at The Glasgow School of Art (GSA) in October 2019. It acknowledges the early Glasgow pioneers of ultrasound and their innovations. While previous accounts have focussed on and celebrated the medical, technical engineering and imaging achievements of this innovation, less has been said about the role of creative design and the thought processes behind the design decisions. Drawing from archival material (including drawings), witness accounts and contemporary interviews, *Ultrasonic Glasgow* repositions the creative, imaginative, conceptual and technical skills of the designer, documenting and highlighting the pivotal role of design in the development process through the work

of the then graduating designer, Dugald Cameron, who later became GSA's Director between 1991 and 1999. Cameron's work, in his first paid commission, transformed a brilliant innovation but a clumsy piece of technical apparatus into an elegant, usable product design and, in so doing, helped revolutionize the clinical management of antenatal treatment and care in Glasgow and beyond: now, every woman in the developed world has at least one scan during her pregnancy. The fragile surviving drawings and photographs endure to form the centrepiece of this exhibition to allow us to scrutinise the very marks on paper that reveal the thoughts of Cameron's highly creative mind to make this apparatus acceptable to and usable by both patient and operator.

With a focus on drawing in the academy, Dr Frances Robertson, Reader in the Department of Design History and Theory, expands accounts of the designer-engineer role through visualisations and conceptions of the 'body' as an element in the design process through designer training and drawing practices, discussing the sensibilities fostered by the life drawing class and its influences on design. In a companion piece, the necessity of drawing as the fundamental skill in the designer's training is re-asserted by Cameron, still drawing daily.

In earlier accounts little, if anything, has been said about the experiences of expectant mothers encountering this then pioneering technology. Susan Roan and Emma Keogh, lecturers in Communication Design, have drawn out, from midwives and expectant mothers in the period 1963-1968, fascinating testimonies of first-hand experiences of early ultrasound procedures and encounters with Donald and his team, in Glasgow hospitals.

Resonating with Cameron's achievements 60-plus years on, new imaginings for emerging ultrasound technologies are envisioned by GSA's current cohort of young Product Design Engineering students, that innovative GSA and University of Glasgow joint programme initiated and co-founded by Cameron in 1987. In highlighting the innovative applications of augmented reality from GSA's School of Simulation and Visualisation, Koegl's digital modelling reveals, in manipulable 3D, the development of the foetus in the stages before birth.

We hope you enjoy this fascinating story which revisits and celebrates not only this vital strand of GSA's creative and innovative DNA extending from the 1950's into and beyond the present day but which also acknowledges the traditions of GSA's antecedent, The Foulis Academy, and GSA's attendant *raison d'être* - founded as a Government School of Design in 1845.

Professor Alastair S Macdonald
Senior Researcher School of Design
The Glasgow School of Art

Pioneering medical obstetrics ultrasound in Glasgow

Alastair S Macdonald

Our particular story has its origins in Glasgow, in the fortuitous conjunction between the industrial application of ultrasound for detecting flaws in metal vessels, the brilliant idea of an obstetrician during his military service on Benbecula pondering how the application of sonar technology - in particular ultrasound - could benefit his own field, the skills of an engineer in grappling with the technology to make it work, and the inspirational vision of a young graduate industrial designer trying to make better design, aesthetic and ergonomic sense of the early engineering apparatus.

Scientific and industrial origins

William Thomson, later Lord Kelvin (1824–1907), formulated the first and second laws of thermodynamics. While Professor of Natural Philosophy at Glasgow University (1846–1899), Kelvin took an interest in a business originally formed by his instrument maker, James White, renaming it Kelvin & James White Ltd, later renamed as Kelvin Hughes Ltd. It was this traditional but highly innovative business which supported the early ultrasound work in Glasgow during the critical formative years.

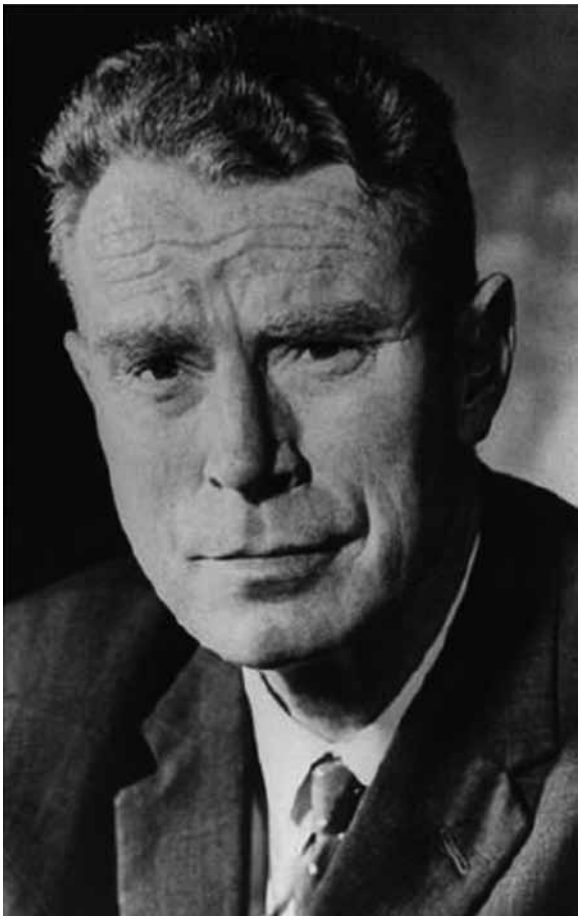
The obstetrician: Ian Donald

Ian Donald (1910-1987) trained in obstetrics and gynaecology in London. In 1954 he was appointed Regius Chair of Midwifery in Glasgow, a position he held until 1976. Donald had the brilliant idea of exploring the use of pulsed sonar in obstetrics while serving as a medical officer on Benbecula during the war when he became familiar with radar. Donald's very earliest ultrasound investigations were on biological materials at Babcock & Wilcox's Glasgow factory. His first experiments in the Western Infirmary, Glasgow, were with an instrument of the Kelvin Hughes Mark IV flaw detector type. In due course, Donald would launch the new science of diagnostic medical ultrasound.

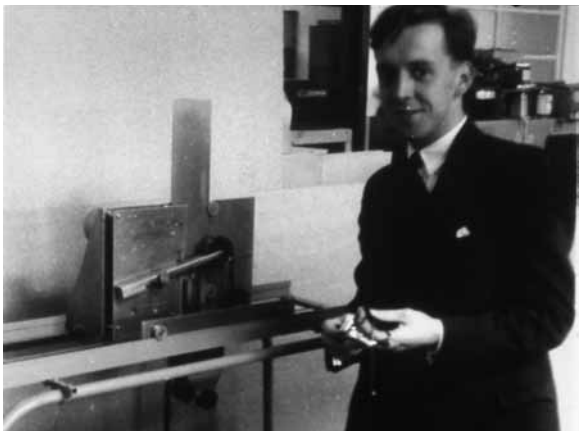
The engineer: Tom Brown

Tom Brown (b 1933) was an engineer working at Kelvin Hughes. Brown's detailed account [2], published in 1999, of the technical development of ultrasound scanning techniques in Scotland 1956-1979, covers the origins of industrial ultrasonic testing for flaws in pressure vessels, the early experiments by Donald in the application of these machines in obstetrics, and the technical challenges in translating the ultrasonic 'echo' into useful imaging 'information'.

In the 1950's ultrasound scanners were being used in industry. This photo from c 1954 shows a Kelvin Hughes Mark IV detector being used in the Babcock and Wilcox factory at Renfrew to check for flaws in its pressure steam boilers.
Photo reproduced by the kind permission of the British Medical Ultrasound Society.



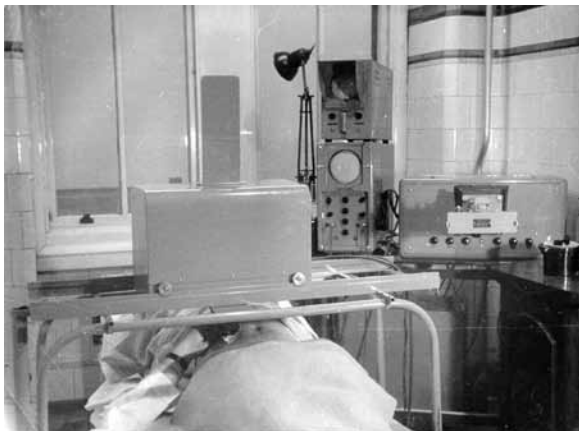
Ian Donald (1910-1987), Regius Chair of Midwifery at the University of Glasgow 1954 to 1976.
Photo reproduced by the kind permission of the British Medical Ultrasound Society.



Brown, standing in front of the newly built contact scanner c.1957.
Photo reproduced by the kind permission of the British Medical Ultrasound Society.

The first contact scanner

Brown: '*The prototype 'bed table' two-dimensional scanner went into use late in 1956* [referred to as a 'bed table' because a hospital bed table was used to support the scanning mechanism]. *It was the first ultrasound scanner which produced a 'compound' cross-sectional scan, combining translational and angular movements with the ultrasonic probe in direct contact with the patient's skin. All previous attempts had been based on much simpler scanning patterns or involved some sort of water-bath 'stand-off' between the probe and the surface of the patient.'* [3]



The first direct contact B scanner was patented and built by Brown in 1956 and was in clinical use later that year in Glasgow's Western Infirmary. Glasgow University's Hunterian Museum holds this scanner as part of its British Medical Ultrasound Society collection.
Photo reproduced by the kind permission of the British Medical Ultrasound Society.

The first automatic scanner

After building the first contact scanner, Brown went on to build the first automatic scanner [4] intended to standardize the compound scanning process and to remove, as far as possible, operator bias from the results. More than two thousand patients were scanned in this way. The process of technical development was very closely linked to the clinical agenda resulting in an early clinical payoff. Through the evidence generated by their results Donald, MacVicar (then registrar in the Department of Midwifery) and Brown alerted the medical profession to the possibilities of the use of ultrasound in their seminal Lancet paper of 1958 [5].

The automatic scanner being operated by Donald and MacVicar in the Glasgow Western Infirmary, c. 1960.
Photo reproduced by the kind permission of the British Medical Ultrasound Society.

Arguably the automatic scanner design was one which should have been further developed and adopted more widely as it addressed issues of operator repetitive strain injury (RSI) in the wrist. However, at that time there was a problematic issue of who should be entitled to operate this. A number of scanners produced in Glasgow and later in Edinburgh can be found in the Glasgow Museums Resource Centre although no models of the Sundén and Diasonograph machines designed by Cameron, discussed below, are known to exist.

Ultrasound scanning and imaging 1956-1972

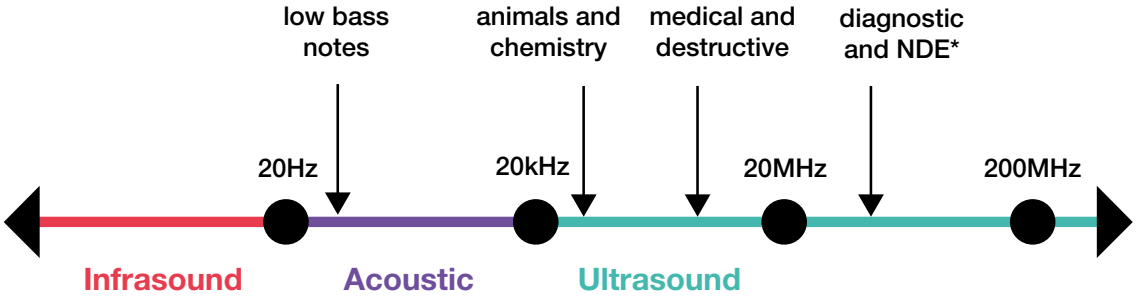
Alastair S Macdonald

When sound waves are generated which have frequencies higher than the upper audible limit of the human ear this is ultrasound (infrasound has frequencies below human's lower audible limit). It is no different from audible sound in its physical properties, except that humans are unable to hear it. Frequencies are expressed in hertz (HZ). This audible limit will vary within individuals: in young healthy adults, the hearing range is usually between a lower limit of 20 hertz and an upper limit of 20 kilohertz (kHz). In older adults, due to changes in hearing caused by ageing, this threshold may be lower. Some animals, such as bats and dolphins, use ultrasound for locating obstacles and prey.

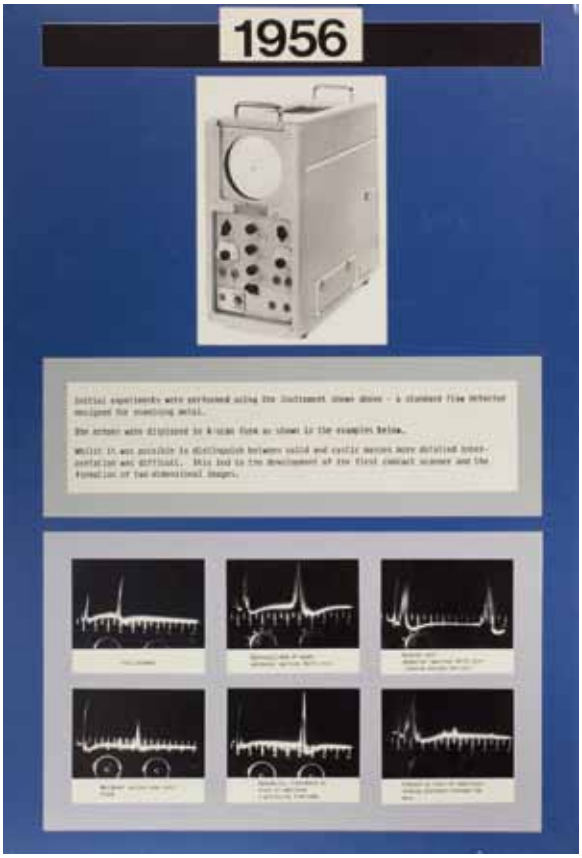
Although radar used electromagnetic waves rather than ultrasonic waves to determine obstacles and measure distances, it was a direct precursor of subsequent ultrasonic systems used in medicine in the later 1940s. In parallel, there had been the development, in the 1930's, of pulse-echo ultrasonic metal flaw detectors to detect the integrity of armour plating in tanks, metal hulls in ships, and pressure vessels such as boilers and it was this industrial technology that was first adapted and used in the Glasgow experiments for the application of ultrasound for medical obstetrics purposes.

