Mechanising the Needle:
The Development of the Sewing Machine as a Manufacturing Tool, 1851-1980

Lin Gardner

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School of Humanities

College of Arts

University of Glasgow

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Abstract

The sewing machine is a ubiquitous technology. Yet despite its contribution to the mechanisation of innumerable trades associated with the needle, its role as a domestic machine has overshadowed its significance as a manufacturing tool. This thesis redresses this imbalance and offers the first comprehensive examination of the sewing machine as a specialised tool for manufacturing. Because the process of mechanisation did not occur in isolation, this thesis employs a cross-disciplinary approach, which interleaves material culture and economic analyses, to situate the process within the dynamic relationships that surrounded it. This multi-dimensional view of machine development not only demonstrates that mechanisation was an adaptive and responsive process, it also reveals the significance of the stitched object and object maker to the direction of the sewing machine's technological development.

The range of manufacturing models produced by one of the world's most significant sewing machine manufacturers, the Singer Company, is used as the primary resource. Trade literature, machine models, and company records from collections in both the United States and the West of Scotland, which was the site of one of the Singer Company's largest factories, capture the scope and diversity of development undertaken by this major American manufacturer. The depth and breadth of this development serve as a proxy for the development of the sewing machine as a manufacturing tool during the nineteenth and twentieth centuries.

The thesis is divided into two parts. The first part concentrates on the range and scope of machine development. It illustrates how the size, shape, material, and construction of stitched objects directly influenced the shape and specialisation of the sewing machine as a manufacturing tool. It also uses examples of prototype building to explore the important influence of the relationship between stitched object maker and machinery maker, and examines the changing appearance of the sewing machine to demonstrate the strength and extent of this influence. The second part examines the interaction between production and consumption. It uses object studies of men's shirts and women's shoes to explore the influence of changing fashion and consumer taste on the direction of specialised machine development. Stitched objects provide an original interpretative source for a history of technology for two reasons. First, they capture the relevance of trade structure to the adoption and diffusion of the sewing machine. And secondly, they provide evidence of the important human role in the process of mechanisation.

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Acknowledgement

I originally trained as a woven textile designer, and later worked as a professional costume maker in theatre, film, and television – all of which is a very long way from undertaking the most academic of qualifications: a PhD. Five years ago I undertook an MLitt in Dress and Textile Histories as a means to combine my career experience and craft skills with academic study. Whilst completing my dissertation the opportunity to apply for this AHRC Collaborative Doctoral Award arose, and I was fortunate enough to succeed in my application. Consequently, my first thanks must go to my supervisors, Professor Lynn Abrams and Dr Marina Moskowitz, not for only granting me the opportunity to undertake this research, but also for encouraging me to use my experience and sensibilities as a maker and user of tools to explore the development of the sewing machine. I am indebted to them for their constant support, excellent advice, and endless patience. I plunged down many rabbit holes, and they gently – and firmly – guided me back to core research questions and analysis. For the rare privilege of a fully funded studentship, I must also thank the Arts and Humanities Research Council (award no. 1507327).

For me, the most rewarding part of a PhD has been the research, and I have spent very many happy hours in archives, museums, and libraries. So I must thank the many curators, archivists, and librarians who offered their knowledge, advice, time, and expertise – this project, literally, could not have been done without them. In particular, I must thank the curator, Laura MacCalman, and the archivist, Christopher Cassells, at West Dunbartonshire Council (the collaborative partner for this award), who were responsible for the Singer Sewing Machine Collection and Singer Archive. Both offered constant support throughout the long gestation of this project and granted me unprecedented access to the trade literature and more than 800 sewing machine models in the collection. I must also thank Rebecca Quinton, curator of European dress and textiles at Glasgow Museums, Ed Johnson, assistant curator at Glasgow Museums Resource Centre, and Lisa Mason, curator at National Museums Scotland. Thanks to funding support from AHRC and the University of Glasgow Graduate School I was able to visit archives in America. I must, therefore, extend my thanks to the staff at the National Museum of American History – Joe at the Archives Center, Jim Roan at the Library, and John DeJong in the Textiles Department. I also managed to visit Hagley Museum and Library, and thank Lucas Clawson for allowing me access to Singer documents at short notice.

I have spent the last five years at the University of Glasgow, and have benefitted from the academic and research community it fosters. I have enjoyed many stimulating conversations with both students and staff in the History department, and at workshops, seminars, and conferences. It has been a pleasure to hear about so many fascinating research projects, and reassuring to find out that I am not the only one who did not find writing an easy task or spent so much time fretting over footnotes (and their punctuation). In particular, I must thank Jonathan, a fellow PhD student who shared my interest in material culture, textiles, and technology. Conversations over coffee provided much-needed encouragement, and I thank him for his honest opinions, good humour, and wit.

Undertaking a PhD is by turns thrilling, exasperating, demoralising, and rewarding, and I have to thank friends and family for sharing both the highs and the lows. Thanks are owed to my long-suffering mum, who listened patiently to stories about how needles were made and the scope of mechanical engineering for far longer than anyone should reasonably be expected to do so. And I am particularly grateful to two friends, whom I have known since Art School, Joanna and Laura. Their constant good humour, sense of the ridiculous, encouragement, tea, sympathy, ice cream, and Milanese bar bites provided much-needed sustenance to both body and soul.

Author's Declaration

I declare that, except where explicit reference is made to the contribution of others, this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

Signature:

Printed name: Lin Gardner

Abbreviations

AC	Archives Center, National Museum of American History, Smithsonian Institution
EDC	Economic Development Committee for the Clothing Industry
GM	Glasgow Museums
NAL	National Art Library, Victoria and Albert Museum, London
NEDO	National Economic Development Office
NMAH	National Museum of American History, Smithsonian Institution
NMS	National Museums Scotland
PAU	Programmes Analysis Unit, set up in 1967 to benefit the British Department of Trade and Industry
SMCSA	The Sewing Machine Collection and Singer Archive
TC	Textiles Collection, National Museum of American History, Smithsonian Institution
TLC	Historical Trade Literature Collection, National Museum of American History, Smithsonian Institution
USMC	United Shoe Machinery Corporation
USPTO PatFT	United States Patent and Trademark Office – Patent Full-Text and Image Database
WDC	West Dunbartonshire Council

Introduction

The sewing machine is, essentially, the complex mechanisation of a deceptively simple tool: the needle. Introduced in the mid-nineteenth century, the sewing machine made an extraordinary contribution to the mechanisation of innumerable trades associated with the needle. It also had a profound impact on the production of stitched objects. Yet despite this contribution, there has been no comprehensive examination of its development as a manufacturing tool. The invention of the sewing machine was pre-dated by objects and skills associated with the needle. Consequently, its development provides an opportunity to explore how object construction, trade structure, and human skill influenced the process of mechanisation. Because objects constructed with the sewing machine offer tangible witnesses to the extent of these influences, I propose to place object studies at the core of this analysis. This innovative approach to the history of technology advocates an interpretation of technological development that does not isolate it, but situates it within its dynamic relationships and emphasises its cultural significance. By combining material insight from object studies with existing economic analyses, this study offers a cross disciplinary examination of machine development over a century that recognises mechanisation as a cultural process, and uses the manufacturing models produced by the Singer Company, an American sewing machine manufacturer which dominated the industry, as a primary resource.

The prominence of the Singer Company during the nineteenth and twentieth century means that any consideration of sewing machine development would not be complete without reference to either the company or its machine products.[1] The phenomenal economic success of the Singer Company, based upon its introduction of hire purchase and company agents, is well documented; and its investment in foreign sales and overseas manufacture was an innovative business practice during the nineteenth century that proved to be instrumental in the creation of a global sewing machine industry.[2] Moreover, the Singer Company also had strong links to the

[1] Isaac Merritt Singer established his business, I. M. Singer, in 1851, and in 1852 his lawyer, Edward Clark, became a partner in the business. In 1863 Clark incorporated the business and it became known as the Singer Manufacturing Company. In 1873 I. M. Singer retired from the company and it was re-incorporated as the Singer Manufacturing Corporation. In 1904, following its international success, it was reorganised as the Singer Sewing Machine Company. However, for the sake of clarity it will be referred to as the Singer Company throughout this thesis. For a brief overview of the company, see David O. Whitten and Jessie E. Whitten, *The Birth of Big Business in the United States, 1860-1914: Commercial, Extractive, and Industrial Enterprise* (Westport, Conn,; London: Praeger, 2006), pp. 55-60.

[2] For successful creation of agencies, see Robert B. Davies, '"Peacefully Working to Conquer the World:" The Singer Manufacturing Company in Foreign Markets, 1854-1889', *The Business History Review*, 43.3 (1969), 299–325 <https://doi.org/10.2307/3112385>; for involvement in creation of global

West of Scotland. It began production of sewing machines in Glasgow in 1867, and in 1885 it built, what was then, the largest sewing machine factory in the world in Clydebank, a small town on the outskirts of the city.[3] However, although its economic achievement and innovative approach to business has been scrutinised, there has been no examination of the sewing machine products upon which the success of the Singer Company was founded. Such an examination would not only highlight the significance of its manufacturing machine products, it would also provide a valuable adjunct to the assessment of its economic achievements.

The sewing machine is a complicated technology. It can be either a domestic machine or a mechanised tool for manufacturing. And to add further complication, the domestic model could also be used for remunerative employment by outworkers in their homes or in small workshops. Subsequently, interest in the social and economic consequences of domestic machine adoption and production has eclipsed consideration of the sewing machine as a specialised tool for manufacturing. The integration of the sewing machine into the home and domestic lives of women has prompted a fruitful examination of domestic occupations, gender, technology, and consumption.[4] And the abuse of outworkers using the sewing machine, predominantly in the garment trade, has also attracted attention.[5] However, focus on the domestic machine, despite the acknowledgement of its contribution to production, does not capture the full significance of sewing machine technology or its contribution to the mechanisation of a diverse range of needle trades. Nor can concentration on the domestic model capture the scope of machine

industry, see Fred V. Carstensen, *American Enterprise in Foreign Markets: Singer and International Harvester in Imperial Russia* (Chapel Hill: University of North Carolina Press, 1984); Andrew Godley, 'Selling the Sewing Machine Around the World: Singer's International Marketing Strategies, 1850-1920', *Enterprise & Society*, 7.2 (2006), 266–314; Andrew C. Godley, 'Pioneering Foreign Direct Investment in British Manufacturing', *The Business History Review*, 73.3 (1999), 394–429 <https://doi.org/10.2307/3116182>; Andrew Godley, 'Foreign Multinationals and Innovation in British Retailing, 1850-1962', *Business History*, 45.1 (2003), 80–100 <https://doi.org/10.1080/713999300>.

