Notes

1 Total Hip Replacement: Introduction, Sources and Outline

1 'Railway Engineer's Suicide', *The Times* (9 May 1933).
2 Henderson, Melvin S. and Pollock, George A., 'Surgical Treatment of Osteoarthritis of the Hip Joint', *Journal of Bone and Joint Surgery*, 22 (1940), 923.
3 Cortisone was first synthesised in 1948 by the pharmaceutical company Merck. For the story of cortisone see Le Fanu, James, *The Rise and Fall of Modern Medicine* (London: Little, Brown and Company, 1999), 17–28.
4 Most of the early designs of these single component prostheses were developed mainly in the US and in France. See Coventry, Mark B., 'Lessons Learned in 30 Years of Total Hip Arthroplasty', *Clinical Orthopaedics and Related Research*, 274 (1992), 22–9.
5 See Lerner, Barron H., *The Breast Cancer Wars: Hope, fear and the pursuit of a cure in twentieth-century America* (Oxford: Oxford University Press, 2001). For reflections on the role of surgery in different countries see Pickstone, John V., 'Contested Cumulations: Configurations of cancer treatments through the twentieth century', *Bulletin of the History of Medicine*, 81 (2007), 164–96.
6 For a history of TB in the twentieth century see Bryder, Linda, *Below the Magic Mountain: A social history of tuberculosis in twentieth century Britain* (Oxford: Oxford University Press, 1988).
7 Osteoarthritis is a degenerative condition, usually seen in older people and often affecting weight bearing joints in the lower limbs. See Cantor, David, 'Representing "The Public": Medicine, charity and emotion in twentieth century Britain', in Sturdy, Steve (ed.), *Medicine, Health and the Public Sphere in Britain, 1600–2000* (London: Routledge, 2002), 145–68.
8 *South Bend Tribune* (12 October 2003).
9 *The Financial Times* (22 May 2003).
10 Eftekhar, Nas, 'Founder of the Hip Society (USA) Frank E. Stinchfield', *Clinical Orthopaedics and Related Research*, 285 (1992), 12.
11 Charnley's significant other works include *The Closed Treatment of Common Fractures* (London: Churchill Livingstone, 1950), *Compression Arthrodesis* (London: Churchill Livingstone, 1953).
12 Sarmiento, Augusto, *Bare Bones: A Surgeon's Tale: The price of success in American medicine* (Amherst: Prometheus, 2003).
13 See Faulkner, Alex, 'Casing the Joint: The material development of artificial hips', in Katherine Ott, *et al.* (eds), *Artificial Parts, Practical Lives: Modern histories of prosthetics* (New York: New York University Press: 2002), 199–226.
14 Miller, Dane, 'Orthopaedic Product Technology During the Second Half of the Twentieth Century', in Klenerman, Leslie (ed.), *The Evolution of Orthopaedic Surgery* (London: Royal Society of Medicine Press, 2002), 211–28.