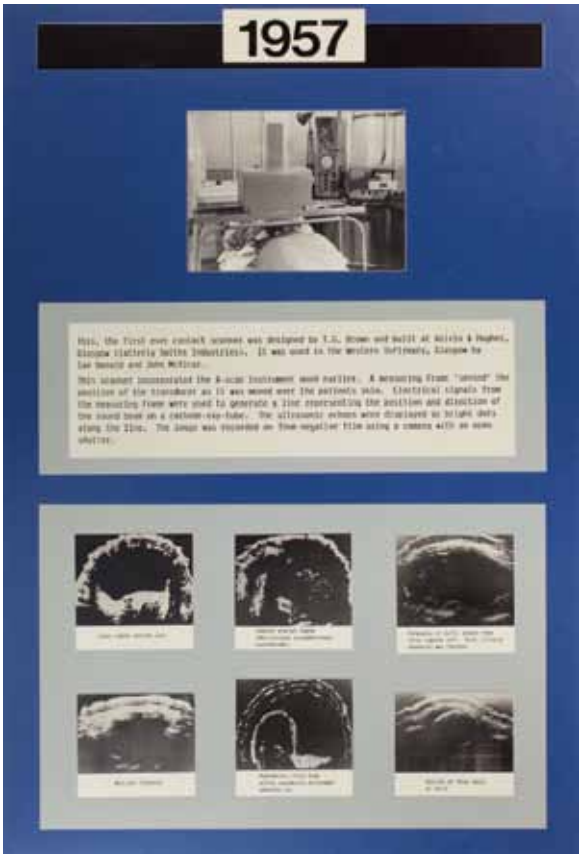
The following panels were assembled by John Fleming (b 1934), an electrical engineer, who joined Brown and Donald and who was involved in jointly developing a number of medical ultrasonic devices including the Diasonograph. The panels were produced to mark Donald's retirement in 1976 and summarise the development, in Glasgow, of the ultrasonic scanning equipment and the types of scan they were capable of producing for use in obstetrics diagnostics during his time as Regius Professor.

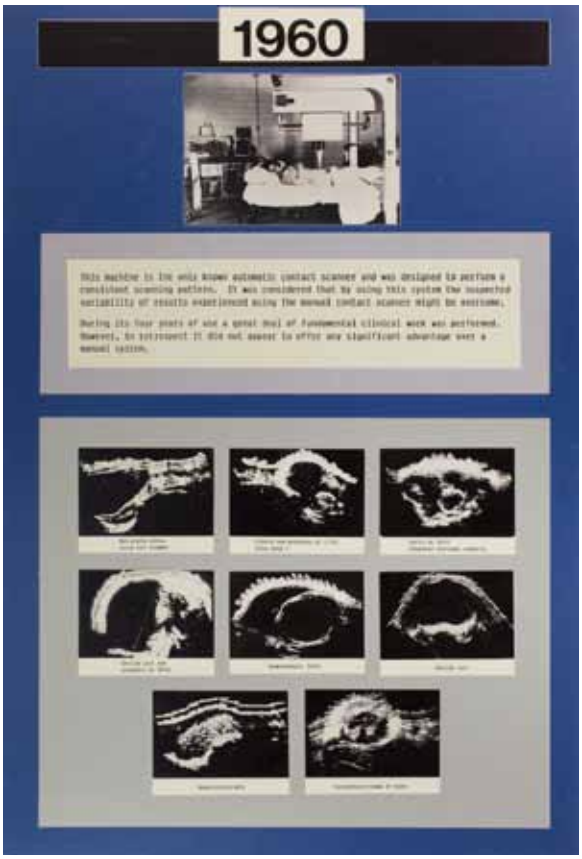
Partly as a result of having agreed to care for the original contact scanner built by Brown and used by Donald, Fleming was asked by the British Medical Ultrasound Society (BMUS) to establish an historical collection. Following an agreement between the University of Glasgow's Hunterian Museum and the BMUS, the Hunterian undertook to provide long-term care for the Collection and Fleming was appointed Honorary Assistant Keeper of Ultrasonic Equipment to the Museum.

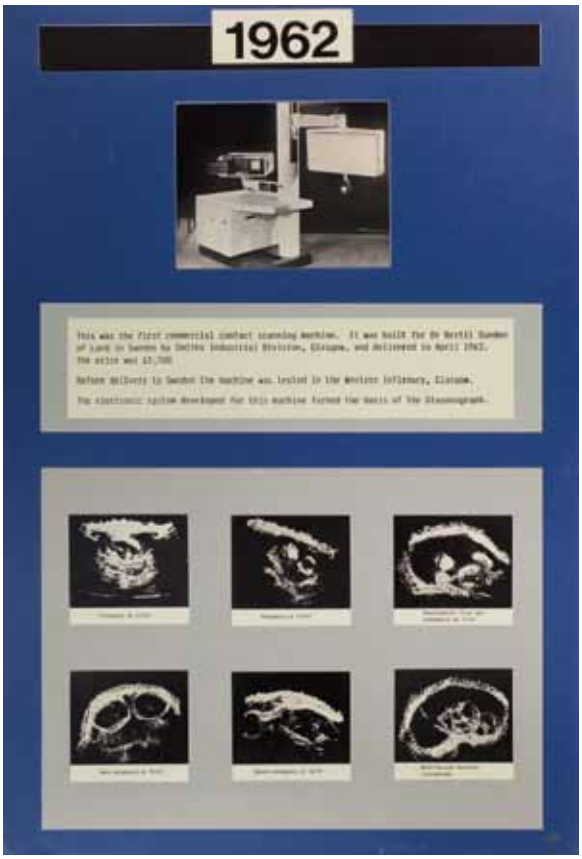


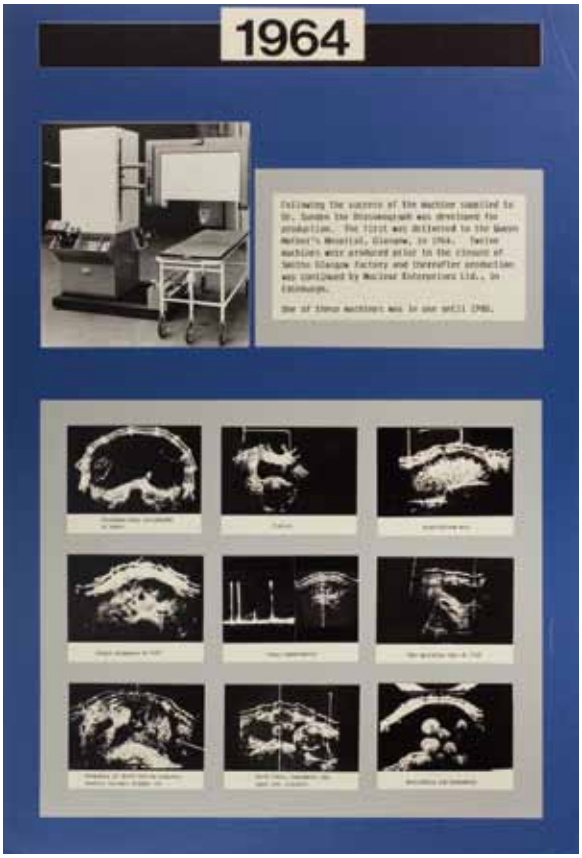
Infrasound, human-perceptible acoustics, and ultrasound frequencies, expressed in Hertz.
*Non Destructive Evaluation


1956

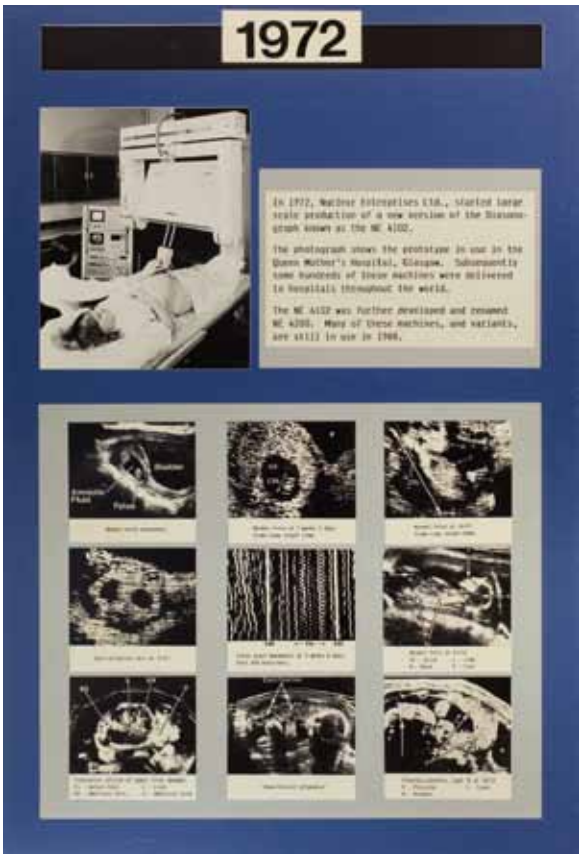

1957


1960


1962



Set of panels created by John Fleming for Ian Donald's retirement in 1976. These show the advances in technology and resulting image quality of the scans during Donald's tenure at the University of Glasgow.
Photos reproduced by the kind permission of the British Medical Ultrasound Society.



From ‘Gun Turret’ to Diasonograph: the Dugald Cameron Archive

Alastair S Macdonald

In this section, extracts from a number of first-hand witness accounts together with material from Dugald Cameron’s surviving design drawings and photos, held by GSA’s Archives and Collections[6], provide a fascinating account of the design development of the two key innovative ultrasonic scanners, the Sundén machine and the subsequent Diasonograph, designed by the then young Cameron (b 1939).

The Glasgow School of Art’s Archives and Collections

The Glasgow School of Art’s Archives and Collections comprise a wide range of material representing the School’s history from its establishment in 1845 onwards. The holdings include School records such as correspondence, minute books, reports, prospectuses and photographs; material from former staff and students such as preparatory work, notebooks and finished artworks; and objects collected by the institution for teaching purposes. The collections continue to grow as material is transferred from internal departments and donated by GSA alumni.

In 2016, Cameron formally donated material relating to his studies at GSA in Industrial Design. This archive provides examples of his work from the general course (years 1 and 2) and his diploma studies (years 3 and 4), when students specialised in a particular subject. The collection also includes his post-diploma work relating to the development of ultrasound machines. The Glasgow School of Art began to teach Industrial Design, the precursor of the Product Design and Product Design Engineering courses, in the late 1940s. Cameron’s folio provides an excellent insight into student projects from the late 1950s and early 1960s and has allowed researchers to track the design development of ultrasound machines in Glasgow.

Industrial Design at GSA

Cameron’s time as a student at GSA began in the junior non-diploma class on 7th January 1957, proceeded with entry to the Diploma course in Autumn 1957 for the two-year general course, and then the two-year specialism in industrial design, and followed by a one-year post-diploma year completed in June 1962.

At GSA, Cameron was working very much under the ethos of Jimmy Goodchild who had graduated from London’s Central School of Art and Design in 1946 when industrial design was still in its infancy. Goodchild had come to GSA to teach Industrial Design and was one of this country’s first tutors of this subject and whose inspirational approach changed many students’ lives.

The Industrial Design studio in the east end basement of the Mackintosh Building c. 1960/61. Left to right: Jimmy Goodchild (tutor), Donald MacLean (fellow student) and Dugald Cameron.
Photo reproduced by the kind permission of Dugald Cameron.

These photos show Cameron, in c 1961/2, using (left) the airbrush for the presentation drawings featured in this publication and (right) on the Harrison lathe which was, until 2017, still in use in the GSA workshop. These photos were taken when Industrial Design was in the east basement of the Mackintosh building with the window giving access to Dalhousie Street.
Photos reproduced by the kind permission of Dugald Cameron.

The 'Gun Turret'

In 1961 Cameron, then in his fourth year, first came into contact with Tom Brown and was invited to become involved in Kelvin Hughes' ultrasound work. After the contact and automatic scanners had been built by Kelvin Hughes, the Obstetrics and Gynaecology Department of the University Hospital in Lund in Sweden placed an order for a new machine.

In 1958, Dr Bertil Sundén, a young Resident in the Obstetrics and Gynaecology Department of the University Hospital in Lund, Sweden, convinced the authorities there to purchase an instrument like Donald's prototype bed-table scanner. The placing of a commercial order for such a machine (at £2500) was a breakthrough and an enormous morale boost for those involved at Kelvin Hughes. It led to the conceptualization of a 'production' hand-operated machine. This instrument is referred to … as either the 'Lund' or 'Sundén' machine. This was the very first direct-contact scanning machine to be sold commercially anywhere in the world. [7]

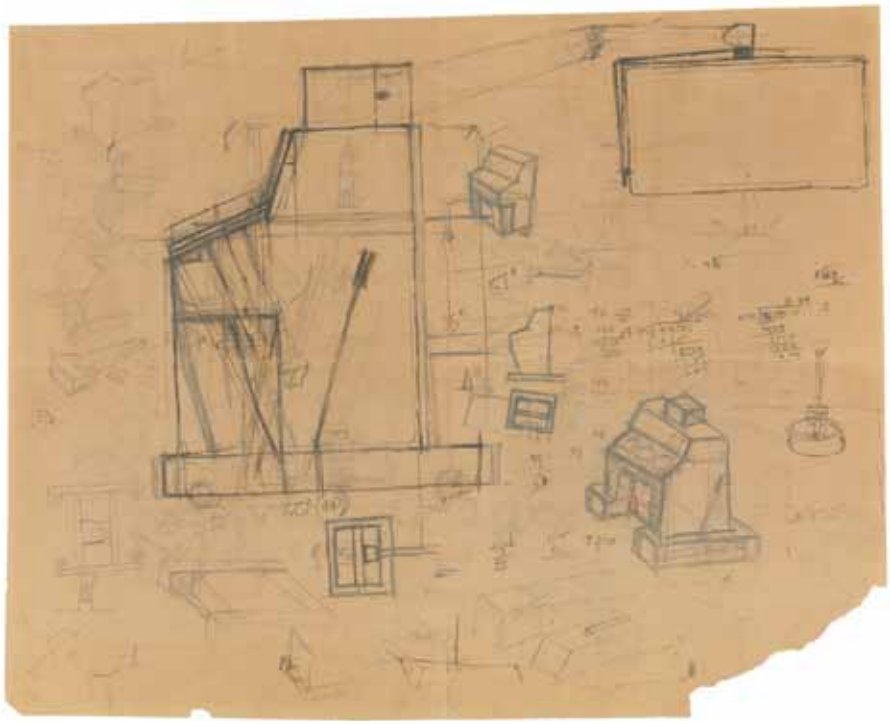
Prior attempts at configuring the designs of earlier machines by Brown and Donald had proved problematic.

Brown: *With the prototype B-scanner, the process of scanning was ergonomically horrific. The number of times I have seen John* [MacVicar] *here, crouching at the bedside, reaching up under this infernal machine, trying to carry out a regular compound scan over the patient, while getting olive oil running up his arms, and bumping his head on the underside of the frame. Generally, it was an ergonomic catastrophe.* [8]

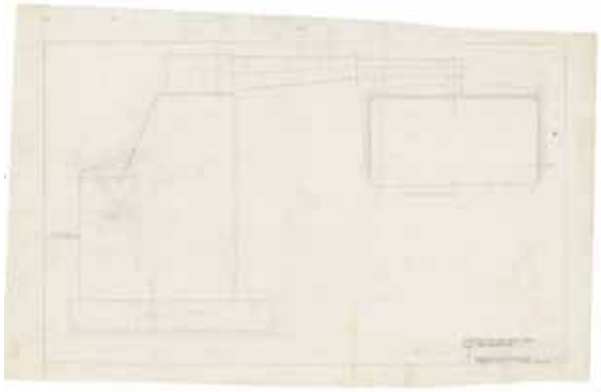
Cameron was asked to draw up Kelvin Hughes' proposal for the scanner. Once he had visualised this for them it was clear that their design was highly problematic.