[3] Iain Russell and Michael McDermott, 'The Sewing Machine – The Singer Factory', in *The History of Clydebank* (Carnforth, Lancs: Parthenon, 1988), pp. 15-22.

[4] *The Culture of Sewing: Gender, Consumption and Home Dressmaking*, ed. by Barbara Burman, (Oxford: Berg Publishers, 1999) <https://doi.org/10.2752/9781847888884>; Andrew Gordon, *Fabricating Consumers*, (Berkeley, CA; London: University of California Press, 2011); Sarah A. Gordon, *Make It Yourself*, (New York: Columbia University Press, 2009); Marguerite Connolly, 'The Disappearance of the Domestic Sewing Machine, 1890-1925', *Winterthur Portfolio,* 34.1 (1999), 31–48; Paula A. de la Cruz-Fernández, 'Marketing the Hearth: Ornamental Embroidery and the Building of the Multinational Singer Sewing Machine Company', *Enterprise & Society*, 15.3 (2014), 442–71; Paula A. de la Cruz-Fernandez, 'Multinationals and Gender: Singer Sewing Machine and Marketing in Mexico, 1890-1930', *Business History Review*, 89.3 (2015), 531-549.

[5] James A. Schmiechen, *Sweated Industries and Sweated Labor: The London Clothing Trades 1860-1914* (London: Croom Helm, 1984); Duncan Bythell, *The Sweated Trades: Outwork in Nineteenth-Century Britain* (London: Batsford, 1978).

specialisation, or fully address the relevance to machine development of the important relationship that existed between makers and their tools.

Although the invention and early manufacture of the sewing machine have been examined, only the adoption and development of the sewing machine as a specialised tool for manufacturing during the second half of the nineteenth century have been explored.[6] Furthermore, this examination comprises the work of only two scholars, Amy Breakwell and Ross Thomson. Amy Breakwell has concentrated on the adoption and diffusion of the sewing machine for manufacturing purposes as a consequence of the American Civil War. She argues that the use of sewing machines for military supply helped overcome its initial unpopularity, and cement its position in US manufacturing following the Civil War.[7] Whilst Ross Thomson's examination of sewing machine development forms part of his larger interrogation of the process of mechanisation in America from the late eighteenth century to the mid-nineteenth century. He first examines sewing machine development as part of the mechanisation of shoe production, focusing on the role of the machine maker as an intermediary in the mechanisation of a craft.[8] He then places this examination within his larger exploration of how American institutions and networks evolved to stimulate, encourage, and sustain innovative technological development prior to the scientific based research and development methods adopted and refined during the twentieth century.[9]

Although each scholar takes a different approach to the examination of machine development, they both focus solely on development undertaken during the nineteenth century. Amy Breakwell concentrates on the American Civil War as a specific prompt and uses evidence from a variety of civilian and military records to trace sewing machine diffusion. Whilst Ross

[6] For a comprehensive examination of the invention of the sewing machine, using the incomparable collection of patent models in the collection of the National Museum of American History, see Grace Rogers Cooper, *Sewing Machine: Its Invention and Development*, 2nd edition (Washington: Smithsonian Books, 1979); for brief surveys of sewing machine development see K. R. Gilbert, *Sewing Machines*, (London: HMSO, 1970) and Carol Head, *Old Sewing Machines*, (Princes Risborough: Shire, 1982); for an astute and impressive examination of the early manufacturing methods pioneered by three major American sewing machine manufacturers during the mid-nineteenth century, see David A. Hounshell, *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States* (Baltimore ; London: Johns Hopkins University Press, 1984), pp. 67-123.

[7] Amy Breakwell, 'A Nation in Extremity: Sewing Machines and the American Civil War', *Textile History*, 41.sup1 (2010), 98–107 <https://doi.org/10.1179/174329510X12646114289662>.

[8] Ross Thomson, *The Path to Mechanized Shoe Production in the United States* (Chapel Hill, N. Carolina; London: University of North Carolina Press, 1989); see also, Ross Thomson, 'Learning by Selling and Invention: The Case of the Sewing Machine', *The Journal of Economic History*, 47.2 (1987), 433–45.

[9] Ross Thomson, *Structures of Change in the Mechanical Age: Technological Innovation in the United States, 1790-1865* (Baltimore: Johns Hopkins University Press, 2009); Ross Thomson also explored the impact of the American Civil War on innovative development, focusing on firearms, shoe mechanisation, and petroleum, see Ross Thomson, 'The Continuity of Innovation: The Civil War Experience', *Enterprise & Society*, 11.1 (2010), 128–65.

Thomson concentrates on business records and a careful examination of machine patents to demonstrate the cumulative and incremental changes in machine development. Although both scholars offer valuable analysis of early machine innovation and diffusion during the nineteenth century, there remains no examination of machine development during the twentieth century. And the manufacturing landscape of the twentieth century altered significantly with the introduction of mass production techniques and increased levels of consumption.[10] Therefore, an examination of sewing machine development that spans both the nineteenth and twentieth centuries would not only reveal the scope and diversity of machine specialisation, it would also provide an opportunity to explore the progress of mechanisation across both centuries.

The development of the sewing machine as a manufacturing tool offers not only a rich case study for the process of mechanisation but also an opportunity to observe the process from the perspective of the machinery maker. For although industrialisation and mechanisation merit the critical scrutiny and analysis they receive, seldom are the machine or machinery maker, so fundamental to both, afforded prominence.[11] It is the economic and social impact of mechanisation that has garnered the most attention.[12] However, a consideration of mechanisation from the vantage point of the machinery maker can reveal the scale and diversity of the technical challenge mechanisation presented, whilst also exposing the risk and uncertainty that accompanied machine development. The Singer Company adapted the sewing machine to make an extraordinary range of objects, which included garments, shoes, sails, carriages, and conveyor belting. Consequently, an examination of machine development from its perspective can convey the complexity of a business that had to deal with such a diverse range of manufacturers. Machine development viewed from the perspective of the Singer Company places machine specialisation within a commercial context, and illustrates how opportunities for technological development were identified, prioritised, and managed.

An exploration of machine development and specialisation also offers unexpected insight into the significance of the human role in the process of mechanisation. Because the sewing machine relied upon human operation, human skill, versatility, and flexibility had to be considered by

[10] David A. Hounshell, ‘Mass Production’ in *Major Problems in the History of American Technology: Documents and Essays*, ed. by Merritt Roe Smith and Gregory K. Clancey (Boston, Massachusetts: Houghton Mifflin Company, 1998), pp. 328-337.
[11] Textile machinery is the exception.
[12] David S. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present*, 2nd edn (Cambridge ; New York: Cambridge University Press, 2003); *The British Industrial Revolution: An Economic Perspective*, ed. by Joel Mokyr, 2nd edn (Boulder, Colo. ; Oxford: Westview Press, 1999); *The Industrial Revolution and Work in Nineteenth-Century Europe*, ed. by Lenard R. Berlanstein, (London: Routledge, 1992); Maxine Berg, *The Machinery Question and the Making of Political Economy,1815-1848* (Cambridge: Cambridge University Press, 1980).

machinery makers. Consequently, the range of human proficiency had implications for the direction of machine development. And although the impact of mechanisation on human skill has often been explored, the influence of human skill on technological development has received little attention or acknowledgement.[13] Exploring mechanisation from the perspective of the machine maker highlights not only the importance of the relationship between makers and their tools but also the significance of this relationship to machine development. The perspective of the machine maker illuminates the vital exchange of knowledge required for successful and continued machine specialisation. Not least, recognition of the important relationship between makers and tools, and the place of skill within that relationship, can offer a counter argument to the displacement of human agency and the disruption of human roles in mechanised production.[14]

Placing technological development within a context of use and exploring mechanisation as cultural process frames this study of the sewing machine as a history of technology. This field of study has shifted from an analytical view of technology that did not consider context, to an interpretative view that seeks to relate technology to society and place the causes and effects of technological development within a larger cultural narrative.[15] In addition to a consideration of the cultural framework that surrounds technology, a further sign of the maturity of the field is its self-reflection.[16] However, despite the changing perspective and maturity of the field, the

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[13] *Divisions of Labour: Skilled Workers and Technological Change in Nineteenth Century England*, ed. by Royden Harrison and Jonathan Zeitlin (Brighton: Harvester Press, 1985); Raphael Samuel, 'Mechanization and Hand Labour in Industrializing Britain', in *Industrial Revolution and Work in Nineteenth Century Europe*, ed. Lenard R. Berlanstein, pp. 26-43.

[14] For discussion of the displacement of human skill and agency, see Karl Marx, *Capital: A Critique of Political Economy. vol.1*, trans. by Ben Fowkes, with Introduction by Ernest Mandel (London: Penguin Books in association with New Left Review, 1990); and Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974).

[15] Early examples, although scholarly and descriptive, focused on mechanical development and those responsible for it, see *A History of Technology & Invention: Progress through the Ages*, ed. by Maurice Daumas (New York: Crown, 1969); and *A History of Technology*, ed. by Charles Singer and others (Oxford: Clarendon Press, 1954); Abbott Payson Usher, *A History of Mechanical Inventions*, Rev. edn (Cambridge, Mass. : Harvard University Press, 1954); Kranzberg and Pursell encouraged exploring technology within a social and economic context rather than in isolation, see Melvin Kranzberg and Carroll W. Pursell, *Technology in Western Civilization* (Oxford University Press, 1967); a focus on technology and cultural interaction has stimulated excellent interpretations of technological development, see Thomas Parke Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore, Md. ; London: Johns Hopkins University Press, 1983); Judith A. McGaw, *Most Wonderful Machine: Mechanization and Social Change in Berkshire Paper Making, 1801-1885* (Princeton, N.J: Princeton University Press, 1987); Susan J. Douglas, *Inventing American Broadcasting, 1899-1922* (Baltimore: Johns Hopkins University Press, 1989).

[16] Melvin Kranzberg was the principal founder of the Society for the History of Technology, and the editor of its journal, *Technology and Culture*, during its first twenty years. To mark this important milestone, a critical reflection and analysis of articles and themes from this period was prepared, see John

seduction of comparing a world with to a world without has led to the history of technology field being criticised for a tendency to focus primarily on new technologies and innovations.[17] Although the sewing machine was a new technology, the objects, skills, and trades associated with the needle, which it sought to replace, were not. The development of the sewing machine, therefore, represents a history of technology that observes how new technological development negotiates long standing trade relationships which it has inherited, and the construction, production, and consumption of stitched objects which pre-date its invention.