15 Klenerman, Leslie (ed.), *The Evolution of Orthopaedic Surgery* (London: Royal Society of Medicine Press, 2002).
16 Klenerman, Leslie, 'Arthroplasty of the Hip', in Klenerman, Leslie (ed.), *The Evolution of Orthopaedic Surgery* (London: Royal Society of Medicine Press, 2002), 13–23.
17 Heck, Charles V., *1933–1983 Fifty Years of Progress* (Chicago: American Academy of Orthopaedic Surgeons, 1983).
18 Waugh, William, *A History of the British Orthopaedic Association: The first seventy five years* (London: British Orthopaedic Association, 1993).
19 See Jeffrey, Kirk, *Machines in Our Hearts: The cardiac pacemaker, the implantable defibrillator and American health care* (Baltimore: Johns Hopkins University Press, 2001).
20 See Blume, Stuart, *Insight and Industry: On the dynamics of technological change in medicine* (Boston: MIT Press, 1992).
21 See Howell, Joel, *Technology in the Hospital: Transforming patient care in the twentieth century* (Baltimore: John Hopkins University Press, 1995).
22 See Pickstone, John (ed.), *Medical Innovations in Historical Perspective* (Basingstoke: Macmillan, 1992); Lowy, I. (ed.), *Medicine and Change: Historical and sociological studies of medical innovation* (Paris: INSERM/John Libbey, 1993); Stanton, J. (ed.), *Innovations in Health and Medicine: Diffusion and resistance in the twentieth century* (London: Routledge, 2002); Lawrence, G. (ed.), *Technologies of Modern Medicine: Proceedings of a seminar held at the science museum* (London: Science Museum, 1994).
23 See Stanton, J., 'Making Sense of Technologies in Medicine', *Social History of Medicine*, 12 (1999), 437–48; Marks, H.M., 'Medical Technologies: Social contexts and consequences', in Bynum, W. and Porter, R. (eds), *Companion Encyclopaedia of the History of Medicine*, Vol. 2 (London: Routledge, 1993), 1592–618.
24 See Cooter, Roger, 'The Politics of a Spatial Innovation: Fracture clinics in inter-war Britain', in Pickstone, John V. (ed.), *Medical Innovations in Historical Perspective*, 146–64.
25 Sturdy, Steve, 'From the Trenches to the Hospitals at Home: Physiologists, clinicians and oxygen therapy', in Pickstone, John V. (ed.), *Medical Innovations in Historical Perspective*, 104–23.
26 See Cantor, David, 'Cortisone and the Politics of Drama', in Pickstone, John V. (ed.), *Medical Innovations in Historical Perspective*, 165–84.
27 'Hip Histories' at the RCS ran from March to July 2006 and more details can be found on the following websites: http://news.bbc.co.uk/1/hi/health/4906010.stm and http://www.hero.ac.uk/uk/culture_sport/archives/2006/radical_surgery.cfm. 'The Patient's Journey' is a permanent exhibition in the foyer of Wrightington Hospital, opened in October 2006; it was designed to educate patients about the benefits, risks and unknowns of Joint Replacement Surgery. 'The Surgeon's Journey' is an exhibition devoted to the work of John Charnley and the development of hip replacement at Wrightington. It will open in summer 2007 and it will be located in the Biomechanics Laboratory where Charnley carried out his experiments. The Hunterian Museum at the RCS (London) has a small permanent display on THR in its upper gallery on the history of surgery; the Thackray Medical Museum (Leeds) also has a display in its 'Pain, Pus and Blood' gallery, that

explores the relationship between Charnley and the Thackray company. In the US, there are a number of museums of science and technology that cover general themes related to THR, including the Museum of Science in Boston, the Museum of Science and Industry in Chicago, and the museums of the Smithsonian Institution in Washington D.C. In the UK, the Museum of Science and Industry in Manchester and the Science Museum in London both have many exhibitions devoted to technology, including medical technologies. The Science Museum has websites focussing on technology, including http://www.ingenious.org.uk and http://www.makingthemodern-world.org.uk.

28 The transcript of the seminar is published in the volume: Reynolds, L.A. and Tansey, E.M. (eds), 'The Early Development of Total Hip Replacement', in *Wellcome Witnesses to Twentieth Century Medicine*, Vol. 29 (London: The Wellcome Trust Centre for the History of Medicine at UCL, 2007).

29 See respectively Schwartz-Cowan, Ruth, *More Work for Mother: The ironies of household technologies from the open hearth to the microwave* (New York: Basic Books, 1983); Hounshell, David A., *From the American System to Mass Production, 1800–1932* (Baltimore: Johns Hopkins, 1988); and Hughes, Thomas P., *Networks of Power: Electrification in western society 1880–1930* (Baltimore: Johns Hopkins, 1983).

30 Rosenberg, Nathan, *Inside the Black Box: Technology and Economics* (Cambridge, CUP, 1982). The volume edited by Pickstone (1992) originated in a Manchester seminar series intended to bring together history of medicine, history of technology, economics of technology, and innovation and policy studies.

31 See e.g., Metcalfe, J.S., *Evolutionary Economics and Creative Destruction* (London: Routledge 1998).

32 See e.g., Pinch, Trevor J. and Bijker, Wiebe E., 'The Social Construction of Facts and Artefacts: Or how the sociology of science and the sociology of technology might benefit each other', *Social Studies of Science*, 14 (1984): 399–441, and the essays in MacKenzie, Donald and Wajcman, Judy (eds), *The Social Shaping of Technology: How the refrigerator got its hum* (Buckingham: Open University Press, 1985).

33 See the series edited by Geljns, Annetine C., *et al.* entitled *Medical Innovation at the Crossroads*, and published by the National Academy Press, Washington; it discusses medical technologies from an economic rationale.

34 Metcalfe, J.S. and Pickstone, John, 'Replacing Hips and Lenses: Surgery, industry and innovation in post-war Britain', Webster, Andrew (ed.), *New Technologies in Health Care: Challenge, change, innovation* (Basingstoke: Palgrave, 2006), 146–60.

35 Timmermann, C. and Anderson, J. (eds), *Devices and Designs: Medical technologies in historical perspective* (Basingstoke: Palgrave, 2006).