Cameron: *I remember saying that I thought it looked like a gun turret and that it was thoroughly inappropriate for pregnant ladies. This was the design drawing: Tom* [Brown] *and I were arguing over how to make it so that it could be used by a seated or a standing doctor, but we determined, in fact, that you couldn't. It was useless for both, and therefore on that ergonomic basis this was not the right configuration for the machine.* [9]

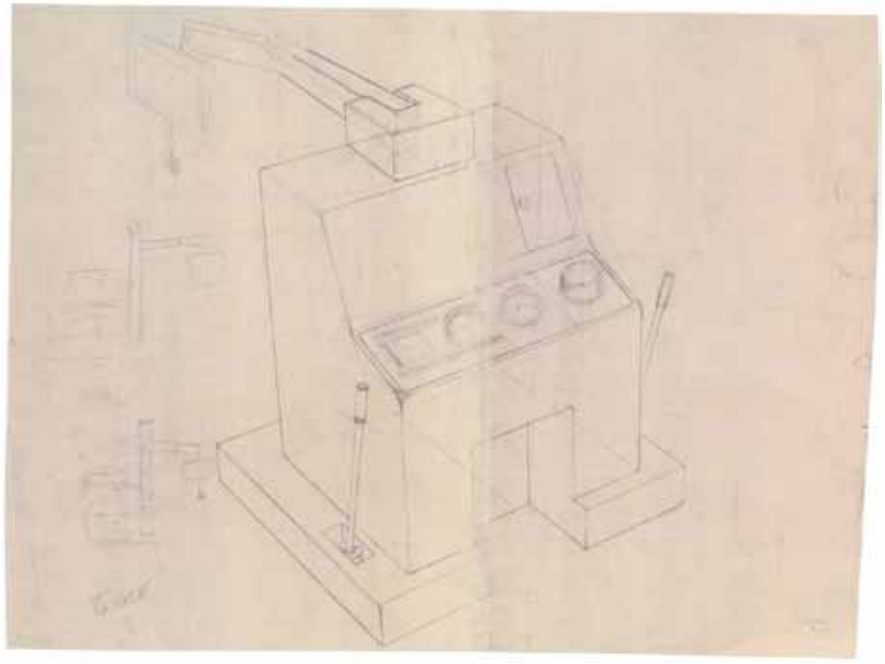
Cameron: *That was my attempt to give a three-dimensional view of what that machine was going to look like. On the left* [of the drawing] *are the two sketches where what we thought we ought to do was to separate out the patient, the doctor, and the machine and try and put these three things in a better ergonomic relationship with one another, so that the doctor would actually be on a level with the patient and seated. That was the first drawing which I had been commissioned to do, and for which I received an order for £21.* [10]



Original sketch by Dugald Cameron of Kelvin Hughes' concept for the Lund machine.
The Glasgow School of Art, DC 091/3/1/1



General Arrangement (GA) tracing (1961) by Dugald Cameron showing side elevation.
The Glasgow School of Art, DC 091/3/1/5



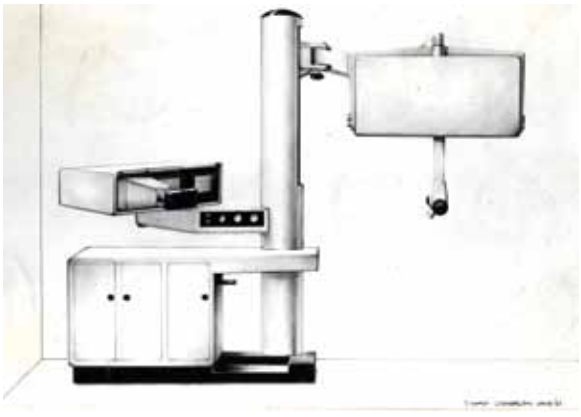
Dyeline print of Cameron's perspective for Kelvin Hughes' concept. Of interest are the small sketches on the left which show Cameron's thoughts on an improved design, later to be developed into the Sundén (or Lund) machine.
The Glasgow School of Art, DC 091/3/1/2

The Sundén machine

Kelvin Hughes' previous automatic scanner had a heavy and bulky (55 x 50 x 43 cm) box which hung over the patient in a way which some patients found potentially menacing. Cameron felt Kelvin Hughes' design could be improved by reconfiguring the elements, considering the ergonomics and operational aspects for the first time in these machines.

Presentation drawings (1962) of an initial concept for (left) a wall-mounted scanning unit and (right) the control panel for the same unit, by Dugald Cameron.
The Glasgow School of Art, DC 091/3/3/1 and DC 091/3/3/2

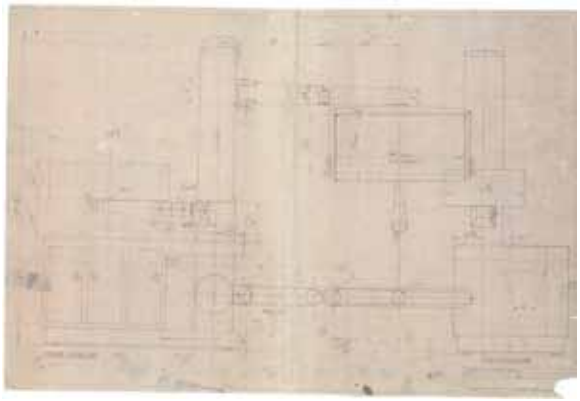
Cameron: *Thinking about those two airbrush sketches, I think that it was an idea I had to wall-mount the transducer arrangement on a wall and reduce the overall size.* [11]



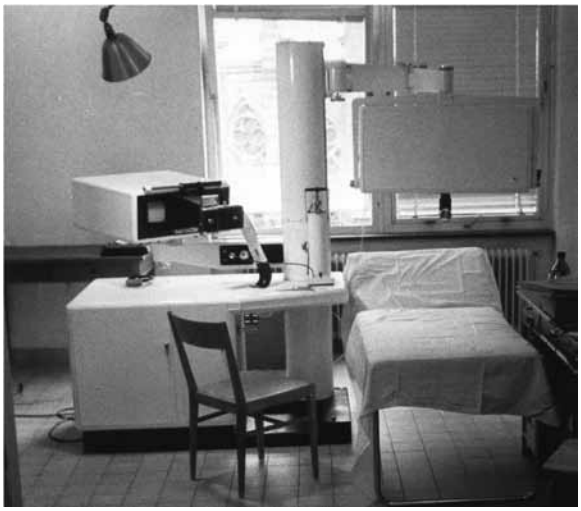
Presentation drawing for the Sundén machine (the original drawing is now lost).
Photo reproduced by the kind permission of Dugald Cameron.

Cameron: *I knew nothing whatever about the whole business, but had a desire to make the thing ergonomically better so that the approach to the patient was better and that the doctors would find it easier to use … I could draw something that wasn't there and therefore I could draw what they were proposing and if you did it in an attractive way, it was used as a sales aid.* [12]

Cameron: *[this had] … a central stem with things growing out of it, including a desk for the operator, doctor typically, and a place for them to keep all their bits and pieces. And be level with the patient, so not looking down on the patient.* [13]



General Arrangement (GA) of the prototype Sundén machine by Dugald Cameron.
The Glasgow School of Art, DC 091/3/2/2



The only known photograph of the original Sundén prototype (now lost) in use in Lund in 1962.
Photo reproduced by the kind permission of Juliet Ross.

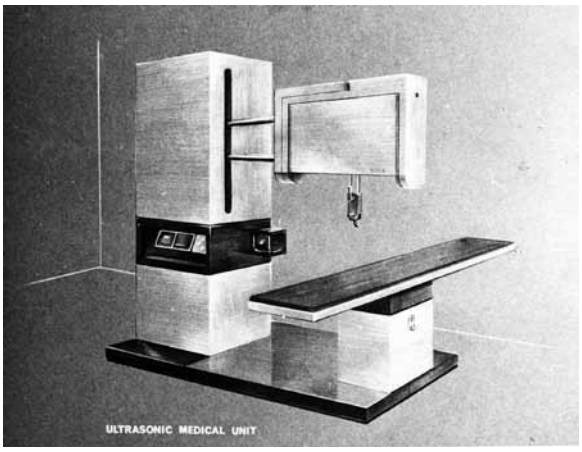
Cameron: *That showed the basic relationship of a desk for the doctor in which he could keep the various bits and pieces, including the olive oil when needed. The machine could be rotated in different*

ways so that it was very handy and the doctor could speak to the patient very easily. We had a lot of discussions about how to make it, but in fact it was made from a proprietary system called Widney Dorlec 52, which was then adapted a bit and I had a lot of arguments about that. In fact, in retrospect, it was the right way to do it, because you didn't want to waste time on a lot of other things in concentrating on seeing if the thing would work. [14]

A multiple view of the original Sundén prototype showing movement of the scanning head.
Photo reproduced by the kind permission of Dugald Cameron.

The Diasonograph

The hand-operated scanner in Lund, Sweden, delivered to Dr Bertil Sundén in Lund in 1962 [15], was designed and developed as a prototype but it was not pursued as a production design. However, the Sundén machine became the prototype for the Diasonograph, the world's first commercial production scanner.



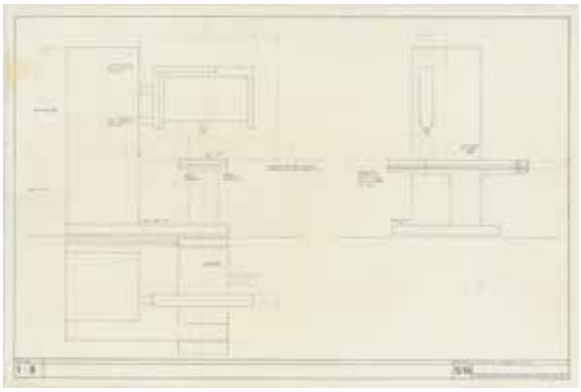
A presentation drawing of the Diasonograph (the original drawing is lost).
Photo reproduced by the kind permission of Dugald Cameron.

Cameron: *… the configuration was split into the mechanics, which are the white bits, and the electronics, which were the grey bits. It was envisaged that the electronics, in fact, would be used on their own, so quite apart from sorting out the design of the machine ergonomically, in terms of patient and doctor, it was also sorted out in terms of mechanics and electronics. I would maintain to this day that the original design of this machine would stand up now in terms of its basic configuration, which was carried through and extended, in terms of the design of the Diasonograph.* [16]

Brown: *… the mechanical complexity involved in the 'elbow-shoulder and wrist-joint' mechanism in the Sundén machine was difficult to make. So when we came to think about a production machine, following the Sundén machine, the measuring frame which is a white box with a probe sticking out at the bottom was the same, however the mechanism for supporting it was simplified, and became a couple of bars that ran backwards and forwards inside a*

strong cabinet. So this was an attempt to make a cheaper Sundén machine. As it happened, it turned out to be far more slab-sided and heavy looking than I wanted, or than Dugald wanted. [17]

Nicolson and Fleming: *The original, elegant plan of the Sundén machine was considerably modified … the new scanner had a simpler, more linear layout. It was also bigger, its slablike sides and massive boxed superstructure proclaiming the factory's industrial heritage. The Diasonograph was Clyde-built, at a time when that epithet still alluded to an admired tradition of heavy engineering. The scanner was certainly heavy, weighing approximately one ton. It rapidly acquired the nickname Dinosaurograph.* [18]

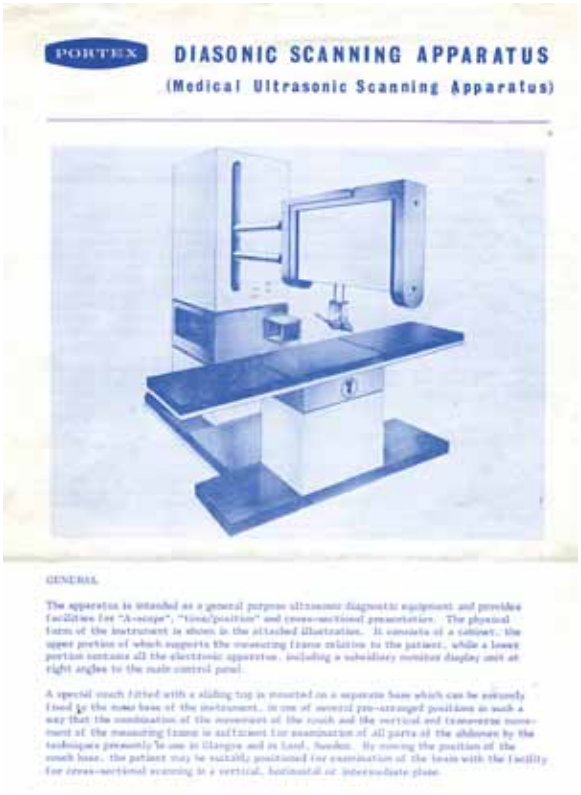


General Arrangement (GA) drawing of the Diasonograph.
The Glasgow School of Art, DC 091/3/3/3

Cameron: *That was the first layout – not drawn by me – of the Diasonograph. This was to be the production version of the Sundén machine, and you see we were intending to make a bed for the patient as an integral part of that machine. The mechanics and the electronics of the thing were all separate. Indeed it was a modular construction ….* [19]

Brown: *The object was to enable the machine to be used by one person. The original design which Dugald produced had an examination couch which was operated from the control panel side of the console. That design was not put into production. What was put into production was a machine that had to be used by*

A second presentation drawing of the Diasonograph (the original drawing is lost).
Photo reproduced by the kind permission of Dugald Cameron.



This drawing was used for the sales leaflet to secure orders before any models were built.
Photo reproduced by the kind permission of Dugald Cameron.

two people, to my disgust and regret, but I was out of the scene by that time. The original design envisaged a situation where two people might well want to use it – one scanning and the other operating the controls – but it had to be possible in my view, and in our view, to operate the machine singlehandedly. [20]

Cameron: *… It actually took quite a lot of thinking about, because part of Tom's* [Brown's] *requirement to make it 'doctor-proof' was to make it very easy to use. However, there were naturally a lot of knobs and switches associated with it, which determined three levels of control. For a really experienced experimenter like Donald, you had a whole series of controls in the panel that you brought forward below the control panel, so that was the tertiary bit. The secondary controls were the middle panel on the right of the camera and the primary controls were on the far right and you had a little blind to draw across, so in fact it could be operated by about three knobs …* [21]

Cameron: *… the wee electronics unit could be used on its own. And I devised with them a means of controlling it. There were three levels of control. The primary control. You only needed to expose a couple of buttons here. The secondary control, which somewhat of a skilled operator could use, and the tertiary control, you pulled forward the panel in the front and you had access to all the adjustments and controls. But you didn't need, all you needed to use the machine, once it was set up, were the controls here. And so there was a bit of ergonomics involved in that but it could be used on its own, and was indeed used on its own. And it was in white and pale grey, fashionable colours of the time.* [22]

The Diasonograph was the world's first ever production model of an obstetrics ultrasound machine. Twelve were built at Kelvin Hughes.