Material culture provides an investigative framework to examine and interpret objects on a variety of levels, and explore the interlocking narratives of production, skill, and consumption that surround them.[18] For this reason, I propose to use object studies as an original interpretative approach to technological development and the process of mechanisation.[19] The production heritage of an object can reveal not only the influence of construction and decoration on machine specialisation, but also the influence of trade structure and scale on the choice of production method. Objects and trades are subject to the influence of changing fashion and

M. Staudenmaier, *Technology's Storytellers: Reweaving the Human Fabric* (Cambridge, Mass ; London: Society for the History of Technology/MIT Press, 1985).

[17] David Edgerton, 'Innovation, Technology, or History: What Is the Historiography of Technology About?', *Technology and Culture*, 51.3 (2010), 680–97 <https://doi.org/10.1353/tech.2010.0007>.

[18] For interpretative methods, see E. McCLung Fleming, 'Artefact Study: A Proposed Model' in *Winterthur Portfolio* 9 (1974), 135-161; Jules Prown, 'Mind in Matter: An Introduction to Material Culture Theory and Method', in *Winterthur Portfolio* 17 (1982), 1-19; for the value, analysis, and scope of material culture studies, see Susan M. Pearce, *Interpreting Objects and Collections* (London: Routledge, 1994); W. D. Kingery, *Learning from Things* (Washington DC: Smithsonian Institution Press, 1996); Christopher Y. Tilley, *Handbook of Material Culture* (London: Sage, 2006).; Steven D. Lubar and W. D. Kingery, *History from Things* (Washington DC: Smithsonian Institution Press, 1993); Victor Buchli, *The Material Culture Reader* (Oxford: Berg, 2002).

[19] Material culture, especially the use of dress and textiles, has provided valuable sources for social and economic history, see *Craft, Community and the Material Culture of Place and Politics, 19th-20th Century*, ed. by Janice Helland, Beverly Lemire, and Alena Buis, (Farnham, Surrey: Ashgate, 2014); *Textiles Revealed*, ed. by Mary Brooks (London: Archetype Publications, 2000); for the value of clothing to examine the production, consumption and significance of dress, see Lou Taylor, *The Study of Dress History* (Manchester University Press, 2002); a collection of small pieces of clothing left by women whose children were accepted by a foundling hospital provided rare, and poignant, evidence of working class dress during the eighteenth century, see John Styles, *The Dress of the People: Everyday Fashion in Eighteenth-Century England* (New Haven: Yale University Press, 2007); and John Styles and Foundling Museum, *Threads of Feeling: The London Foundling Hospital's Textile Tokens, 1740-1770* (London: Foundling Museum, 2010); textile sample books also provide rare evidence of textiles that have not survived in dress, see Stana Nenadic and Sally Tuckett, *Colouring the Nation* (Edinburgh: National Museums Scotland, 2013); Lesley Ellis Miller, *Selling Silks* (London: V&A Publishing, 2014); Philip Sykas, 'Calico Catalogues: Nineteenth-Century Printed Dress Fabrics from Pattern Books', *Costume*, 33.1 (1999), 57–67 <https://doi.org/10.1179/cos.1999.33.1.57>; for the value of objects as a source of analytical study and interrogation, see *The Object Reader*, ed. by Fiona Candlin and Raiford Guins (London: Routledge, 2009); *Tangible Things: Making History through Objects*, ed. by Laurel Thatcher Ulrich and others (New York, NY: Oxford University Press, 2015).

consumption patterns, and an examination of objects can reveal the significance of consumption to production, which is often overlooked.[20] In addition to an exploration of machine development in response to object construction, an examination of objects can also explore the influence of consumption on the process of mechanisation. It can reveal the response of machine makers to changes in fashion, retailing, and taste. Not least, stitched objects provide tangible witnesses to the significant relationship between makers and their tools, as well as providing evidence of human skill, proficiency, and initiative.

The sewing machine could only be successfully developed for a wide variety of applications because machinery makers understood the priorities of stitched object makers. An appreciation of the characteristics and qualities of stitched objects was fundamental to the specialisation of the sewing machine as a manufacturing tool. Therefore, a history of technology that can include an examination of objects made by that technology adds another dimension to the interpretation of machine development and mechanisation. It also underlines the cultural context and significance of technology and stresses the importance of the stitched object as a point of discussion between object maker and machinery maker. The social construction of technology, or SCOT analysis, recognises the importance of social interaction to the shaping of technology, but in the absence of either prototypes or working machine models with which to interact, it is the qualities of the stitched object and the priorities of the object maker that determined the initial direction of development.[21] A history of technology that includes an examination of objects can explore the value of this interaction, and reveal the challenges that mechanising a complex stitching process represented.

Technological development does not occur in isolation. So I propose to combine material insight from object studies with existing economic analyses and interpretation to place the sewing machine in the context of use and view development from a variety of angles. The aim of this approach is to not only identify, and explore, the sources of influence on machine development but also to emphasise their significance. As Nathan Rosenberg observed, 'it is absolutely essential not to develop too narrow a focus in the study of technology, because a narrow focus severs the link between a given technology and many of the factors that will, inevitably, determine its effectiveness and significance.'[22] Sewing machine manufacturers

[20] For the significance of consumption, see Daniel Miller, *Consumption and Its Consequences* (Cambridge: Polity, 2012); Ben Fine and Ellen Leopold, *The World of Consumption* (Routledge, 1993); Alison J. Clarke, *Tupperware* (Washington DC: Smithsonian Institution Press, 1999).
[21] *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. by Wiebe E. Bijker, Thomas Parke Hughes, and T. J. Pinch, Anniversary edn (Cambridge, Mass. ; London: MIT Press, 2012); Wiebe E. Bijker, *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*, (Cambridge, Mass. ; London: MIT Press, 1995).
[22] Nathan Rosenberg, *Inside the Black Box* (Cambridge University Press, 1982), p. 56.

sought to mechanise a diverse range of needle trades, all of which varied in scale and structure. Although some might share modes of practice, each trade had its own idiosyncrasies and offered different responses to the adoption and diffusion of the sewing machine as a manufacturing tool. A single trade could support both large and small businesses, which might retail as well as manufacture their products. Situating machine development within an economic analysis of a trade serves to illuminate the significance of business scale to the direction of machine development, and illustrate the challenge of producing mechanised tools for different levels of production within the same trade. Economic analysis also reveals how the direction of machine development responded to indecision and dilemma within a trade, and whether machinery makers were able, or willing, to offer technological solutions.

The focus of this thesis is the development of the sewing machine as a manufacturing tool, and, initially, I believed research would concentrate on object studies of sewing machine models. However, a more intriguing resource proved to be the trade literature published by the Singer Company during the nineteenth and twentieth centuries. These illustrated trade catalogues, handbooks and product leaflets provided both a unique summary of specialised machine development and a rich source of information about the important relationship between Singer and its trade customers. Descriptions and illustrations of machine models found in trade catalogues portrayed the scope of machine development, whilst the descriptions of stitched object construction found in trade handbooks provided compelling evidence of a dialogue and an exchange of knowledge between object maker and machinery maker. The layout and content of the trade catalogues and handbooks also represented the editorial choices of the Singer Company, which offered the machinery maker's interpretation of, and perspective on, the process of mechanisation. Not least, the use of trade literature to trace the development of the sewing machine as a manufacturing tool emphasised the important commercial aspect of mechanisation.

Although a significant number of trade catalogues and handbooks produced by the Singer Company during the nineteenth and twentieth centuries have survived, they are spread amongst several collections in the West of Scotland and the United States. One of the most comprehensive collections of Singer's trade catalogues, which dates from 1895 to the mid-1970s, belongs to the local council of West Dunbartonshire. This collection of trade literature forms part of a larger collection that includes Singer Company records and 800 sewing machine models, which passed to the local council when the Singer factory, built in Clydebank in 1885, closed in 1980.[23] The National Museum of American History (NMAH) Archives Center has a

[23] In 2014 The Sewing Machine Collection and Singer Archive of West Dunbartonshire Council was recognised as a Nationally Significant Collection by Museum Galleries Scotland, on behalf of the Scottish Government.

comprehensive collection of nineteenth-century trade literature produced by several American sewing machine companies, including the Singer Company.[24] In addition to this, the Library and Textile Department of NMAH also hold trade literature produced by Singer, which dates from 1896 to the early 1940s. Hagley Museum and Library also holds a small, but significant, collection of trade handbooks published by the Singer Company between 1900 and 1922. In combination, these surviving publications illustrate the breadth of machine development and production in both the United States and Scotland between 1851 and 1980.

Examples of machine models produced by the Singer Company provide valuable case studies of prototype development, and illustrate how changes in machine appearance reflected the full extent of consumer influence. Examples of prototype machines could be dated and cross referenced with catalogue entries to trace the conception and development of new machine models, which helped establish their introduction to the market. Moreover, material observation from object studies of surviving machine models from both the nineteenth and twentieth centuries can support the veracity of catalogue descriptions and illustrations. The Singer Company also used machine appearance to distinguish between its domestic and manufacturing machine products; and a comparison of how Singer approached the appearance of each provides valuable insight into how the company perceived and responded to both its customers and contemporary design aesthetics. Industrial design drawings and photographs of clay model prototypes, which were made between the early 1930s and late 1970s, are combined with machine models and catalogue illustrations to illuminate Singer's strategic approach to industrial design during the twentieth century.[25] Examples of designs that were commissioned, but never put into production, also serve to illustrate how consumer priorities proved influential in all areas of machine development.

An examination of stitched objects offers a new approach to the discussion of technological development. An assessment of how much machine development was influenced by the construction and style of an object is made through a comparison of stitched objects made between 1840 and 1980, before and after the introduction of the sewing machine. Although the sewing machine was developed to construct a variety of objects, for the sake of clarity and

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[24] The Sewing Machine Historical Trade Literature Collection forms part of the Warshaw Collection of Business Americana, held by NMAH Archives Center.