36 Anderson, Julie, 'Greenhouses and Bodysuits: The challenge to knowledge in early hip replacement surgery', in Timmermann, C. and Anderson, J. (eds), *Devices and Designs*, 175–92.

37 Anderson, Julie, 'Innovation and Locality: Hip replacement in Manchester and the Northwest', *Bulletin of the John Rylands Library of the University of Manchester*, Vol. 87 (2007), forthcoming.

38 Cooter, Roger, *Surgery and Society in Peace and War. Orthopaedics and the organization of modern medicine* (Basingstoke: Macmillan, 1993).
39 See Pickstone, John V., *Medicine and Industrial Society: A history of hospital development in Manchester and its region 1752–1946* (Manchester: Manchester University Press, 1985); Cooter, Roger and Pickstone, John, 'From Dispensary to Hospital. Medicine, community and workplace in Ancoats, 1828–1948', *Manchester Regional History Review*, 7 (1993), 73–84; and Butler, S.V.F., 'Academic medicine in Manchester: The careers of Geoffrey Jefferson, Harry Platt and John Stopford', in *Bulletin of the John Rylands Library of the University of Manchester*, Vol. 87 (2007).
40 This long Manchester history, from the bone-setters near Rochdale to the present day connections of Wrightington with multinational prosthesis manufacturers, is explored in Pickstone, John V., 'Bones in Lancashire: Towards long-term contextual analysis of medical technology', in Timmermann, C. and Anderson, J. (eds), *Devices and Designs*, 17–36. It is, throughout, a very transatlantic history.
41 Schlich, Thomas, *Surgery, Science and Industry: A revolution in fracture care, 1950s–1990s* (Basingstoke: Palgrave, 2002).
42 McKee had also visited Thompson in New York and used a modified Thompson early in his practice. Philip Wiles used a two-component hip prosthesis – one of the first known designs. See Wiles, Philip, 'The Surgery of the Osteo-Arthritic Hip', *British Journal of Surgery*, 45 (1958), 488–97.
43 In a few cases it was agreed with Charnley that a prosthesis could be called the Charnley type. These included one by Maurice Müller from Berne. A vast number, however, were not.
44 Stryker fact book, 2006–7 http://library.corporate-ir.net/library/11/118/118965/items/233597/2006_2007FactBook.pdf
45 Hidefjäll, Patrik, 'Biotronik: 40 years of German entrepreneurship in medical technology', in Timmermann, C. and Anderson, J. (eds), *Devices and Designs: Medical technologies in historical perspective* (Basingstoke, Palgrave, 2006) 112–36; Jeffrey, Kirk, *Machines In Our Hearts*; Thomas Schlich, *Surgery, Science and Industry*.
46 See the *National Joint Registry Report Summary* (2004), 6 or http://www.njr-centre.org.uk/documents/reports/annual/1st/sumreport04.pdf
47 Saleh, K.J., *et al.*, 'Economic Evaluations in the Hip Arthroplasty Literature: Lessons to be learned', *Journal of Arthroplasty*, 14:5 (1999), 527–32.
48 Madhok, R., *et al.*, 'Utilization of Upper Limb Joint Replacements During 1972–90: The Mayo Clinic experience', *Proceedings of the Institution for Mechanical Engineers*, Vol. 207 (1993), 239–44.
49 The Royal College of Surgeons of England, *An Investigation of the Performance of the 3M Capital Hip System*, London (2001), 12.

2 Surgeons and Engineers in Postwar Britain: Medical Technology in Local Contexts

1 This procedure is known as 'arthrodesis' (the surgical fusion of a joint to reduce pain and improve stability). It was developed around 1800 by P.F. Moreau in France and H. Park in Liverpool for excising tuberculosis

joints to get rid of the infection (Park, H. and Moreau, P.F., *Cases of the Excision of Carious Joints* (Glasgow: J. Scrymgeour, 1806). It was always a more common procedure for the knee (and later the spine, wrist and ankle) than the hip. The term was first used to describe an ankle operation by Eduard Albert of Vienna in 1882 (see 'Einige Fälle von kunstlicher Ankylosenbildung an paralytischen Gliedmassen', *Wiener medizinische Presse*, 23 (1882), 725–8) and further developed by H.A. Brittain in Norwich, who published *Architectural Principles in Arthrodesis* in 1952.