Cameron: *We were due to get a Design Award, one of the very first ones, for the Diasonograph. Unfortunately, when the evaluation team came up to see it the actual machine was covered in notes and*

Design by Dugald Cameron for the Diasonograph's console design with the three levels of control and Polaroid camera.
Photo reproduced by the kind permission of Dugald Cameron.

whatnot and I think Professor Donald was showing the full range of its activities and it frightened the life out of them. In fact, had it been a nurse or someone using it, we perhaps would have got the Design Award. There was a lot of early ergonomic thinking that went into the design, particularly for the design of the Sundén machine, which preceded the Diasonograph. [23]

Having begun his design consultancy work with Kelvin Hughes at Hillington in 1961 with the Sundén machine while in his Diploma year and continuing with the Diasonograph and some industrial flaw detectors, his involvement with Kelvin Hughes at Hillington ended when Smiths Industries closed Kelvin Hughes at Hillington in 1966. Unfortunately, no models of either the Sundén or Diasonograph machines designed by Cameron and made at Kelvin Hughes Ltd are now in existence. However, Glasgow's Hunterian Museum holds the first contact scanner as a part of its British Medical Ultrasound Society collection and an automatic scanner is held, along with a number of later Nuclear Enterprises' machines, in Glasgow Life's collection at its Museums Resource Centre at Nitshill.

Following the production of the Diasonograph, there was an issue over patents in 1965, and Kelvin Hughes folded shortly thereafter. The design and production of later versions of the Diasonograph and other obstetric

The first Diasonograph, built at Kelvin Hughes at Hillington, c 1964. Standing beside it, to add scale to the photo, is Arthur Johnson, one of the draughtsmen involved in the project.
Photo reproduced by the kind permission of Dugald Cameron.

ultrasound machines, without Cameron's further involvement, was continued by Nuclear Enterprises, based in Edinburgh, until the 1970's. However, Cameron's involvement with medical ultrasound was briefly revived when Brown started to develop the Multiplayer/3D scanner at Sonicaid in the 1970s.

Professor Dugald Cameron OBE DSc DA

Cameron (b 1939) began part-time teaching at GSA in December 1962, a few months after completing his Post-Dip. He was free-lancing at the same time and continued practice into the 1980s. He became full time senior lecturer and the Head of Product Design at The Glasgow School of Art in 1970, Head of Design in 1982 and established the seminal Product Design Engineering programme with the University of Glasgow in 1987. He became GSA's Director in 1991, retiring on 4 October 1999. He is also known for his many publications, his Squadron Prints, paintings of aircraft and other forms of transport and his enthusiasm and exceptional energy in helping rescue historical locomotives and aircraft for museums' collections in the UK. 60 years on from starting as a student at GSA, Cameron remains highly active as attested by his work celebrating the RAF's 100th anniversary in 2018. His paintings are in the collections of the. National Museum of Flight, the Royal Navy Submarine Museum and the Fleet Air Arm Museum. A Companion of the Royal Aeronautical Society, he was granted the Baird of Bute Society's aviation award in 2013. He was awarded the Lord Provost of Glasgow's Gold Medal for Education in 1998 and appointed an OBE in the 2000 New Year Honours for services to Art and Design. That same year he was made an honorary Doctor of Science by the University of Strathclyde, and he is also an Honorary Professor in the Department of Aerospace Engineering at the University of Glasgow.

Cameron with his paintings celebrating the Royal Air Force's 100th anniversary at an exhibition at the University of Glasgow Memorial Chapel in 2018.
Photo reproduced by the kind permission of The University of Glasgow.

Endnotes

1 Donald, MacVicar and Brown 1958.
2 Brown 1998.
3 Tansey Christie 1998: 5 (note 13).
4 An automatic scanner is held in Glasgow Life's collection at its Museums Resource Centre at Nitshill (Collection item number PP.2009.3.2 Kelvin Hughes automatic scanner 1959).
5 Donald, MacVicar and Brown 1958.
6 GSA Archives and Collections, reference DC 091.
7 Tansey and Christie 2000: 21 (note 48).
8 Brown 1998: 20.
9 Tansey and Christie 2000: 22.
10 Tansey and Christie 2000: 22.
11 Personal email from Cameron to Macdonald 8 January 2018.
12 Tansey and Christie 2000: 22.
13 The History of Modern Biomedicine Research Group 2014: 3.
14 Tansey and Christie 2000: 23.
15 Nicolson and Fleming 2013: 16
16 Tansey and Christie 2000: 27-28
17 Brown 1998: 23-24.
18 Nicholson and Fleming 2013: 165.
19 Tansey and Christie 2000: 22.
20 Brown 1998: 34.
21 Tansey and Christie 2000: 28.
22 The History of Modern Biomedicine Research Group 2014: 3.
23 Tansey and Christie 2000: 28.

Bibliography and Further Reading

Brown, T.G. (1999) Development of ultrasonic scanning techniques in Scotland 1956-1979, Personal recollections by T. G. Brown and Virtual Reality in Ultrasonic Imaging: a project out of time? Available from: http://www.ob-ultrasound.net/brown-on-ultrasound.html [Accessed 17 April 2017]

Cameron, D. (2018) A Home for Lost Dogs: Glasgow School of Art and Parallel Passions: A Memoir. Kestrel Press, Irvine.

Constance, A. *Motion S5M-14921 on the 60th anniversary of the ultrasound scanner*. 11th December 2018, The Scottish Parliament. Available from: https://www.scottishparliament.tv/meeting/members-business-60th-anniversary-of-the-ultrasound-scanner-invented-in-scotland-december-11-2018 [Accessed 30 May 2019]. Transcript Available from: https://www.theyworkforyou.com/sp/?id=2018-12-11.5.0 [Accessed 30 May 2019].

Donald, I., MacVicar, J. & Brown, T. G. (1958) Investigation of abdominal masses by pulsed ultrasound, *Lancet,* 1:1188-95

Fleming, J.E.E., Spencer, I.H. & Nicholson M. (1999) Medical Ultrasound - germination and growth. In (Eds) G.M. Baxter, P.L.P, Allan & P. Morley, *Clinical Diagnostic Ultrasound*. 2nd Ed. Blackwell Publishing

McNay, M. B. & Fleming, J.E.E. (1999) Forty Years of Obstetric Ultrasound 1957-1997: From A-scope to Three Dimensions. *Ultrasound in Med. & Biol*., 25 (1); 3-56

Nicolson, M. & Fleming, J.E.E. (2013) *Imaging and Imagining the Fetus: The Development of Obstetric Ultrasound*. Baltimore: Johns Hopkins University Press

Rice, C. (2018). *Ultrasonic Glasgow.* https://vimeo.com/303013461

Selbie, T. (2018) *The man who sketched the ultrasound machine*. News article, 1st December. BBC Scotland*.* Available from: https://www.bbc.co.uk/news/uk-scotland-46386317 [Accessed 30 May 2019]

Tansey, E. M. & Christie, D. A. (eds) (2000) *Looking at the Unborn: Historical aspects of obstetric ultrasound*. Wellcome Witnesses to Twentieth Century Medicine, vol. 5. London: Wellcome Trust. Available from: http://www.histmodbiomed.org/sites/default/files/44827.pdf [Accessed 29 May 2019]

Tansey, E.M. & Yabsley, A. (intvrs); Tansey, E.M. &, Yabsley, A. (eds) (2017) *Cameron, Dugald: transcript of a video interview (28-May-2014).* History of Modern Biomedicine Interviews (Digital Collection), item e2017168. London: Queen Mary University of London. Available from: https://qmro.qmul.ac.uk/xmlui/bitstream/handle/123456789/23255/e2017168.pdf?sequence=15 [Accessed 29 May 2019]

The Glasgow School of Art. (2018) *Making Waves: The GSA Public Lecture by Professor Dugald Cameron OBE*, The Royal College of Physicians and Surgeons Glasgow, 29th November. Available from: http://www.gsa.ac.uk/life/gsa-events/events/m/making-waves/ [Accessed 30 May 2019]

The History of Modern Biomedicine Research Group. (2014) *Interview with Dugald Cameron*. (Transcript) 28th May, Glasgow Art Club. Available from: http://www.histmodbiomed.org/sites/default/files/Interview%20with%20Dugald%20Cameron%20FINAL.pdf [Accessed 29 April 2019]. Associated videoclips are available from: http://www.histmodbiomed.org/taxonomy/term/dugald-cameron.html

Drawing and drawing for a purpose

Dugald Cameron OBE DSc DA

To draw something is to engage in a process of coming to an understanding of it and responding to it. By drawing, I mean really looking at something and then trying to express and explain it in visual terms. Photographs, though very useful for reference simply do not, maybe cannot, tell you the whole story.

It is a fundamental human ability of which all are capable in their own particular ways. It is the simple language of creativity and tangible expression of the imagination. It is also a joy and a most satisfying activity for its intrinsic merits. It needs to be engaged in from an early age.

It is the universal, creative language of making things used by artists and designers of all sorts. I certainly include in this engineers, designers and architects, blurred though the distinction between them is, for on a good day they can all be artists!

It can still be done entirely adequately using the simple lead pencil on paper without the necessity for even batteries, let alone sophisticated electronic devices, in space or even under water.

Simple 'mark making' might be a part of this as might an expressionist image but what I mean is what is called figurative drawing; that is, expressing the nature and form of an object on a flat two-dimensional surface by means of line, tone and maybe colour. Yes, of course, the life room is a true test, perhaps *the* true challenge and test of skill. Much nonsense has been spoken on this in recent times, sadly often by those who should know better but don't. Art Schools give up this central activity at their peril!

To draw something is to own it, for your drawing of it gives you a kind of ownership. This I felt when a boy and couldn't have, of course, the locomotives, aircraft and ships which fascinated me or even the models but drawing them assuaged my desire and satisfied my frustrations!

I have managed to draw something almost every day of my life and I intend to keep doing so. It can be tantalising, even frustrating, but eventually satisfying. It is an antidote to committees and a solace from bureaucracy.

'Mere craft skills' are often referred to by smart, though vacuous, metropolitan opinion, short of anything useful to say and desperately trying to maintain their fashionable credentials. It seems to have become fashionable to decry 'mere hand skills' in favour of 'the idea' or, rather, talking about it. Nonsense of course but

Dugald Cameron self-portrait (c. 1958).
Photo reproduced by the kind permission of Dugald Cameron.

so much easier and in tune with the times when ‘process’ not ‘product’ is regarded as important. In my view, process is only as good as the product it produces and is of no intrinsic value. It is a central feature of managerialism, that malign virus that holds that it is possible, even desirable, to run something without actual knowledge and experience of what is being managed. Look around for its many manifest failures like much of our railway system. It is the very stuff of that menace, the ‘consultant’!

There is an intrinsic value in good drawing, quite apart from its use in explaining, expressing, illuminating and illustrating the ideas of creators. It has a sustaining power so much greater than the fleeting amusements of, mistakenly called, conceptual one-liners.

I have pitched my mental tent in the no-man’s land between science and art or maybe between design and technology. The art of engineering is, to me, one of the great arts of mankind with drawing in many of its forms being fundamental to it.

Drawing is our common creative language and that by which we can convert ideas into visible reality for our own and others’ purposes, conveying to others the means of making what we have in mind and in so doing clarifying our own intentions.

We now value Victorian engineering drawings as works of art and they are. In their day, however, they were the means by which the goods were made and the elaborate colouring a way of clearly showing what went on; from practical necessity to work of art.

The drawings I was commissioned to do for Tom Brown at Kelvin Hughes in 1961 and thereafter gave the customer a view of what he was buying before the machines were completed. My drawings related to the development of the medical obstetric ultrasound machines were commissioned to let the client see what he had ordered long before it had been made, in the case of the Sundén machine and before the ‘Diasonograph’ had been made, as a sales aid.

‘Give us a pen’, engineers would say, ‘it works like this’. What I’ve always valued, what we still all need in creative work, is drawing and true sociability, as we still see in collaborative and open methods of the current PDE students in this exhibition.

Life class: from academic drawing to ergonomic body. Influences and empathy from the life room

Frances Robertson

To draw something is to engage with the process of coming to an understanding of it. By drawing, I mean really looking at something and then trying to explain it in visual terms. To do so from the life, that is in front of the actual object is really to get to know it. From first-hand experience, be it a building, aircraft or person—photographs—though very useful, simply do not, maybe cannot, tell you the whole story... To draw something is to own it, for your drawing of it gives you a kind of ownership. (from Dugald Cameron 'Drawing' statements)

Cameron's archive of drawings is an important resource that gives insight into his student training in the late 1950s, into his creative development through drawing and also, as seen in the opening chapters of this publication and exhibition, how these contributed to the form and configuration of the first commercial ultrasound obstetric scanning equipment.[1] But this archive also gives us some understanding of how designers have used drawings to see and feel.

There are two equally important parallel streams of drawings in the GSA Cameron archive: life drawing, and industrial designs—from first sketches through to fully realised presentation drawings. In the 1950s, GSA embraced the life room and its close study of human anatomy in an art school tradition that goes back to the art academies in the Renaissance. Students such as Cameron attended traditional academic drawing classes every morning in their first two years of study on the General Course. In Cameron's archive we see how tradition meshed with innovation as these established approaches to the study of the human form ran alongside new ergonomic techniques of design drawing, and the ways in which industrial designers were re-visualising the body.

In both kinds of drawing we see many unexpected similarities. Overall Cameron's drawings are concerned with the lucid exposition of how outer and inner forms and structures work together in three-dimensional objects, through the two-dimensional medium of marks on paper.