[25] The Singer Industrial Designs Collection consists of drawings, sketchbooks, presentation drawings, and photographs of clay models made by both freelance industrial designers commissioned by the Singer Company, and the internal design department. The collection is held in the NMAH Archives Center. The majority of designs are dated and include the names of designers, but there is no indication of who commissioned the designs, or the criteria for rejection or acceptance. Drawings and clay models were cross referenced with either surviving machine models or illustrations in trade literature to ascertain whether a commissioned design was ever put into production. Although designs could be patented, the existence of a design patent proved to be no guarantee that the design was ever put into production.

depth of analysis I chose to focus on machine development in relationship to only two: men's shirts and women's shoes.[26] The shirt was chosen for two reasons. First, the ubiquity of the garment, and secondly, because of the relationship between the sewing machine and garment manufacture, no consideration of machine development would be complete without reference to its use in the garment industry. Women's shoes were chosen because they demonstrated the use of the sewing machine for decorative as well as constructive purposes, and also for the fact that the structure of the shoe industry differed from that of the garment industry. Object studies of men's shirts focus on how an object's construction and stylistic changes influenced machine development and specialisation. Whilst object studies of women's shoes focus on how trade scale and structure influenced machine development and diffusion. In addition, wherever possible, shirts and shoes made locally were examined in order to relate local production and machine use to the overall scale and structure of a trade.[27]

The thesis is divided into two parts. The first part focuses on how specialised manufacturing models were developed, and how the exchange of knowledge between stitched object manufacturers and the Singer Company can be discerned in the direction of this development. Chapter One concentrates on the range and breadth of model development between 1851 and 1980. It uses the depiction and description of machine development found in trade catalogues and handbooks published by the Singer Company to relate different stages of development to the process of mechanisation. Chapter Two focuses on the process of development and its role within the business of machine making. It uses examples of prototype building to explore how opportunities for development were identified through dialogue with potential trade customers and explores how the risks associated with speculative development and innovation were managed by machine manufacturers. Chapter Three illustrates that consumer influence extended beyond the mechanical. How Singer made strategic use of machine shape and embellishment is explored through a comparison of domestic and manufacturing models. This exploration reveals that in the nineteenth century Singer used machine appearance to distinguish between its domestic and manufacturing ranges, whilst in the twentieth century emerging industrial design principles were used only to herald significant technical improvements to models within its manufacturing range.

The second part of the thesis uses object studies to offer an analysis of how the construction of stitched objects, the scale and structure of trades, and human skill specifically influenced the development of sewing machine models for manufacturing. Chapter Four traces the production

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[26] Men's shirts and women's shoes in the collections of Glasgow Museums and National Museums Scotland were examined and photographed.

[27] Entries from the *Glasgow Post Office Directory* were combined with Glasgow Census records to reconstruct the business profiles of local shoe manufacturers.

heritage of men's shirts over a century to illustrate how the construction and changing style of an object can influence the specialisation of manufacturing models within a trade. It also explores how the indecision caused by the separation of manufacture from retail within the garment industry influenced the direction of Singer's machine development. Chapter Five uses examples of women's shoes to emphasise the influence of decorative use on machine specialisation and to examine the influence of trade adoption and initiative on the direction of machine development for the shoe industry. And Chapter Six argues that the introduction of the sewing machine did not displace skills, but required the acquisition of new skills because it was so dissimilar to sewing with a needle. Examples of men's shirts and women's shoes provide evidence of the range of human proficiency. These examples also demonstrate that this range was an important consideration and stimulus for the ongoing development, and technical improvement, of the sewing machine as a manufacturing tool.

The intention of this thesis is to present a multi-dimensional view of sewing machine development that illuminates the range of influences that affected the process of mechanisation during the nineteenth and twentieth centuries. It places object studies at the core of the examination to offer an original interpretative approach to technological development, and emphasise the important cultural significance of technology. An observation of stitched objects both identifies the sewing machine in use as a manufacturing tool and underlines the significance of an object's construction and style to the direction of specialised machine development. An interleaving of material culture and economic analyses serves to illustrate the importance of the relationship between stitched object maker and machinery maker. It also demonstrates how the scale and structure of needle trades and the range of human skill and proficiency influenced the adoption, development, and diffusion of the sewing machine as a manufacturing tool.

Part I

The Machine

The first part of this thesis examines the development of the sewing machine as a specialised manufacturing tool from the perspective of the machinery maker. This perspective not only reveals the scope of machine development undertaken by the Singer Company over a century, it also explores the role of development in the process of mechanisation and the business of the machinery maker. It uses both the mechanical specialisation and appearance of the sewing machine to identify the importance of the relationship between stitched object maker and machinery maker, and the influence of this relationship on the direction of machine development.

Chapter 1 Portraying the Scope of Sewing Machine Development, 1851-1980

Figure 1-1 Front and reverse of early Singer advertising leaflet, *c*.1853 (NMAH AC, TLC Singer box 3, folder 3)
Images removed due to Copyright restrictions.

On a small single sheet advertisement, printed in 1853, Isaac Merritt Singer promoted his first sewing machine, patented in 1851, to those whom he considered would be his company's customers: manufacturers (Figure 1-1). The machine was depicted in use on one side of the advertisement, whilst on the reverse I.M. Singer addressed, 'Clothiers, Shoe Manufacturers, Tailors, Saddlers, Manufacturers of Shirts and Collars, Mittens and Gloves, Ladies' Dresses, Cloak and Mantillas […].'[1] With no mention of family use, this early advertisement emphasised the fact that the Singer sewing machine was conceived as a manufacturing tool. Yet, despite its role in the mechanisation of innumerable needle trades, there has been no comprehensive examination of its development. The sewing machine made an extraordinary contribution to mechanised production, and its development exemplifies both the process and progress of mechanisation during the century after its introduction. Therefore, the opening chapter of this

[1] National Museum of American History, Smithsonian Institute Archives Center (hereafter NMAH AC), Sewing Machine Historical Trade Literature Collection, Singer Manufacturing Company (hereafter TLC Singer), box 3, folder 3 – single sheet Singer Company advertisement, *c*. 1853.

thesis traces the development of the sewing machine as a versatile manufacturing tool, and examines its contribution to the mechanisation of stitched object production during the nineteenth and twentieth centuries.

The significance of the sewing machine as manufacturing tool to the early success of the Singer Company cannot be underestimated. As the economic historian, Andrew Godley, observed, 'in the early years the most important market was the US industrialists in the rapidly growing clothing sector. It was not until after the American Civil War that the family market grew.'[2] Garment manufacturers in America and Europe were among the first to appreciate the advantages that the sewing machine offered. Historians, Edwin G. Burrows and Mike Wallace, acknowledged the importance of the sewing machine to the garment trades of New York during the nineteenth century, commenting that the 'demand for Singer's heavy industrial models grew brisk as wholesale clothing manufactories insisted their subcontractors use them to standardise stitching and increase output.'[3] In Britain the strength of the garment trade allowed Singer's influential European sales agent, George B. Woodruff, to create a successful sales network. He chose to focus on selling the machine to the garment manufacturers of major British cities, a strategy which yielded the majority of British sales well into the 1880s.[4] The sewing machine as a manufacturing tool played a vital role in both the mechanisation of needle trades and the expansion of the Singer Company.

Mechanisation is an important process. However, it is rarely observed from the perspective of the machinery maker or examined in relation to the construction of objects. Any consideration of mechanisation is often subsumed within the larger narrative of industrialisation.[5] Consequently, an examination of the development of the sewing machine offers an opportunity to observe the fundamental relationship between machine development and object production from the perspective of the machinery maker. Katrina Honeyman reveals the value of this perspective in an excellent account of the mechanisation of woolcombing. She notes that, 'technical innovations […] were conceived of and developed within specific industrial organisations […].'[6] Examinations of garment and furniture production also provide evidence of

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[2] Andrew Godley, 'Early Foreign Investment in Britain: Singer and Siemens the pioneers', p. 10.
[3] Edwin G. Burrows and Mike Wallace, *Gotham: A History of New York City to 1898* (Oxford; New York: Oxford University Press, 1999), p. 665.
[4] Andrew Godley, 'Pioneering Foreign Investment in Britain', p. 12.
[5] *The British Industrial Revolution: An Economic Perspective*, ed. by Joel Mokyr; David S. Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present*; *The Industrial Revolution and Work in Nineteenth-Century Europe*, ed. by Lenard R. Berlanstein.
[6] Katrina Honeyman and Jordan Goodman, *Technology and Enterprise: Isaac Holden and the Mechanisation of Woolcombing in France, 1848-1914*, Pasold Studies in Textile History, 6 (Aldershot: Scolar Press, 1986), p. 3.

the significance of product and trade to the development of machinery, as well as offering valuable insight into the mechanisation of object production.[7] Although Ross Thomson does include the development of the sewing machine in his thorough examination of the mechanisation of the shoe industry, he focuses on the complex technological and conceptual shift that permitted the mechanisation of a craft, rather than the development of machinery in response to the products of craftsmen.[8]

An examination of machine development serves to highlight the significance of an object's shape, size, construction, quality of finish, and level of production to the process of mechanisation. It also demonstrates that the process of mechanisation is a business. The perspective of the Singer Company reveals that successful machine development depended upon familiarity with the products and aspirations of trade customers. The size and ambition of businesses within a trade could vary significantly, which created a complex customer profile for any machinery maker.[9] Needle trades encompassed custom makers, batch production, and mass production. An examination of machine development can reveal how machine development met those challenges. It can also reveal how the Singer Company created development opportunities from these challenges to expand and sustain its business. Not least an examination of machine development can reveal how a single sewing machine model patented in 1851 could be expanded into a diverse range of specialised manufacturing tools within a century.