2 The most common procedure to restore movement in a painful, stiff hip in the early 20th century was 'osteotomy' (the surgical cutting of a bone to shorten, lengthen or realign it). In 1827 the US surgeon, John Rhea Barton, described an operation which cut through the femur between the greater and lesser trochanters to create a false joint to secure motion in an ankylosed hip ('On the treatment of ankylosis by the formation of artificial joints', *North American Medical & Surgical Journal*, 3 (1827), 179–92). In Liverpool in the 1930s, Thomas Porter McMurray developed a displacement osteotomy for fractures of the femoral neck and arthrodesis of the hip (McMurray, T.P., 'Osteoarthritis of the hip joint', *Journal of Bone and Joint Surgery*, 21B (1939), 1–11).

3 Ghormley, Ralph K. and Coventry, Mark B., 'Surgical Treatment of Painful Hips of Adults', *Journal of Bone and Joint Surgery*, 22B (1942), 426.

4 Henderson, Melvin S. and Pollock, George A., 'Surgical Treatment of Osteoarthritis of the Hip Joint', *Journal of Bone and Joint Surgery*, 22B (1940), 930.

5 *The Orthopaedist*, Vol. 1, No. 3 (March 1920), 6.

6 For instance, treatment at the Wrightington TB hospital (near Wigan), opened in 1933, combined established sanatorium regimes and the teachings of Sir Robert Jones (of Liverpool), leading to a scheme of rest, fresh air and good food, augmented with artificial light therapy. No surgery was performed on the infected joint until the disease was cleared. For more details see Swinburn, W.R., *Wrightington Hospital 1933–1983: The story of the first 50 years* (Wigan: Wrightington Hospital, 1983).

7 Wiles reported the results of this pioneering surgery in Wiles, P.W., 'The surgery of the osteoarthritic hip', *British Journal of Surgery*, 45 (1958), 488–97.

8 These half replacements for the femur of the hip are known as 'hemi-arthroplasties' and early ivory prostheses were used by Themistocles Gluck in Berlin (1894) and Hey Groves in Bristol (1923).

9 These procedures are known 'inter-positional arthroplasties'. Louis Ollier in Lyon (1885), John B. Murphy in Chicago (1902) and Putti in Italy (1921) tried a number of inter-positional materials including gold and fat and fascia.