In a successful life drawing, as in Figure 1, the outer contours tell us how three-dimensional forms sit in space; they also give a clue about some of the hidden anatomical structures of the body. In Figure 1 we can see both the gently turning cylindrical form of the upper arm and the more boxlike upper torso. We can also clearly see indications of the interior structures of the body, for example the complex bony hinges around the elbow, knee and ankles, or that little dent at the top of the leg where the *gluteus medius* muscle is attached to the pelvic crest.[2]

Nude study was central to academic drawing, with a highly cultured emphasis on both classical learning and cutting edge scientific information.[3] That is why every self-respecting art school in Europe gave classes in artists' anatomy while also filling its corridors with casts of famous Greek statues such as the Apollo Belvedere, the Venus de Milo, or the 'Gladiator'.[4] Academic technique was largely demonstrated through the production of tonal and linear drawings on paper, and by the start of the twentieth century focused on three modes of drawing: the life room, perspectival and mathematical drawing, and architectural practice.[5] In Cameron's drawing classes still life sessions were designed to bring direct observation and accurate perspectival

Figure 1: Life drawing. Dugald Cameron, 1958.
The Glasgow School of Art, DC 091/1/2/32

rendering into alignment. Figure 2 shows a striking and elegant group made up from the simplest units of studio furniture: two high plinths, topped by a drawing stool, a ‘donkey’ with its easel prop at one end, and flanked by jars, barrels and a circular bath. When drawing human bodies and artefacts shaped for the body’s use, there is a focus on accurate observation and rendering of three-dimensional structure, dimension, and articulation conveyed by a two-dimensional linear or tonal drawing made by the most economical of means such as charcoal, pen or pencil. As Albert Boime has observed, the discipline and constant exercise of academic drawing training had the ‘virtue of instilling in the pupil an unshakeable confidence in his

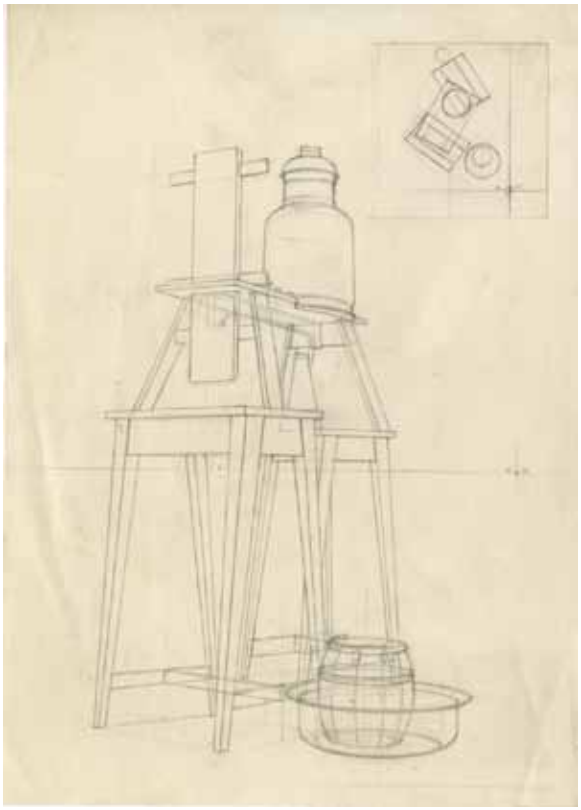


Figure 2: Still life perspective. Dugald Cameron, 1957.
The Glasgow School of Art, DC 091/1/2/44

Figure 3: Life drawing, from memory. Dugald Cameron, 1958.
The Glasgow School of Art, DC 091/1/2/31

drawing ability, and allowed him to tackle complicated subjects'.[6]

Intense life room work at GSA was intended to equip students to be art teachers in secondary schools as this was the main route into employment for the majority of art students at the time. Memory drawing was also developed as a transferable and useful skill in life class, as a way of capturing forms and structures from first hand observation. In Figure 3 we see how the linear envelope around the nude form holds together an almost abstract composition of elements balanced in a vertical/ horizontal space.[7]

GSA, founded as one of the nineteenth century state-funded Government Schools of Design, also had a duty to its manufacturing hinterland. Mechanical and technical drawing and design had always featured, but was strengthened by a new emphasis after the Second World War on industrial design, Cameron's specialism in his final years as a student. Technical and mechanical drawing carries a ghost presence of the human form, even though figures almost never appear. During industrialisation the tool and the machine became a substitute for the human body in manufacturing.[8] Mechanical engineers and industrial factory masters carried out minute analyses of skilled worker actions, and then translated these into banks of machines tended by human minders. In fact every tool or artefact, even the simplest, recalls the human frame and its capabilities in some way—from the 'donkey' that art students sit at to draw, through to the handle of a pair of scissors, a pencil, or a screwdriver (Figure 4).

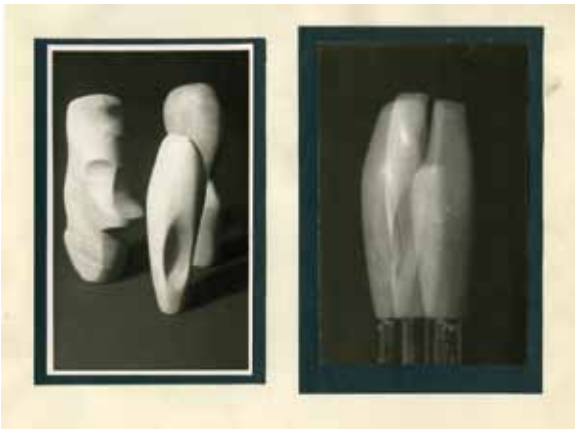


Figure 4: Design for a screwdriver handle. Dugald Cameron, 1959.
The Glasgow School of Art, DC 091/2/1/27 page 3

Figure 4 shows a screwdriver handle designed after an investigation of 'grip' in the hand of the worker, achieved by squeezing a modelling medium and taking a cast of the inner hand space during tool work. This is another way of recording and feeling into a hidden interior space that is crucial for the design, and reflects Cameron's ergonomic, human-centred aims in design.

Ergonomics, or 'human factors' is a twentieth century technique for attempting to reconcile humans and machines, coming to prominence in the same period that Cameron was a student in the period after the Second World War. Human bodies started to come back in to technical drawings and specifications in a more detailed way. Initially this was intended to address worker stress and productivity in factories.[9] During the Second World War, with the rapid development of military equipment and machinery, the complexity and operating speeds of, e.g., weapons or aircraft subjected the human operators to stress they could not deal with.[10] The emphasis was firmly on the working environment imagined as a 'closed loop servo-system' aiming for a man-machine system with 'maximum efficiency', describing the human body as a kind of input-output machine of physical exertion.[11]

Cameron was influenced in ergonomic approaches and design style by American industrial designers.[12] In ergonomic manuals and guides the body is treated in a kinematic manner, an idea taken from mechanical engineering as an understanding of the possible movements of a body or system of bodies in space—in ergonomics there are also added physiological and stress factors constraining the body (see Figure 5).

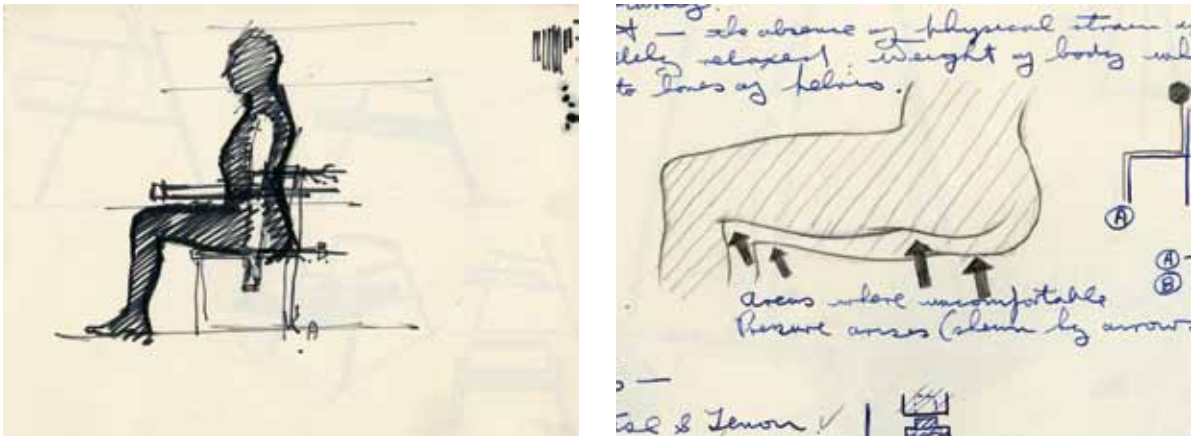


Figure 5: Design notes on ergonomic factors in seating from student sketchbooks. Dugald Cameron, 1959.
The Glasgow School of Art, DC 091/2/1/26 page 7 (left) and DC 091/2/1/26 page 21 (right)

Cameron has two styles of drawing, one very exact and detailed—expressed as either technical and specification drawings, but also as finished 'presentation' drawings—though these are usually rendered as paintings, in hyperreal of photoreal style. His favoured medium for these was either gouache or, at a more minute level, Humbrol enamels which are the kind of paints used in model making.[13] The other style Cameron used for design drawings is more gesturally energetic, partly because he is himself is an energetic and active personality, but also to show a process of thinking, with a sense of trying out speculative forms to get the right configuration, and give a sense also of the moveable quality of the object.[14]

Cameron's drawings and design practice has developed from close observational drawing, and from the developed skill of visualising both the outside and inside of three-dimensional forms simultaneously. This was the purpose of academic drawing training that was becoming discredited and obsolete in art schools during Cameron's career. Although these intensive drawing practices were often viewed as cold or hard by their detractors — 'academic' in the derogatory sense, the immersive practice of really getting inside the subject developed empathy and structural understanding. However, this mode of visual learning has been supplanted and often dislodged by new technologies of vision and new approaches to art and design have gained more traction now.

The ultrasonic project is an example of the complex issues of what is being seen, what is allowed to be seen, and who the viewers might be. Ultrasonic imaging has had a momentous social impact because it can visualise the foetus.[15] Before this technique was developed, doctors relied on patient spoken testimony, on dissection of cadavers, and on a painstaking personal knowledge gained though long patient contact, as doctors had to learn to 'read' the body of a pregnant women and the status of the foetus through palpation—seeing through feel, through the hand.[16] Second wave feminists regarded the ultrasound scanner with suspicion, accusing the technology as an impersonal mechanical intrusion into the intimate realm of childbearing.[17] In part this was because it brought forward the doctor and the foetus as agents (ultrasound and similar visualisation techniques helped to drive publicity for the so-called 'pro-life' anti-abortion movement), and pushed away pregnant women and midwives from control of what was happening in that inner realm of the womb.

By contrast to observational and anatomical methods, the ultrasound image is built up from echoes coming from various hidden masses in the body, and is an adaptation of techniques used in military applications for underwater submarine detection developed during the First World War (and later during the Second War as radar). 'Sonar' as Ian Donald preferred to call ultrasound (acronym for 'sound

navigation and ranging' –the technique and use—conjured links in the minds of commentators such as Donald between the 'fetus in utero and a submarine at sea'. [18] This is a powerful image, and it conjures powerful emotions in the way it joins together techno-enthusiasm for a wartime military invention with the decision to observe the inner workings of the pregnant womb. As we see in the sweep of this exhibition, these powerful currents of representation and control still call up a disturbing range of responses to these hidden realms, and they demand the fullest range of thought. Turn back to the questing line, reflective space, and careful consideration of what to include in Cameron's Self-Portrait in his section of this publication. Cameron's drawings from life show that close sustained engagement with the figure, and nuanced sensibility about mark making, judgement and observation are still of value as we face the human in design.

Endnotes

1 GSA Archives Records relating to Dugald Cameron in the period 1957-2003 are available at: GB 1694 DC 091. In addition to this substantial archive of visual material, Cameron retains a further and even more extensive personal private archive of work, some of which he has generously shared during research for the exhibition and publication.

2 Cameron's teacher in both artists' anatomy (with classes once a week) and life drawing (every morning) was W. Drummond Bone. Cameron writes: 'Drawing was all from piles of boxes for perspective, the antique and, primarily from life… There is hardly a day goes by, nearly fifty years on, that I do not bless Willie Bone and his disciplined teaching'. Current students and this author instead will normally find their own way around the body with printed guides such as *Master Class in Figure Drawing* and landmark directions cited here, Hale 1991: 36-7.

3 Petherbridge 2010: 221-222

4 Goldstein 1996: 54; Boime 1971: 24-5; Elkins 2001: 16-27, and see Glasgow School of Art 2018 blog entry that discusses the now-defunct cast collection (the second fire at GSA outdid the mild scorching from the first fire with complete destruction of the collection) at 'Visualising Laocoon' https://gsaarchives.net/2019/01/visualising-laocoon/

5 Goldstein 1996: 54; Boime 1971: 24-5; Elkins 2001: 16-27. For further examination of life drawing teaching methods in post-War period see Coldstream, William (1908-1987) Principal of the Slade School of Art from 1949, promoting a distinctive style of life drawing based on direct observational measuring by eye at arms length with thumb and pencil or brush, laying down a web of reference points, based on interlocking units of length contained within the composition (for example, from a landmark point such as the end of the clavicle to some other visual marker) Petherbridge 2010: 231-232.

6 Boime, Albert (1971) *The academy and French painting in the nineteenth century* New Haven and London: Yale University Press

7 The control and cool atmosphere of these life room drawings hides an important emotional dimension of student training. As Cameron recalls it, entering the life classes as was a testing moment, not only a new and challenging activity for art students, but the conventionally shocking act of observing and drawing from the nude would be taking place in a mixed sex group—boys and girls thrown suddenly into an unfamiliar group of peer and potential partners.

8 Many alarmed commentators such as Thomas Carlyle warned of 'iron fingers' that would supplant the skilled hands of human workers, see Freedgood 2003.

9 Forerunners to 'ergonomics' were scientific work efficiency studies around the time of the First World War, for example the Industrial Fatigue Research Board (IFRB) in Britain (Murrell 1965: vii) and similar 'time and motion' investigations in the United States by Taylor or Gilbreth.

10 Under Second World War conditions laboratories were set up in the UK at the Universities of Oxford and Cambridge and in also the US (The Psychology Branch, Aero-Medical Laboratory, Dayton, Ohio) who all collaborated with the various Armed Forces (who also carried out their own experiments). After the War the Ergonomics Research Society was formed using a new word was coined to embrace this field of enquiry, *ergonomics*, from *ergos*= work and *nomos*= natural laws.

11 As the British investigator of factory work, Murrell, put it, the useful parts of the worker body were 'two major systems of levers –arms and legs—joined by an articulated column', the spine (Murrell 1965: 16).

12 See interview with Dugald Cameron, Glasgow Art Club, 28 May 2014. Cameron cites American industrial designers such as Harold Van Doren, Henry Dreyfuss and his book *The Measure of Man* and Walter Dorwin Teague. From the UK, after the War, Douglas Scott (1913-1990) teaching at Central St. Martin's designer of the AEC Routemaster bus, and the AGA cooker, founder member of the Society of Industrial Artists, 1930. For life drawing Cameron mentions William Drummond Bone, see footnote 2 and also GSA Archives DC 047/1/2 art history and DC 047/1/4 drawings of face and figure for life drawing.

13 As in nineteenth century engineering, very highly finished presentation drawings—for example of the Sundén ultrasound scanning equipment—were used as substitutes of 'representatives' of the actual items—as these were made and sent over because manufacturing the new and innovative actual equipment was taking a bit longer than estimated.