Although a number of Singer's manufacturing machine models have survived in collections throughout Europe and America, this chapter will examine machine development as it is portrayed in trade literature published by the Singer Company. Illustrated catalogues and handbooks both summarise the development of the sewing machine as a specialised tool for manufacturing and capture the relationship between machine development and the progress of mechanisation during the nineteenth and twentieth centuries. In order for these trade

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[7] Katrina Honeyman, *Well Suited: A History of the Leeds Clothing Industry, 1850-1990*, Pasold Studies in Textile History, 11 (Oxford ; New York: Oxford University Press, 2000); Sharon S. Darling, *Chicago Furniture, 1833-1983: Art, Craft & Industry* (Chicago: Chicago Historical Society in association with W.W. Norton, New York.); Ben Forster and Kris Inwood, 'The Diversity of Industrial Experience: Cabinet and Furniture Manufacture in Late Nineteenth-Century Ontario', *Enterprise & Society*, 4.2 (2003), 326–71 <https://doi.org/10.1017/S146722270001226X>; Clive Edwards, '"Improving" the Decoration of Furniture: Imitation and Mechanization in the Marquetry Process in Britain and America, 1850-1900', *Technology and Culture*, 53.2 (2012), 401–34 <http://doi.org/10.1353/tech.2012.0073>.
[8] Ross Thomson, *The Path to Mechanised Shoe Production.*
[9] For the difference in business scale during industrialisation, see Charles Sabel and Jonathan Zeitlin, 'Historical Alternatives to Mass Production: Politics, Markets and Technology in Nineteenth-Century Industrialization', *Past & Present*, 1985, 133–76; for the different challenges created by batch and mass production, see Philip Scranton, 'Diversity in Diversity: Flexible Production and American Industrialization, 1880–1930', *Business History Review*, 65.01 (1991), 27–90 <https://doi.org/10.2307/3116904>.

publications to effectively communicate the range and quality of Singer's manufacturing products, they included detailed illustrations and descriptions of machine models, stitched objects, and contemporary manufacturing practice. The comprehensive range of machine models they featured, and the quality and level of detail they included, made these trade publications not only persuasive marketing tools but also valuable witnesses to the development of Singer's industrial machine products during the nineteenth and twentieth centuries.

Because trade literature represents the editorial choices and decisions of the Singer Company, it offers a rare opportunity to view machine development and the process of mechanisation from the perspective of the machinery maker. As the historians Boris Emmet and John E. Jeuck, in their description of the catalogues of Sears, Roebuck and Company, noted, 'the catalogue […] was the company's to have and to hold, to alter with the times, to shape to its will, and to use as an avenue of direct contact with its customers.'[10] Singer's editorial choices not only underscore the commercial aspect of mechanisation they also highlight the significance of the dialogue between stitched object maker and machinery provider. As Claire L. Jones, writing about medical catalogues, observed, 'the catalogue, like other technologies, was shaped by both producers and end-consumers, and its form and purpose – its two most essential dimensions – were continually negotiated between the two […].'[11] Consequently, an examination of trade literature can offer a comprehensive summary of machine development and an opportunity to reveal the importance of the relationship between Singer and its trade customers.

This chapter is in three sections. The first section examines the Singer Company's development of the sewing machine as a manufacturing tool during the second half of the nineteenth century and concentrates on its adaption to the shape, size, and material of stitched objects. The second section focuses on development after 1900 and examines the development of the machine in response to the division of labour and specific tasks involved in the construction of stitched objects. It uses three examples of task specific machine development to illustrate the influence of product quality and production volume on the process of mechanisation. It also argues that the descriptions of machine models and the construction of stitched objects featured in Singer's trade literature not only conveys the depth of knowledge that Singer required to develop task specific models, it also offers evidence of the dialogue and exchange of knowledge that must have occurred between Singer and its trade customers. The final section explores how the use and delivery of external power and the re-organisation of production and production space

[10] Boris Emmet and John E. Jeuck, *Catalogues and Counters: A History of Sears, Roebuck and Company* (Chicago, Ill: University of Chicago Press, 1950), p. 89.
[11] Claire Jones, *The Medical Trade Catalogue in Britain, 1870-1914*, Science and Culture in the Nineteenth Century, number 22 (London: Pickering & Chatto, 2013), p. 10.

contributed to machine diversification and specialisation during the nineteenth and twentieth centuries.

Machine Development, 1851-1900

The first essential task of the Singer Company was to persuade manufacturers that the sewing machine was a viable and efficient alternative to hand sewing, as Joel Mokyr remarked, ‘Invention and innovation almost always involve some willingness to bear risk. Changing a known and trusted production method, even in marginal ways, involves something of a gamble.’[12] A reluctance to adopt mechanised production tools could be observed in a variety of industries. Clive Edwards noted that for furniture makers during the second half of the nineteenth century, ‘The enduring nature of existing technologies, a continuation of old ways, was frequently ingrained […] Specific methods that had emerged as the dominant and preferred processes tended to perpetuate themselves and hinder any radical innovations because they worked satisfactorily.’[13] In order to persuade manufacturers to replace hand sewn construction with machine sewn construction, Singer had to quickly and effectively adapt the sewing machine to stitch a diverse range of objects.

The sewing machine proved to be a supremely adaptive technology because all machines, whether for domestic or manufacturing use, shared the same mechanical principal, the conversion of motion. A single rotating shaft located within the body of the machine provides its impetus. This rotation, through the use of gears and additional mechanisms, could then be converted into lateral or perpendicular movement (Figure1-2). The predominant machine stitch was a lockstitch created by interlocking two separate threads. A needle carried the top thread into the material. The retraction of the needle created a loop beneath the material through which the second thread, held in a bobbin beneath the machine bed, could pass. Although additional mechanisms could create different stitch types, they still derived their movement from the rotation of the internal shaft (Figure 1-3). In order to work successfully the sewing machine relied upon several indispensable mechanisms, each of which had been patented by several different inventors during the mid-nineteenth century.[14] Although the mechanical principle of

[12] Joel Mokyr, *The Lever of Riches: Technological Creativity and Economic Progress* (New York ; Oxford: Oxford University Press, 1990), pp. 157–58.

[13] Clive Edwards, '"Improving" the Decoration of Furniture', p. 402.

[14] I.M. Singer was among those who invented mechanisms which were so indispensable to the successful function of the sewing machine that they remain part of its technology to this day. However, until each of the inventors agreed to participate in a patent pool, which lasted from 1856 to 1877, the fledgling sewing machine industry was stymied in litigation. Only once the major sewing machine manufacturers involved in the patent pool were no longer required to constantly defend their patent rights could the sewing machine industry expand. For descriptions of the invention of various mechanisms, see Grace Rogers

the sewing machine remained the same, its shape and size could be altered to accommodate the shape and size of objects to be stitched.

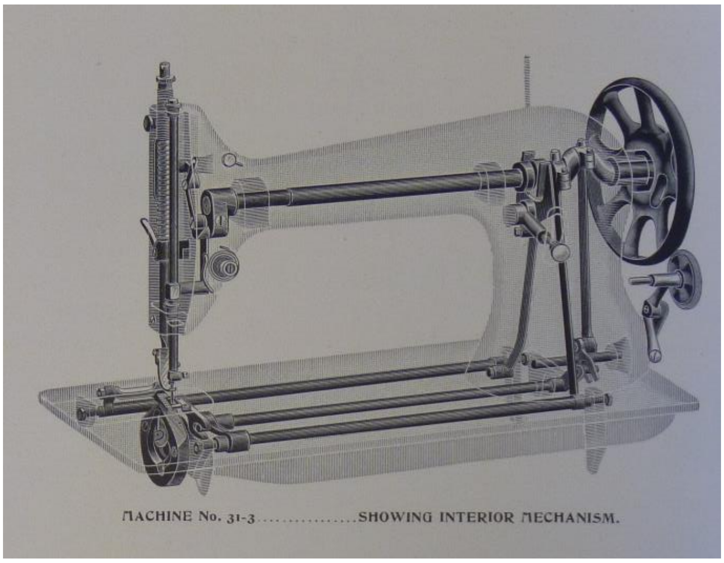


Figure 1-2 Model 31-3 showing internal mechanism shared by all sewing machines, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

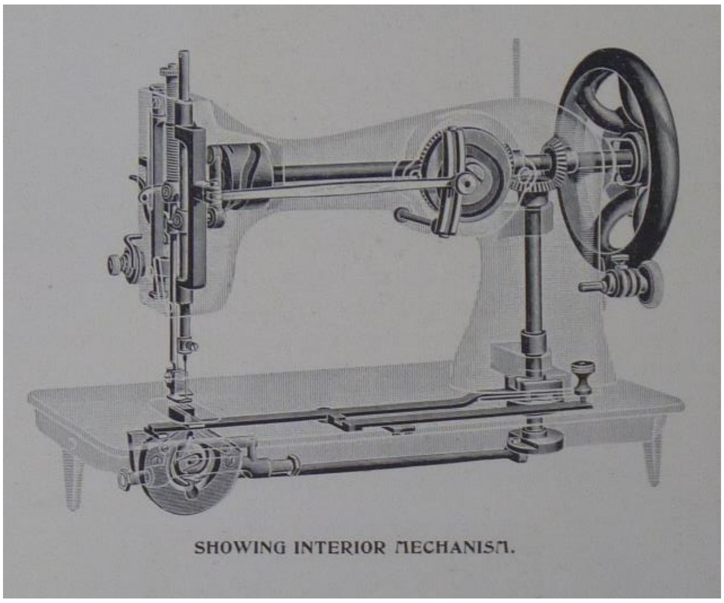
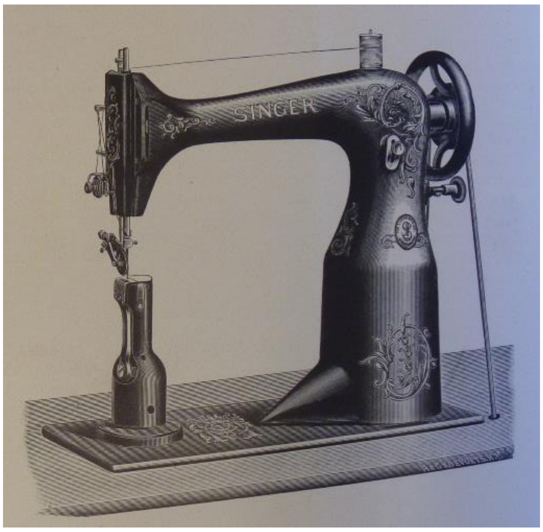


Figure 1-3 Model from Class 32, showing additional mechanism to create a zig-zag stitch, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

Cooper, *Sewing Machine: Its Invention and Development*; for discussion of the creation of the patent pool, see Adam Mossoff, 'The Rise and Fall of the First American Patent Thicket: The Sewing Machine War of the 1850s', *Arizona Law Review*, 53 (2011), 165-211; and for discussion of the impact of the patent pool on technological development, see Ryan Lampe and Petra Moser, 'Do Patent Pools Encourage Innovation? Evidence from the Nineteenth-Century Sewing Machine Industry', *The Journal of Economic History*, 70.04 (2010), 898–920 <https://doi.org/10.1017/S0022050710000768>.