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12 Thompson, F.R., 'Vitallium Intramedullary Hip Prosthesis – preliminary report', *New York State Journal of Medicine*, 52 (1952), 3011–20; Thompson, F.R., 'Two and half years' Experience with the Vitallium Intramedullary Hip Prosthesis', *Journal of Bone and Joint Surgery*, 36A (1954), 489–502.
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14 Law, W.A., 'Late Results in Vitallium Mould Arthroplasty of the Hip', *Journal of Bone and Joint Surgery*, 44A (1962), 1497.
15 Haboush, E.J., 'A New Operation for Arthroplasty of the Hip based on Biomechanics, Photoelasticity, fast-setting Dental Acrylic, and other considerations', *Bulletin of the Hospital for Joint Diseases*, 14 (1953), 242–77.
16 McKee, G.K. and Watson-Farrar, J., 'Replacement of Arthritic Hips by the McKee-Farrar Prosthesis', *Journal of Bone and Joint Surgery*, 48B (1966), 245.
17 In Charnley's 1953 book, *Compression Arthrodesis*, he advocated a technique called 'central dislocation' of the hip, which was a type of arthrodesis, sometimes using a compression screw. For an evaluation of his new method see Charnley, John, 'Experiences in the Evolution of a New Operation for Osteoarthritis of the Hip Joint', *Journal of Bone and Joint Surgery*, 34B (1952), 506.
18 McKee, G.K., 'Faith healing by a Fellow of the Royal College of Surgeons', *The Mancroft Review*, publisher and date unknown, 1.
19 McKee, G.K., 'Faith Healing', 1.
20 McKee, G.K., 'The Use of Metal in Bone Surgery', *Proceedings of the Royal Society of Medicine*, 50 (1957), 837–40.
21 McKee, G.K., 'Artificial Hip Joint', *Journal of Bone and Joint Surgery*, 33B (1951), 465.
22 McKee, G.K., 'Artificial Hip Joint' (1951), 465.
23 McKee, G.K., 'Developments in total hip joint replacement', *Proceedings of the Institution of Mechanical Engineers*, 181 (1966–7), 85–9.
24 McKee, G.K. and Chen, S.C., 'The Statistics of the McKee-Farrar Method of Total Hip Replacement', *Clinical Orthopaedics and Related Research*, 95 (1973), 26.
25 McKee, G.K. and Chen, S.C. (1973), 29.
26 McKee, G.K. and Chen, S.C. (1973), 30.
27 McKee, G.K., 'Development of Total Prosthetic Replacement to the Hip', *Clinical Orthopaedics and Related Research*, 72 (1970), 101–2.
28 McKee, G.K. and Chen, S.C. (1973), 26–33.
29 K.H. Täger in Germany was a notable example. See Täger, K.H., 'Untersuchungen an Oberflächen und Neogelenkkapseln getragener McKee-Farrar-Endoprothesn', *Archiv für orthopädische und Unfall-Chirurgie*, 86 (1976), 101–13, and Täger, K.H., 'Oberflächen und Neogelenkkapseln getragener McKee-Farrar-Endoprothesen', *Archiv für orthopädische und Unfall-Chirurgie*, 87 (1994), 39–49.
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45 Visuri, T. and Koskenvuo, M., 'Cancer Risk after McKee-Farrar Total Hip Replacement', *Orthopaedics*, 14 (1991), 137–42.
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50 For Charnley's own account of how the Unit was set up see Charnley, John, 'The Development of the Centre for Hip Surgery at Wrightington Hospital', in Swinburn, W.R., *Wrightington Hospital 1933–1983: The story of the first 50 years* (Wigan: Wrightington Hospital, 1983), 36–42.
51 Schlich, Thomas, *Surgery, Society and Industry. A revolution in fracture care, 1950s–1990s* (Basingstoke: Palgrave, 2002).
52 Butler, S.V.F., 'Academic Medicine in Manchester: The careers of Geoffrey Jefferson, Harry Platt and John Stopford', in *Bulletin of the John Rylands Library of the University of Manchester*, Vol. 87 (2007), forthcoming.
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55 See Waugh, *Charnley* (1990), 117, for an account of these early, home-grown manufacturing practices.
56 Waugh, *Charnley* (1990), 117.
57 The rig was a sliding beam with samples of the stainless steel femoral component on it. On the 'heads' were samples of the acetabular material. The rubbing action was loaded to the equivalent of 300 pounds per square inch.
58 The operation was developed by the Oswestry GP, and later Oxford orthopaedic surgeon, Gathorne Robert Girdlestone (Girdlestone, G.R., 'Acute Pyogenic Arthritis of the Hip: An operation giving free access and effective drainage', *The Lancet*, 244 (1943), 419–21). It was developed as an operation to excise infected joints that was often life-saving in the pre-antibiotic era and it followed from the earlier work of many surgeons, including Anthony White who performed joint excision in London in 1822. It involves removing most of the hip joint and capsule and it is still used as a last resort, usually after a number of failed THRs. The joint becomes fixed with fibrous tissue and the patient walks with a stick and two-inch shoe raise. They have a limp but usually no pain.
59 Waugh, *Charnley* (1990), 139–40.
60 Interview: Mr. Harry Craven, Wrightington, 25/9/2001.
61 Waugh, *Charnley* (1990), 122.
62 Interview: Mr. Harry Craven, Wrightington, 25/9/2001.
63 Waugh, *Charnley* (1990), 124.

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65 Charnley, John, 'Total Prosthetic Replacement of the Hip', *Triangle*, 8 (1969), 211–16. For further results, see Charnley, John, 'Total Hip Replacement by Low-Friction Arthroplasty' (1970), and Charnley, John, 'The long term results of Low Friction Arthroplasty of the Hip Performed as a Primary Intervention', *Journal of Bone and Joint Surgery*, 54B (1972), 61–76.
66 Wainwright, Penny, *Opposite the Infirmary: A history of the Thackray company 1902–1990* (Leeds: Medical Museum, 1997), 76–7.
67 For an account of Charnley's trochanteric osteotomy surgical approach and method, see Charnley, John, *Low Friction Arthroplasty of the Hip: Theory and practice* (New York: Springer-Verlag, 1979).
68 Charnley, *Low Friction Arthroplasty (*1979), 347.
69 Scales was a prime mover in setting up this first university department of Biomedical Engineering in Britain. On returning from National Service in the Royal Army Medical Corps, Scales had convinced the Director of the Institute of Orthopaedics, H.J. Seddon, that there was a place for biologically inert plastic materials to replace diseased joints and he led a new department of plastics. In the early 50s, he developed metal on plastic knee prostheses to treat tumour cases and was instrumental in the setting up of a bone tumour unit at the RNOH. As mechanical engineers became interested in his work, he persuaded British Petroleum to second one of its engineers to Stanmore. Scales became the first professor of biomedical engineering in the newly-created department in 1974.
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94 Ling, Robin, 'The Development of the Exeter hip' in Faux, J.C. (ed.), *After Charnley* (Preston: The John Charnley Trust, 2002), 146–69.
95 Ling tried the direct lateral approach during one year but lack of patient mobility and increased postoperative pain caused him to return to the posterior. He also used a wide trochanterotomy from the posterior approach when recovering failed stems.
96 Charnley was never convinced but he did finally visit Exeter in 1982, shortly before his death. He was impressed by the research undertaken by Clive Lee, in conjunction with the Department of Chemistry, on the metabolism of methyl methacrylate. He went in theatre with Ling and was characteristically anxious about the positioning of the femoral component, given what you could see with posterior approach. He found the absence of the greater trochanter until the suturing stage very disorientating. (Interview: Dr Clive Lee, Exeter, September, 2002).
97 Ling, R.S.M., Lee, A.J.C. and Thornett, C.E.E., 'The Collarless Intramedullary Stem', *Journal of Bone and Joint Surgery*, 60B (1978), 137.
98 Interview: with Dr Clive Lee, Exeter, September 2002.
99 Ling, Robin, in Faux, J.C. (ed.) *After Charnley* (2002), 152.
100 'First Annual Report', *National Joint Registry for England and Wales* (September 2004).
101 Waugh, *Charnley* (1990), 93 and 130–1.