14 We can see this mixture of drawing styles in star engineers going back to the nineteenth century, for example in the work mechanical engineer James Nasmyth—where he used energetic clouds of lines when he was thinking through how to design a railway transport bed component in his sketchbooks, but with public drawings prepared in parallel in an exact and minute finished style for publicity and contractual purposes.

15 Fifty years ago, the unborn human being was hidden, enveloped within the female abdomen, away from the medical gaze'. The fetus was understood by doctors only through the medium of the women's verbal testimony, but then due to ultrasound scanning, the developing human being became for the first time in its history, a clinical entity, a patient in its own right… it now gained a 'public presence, a social identity'. This new person was quickly recruited by pro-life campaigners during debates about abortion. At the same time, the latter half of the twentieth century also saw a transformation in the British way of birth. Before 1950, most confinements took place at home; after the setting up of the National

Health Service (NHS) in 1948, this situation changed, by the 1970s, most births took place in hospital… 'the ultrasound scanner was both a major agent for and a potent symbol of the medicalization of childbirth'. (Nicholson and Fleming 2013: 1-2). Evidently, reproduction and the medical practices surrounding it are essentially contested domains. As the feminist writer Ann Oakley notes, the rise of ultrasound from unknown procedure to routine use illustrates the essential use of technological innovation in health care' (Oakley 1984: 156).

16 Dr. James Willcocks recalls forming an 'image of the fetus with the hands via abdominal palpation, p. 30 Wellcome Witness Seminars.

17 Nicholson and Fleming 2013: 11; Oakley 1984

18 Nicholson and Fleming 2013: 157

Bibliography

Brown, T.G. (1999) Development of ultrasonic scanning techniques in Scotland 1956-1979, Personal recollections by T. G. Brown and Virtual Reality in Ultrasonic Imaging: a project out of time? T. G. Brown 1999. Available at http://www.ob-ultrasound.net/brown-on-ultrasound.html

Freedgood, E. (2003) *Factory production in nineteenth century Britain* Oxford: Oxford University Press

Goldstein, C. (1996) *Teaching art: academies and schools from Vasari to Albers* Cambridge: Cambridge University Press

The History of Modern Biomedicine. Interview with Dugald Cameron, 28 May 2014, Glasgow Art Club. Accessed 21 April 2017. Available from http://www.histmodbiomed.org/article/dugald-cameron

Hale, R. B. (1991) *Master class in figure drawing*, compiled and edited by Terence Coyle New York: Watson-Guptill

Lane, D. (2017) 'The digital as para-world: design anthropology and information technologies' in Clarke, Alison J., ed. (2017) *Design anthropology: object culture in the 21st century* New York: SpringerWien: 202-211

Murrell, K. F. H. (1965) *Ergonomics: man in his working environment* London: Chapman and Hall

Nicolson, M. and Fleming, J. E. E. (2013) *Imaging and imagining the fetus: the development of obstetric ultrasound* Baltimore: The John Hopkins University Press

Oakley, A. (1984) *The captured womb: a history of the medical care of pregnant women* Oxford: Blackwell

Petherbridge, D. (2010) *The primacy of drawing: histories and theories of practice* New Haven and London: Yale University Press

Tansey, E.M. and Christie, D.A. (2000) Looking at the unborn: historical aspects of obstetric ultrasound. Wellcome Witnesses to Twentieth Century Medicine Volume 5 – January 2000 A Witness Seminar held at the Wellcome Institute for the History of Medicine, London, on 10 March 1998. Accessed 21 April 2017. Available from www.histmodbiomed.org/sites/default/files/44827.pdf [Wellcome Witness Seminars, 1993-1999, 'Obstetric ultrasound: historical perspectives' organisers Dr. Malcolm Nicolson and Dr. E.M. Tansey]

Tilley, A. R. (1993) *The measure of man and women: human factors in design* New York: The Whitney Library of Design

Human echoes: an oral record of women's lived experience of ultrasound during pregnancy in 1960s Glasgow

Susan Roan and Emma Keogh

'Human echoes' is an ongoing practice-based research project that seeks to give voice to the lived experience of women in Glasgow who received obstetric ultrasound scans in the 1960s, when Glasgow led the world in its development.

The experiences of childbearing for the women interviewed for this project were vastly different from those of their own mothers. As the place of birth shifted from home to hospital, there was a seismic shift in the culture of pregnancy and childbirth in the UK. This project seeks to record narratives of pregnancy and birth as part of this changing culture in 1960s Glasgow. Drawing on sound recordings of 28 interviews with midwives and doctors who witnessed the early use of obstetric ultrasound and the women who had an ultrasound scan during their pregnancy in Glasgow between 1963 and 1968, this project aims to shine a light on the narratives of the women who were, themselves, pioneers of ultrasound.

For this publication and exhibition, extracts from the many narratives shared by the women, midwives and doctors during interviews conducted between March and June 2019 have been selected to take the reader through the process and experience of having an ultrasound scan - before, during and after – the event. We provide, for context, the questions we asked during the interviews.

Perspectives from Medical Staff

Patricia Cassidy
Pupil Midwife 1964-65
Clinical Midwife 1965-84
Midwifery Lecturer 1984-2004
The Queen Mother's Hospital

> Professor Donald used to talk about the 'iron curtain of the abdomen'. And he was – *fascinated* about what went on and he thought if he could get behind that iron curtain, then we could find out more about the progress of pregnancy. He wanted to know, *what* was going on *inside* – and could he do anything about that – and could he help.
>
> I remember Professor Donald giving a lecture and talking about how he went to Babcock and Wilcox…and he talked about something that he was interested in that he found out during the war...and if there were transmission of sound waves through the water, they would bounce off matter and be referred back – and he thought – If you can you do it through water, can you do it through liquor?[1]
>
> Before the ultrasound, they didn't *know* what was going on. Every woman who was pregnant just hoped and prayed that she would have a healthy outcome. They *did not know* if there was a problem…they didn't know about that until the baby was born. Occasionally, if there was a problem, they would have an x-ray. Medical staff were always reluctant to do x-rays during pregnancy for reasons that are well documented. We would do a lot more palpating of the abdomen[2], yes – in those days

we would palpate the abdomen – and we learned a lot that way about the lie and the presentation of the fetus… Nowadays, it's sonar and they use inch tapes and things, that we didn't use, we just used our hands – and our skill, in palpating the abdomen…

We did have a lot of patients in those days – if there was any prenatal bleeding, then the worry was, it would be a *placenta praevia*[3] So *any* prenatal bleeding, we kept the patients in because if they started to bleed, they would bleed very severely. And you *could not* tell. One thing that was totally, totally – *forbidden* was to do a vaginal examination – a digital examination prenatally [if there was] any bleeding *in case* you provoked more bleeding. So, we *did not know* where the placenta was until the clinical signs would manifest themselves. That was why we kept patients in.

Dr Burnett Lunan
Senior House Officer 1966
Junior Doctor 1969
The Queen Mother's Hospital

The ultrasound machine had been used in Rottenrow[4] as Ian Donald was developing this prototype, as it was called – an ultrasound, and there was also I believe a machine at the Western Infirmary for gynaecological problems but as far as obstetrics was concerned, when the Queen Mother's Hospital[5] opened in 1964 the equipment that Donald had been working on was taken with his team to the The Queen Mother's Hospital and it was established there – and they had an ultrasonic department in the new building. It wasn't just a "big cupboard" which they used in the old hospital and so they had the facilities for women to prepare for being examined and that sort of thing built into the hospital.

It was obviously a new development and – there was a lot of sort of – well there was even controversy about it because – people were unsure of how safe it was going to be and how much informed consent you could expect patients to give for these procedures to be carried out. And inevitably in medicine, there was a strong conservative with a small 'c' element, that sort of resisted – moving into areas that they were unfamiliar with. But on the other hand, there was this – I mean Ian Donald was a charismatic personality and he certainly provided a lot of enthusiasm for the research that was being done at that time, and was very optimistic about its uses and so whenever the opportunity arose – he loved an audience and he would take the students in to see a procedure being carried out. And even as junior doctors – we would be expected to follow patients into the examination area and observe the examination of the patient.

…there was an element of wonder about it. Previously you saw images on say an x-ray which were static, they were just – one photograph of what was going on, whereas with the ultrasound you were actually seeing *movement* and – *that in itself* – was remarkable to see and obviously it is an insight into what was going on inside the womb – and from that point of view, yes it was completely new… but – *to see* – a movement inside their uterus was obviously – quite an exciting thing to see.

Perspectives from the women who experienced ultrasound scans and midwives who accompanied them

How did it come about that you had/saw an ultrasound scan?

Pat Anusas
Midwife 1963-65
The Queen Mother's Hospital

I was working as staff midwife in the West Wing. The day that I was asked, the sister of the ward said to me "Pat, you go along, Professor Donald has this thing going on" – and it was very much like, it was a trial, but it wasn't going to come to anything – it was

a feeling that it was just Professor Donald who was such a wonderful man – but – "just you go along and see what it's all about" – and I went along on those terms – not thinking that it was going to revolutionise the whole of midwifery care, never for a minute did I think that – never.

Elizabeth Cuninghame
1970

I wasn't really keeping well after losing the baby so I went to see this other doctor cause my friend had said how nice he was…and he was a wonderful man and he said to me when you get pregnant again I'm going to get in touch with a friend of mine and that was Professor Ian Donald, "and he'll look after you". So I had to go out to Glasgow – to get the scan.

Roberta Capuano: summer, 1966.
Reproduced by kind permission of Roberta Capuano.

Eleanor Scanlon
Student Nurse 1968
The Queen Mother's Hospital

That particular day, because I'm this spare part, somebody has said, "*you* go with Mrs – the lady. She's going down to get this ultrasound done and it's down at the Western[6], so – you accompany her". So I go and I meet the lady and "oh I've to take you to this *thing*" – The two of us are all excited because we haven't a *clue* what we're going to.

Patricia Cassidy
Pupil Midwife 1964-65
Clinical Midwife 1965-84
Midwifery Lecturer 1984-2004
The Queen Mother's Hospital

Professor Donald – oh everybody metaphorically stood to attention when he came in – it was the Sister that would take him round and he usually had an entourage if he was doing a visit – but he came in at other times, quite unofficially – when he was looking for patients to scan.

Alice Cumming
1967

My mum was an auxiliary, well, something more than an auxiliary, but she worked in the theatre a lot – and that's how I got asked if I would come and have the scan taken – I didn't know what a scan *was* – "oh you'll just do it [for Professor Donald]" – She just said you would *do it*, not *will* you – "you'll *just come*" – and even as a married woman and pregnant, you still did what your mother said.

Anne McCurry
1966

My visits prior – they thought I was very large – "Was there twins in the family?" And I said "Yes, there were two sets of twins in the family" – so they said that I may be expecting twins – so an appointment was made.

May Boland
1963

I thought it was a fairly normal pregnancy. My dad insisted on seeing

a gynaecologist obstetrician in the West End. We were living in Largs so, I used to come up for my checkups, and one of those checkups – that was probably the end of November '63 by that time. One of these checkups he asked the usual questions of normal movement – and I said "How would *I* know about normal movement? I've never been pregnant before"*.* And he said "I'm not very happy about the size of the fetus*.* How would you feel about having a proper checkup?*"* And it was to be the Rottenrow, and he told me that a Professor Donald was trialing these things – and I said "Fine, I would do whatever".

What did you know about having an ultrasound scan before you had/saw one?

Janette McMaster
1965

It was only just kind of opened, the Queen Mother's at that time – It wasn't long opened I don't think – just remember vaguely – and thinking and it was absolutely a miracle, you know this *magic* that you can actually see bits of the baby.

Janice Thomson
1967

Nobody knew what I was talking about – and I think because my Dad had been a naval officer I was kind of familiar with the concept of ultrasound – because they had ASDIC[7] – and during the war, they used it to detect submarines – under the ships – so I knew it was the same idea as that and probably had been developed from that – so that's how I explained it to most people.

Sheena Kyle
1965

No, never heard of it. It was Professor Donald and he came in and explained that it was pioneering and they were starting to use this. And he says it doesn't harm you in any way, you don't feel it, it's not painful – he probably had to explain that, people weren't sure – they wouldn't have known whether they were drilling in, or…

Alice Cumming
1967

I'd never heard it talked about. "You'll get a picture of your unborn baby – they'll be able to determine how well your baby is" is what she said – that was how she [my mother] got me to go.

Can you tell us what you remember about the day of the ultrasound scan?

Anne McCurry
1966

I made my way to the Queen Mother's Hospital – everybody talked about *the hill* up the Queen Mothers – I saw it recently– it's really not that big, but in those days – to me – it was Mount Everest.

Alice Cumming
1967

The Queen Mothers was *the* place then. It was really new and fresh and lovely, it really was *beautiful*…

Elizabeth Cuninghame
1970

I was very nervous cause even you know the fact that I had to go away to Glasgow, [from the Isle of Islay] in those days we didn't travel as much as we do now so it was a very big thing all in all, to get on the ferry, and then drive to Glasgow, find the hospital and you're all very nervous and uptight and worried about what the scan would show too you know, Was everything going to be ok?

Elspeth McLellan
1968

I had to go to the Queen Mother's hospital, which was quite a trek from Paisley, and I had Mhairi with me, my other girl. And we had to get two buses I think, and then walk up the big hill, right up to the Queen Mother's. And when we got there – I remember the doctor so vividly. I could almost

recognise if he walked in here, although he would be totally different now. He was black, he was so black and I hadn't really seen a black person before and he was so charming – and he explained everything to me, what was going to happen, and all the rest of it. Very, very reassuring – And then I had to drink, I think it was about four pints of water. And, you know it was explained to me that I would need to keep that in while they were doing the ultrasound – and the reason I had to drink it was to lift the womb up so that it could be, you know, the machine could get the photographs or whatever. So I did that with Mhairi sitting beside me [laughs] then they took me in where the machine was and it was [breathes in] really quite – you know, like science fiction as I say.

Sonia Wilson: the caravan at "Ringstones" on the day of my 21st birthday and first anti natal appointment at QMH, 1967.
Reproduced by kind permission of Sonia Wilson.