Machine Shape

Not all objects can be stitched flat. Therefore, the first significant alteration made to the machine during the second half of the nineteenth century was to the shape of the machine bed. Exchanging a flatbed for a vertical post or cylinder arm meant a machine could stitch tubular shapes. Moreover, the additional space around the pillar or cylinder arm gave the machine operator considerably more manoeuvrability when stitching objects that were irregularly shaped. An illustrated catalogue published by the Singer Company in 1896 described the vertical post of the Class 34 machines (Figure 1-4) as being, ‘admirably adapted for reaching into and making lock-stitch seams on hollow articles or convex surfaces at points difficult to reach with a machine having a horizontal bed.’[15] In addition, the widths and heights of the pillar or arm could be varied to match the size of an object. The catalogue published in 1896 features model 46K1, which had a narrow pillar 3⅝ inches tall with a diameter of ¼ inch and was specifically developed for the stitching of piqué gloves (Figure 1-5). The same catalogue also featured model 10-1 (Figure 1-6), which was a much larger and sturdier machine with an arm 23 inches long used exclusively for leather harness manufacture.[16]



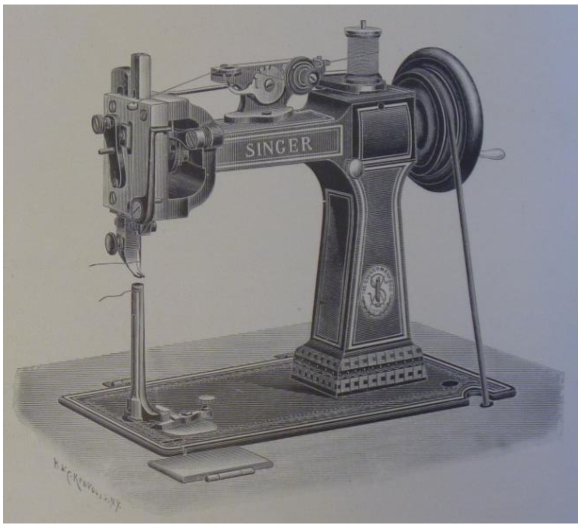
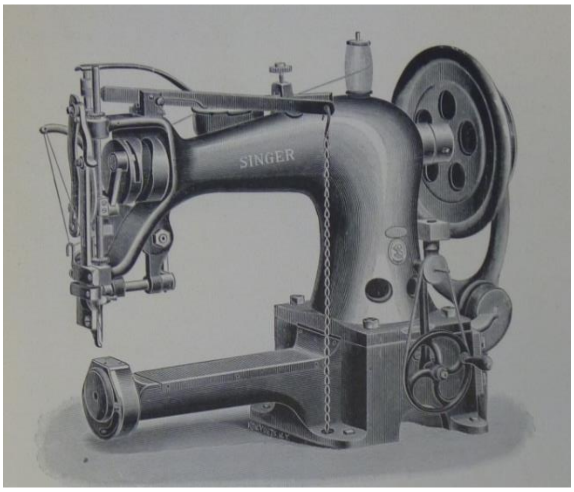


Figure 1-4 (Left) Model 34-2 with vertical post of seven inches, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

Figure 1-5 (Right) Model 46 K1, for stitching piqué gloves, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

[15] NMAH Library, *Catalogue of Singer Sewing Machines, Illustrating Their Construction, Their Variety and Their Special Uses by Manufacturers*, ([New York(?)]: Singer Manufacturing Company, 1896), p. 208.
[16] Ibid., p. 103.



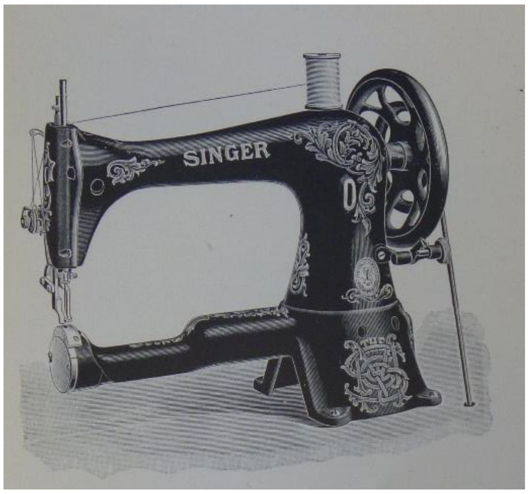
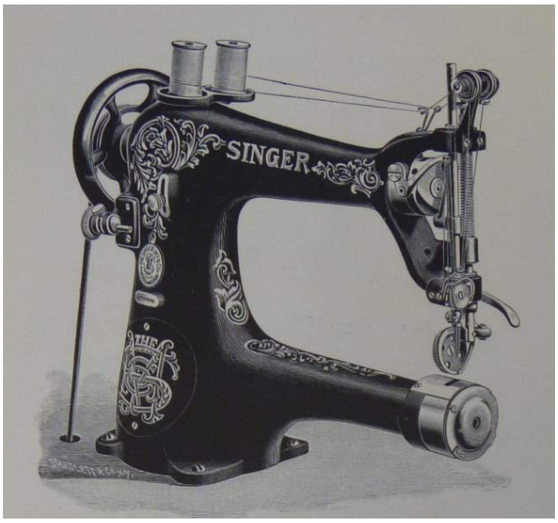


Figure 1-6 (Left) Model 10-1 with a 23 inch arm for harness stitching, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

Figure 1-7 (Right) Model 17-12 with a 10 ½ arm for stitching irregular shaped leather objects, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)



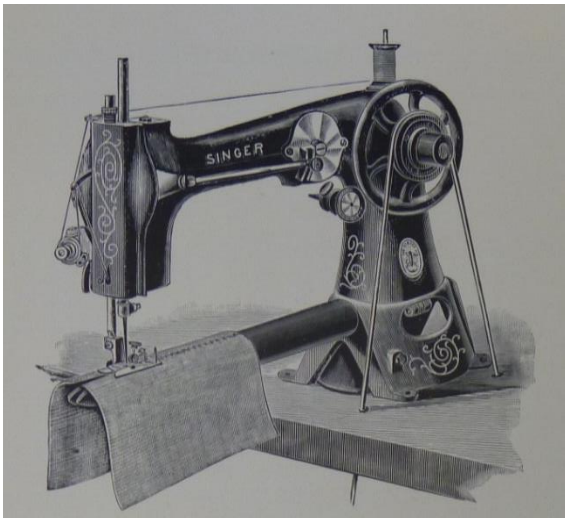


Figure 1-8 (Left) The head of model 18-5 is turned to face the operator, it has two needles for parallel stitching, and the stitch direction is from left to right, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

Figure 1-9 (Right) The head of model 19-10 is also turned to face the operator, it makes a zig zag stitch, and the stitch direction is along the arm, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

Singer also increased the versatility of machine models by combining a change of machine shape with additional features. For example, the arm of model 17-12, although relatively short at 10 ½ inches, had an indentation in its arm (Figure 1-7). This indentation provided additional manoeuvrability for the operator and, according to the catalogue published in 1896, it was used for, 'Horse Boots, Musical Instrument Cases, Gun Cases, and similar articles of irregular shape requiring very strong stitching.'[17] Singer could also change the orientation of the machine head. The head of model 18-5 faces the operator and replaces stitching away from the body, at a right angle, with stitching parallel to the body, from left to right (Figure 1-8). In addition to a change of stitch direction, model 18-5 was also fitted with two needles to create parallel lines of stitching.[18] Model 19-10 was also turned to face the operator, but instead of a straight stitch this model created a zig zag stitch (Figure 1-9). It also allowed the operator to stitch in the direction of the barrel arm, which allowed the length rather than the circumference of a hollow article to be sewn.[19]

The shape of stitched objects was an important influence on the development of Singer's manufacturing models during the nineteenth century. In its effort to encourage stitched object manufacturers to adopt the sewing machine Singer demonstrated its willingness and ability to make alterations to the shape of its machine models. These alterations indicate the level of effort expended by Singer. They also provide evidence of the company's keen observation of object making and discussion with object makers. In the construction of an object by hand and needle, both hand and needle are free to move in and around the object being stitched. However, the sewing machine relies upon a fixed needle position, which means the object must be manipulated and manoeuvred under the needle. Only familiarity with the shape of stitched objects and their construction would have encouraged Singer to significantly alter the shape of a sewing machine model in order to compensate for the flexibility of the hand plying the needle. Moreover, the addition of different stitch types demonstrated a knowledge of materials. The zig zag stitch, for example, created a flexible stitch that would prove useful for constructing knitted goods. Singer's range of machine adaptions during the second half of the nineteenth century clearly displayed knowledge of the shape, materials, and construction of a diverse range of stitched objects.

[17] Ibid., p. 143.
[18] Ibid., p. 147.
[19] Ibid., p. 153.

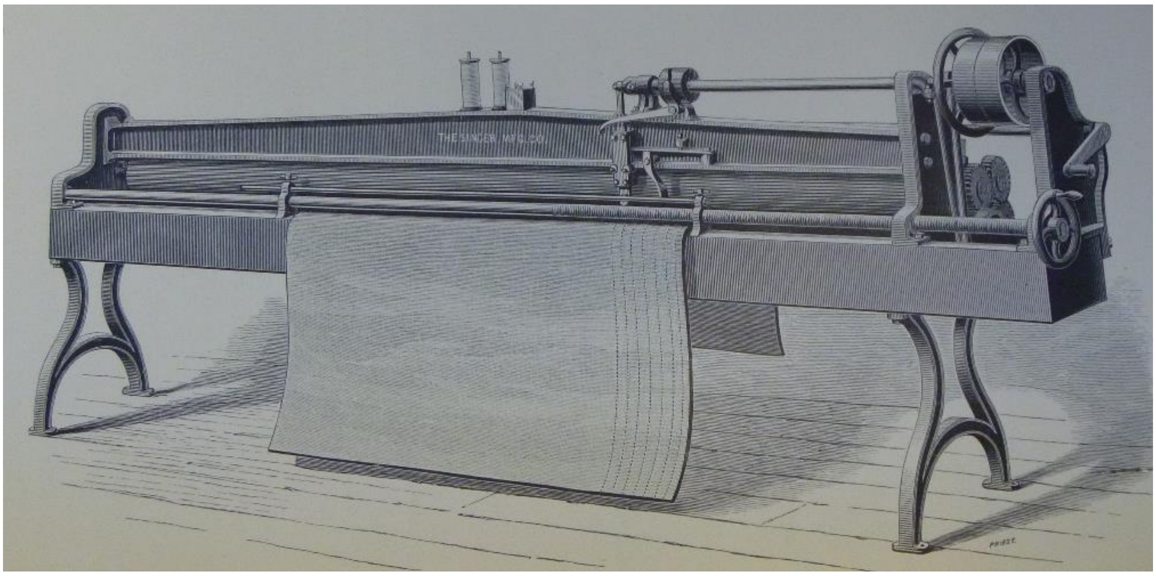


Figure 1-10 Model 9-1 for stitching wide conveyor belting, largest Singer machine ever constructed, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