3 The Industrial Development of British Hip Replacements and the Charnley/Thackray Relationship

1 Downs Orthopaedic Surgery Catalogue, 1983.
2 The factory on Tabard Street closed in 1981.
3 Down Bros. and Meyer and Phelps Catalogue, 1951.
4 Advertising Section, *Journal of Bone and Joint Surgery*, Vol. 46A (1964), no page number.
5 Down Bros. and Meyer and Phelps Catalogue, 1951.
6 Norman S. Martin had shown his prosthesis at the 1948 meeting of the British Orthopaedic Association in Belfast. Down Bros., Mayer and Phelps Catalogue, 1951.
7 Down Bros., Mayer and Phelps Catalogue, 1961.
8 London Splint Company Catalogue, 1964.
9 Advertising Section, *Journal of Bone and Joint Surgery*, Vol. 54B (1972), no page.
10 Lusterlite Pamphlet, no date c. 1950s.
11 Lusterlite Pamphlet, no date c. 1960.
12 Discussion with Alan Humphries, Thackray Museum, Leeds, June 2006.
13 Downs Catalogue, 1978.
14 Advertising Section, *Journal of Bone and Joint Surgery*, Vol. 54B (1972), no page number.
15 Advertising Section, *Journal of Bone and Joint Surgery*, Vol. 56B (1974), no page number.
16 'By the late 1930s we were coming out of the depression and J.O. Zimmer needed capital to grow on so he brought all of his sales force, which were a total of ten people, to Warsaw and sold thirty percent of the company to them. He forgot to invite the guy from New York. Well there are two stories and J.O. Zimmer had died long before I got involved in orthopaedics so I didn't hear his side of the story, although I've read it in print. But I did hear directly from Frank Siemen who ultimately founded an orthopaedic equipment company. He was the New York distributor and he claims that J.O. Zimmer deliberately invited him a day late. J.O. Zimmer's claim was that typical of a New Yorker he showed up a day late. So I don't know which story, but anyway he didn't get a piece of the action and Mr Siemen who was actually a native New Yorker, and Mr Zimmer never got along very well apparently; and so they agreed that he would go to Europe and establish Zimmer's presence in Europe, which he did, and at the same time registered the Zimmer name in his own name in fifty seven countries and ultimately sold the name back to OEC in the mid-80s.' Interview with Dane A. Miller, September 2002.
17 See History – the JRI Story: www.jri-ltd.co.uk.
18 Howse Catalogue, 1976.
19 *The Times* (26 April 1972).
20 Phyllis Hampson in Reynolds, L.A. and Tansey, E.M. (eds), *The Early Development of Total Hip Replacement*, 'Wellcome Witnesses to Twentieth Century Medicine', Vol. 29 (London: The Wellcome Trust Centre for the History of Medicine at UCL, 2007).