May Boland
1963

…and I can remember perfectly – on the Friday, if a think about it that was probably the 22nd. On the Friday, was the day that John F. K. was assassinated. We were sitting in our living room and I was getting upset at the thought of coming, because something wasn't right – and my girls were all working underneath – it was a Friday, a late-night – because we lived above the hairdressers, the girls were all working – and there was a dance on in the hotel just down the road, and I think it was, whatever the news programme was, the night-time news programme – and all of a sudden it came up that – and it was – devastating – everybody was – My appointment to the Rottenrow was for the Tuesday, which was the 26th which was actually my wedding anniversary, my first wedding anniversary – I can remember greetin' – packing my wee suitcase that I had packed the year before for my honeymoon [laughs] and I went in – I think I was kept in overnight…

Eleanor Scanlon
Student Nurse 1968
The Queen Mother's Hospital

And we got taken down in – I think it was a taxi – we didn't go in an ambulance, I think it was a taxi – it wasn't very far, you know. And we get to the Western and, of course, I'm on home turf there – and it's the x-ray department. And the x-ray department in the Western was *down* in the *dunny*. That was the expression used. It was *horrible*, it was the basement and it was *really, really* old-fashioned, very old-fashioned. Horrible kind of place to work *all* day – virtually no daylight – horrible. And these big long corridors with just curtains and so on, you know. And the patient and I arrive and she had to have this full bladder. I don't know if this still happens, but she had to have the full bladder and she was *very very* pregnant, you know, this lady. The baby was washing about in a tummy full of liquid but she still had to have the full bladder. So, she was a bit – em, you know – unhappy [laughs]. So I'm kind of chatting away and all that – and we waited in the corridor and then Professor Donald takes us in behind one of these sets of curtains. And he's his usual lovely self – I'd only seen him from afar at this point – em, he was just a sort of *God*

walking about the place – and I didn't really know him. I knew he was nice. He was a nice man and he was awful friendly.

Maureen McCarthy
1967

I felt it was the early stages – they did explain quite a bit in the Queen Mother's you know, about it – and they were explaining about Professor Donald and Tom Brown and things like that – one time I went up for a checkup and they were doing the second scan and Professor Donald was there – you know, in the hospital. And I think it was actually passing I think, that's what it was – and I was waiting to go in. He said "Oh let's go and have a look – come in!"

Can you describe as much as you can remember about having/seeing the ultrasound scan? Can you remember anything about the ultrasound machine? What did it look like? Do you remember who did the ultrasound scan?

Sue Underhill
1965

I suppose I was lying on a couch or something, ready to be examined – and he was a tall man, as you will probably know – and he was towering above me – and he said he was the only one in the world who could do this test – now that *did* frighten me…

Maureen McCarthy
1967

One of the nurses put the gel on, and he's running – and of course I never thought to myself – gentleman he was, he was an absolute gentleman. I didn't think Who are you? – whatever. But now when I think on it, you know – I was quite *honoured* really.

Margaret Stratton
1965

It was big yes, and he told me it was developed from sonar in submarines – he did tell me that, that's how he first got onto this thing and this was all experimental.

Maureen McCarthy: feeding Martin on the day of his christening, 1968.
Reproduced by kind permission of Maureen McCarthy.

Heather Thomson
1967

But obviously you're very scared because you don't know what's happening – but they must have told me…not to worry about it, it wasn't sore, it was just to see how the baby was growing – which – she wasn't.

May Boland
1963

My memory was of Professor Donald coming into the ward with what I would describe as an operating trolley with a great big square TV on it – and young students with him.

Anna McHarg
1967

Professor Donald – he was the – he was God! [laughs] you know [whispers] *Professor Donald coming in – quiet!* [laughs] That's all I remember, I remember he was a big man, big tall man if I remember rightly – but [whispers] – he was *God!* [laughs]

Sonia Wilson
1967

I remember where we were in the Queen Mother's Hospital and – the actual room was nothing like the

rooms that I had ultrasounds in after that time. It looked like it had been set up in a corridor – and there was a fire door here and the fire door behind me, and there was all this machinery, all this heavy machinery – it was just a jumble of stuff with a television screen – or a monitor of some sort – em – and you had to take *all* your clothes off – so literally you didn't have a stitch of clothing on – no bra, not anything. And they gave you a gown – that's all you had on. And then you went through to this room and lay on this table like a cadaver waiting for an autopsy and they poured oil all over you – and I was just back from South Africa, and I was just very young, and very slim, I had a suntan and my blonde hair – and I thought I was the bee's knees [laughs].

Janice Thomson: Simon at 2 weeks old, 1967.
Reproduced by kind permission of Janice Thomson.

Alice Cumming
1967

And when I got there, I thought it was just going to be my mum and Professor Donald and a nurse – no – there was about twenty-two American doctors there – he was trying to sell them this that he had invented. It was a room like this – it would maybe be 12 feet by 14 feet and a sort of like a dentist chair bed – that's all I can remember – and dark – it was all in the dark – and I'm there thinking Oh God, why am I here, why did I allow this to happen?...

Can you tell everything that you can remember about the ultrasound scan itself? Do you remember what you saw on the screen? Can you describe what you saw?

Eleanor Scanlon
Student Nurse 1968
The Queen Mother's Hospital

The lady, we'd to get her up on the table, which is *not* easy, because she's *really really* big. And he explains what he's going to do – and it's all about soundwaves – deep sea navy talk [laughs]. And she's just thinking – toilet, toilet [laughs] – and I'm thinking – *What* the *hell* is he on about? [laughs]. So anyway, he gets started and the stuff goes on the tummy and he started putting his little machine across her tummy – and he's *mega excited* at this picture of *the baby.* And she and I are looking at one another, you know – and there's this – bunch or scribble [laughs] on the screen [laughs]. There's nothing else you could call it but scribble. And, you know, nowadays they're fabulous, aren't they – whole babies there – but it was a bunch of scribble because it was only bouncing off bones. And, he has to say to us, *"That's* the baby's *head* – and that's the baby's *spine* – you really couldn't make out limbs, it was very, very rudimentary. And she and I nodded in agreement – and he was so happy that we felt happy for him [laughs] – but it just was – it was mystifying, completely mystifying…

Anne McCurry
1966

I was told to look to the right – and I would see pictures, black and white. Looking at the screen it was like – space – it was like an alien from outer space, I couldn't even figure out a baby…

Patricia Cassidy
Pupil Midwife 1964-65
Clinical Midwife 1965-84
Midwifery Lecturer 1984-2004
The Queen Mother's Hospital

It had to be *explained* what I was actually seeing – and of course, it has never been done before, nobody had ever *seen* it, there was no experience, there were no pictures in books or anything…this was *really* revolutionary.

Margaret Stratton
1965

I just remember being a bit in awe, I never questioned why or what or anything but he said that he would have to diagnose that I was definitely pregnant, which I thought was a bit strange being admitted to the maternity hospital – we have to verify that you are pregnant, and he told me he was carrying out this new treatment. I do remember he was very tall and reddish hair, I do remember very gentle, very kind, and explained everything as he was going along – He told me it was developed from sonar in submarines – he did tell me that, that's how he first got onto this thing and this was all experimental – but in years later I thought, you know you just accepted that – you never thought, Gosh, I hope nothing could harm the baby! But no, he was very, very kind…

Maureen McCarthy
1967

I just thought it was an absolutely fantastic machine, that I could look up – because they said to me, "Look over there and you'll see it, what's happening" – I didn't think I would see that when I went into the room. I thought it was just like an x-ray I wouldn't see anything – and he says "No, just look there and you see and the baby is moving" and things like this. Absolutely wonderful. Wonderful.

Rachel Macleod, Baby's first feed at home, 1966.
Reproduced by kind permission of Rachel Macleod.

Pat Anusas
Midwife 1963-65
The Queen Mother's Hospital

When I went into the room I can always remember the room was all dark – the blinds were all shut, the patient on the bed and Professor Ian Donald was standing at the wall. What he said then was "I'm going to explain to you what's going to happen to both me and the mother" – now I don't know how far on in the pregnancy she was – if I can remember right, the picture of the baby that I saw – the outlines of the baby, it was very grainy – probably she would be about 30 weeks or something like that, I'm not exactly sure – Professor Ian Donald was the type of doctor who was extremely kind and he always put the patient first and he would always put the staff first – and he explained in detail, and I couldn't believe it – I was standing there and I still to this *day* can't believe what I saw. That when the screen came up – it was on the wall, and he was quite excited because it was working – he didn't know if it was going to work or not –

but it *did* work. And both the mother and I were so excited – she couldn't believe she could see her baby on the screen on the wall – he was so excited when it eventually did show on the screen – I think he was absolutely – I think he probably was as shocked as we were, you know [laughs]. The screen for seeing the grainy picture of the baby, it was projected onto the wall, and that's why it had to be dark. I was wondering why I was going into a darkened room, but it was to see the picture more clearly. It was maybe 1 to 2 feet in size – maybe 24-30 inches. It was grainy but you could see the baby moving…

Sonia Wilson
1967

… I'm lying there naked (laughs) – and – the machine broke down – and this doctor came – and he was very jolly and it was all like a big joke to him – and I could see *nothing. I* could see lights and I could see darkness – I didn't see any baby at all – and the baby was this size, you know [laughs] – I was looking for *a baby*! And – the machine broke down – and he's mumbling and trying to fix it and trying to fix it – and then he said he would need to phone for an engineer – and here I am, lying in the condition that I am lying in [laughs]. And he got a bit of paper towel off the wall and a great big roll like this – and placed it on my tummy or on my bosom – and all the oil that was under the – was getting soaked into the – I can see my bikini line through the paper! [laughs] – and this engineer came in [laughs] – this 25-year-old engineer came in with his toolbox and his screwdrivers – and – he was horrified – and I was horrified, and this doctor [laughs] – saw our horror and thought it was the funniest thing he had ever seen in his whole life – and was *cracking* with laughter – and this guy is down on the floor trying to hide, and I'm lying here naked trying to hide [laughs] with nothing to – [laughs] – I can see my toes – with just this *transparent paper*. It was *awful! It was horrifying!* It really was *awful.*

Alice Cumming
1967

"Now, tell you what I'm going to do, I'm going to put a little oil on you and I'm going to scan this across, it won't hurt you in any fashion whatsoever" – that's how he spoke – I thought aye fine – I never answered – I was too terrified to answer…and it was so noisy – I remember the noise of it – it was like *crackling.*

I can actually close my eyes and I can still see the picture – it's just like em – black – and it's like dark shapes and light shapes and a wee – a wee squiggle in the middle – it doesny look like a baby – but he was able to see – but I remember thinking – Oh that's moving in and out! –but I didn't realise – it's a *heartbeat* – cos I just thought his picture was moving in and out.

And – I got the picture which – the world was amazed at – black and white – I remember that he was all excited about this getting printed – and they were printing it for these Americans _ **(SR)** ***Did they give some prints to the Americans?*** They might well have done – they wouldn't have asked my permission anyway cos you didn't have to give your permission for anything in those days – but I got to keep it. He said "I was an engineer long before I was a doctor" – he was very matter of fact – but there was a *kindness* to him…

Did you get a photograph to take home?

Patricia Cassidy
Pupil Midwife 1964-65
Clinical Midwife 1965-84
Midwifery Lecturer 1984-2004
The Queen Mother's Hospital

I know that some were given out – but they were Polaroid and they were expensive – and I think it was the expense that meant that not everyone could automatically get a photograph.

Wilma Paterson
1967

> But that *was* momentous because he took me up and he put me under his machine and produced *the photo*…it's one of my son's prized possessions.

Elizabeth Cuninghame
1970

> Well he gave me the picture of my baby and he said "And I'm taking one of them to America cause I'm going out to America to you know, talk about the scans out there…"

Maureen McCarthy
1967

> I do remember thinking when I got it done … *I must keep these* [photographs] [laughs] – never thought I'd keep one for 51 years, but there you are.

Alice Cumming
1967

> It was a Polaroid picture – it has a white border round it…It took about two minutes. I remember I was getting the oil taken off me and I was just a piece of meat lying on the table, I didny count so nobody worried about me – and then him handing it to me – and saying – I remember what he said – "You're *very lucky*" – that was what he said – "you're *very lucky*" – and I thought, *So are you!* But I wouldn't have opened my mouth.

Anna McHarg: On our way home from a caravan holiday near Lochinver, 1967
Reproduced by kind permission of Anna McHarg

Further work

The above provides insightful glimpses from the many stories that participants shared about their experiences of ultrasound scanning during pregnancy in the Queen Mother's Hospital, when the technology had been newly invented in Glasgow.

During the interviews, further questions were asked about attitudes to pregnancy, experiences of pregnancy and prenatal care in 1960s Glasgow; sex education and birth knowledge at that time; ways of accessing knowledge of fetal development before obstetric ultrasound; and memories of the newly opened Queen Mother's Hospital. Further work is planned to make much more of this material available.

Endnotes

1 The amniotic fluid is commonly called water or waters (Latin liquor amnii).

2 Abdominal palpation', means to examine by touching and feeling. A midwife or doctor will use abdominal palpation during an antenatal visit to examine the development and position of the fetus.

3 A condition in which the placenta partially or wholly blocks the neck of the uterus, so interfering with normal delivery of a baby.

4 Rottenrow is best known as the address of the former Glasgow Royal Maternity Hospital, founded in 1834, itself referred to locally as 'The Rottenrow' and which became a world-renowned centre of excellence in gynaecology.

5 The Queen Mother's Hospital, affectionately known as the Queen Mum's or QM, opened on the Yorkhill site in 1964 and closed in 2010.

6 The Western Infirmary served as a teaching hospital for Glasgow University. It opened in 1874 at the Gilmorehill campus in the West End of Glasgow and closed in 2015.

7 ASDIC was an early form of sonar used to detect submarines.

Acknowledgements

We would like to show our huge gratitude to the following people for their generosity in sharing their ultrasound experiences for this project:
May Boland, Roberta Capuano, Alice Cumming, Elizabeth Cuninghame, Sine Hammet, Sheena Kyle, Rachel Macleod, Maureen McCarthy, Anne McCormack, Anne McCurry, Anna McHarg, Elspeth McLellan, Janette McMaster, Wilma Paterson, Margaret Stratton, Heather Thomson, Janice Thomson, Elizabeth Tough, Sue Underhill, Sonia Wilson, Lorna Young.

Medical Perspective:
Patricia Anusas, Sandra Cairns, Patricia Cassidy, Iona Fisher, Dr Burnett Lunan, Dr Christian Roan, Eleanor Scanlon.

We would also like to thank the GSA School of Design academic support staff for their assistance during the interview process and Alastair Macdonald for his support and encouragement throughout the project.

This project was also supported by funding from The Glasgow School of Art Research Development Fund and a Royal Society of Edinburgh Arts and Humanities Research Grant.