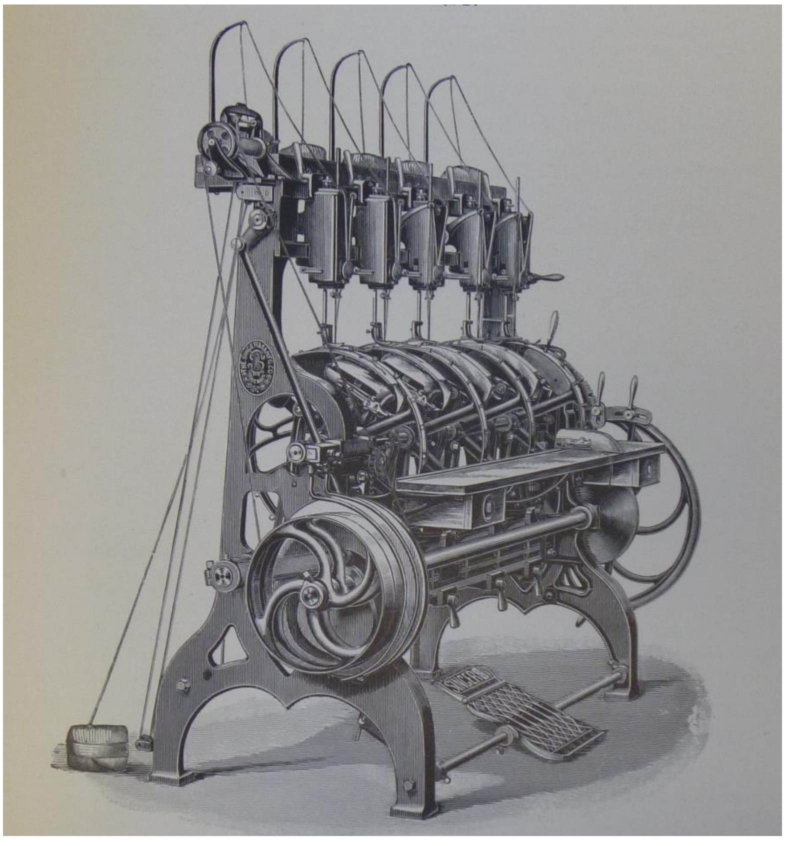


Figure 1-11 Model 14-3 for stitching jacquard cards, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

Machine Size

The Singer Company made significant changes not only to the shape of the sewing machine for manufacturing purposes but also to its size. Singer described model 9-1 as, 'the largest sewing machine ever constructed, especially designed for simultaneously making parallel rows of stitching on heavy canvas or Belting of unusual width […].'[20] The machine bed was 18 feet long and weighed 5000 pounds, and was capable of stitching conveyer belting up to 100 inches wide and 1½ inches thick (Figure 1-10).[21] Another large machine type designed by Singer was Class 14. Model 14-3 was designed to lace or stitch jacquard pattern cards together and came in two sizes, one size could stitch cards between 4 inches and 26 inches long, whilst a second model could stitch cards up to 42 inches in length (Figure 1-11). The machine heads were adjustable, which made it very flexible, and the 1896 catalogue stated, 'the entire range of cards of any manufacturer can be put through this machine, although their variations may be considerable.'[22] Classes of machines designed to construct belting or join jacquard pattern cards were in production by the close of the nineteenth century and remained among the largest machines that the Singer Company ever produced.

These large machine models illustrate Singer's engineering expertise and the scope of its ambition. The production of these large machines demonstrates that Singer could develop machines for the manufacture of goods for public consumption whilst also widening the scope of development to include machines capable of stitching objects used in the processes of manufacturing these goods. The existence of these machines indicates the level of Singer's inquiry into the uses for the needle and demonstrates its willingness to explore every opportunity to mechanise the stitching process. The scale of these machines also demonstrates that Singer was prepared to build machines for a single specific purpose with no transferable applications.

Attachments

In addition to altering the shape and size of machines, Singer also improved their versatility and effectiveness by offering attachments, supports, and guides. For example, model 45K42 was developed for use in saddlery, and because the thread was often required to be waxed in order to remain waterproof, Singer added a 'wax heating arrangement' to make the use of a waxed thread significantly easier (Figure 1-12).[23] Another creative use for an attachment is found with model 24K2. According to an illustrated catalogue published by Singer in 1907, model 24K2

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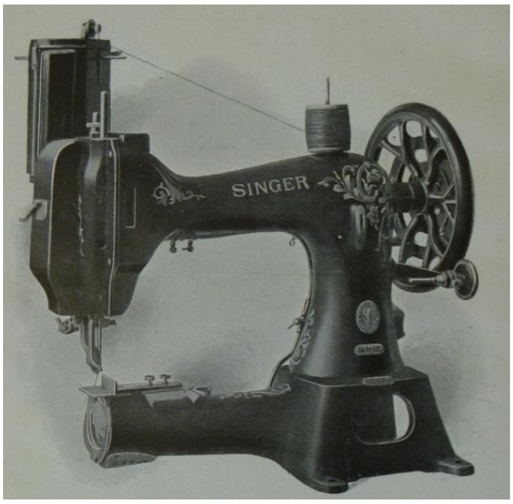
[20] Ibid., p. 90.
[21] Ibid., p. 86.
[22] Ibid., p.108.
[23] The Sewing Machine Collection and Singer Archive (hereafter SMCSA), West Dunbartonshire Council Archives (WDC), box GDWD 1/1/3(2) - *Catalogue of "Singer" Sewing Machines Manufactured at Kilbowie, Clydebank* ([Glasgow (?)]: Singer Manufacturing Company, 1907), p. 82. Although the heating arrangement with model 45K42 is illustrated in a 1907 trade catalogue, it was developed before the turn of the century as it is featured in SMCSA, WDC, box GDWD 1/1/3(2) - *Catalogue and Prices of Singer Sewing Machines Manufactured at Kilbowie, by Clydebank* ([Glasgow(?)]: Singer Manufacturing Company, 1900), p. 28.

was ‘specifically designed for binding and trimming lace curtains in one operation.’[24] However, the small pieces of trimmed curtain could be caught under the needle or fall into the machine and jam the mechanism. Therefore, to remove the trimmings Singer fitted a compressor unit beneath the machine to continuously blow air through a tube across the edge of the curtain as it was being trimmed and bound (Figure 1-13). The invention of these ingenious and often modest attachments illustrates the influence of the stitched object upon machine development. Their invention also demonstrates the depth of Singer’s knowledge about the smallest details of object construction.



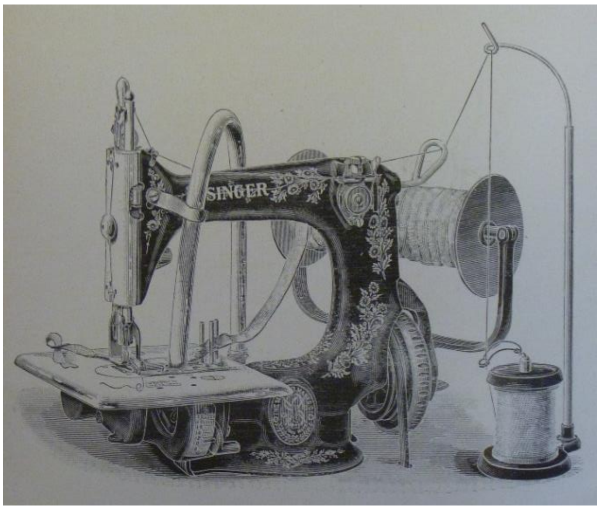


Figure 1-12 (Left) Model 45K2 fitted with heating attachment for use with waxed thread, *Catalogue of “Singer” Sewing Machines* 1907 (The Sewing Machine Collection and Singer Archive (SMCSA), WDC)

Figure 1-13 (Right) Model 24K2, fitted with air compressor and blower attachment, *Catalogue of “Singer” Sewing Machines* 1907 (SMCSA, WDC)

Dates of Development

Although it is difficult to determine exactly when each manufacturing model was introduced, some indication of the scale and scope of machine development can be gleaned from early trade literature produced before the publication of price lists and illustrated catalogues during the last decade of the nineteenth century. A small 29 page pamphlet published by Singer *c*.1865 includes descriptions of only three manufacturing machines.[25] Model no.2 was described as, ‘adapted to manufacturing purposes generally. It will sew anything from a shirt bosom to the thickest leather.’[26] The pamphlet also states that Singer could provide a range of attachments to extend the number of applications for this machine. Model no.3 was described as the ‘only machine made for carriage trimmers’ use. It is of extra size with an arm long enough to take

[24] SMCSA, WDC, box GDWD 1/1/3(2) - *Catalogue of “Singer” Sewing Machines* 1907, p. 53. It is also featured in *Prices of Singer Sewing Machines* 1900, p. 19.
[25] NMAH AC TLC Singer, box 3, folder 1 - *The Singer Sewing Machines* ([n.p.]: Singer Manufacturing Company, [1865(?)]).
[26] Ibid., p. 17.

under it and stitch the largest sized dashes.'[27] The description of model no.3, therefore, suggests that Singer had begun to adapt the sewing machine to the specific size and shape of objects by the close of the 1860s.

A catalogue published in 1876, to accompany Singer's exhibition of machines and machine sewn goods at the World's Fair in Philadelphia, suggests that although no further development in machine shape or scale had been introduced, Singer had extended the range of applications for which the sewing machine could be used. The catalogue encouraged visitors to come and witness Singer machines, 'daily making shoes, making corsets, making ladies' wear, making gloves, working button holes, braiding, embroidering, etc. just as they are used in various manufactories throughout the world.'[28] It also introduced model no.4, which Singer stated had, 'great capacity for heavy work, and to show this practically, it is proposed to sew […] 100 thicknesses of cotton […].'[29] The exhibition and catalogue also emphasised the importance of stitched objects to the promotion and sale of the sewing machine. The catalogue described more than a 100 examples of machine sewn goods ranging from saddles to custom made gowns costing more than $3000. These examples were used by Singer to not only demonstrate the range of the sewing machine as a manufacturing tool but also to convince both stitched object manufacturers and the public of the desirability of machine sewn goods.