21 For a complete history of the Thackray Company see Penny Wainwright, *Opposite the Infirmary: A history of the Thackray company 1902–1990* (Leeds: Medical Museum, 1997).
22 *Ibid*.
23 Letter from Jose Manuel Del Sol to William Waugh, 6 June, 1988.
24 William Waugh, *John Charnley: The Man and the Hip* (London: Springer-Verlag, 1990), 169–70.
25 'Surgeon and Engineer', *The Lancet* (11 February, 1961), 325–6.
26 Charnley, J., 'Surgeon and Engineer', *The Lancet* (25 February 1961), 449.
27 Letter to John Charnley from W.P. Thackray, 7/5/71. (This and the other Charnley letters referenced below are in the Charnley Papers, Manchester Medical Archive, John Rylands University Library, University of Manchester).
28 Wainwright, *Opposite the Infirmary* (1997), 76.
29 Charnley, 'Surgery of the Hip Joint', *British Medical Journal* (19 March 1960).
30 Advertising Section, *Journal of Bone and Joint Surgery*, 52A (1970), no page.
31 Letter to Charnley from T. Beardmore, 12/12/68.
32 Wainwright, *Opposite the Infirmary* (1997), 79.
33 Thackray Catalogue, 1975.
34 Thackray Catalogue, 1970.
35 Thackray Catalogue, 1970.
36 Advertising Section, *Journal of Bone and Joint Surgery*, 52A (1970), no page.
37 *Charnley Instruments for Low Friction Arthroplasty of the Hip Joint*, Thackray Catalogue, 1969, 3.
38 Thackray Catalogue, 1981.
39 Foreword in Thackray Catalogue, 1975.
40 Thackray Catalogue, 1975.
41 Letter to W.P. Thackray from Charnley, 22/4/68.
42 Letter to Charnley from W.P. Thackray, 27/2/68.
43 Letter from Charnley to J.L.W. Lockhart, 26/1/68.
44 (AAOS on line).
45 Put into 2005 prices using GDP deflator, these indicate increases: taking 1968 as 100, to 162 by 1995, 170 by 1996 and to 355 by 2004. While the rise of 62% from 1968–1995 seems reasonable, the doubling in price between 1995 and 2004 seems high.
46 Advertising Section, *Journal of Bone and Joint Surgery*, 54B (1972), no page.
47 These included Howmedica (1972), Deloro Surgical (1972), Zimmer (1972), OEC (1973) and Downs Surgical Ltd (1975). A Charnley prosthesis modified by Kerboull was advertised by Benoist Girard and Co. in 1975.
48 Letter from T. Beardmore to Charnley, 9/7/68.
49 Letter to P.C. Blackmore, Sales Manager London Splint Company, from John Charnley, 1/7/68.
50 Letter from John Charnley to W.P. Thackray, 6/4/72.
51 Letter to W.P. Thackray from Charnley, 4/12/73.
52 Personal Views on the Failure of Thackray to Develop Their Potential According to my Hopes, 13/1/76. Note in Charnley Archive.
53 Advertising Section, *Journal of Bone and Joint Surgery*, 53A (1971), 108–9.

54 Letter from Charnley to P.C. Blackmore, 1/7/68.
55 Charnley-Müllers were also copied and many Charnley-Müller types were advertised in the *Journal of Bone and Joint Surgery*.
56 Letter to Lockhart from Charnley 24/7/70.
57 This was eventually scrapped when it was realised that Thackray would not be able to gain access to competitors' factories to assess whether or not the patent was being infringed. See correspondence between Tod Thackray and Charnley, May 1971.
58 In 1981, one surgeon purchased some prostheses manufactured by a large rival firm and posted them to Thackray as he felt that the other firm's business practices were unethical. Letter from Charnley to Ron Frank, 21/5/80.
59 Discussion with Christopher Faux, 2007.
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64 For example, see Waugh, *John Charnley*, pp. 218–19.
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66 Letter to John Thackray from John Charnley, 5/7/72.
67 Presentation to the Institution of Mechanical Engineers, 3/1/74.
68 Letter to John Thackray from Charnley, 9/6/71.
69 Discussion with Alan Humphries, Thackray Museum, Leeds, June 2006.
70 Letter to R. Frank from Charnley, 28/8/75.
71 Letter from Charnley to John Thackray, 27/8/71.
72 Charnley was not actually sued throughout his medical career. Letter to G. Robinson from Charnley, 14/5/73.
73 Report to G.J. Robinson from G. Parkin, 5/11/73.
74 Letter to W.P. Thackray from Charnley, 5/3/74.
75 Letter to W.P. Thackray from Charnley, 14/3/74.
76 Letter to Charnley from M.P. Jones, 3/1/74.
77 Letter to Charnley from J.D. Boyd, 9/4/74.
78 Letter to J.P. Thackray from Charnley, 5/1/71.
79 Letter to Charnley from R. Frank, 23/9/74.
80 Letter to W.P. Thackray from Charnley, 23/11/72.
81 Waugh, *Charnley*, p. 216.
82 OEC was bought by Biomet in the mid-1980s.
83 Company History Listings, Thackray Museum Archive, Leeds, England.
84 www.corin.co.uk/aboutus.asp.
85 *The Sheffield Star* (9 July 2003).
86 www.smithandnephew.com (accessed 15 August 2004).
87 www.smithandnephew.com (accessed 15 August 2004).