60 years on: nurturing young design engineers

Craig Whittet and Aileen Moar Biagi

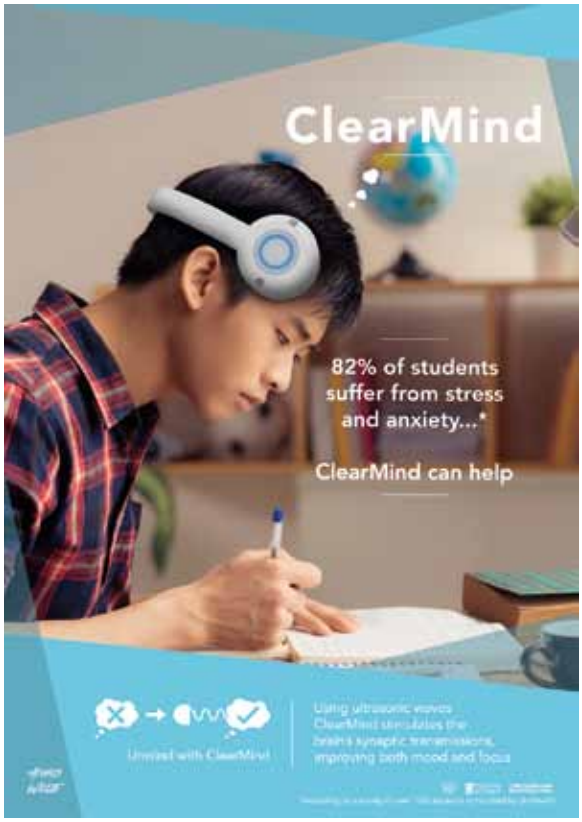
Product Design Engineering

Cameron co-founded Product Design Engineering (PDE) in 1987 with Brian Scott, then James Watt Professor at the University of Glasgow. PDE brings together two cultures - the studio and creative environment of one of Europe's leading art schools - the GSA, and a world top 100 university (QS World Ranking) - the School of Engineering at the University of Glasgow to offer Bachelor of Engineering (BEng) with Honours or Masters of Engineering (MEng) degrees. The GSA element offers studio-based, student-centred learning fostered through design project challenges.

PDE goes ultrasonic

In 2017, echoing Cameron's approach of six decades previously, third year students from the PDE programme were given an opportunity to respond to a similar challenge to explore the potential application of the many new and emerging developments in ultrasound to a wide range of contemporary and future scenarios.

Working in small teams, PDE students were able to benefit during the two-stage review process from input not only from the current PDE studio staff, but also from Cameron himself and academic researchers working in Glasgow and Edinburgh universities within the field of ultrasound research. Using this contemporary research as a basis, each of 12 student teams was asked to rapidly generate 30 initial ideas and then to select and present three concepts. After interim review, each team then worked up one of their concepts to a higher level of detail and

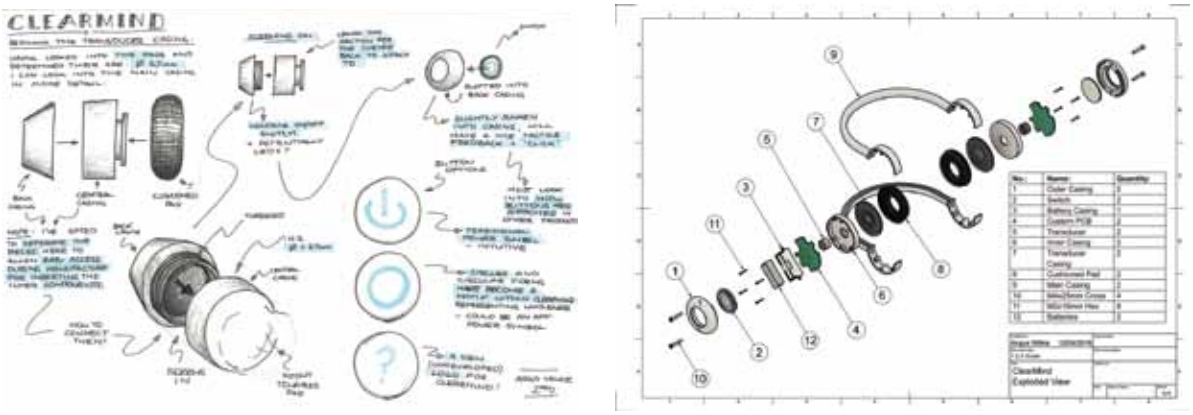


(Left) Concept for 'ClearMind': ultrasound is used to elevate mood and provide improved focus for the user when applied to a user's temples: positive results are thought to come from ultrasonic waves stimulating the membrane channels and synaptic tissue within the brain. (Right) 'Hydrosonic' concept for a diving mask using real-time ultrasonic sonar to enable divers to see the ocean floor and other vital diving information on a heads-up display using retinal projection directly into the eye.
Images: (left) Angus Wilkie © 2017, (right) Samuel Watson © 2017, reproduced by kind permission.

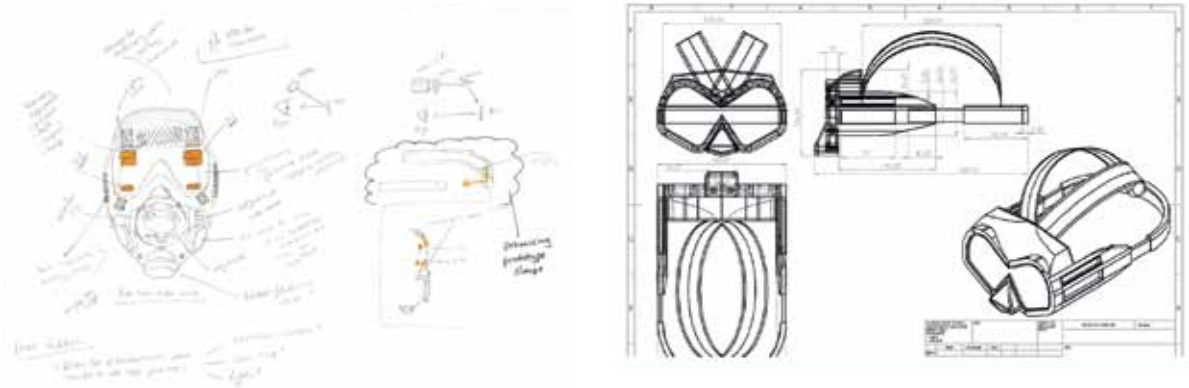
created video prototypes to communicate their proposals. This mode of working has a number of attractions: research and ideas can be shared amongst the cohort and concepts rapidly developed, communicated and critiqued. Concepts emerging at the initial stage included, e.g., a wound welder, a portable obstetrics point of care kit, a hand-held levitator, a hydroponics 'fogger' to reduce the need for water used to grow plants, a coffee-maker using ultrasound to shatter the beans and boil the water, devices for treatment such as for speech therapy, diagnostic devices for measuring muscle fatigue, navigation devices for visually impaired people or for situations where vision is impaired (such as in fire-fighting), personal locking devices, or recreational devices, e.g., for improving one's golf swing.

Some students took the development of ideas beyond the team concept stage and developed these on an individual basis: their folios of the in-depth designs display a broad range of skills attractive to industry: detailed research, conceptualisation, design, engineering calculations and sciences, prototyping, component design and assembly, CAD drawing, evaluation.

Employment rates are very high with PDE graduates sought after by household names such as Apple Computers (USA), BAE Systems, Mitsubishi, TomTom, Cambridge Consultants, Dyson, Hoover-Candy, JCB and Philips. There is also a strong track-record of graduates establishing their own companies based on the intellectual property generated during their time in PDE.



Folio pages showing (left) sketch-thinking, and (right) component assembly for the ClearMInd concept.
Images Angus Wilkie © 2017 reproduced by kind permission.



Folio pages showing (left) sketch-thinking, and (right) final prototype for Hydrosonic, a diver's mask concept.
Images Samuel Watson © 2017 reproduced by kind permission.

Virtually real: augmented reality

Steve Love and Matthieu Poyade

The School of Simulation and Visualisation

The School of Simulation and Visualisation (SimVis) at The Glasgow School of Art is one of five Schools that combines academic study at Undergraduate, Masters and PhD level with a broad range of research and commercial activities. Its core areas of activity are primarily centred around the development of new technologies, tools, techniques and methodologies that support new media and digital content creation. In particular, core research focuses on human computer interaction, haptics, motion capture, real-time interaction, user-centred design, photorealistic 3D visualisation, serious games and ambisonic sound.

smARt sonography

In 2016, SimVis student Sophie Koegl produced, for her MSc dissertation in Medical Visualization and Human Anatomy [1], a booklet which used augmented reality (AR) showing interactive 3D material on prenatal development. She says:

Obstetric ultrasound (US) makes it possible to see and monitor the foetus. It has become one of the most profound progresses of medicine in the 20th century. It has completely revolutionized prenatal health care. Nevertheless, despite medical appointments and easy knowledge access via the internet, on-going mothers and family members or friends have difficulties with understanding ultrasound scans. According to a study (Kohut, 2002) [2] women are not very aware of the purpose, benefits and limitations of pre-natal US. Kohut concludes that a majority of pregnant women lack information about the ultrasound examinations to make informed choices.

By looking at the possibilities of Augmented Reality (AR) in visualizing complex topics in order to understand them better, I came up with the idea to use this technology to support expecting women and couples in the topic of pre-natal ultrasound. Therefore, a booklet was designed – 'I don't see it – Peanut To Baby'- which shows the basic principles of ultrasound, why US examinations are offered and the main features one can see on a routine pre-natal US scan. For greater immersion, an AR application (app) will enhance the experience of the booklet by showing certain content interactively in 3D. With such an AR-booklet, the aim is to enhance women's understanding of pre-natal ultrasound.

Screenshot from Sophie Koegl's online video showing augmented reality features of booklet. Image Sophie Keogl © 2016 reproduced by kind permission.

Endnotes

1 Sophie Koegl's dissertation is available to view in the Glasgow School of Art Library in the Dissertation Collection: GSADIS 2016/KOE (https://capitadiscovery.co.uk/gsa/items/eds/cat03982a/GSA.234923?query=Koegl&resultsUri=items%3Fquery%3DKoegl%26target%3Deds%26facet%255B0%255D%3Dfulltext%253Ayes&facet%5B0%5D=fulltext%3Ayes&target=e-ds) and is also available at: https://drive.google.com/file/d/0Byrqt4IyJQ_pRFFGdHprSmlWN2s/view

2 Kohut R. J, Dewey D, Love E. J. Women's knowledge of prenatal ultrasound and informed choice. Journal of Genetic Counseling. 2002;11(4):265–276.

Acknowledgements

Ultrasonic Glasgow was conceived and curated by Professor Alastair Macdonald, Senior Researcher School of Design at GSA. In addition to those individuals already acknowledged above, he wishes to thank the following individuals and organisations for their generous assistance with the content, research, critique, production, mounting and funding of this exhibition.

Inspiration and mentoring
Professor Dugald Cameron, OBE DSc DA

Product Design Engineering student project
Craig Whittet, Programme Leader, Aileen Moar Biagi and Wael Saeiby, Lecturers, Product Design Engineering, School of Design, GSA.
Professor James M. Scobbie, Clinical Audiology, Speech and Language Research Centre, and Miriam Smith, Business Development Manager, Queen Margaret University, Edinburgh.
Professor Sandy Cochran, Professor of Ultrasound Materials and Systems, Dr Paul Harkness, Reader, and Dr Paul Prentice, Lecturer, School of Engineering, University of Glasgow.
The 2017 cohort of 3rd year students of Product Design Engineering, School of Design, GSA: Team 1: Alexander Duff, Fara Stringfellow, Matthew Davis; Team 2: Alistair Byars, Gregor Mackay, Roanna Hutcheson; Team 3: Adam MacDonald, Cathel Robertson, Jessica Vinnels, Neil Gauld; Team 4: Christopher Welch, Kieran Kay, Penny Morton, Corrie Grant; Team 5: Caroline Tougher, Jay van den Hoven, Molly Akers; Team 6: Cameron McMillan, Jemma Brown, Morven Graham, Scott Neill; Team 7: Stephanie Parker, Africa Perez Calderon; Joseph Pollard, Jiahui Lu; Team 8: Patrick Neison, Chiara Rossi, Catriona Brown, Man Wong; Team 9: Louis Slorach, Qasim Ali, Emma-Marie Magro; Team 10: Robert Mueller, Rachel Hughson-Gil, Paul Malcolm; Team 11: Angus Wilkie, Isobel Leason, Michael O'Donnell; Team 12: Samuel Watson, Rebecca Jones, Matthew Sheppard.

Archives and Collections
Susannah Waters, Archives and Collections Manager, Cat Doyle, Jennifer Lightbody, Michelle Kaye, Megan Allan, GSA Archives and Collections.
Ed Johnson, Assistant Curator, Collections, Glasgow Museums Resource Centre.
Dr Alistair Tough, Archivist NHS GG&C, Glasgow Libraries, Mitchell Library Archives.

Exhibitions and Cultural Engagement
Jenny Brownrigg, Exhibitions Director, GSA Exhibitions.
Caroline Grape, Exhibitions and Cultural Engagement Coordinator, GSA Exhibitions.

British Medical Ultrasound Society
Joy Whyte, General Secretary, British Medical Ultrasound Society.
John EE Fleming, British Medical Ultrasound Society.
Professor Peter Hoskins, Professor of Medical Physics and Biomechanics, University of Edinburgh.

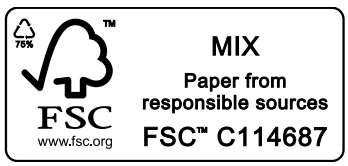
Colleagues, alumni and students
Dr Frances Robertson, Reader in Material Cultures of Drawing, School of Design, GSA.
Susan Roan and Emma Keogh, Lecturers in Communication Design, School of Design, GSA.
Professor Steve Love and Dr Matthieu Poyade, School of Simulation and Visualisation, GSA.
Sophie Koegl, MSc student 2016, Medical Visualization and Human Anatomy, School of Simulation and Visualisation, GSA.
Callum Rice, GSA Alumnus, film-maker.

Scottish Parliamentary Motion, S5M-14921,
11th December 2018.
Angela Constance, MSP, Almond Valley, Michael Russell, MSP Argyll and Bute.

Funding and support
The Royal Society of Edinburgh, Arts & Humanities Small Research Grant.
The Royal College of Physicians and Surgeons of Glasgow.
Glasgow City Council.
The Glasgow School of Art Research Development Grant.
The Glasgow School of Art Exhibitions.
The Glasgow School of Art Marketing.
The Glasgow School of Art Press Office.

Publication and exhibition graphics
Christine Jones, Graphic Designer.

Printed on Revive 100 Natural and Revive 75 Matt.



Arguably the most important technological development to affect the lives of women in the last 60 or so years has been diagnostic obstetric ultrasound. For a few short years in the late 1950s and early 1960s, Glasgow led the world in its development. A unique collaboration between clinical obstetrics, engineering, electronics and industrial design expertise created the very first prototypes and production models of ultrasound scanners for use in routine obstetrics scanning - anywhere in the world - for use in Glasgow hospitals

I had a desire to make the thing ergonomically better so that the approach to the patient was better and that the doctors would find it easier to use. I could draw something that wasn't there and therefore I could draw what they were proposing which I didn't think looked appropriate for pregnant ladies. Through my drawings I was able to persuade Tom Brown to change what he was proposing for the Sundén machine. I would maintain to this day that the original design of this Sundén machine would stand up now in terms of its basic configuration, which was carried through and extended, in terms of the design, in the Diasonograph. Dugald Cameron