4 Medical Technology and Industrial Dynamics: The United States and the Global Market

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2 The Stryker frame was a bed which was designed in the 1930s in which the patient could be turned so as to prevent pressure sores that could become seriously infected. See Breneman, James C., *The Stryker Story: Homer's Iliad* (Michigan: Phil Schubert and Associates, 1992).
3 www.depuy.com (30 May 2003).
4 Zimmer, *In the Spirit of Excellence* (Warsaw: Zimmer, 1986), 7.
5 See Guttmann, Ludwig, *Spinal Cord Injuries: Comprehensive management and research* (Oxford: Blackwell Scientific Publications, 1973), 5; and Ward, R.O., 'The Management of the Bladder in Spinal Injuries', in H. Hamilton Bailey (ed.), *Surgery of Modern Warfare* (Edinburgh: E & S Livingstone, 1944), 661.
6 Advertisement, *Journal of Bone and Joint Surgery*, Vol. 54A (1972), no page.
7 Austin Moore and Harold Bohlman inserted the first Vitallium endoprosthesis in 1943. F.R. Thompson of New York inserted his first prosthesis in 1953. Both prostheses are still in use today. See Klenerman, Leslie, 'Arthroplasty of the Hip', in Klenerman, Leslie (ed.), *The Evolution of Orthopaedic Surgery* (London: The Royal Society of Medicine Press, 2002), 14.
8 Catalogue from the London Splint Company, 1964, no page. The London Splint Company was closely allied with Howmedica.
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10 Zimmer pamphlet, no date.
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13 *Journal of Bone and Joint Surgery*, Vol. 46A, 1964.
14 Advertisement, *Journal of Bone and Joint Surgery*, 46A (1964), no page.
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16 Advertisement, *Journal of Bone and Joint Surgery*, 53A (1971), no page.
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30 Standard and Poors, 2003.
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68 *The New York Times* (21 May 1978).
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5 Change and Stability in Technical Systems: Materials and Environments

1 Although very recently this has become less of a factor as surgeons at specialist centres are often trained in multiple approaches and select prostheses and approaches based on the clinical needs of the patient.
2 Bijker and his colleagues have looked at competing technologies in the bicycle and concluded that many of the reasons for a particular technology 'winning out' over another were that certain bicycles came to embody the interests of particular social groups. See Bijker, W.E., Hughes, T.P. and Pinch, T. (eds), *The Social Construction of Technological Systems: New directions in the sociology and history of technology* (Cambridge, MA: MIT Press, 1989); Bijker, W.E., *Of Bicycles, Bakelites, and Bulbs: Toward a theory of sociotechnical change* (Cambridge, MA and London, England: MIT Press, 1995).
3 In discussion with Christopher Faux, he suggested that the general consensus on follow up is 6.5 years.

4 An example of a relatively slow feedback systems on failures and the many variables involved can be found in the case of the Charnley Elite-Plus hip system put on the market by DePuy in 1993. Some combinations offered a new type of polyethylene (Hylamer) and a new type of ceramic head (Zirconia). Despite performing well in laboratory tests, 17% of these combinations failed and a further 41% were loose after ten years. But early failures did not become apparent until 1997 and the extent of the failures and potential future failures were not fully know until 2005 after long-term radiostereometric analysis. See Livingston, B.J., *et al.*, 'Complications of Total Hip Arthroplasty Associated with the use of an Acetabular Component with a Hylamer Liner', *Journal of Bone and Joint Surgery*, Vol. 79A (1997), 1529–38; Hauptfleisch, J., *et al.*, 'The Premature Failure of the Charnley Elite-Plus Stem', *Journal of Bone and Joint Surgery*, Vol. 88B (2006), 179–83.

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Although the data sources changed during the period, the data are comparable. Data were drawn from the Hospital In-Patient Enquiry scheme (HIPE) 1967 to 1985, and from Hospital Episode Statistics (HES) 1989–2005. HIPE data refer to Deaths and Discharges, and HES to Admissions which measure the same thing, that is persons admitted or equivalently, discharged. The use of admissions rather than consultant episodes avoids the problem of some patients having multiple episodes of care within a single admission. The graph shows a rise in 1967–1985 under HIPE followed by a gap to 1989 which is shown with a lower total than 1985. This is likely to be due to HES undercounting for the first few years. As shown the number rose sharply in 1992 to above the 1985 level and continued to rise sharply thereafter. The gap 1996–1998 is due to the non availability of HES online for those years.

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