Most of Singer's specialised machine development for manufacturing during the nineteenth century appears to have taken place during the last quarter of the century. A single sheet advertising leaflet printed by Singer *c*.1880-1883, which focused mainly on domestic models, included a single paragraph describing manufacturing machines. It stated that there were 'thirty different varieties, from Lightning Stitcher with a 9 inch head or a Dashboard Machine with a 75 inch head, to a ponderous Machine one hundred and ninety-two inches long, weighing $1^{3}/_{4}$ tons, for sewing belting ninety inches in width.'[30] The paragraph also noted that its 'carpet sewing machine is the only success ever yet achieved in that direction.'[31] In 1896, an illustrated trade catalogue specifically produced for manufacturers featured 33 separate classes of machine, and stated that, 'we make machines for stitching every kind of material, from the thinnest lawns to fabrics two inches in thickness, applied in an infinite variety of forms and successfully overcoming difficult conditions.'[32] The range and scale of the manufacturing models described

[27] Ibid., p. 19.
[28] NMAH AC, TLC Singer, box 3, folder 4 - *Singer Manufacturing Company's Catalogue of Exhibits* ([n.p.]: Singer Manufacturing Company, 1876), p. 13.
[29] Ibid., p. 13.
[30] NMAH AC, TLC Singer, box 3, folder 3 - Singer advertising leaflet, *c*.1881-1883.
[31] Ibid.
[32] NMAH Library, *Catalogue of Singer Sewing Machines* 1896, p. 82.

in these two documents is far more extensive than any earlier descriptions, which suggests that significant development had taken place during the period after the World's Fair in 1876.

Machine Classes

The diversity of shape, size, and materials that existed among stitched objects meant that no single model of machine could accommodate them all, and as the range grew Singer created and defined classes of machines for specific sewing purposes. Each class was then further sub-divided into variations, which refined their use and increased the versatility of the class. By the close of the nineteenth century, all Singer sewing machines bore two numbers separated by a letter or a dash. The first number identified the class of machine, the second number its variation within that class, and a letter or dash identified its place of manufacture.[33] An illustrated catalogue published in 1896 represents one of the earliest surviving lists of manufacturing models produced by the Singer Company. Its index included 33 separate classes of machines with between 2 and 61 variations within each class. The range and scope of development represented by the models featured in this catalogue demonstrate a remarkable achievement for a company that had patented only a single manufacturing model less than half a century earlier. It also illustrates the number of trades to which the Singer sewing machine had gained access.

The illustrated catalogue published by the Singer Company in 1896 shows the scope and diversity of machine development by the close of the nineteenth century. The prominence afforded to stitched objects also emphasises their significance to both the development and sale of the sewing as a manufacturing tool. The catalogue ends with a comprehensive list of stitched objects, in alphabetical order, accompanied with reference to the pages that feature machines suitable for their construction. Moreover, throughout the catalogue, constant reference is made to the stitched objects for which machines were developed. Pamela Walker Laird observed that American advertisers in the early twentieth century advised copywriters to discuss products, 'from the perspective of the consumer's "environment" […].'[34] Although relating machine models to stitched objects can certainly be considered as an astute marketing ploy, it also underlines the importance of the relationship between stitched objects and the sewing machine. By foregrounding the stitched object, the layout of the catalogue not only emphasises the

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[33] No letter in a Singer machine's product number meant that it was made at the Elizabethport factory in New Jersey; and the letter 'K' continued to identify the Kilbowie factory in Scotland, even after the name of the town was changed to Clydebank in 1886. In 1905 Singer bought one of its greatest rivals, the Wheeler and Wilson Company, which manufactured machines in a factory in Bridgeport, Connecticut. Singer initially continued to produce machines under the Wheeler and Wilson brand name, but eventually applied the Singer brand name to all machines produced in the factory at Bridgeport. The letter 'w' identifies machines made at the Bridgeport factory.

[34] Pamela Walker Laird, *Advertising Progress: American business and the rise of consumer marketing*, (Baltimore, MD; London: Johns Hopkins University Press, 1998), p. 376.

commercial aspect of mechanisation but also the fundamental purpose of the machines and mechanised tools that were its instruments.

Machine Development, 1900-1980

All stitched objects are made by a series of fragmented tasks. The subsequent division of labour that accompanies this was neither a new idea nor one promoted by the introduction of mechanisation. As Adam Smith observed in the late eighteenth century, 'The greatest improvement in the productive powers of labour, and the greater part of the skill, dexterity, and judgement with which it is any where directed, or applied, seem to have been the effects of the division of labour.'[35] This section, therefore, illustrates how the division of labour and the specific tasks associated with an object's construction broadened Singer's range of machine models and influenced the direction of its machine development during the twentieth century. It begins by illustrating the prominence of object construction in its trade publications and then provides three examples of machine specialisation that serve to illustrate the depth of knowledge that Singer had acquired about object construction. These examples also demonstrate that although the process of mechanisation did not stimulate the sub-division of labour, the direction of machine development during the twentieth century represented a direct response to the principle.

Catalogue Divisions and Descriptions

Indices included in trade catalogues published by the Singer Company reveal how influential the division of labour was to the development of the sewing machine during the twentieth century. Prior to 1900 catalogues included comprehensive, alphabetical lists of objects accompanied by a recommendation for the machine model most suitable for its construction. Post 1900 objects included in a catalogue index were also accompanied with a detailed breakdown of the separate tasks involved in the object's construction, as well as a recommendation for the machine most suitable for each task. As the century progressed, the list of separate tasks and specialised machines increased. For example, a separate index published in 1928 included a range of machines suitable for 11 separate tasks involved in the stitching of 'Motors and Carriage Trimmings'.[36] The tasks included, 'Welting, Piping […] Making Door Flaps […] sewing Listings to Roof Linings […] sewing Celluloid Curtains with metal frame

[35] Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776), quoted from *Factory Production in Nineteenth-Century Britain*, ed. by Elaine Freedgood (New York ; Oxford: Oxford University Press, 2003), p. 85.
[36] SMCSA, WDC, box GDWD 1/1/5, item 28: *Singer Sewing Machines Recommended for Use in Various Industries* ([n.p.]: Singer Manufacturing Company, 1928), p. 33.

[…].'[37] In 1956 the list of tasks involved in the stitching of automobile interiors had grown to more than 30, including, 'Binding Assist Straps, Piping or Plaiting Seat Cushions, Sewing Carpet Kick Pad to Door Panel, Stitching Pockets in Door Panels […]'.[38] Although several of the machine models listed were capable of more than one task, the level of detail recorded demonstrates Singer's close observation of changes to construction, and its ability, and willingness, to adapt machines to accommodate those changes.

During the early twentieth century, in addition to trade catalogues, the Singer Company also produced a selection of trade handbooks. The layout of these handbooks, produced for manufacturers of shoes, hats, gloves, garments, and hosiery, traced the construction of stitched objects using illustrations of objects to recommend the most appropriate machines for each specific task. In a 64 page handbook, produced for the shoe industry in 1908, Singer placed beneath illustrations of men's and women's shoes a list of the separate tasks involved in the shoe's construction, accompanied with a recommendation for the most appropriate machine for each task (Figure 1-14).[39] *The Singer Handbook for the Hosiery Industry*, published *c*. 1920, included 200 pages of machine descriptions, knitted product descriptions, and advice on the organisation of production and production space.[40] The handbook included illustrations of machines, garments, and workspaces. It also featured images of garments annotated with recommendations for machines designed for specific aspects of garment construction (Figure 1-15). And by 1922, an 80 page handbook produced for the hat industry included detailed descriptions of specific tasks accompanied with illustrations depicting specialised machines involved in the task described (Figure 1-16).[41] Throughout the early twentieth century, illustrations and descriptions of stitched object construction became increasingly important features of these trade publications.

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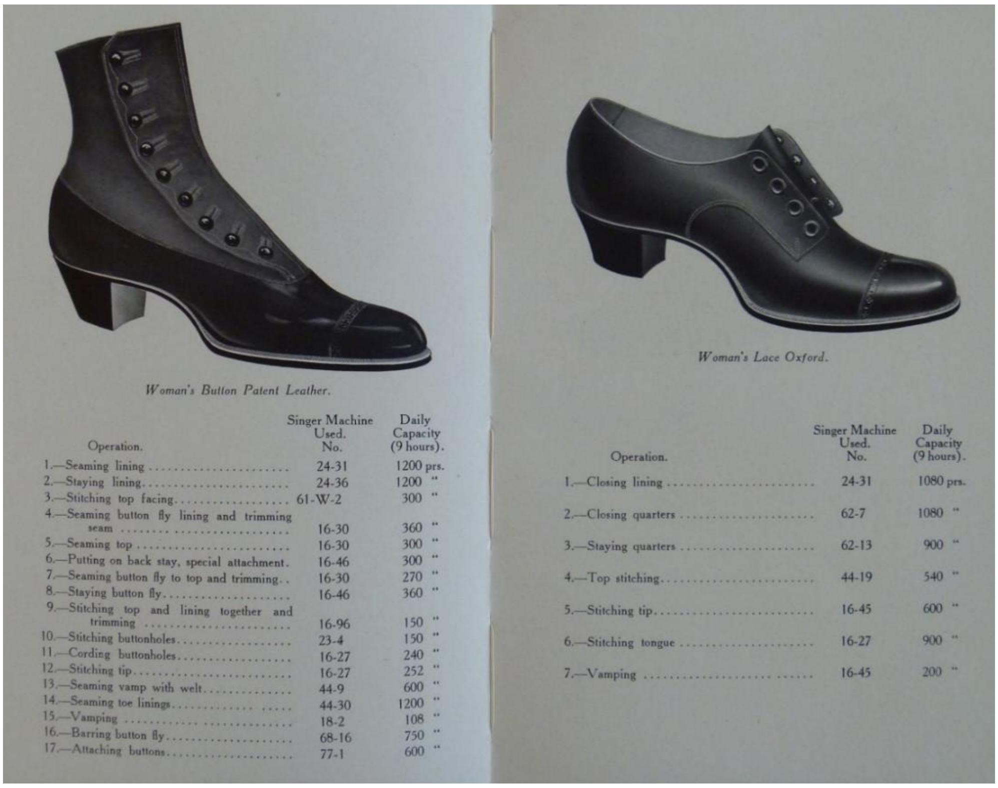
[37] Ibid., pp. 33-34.

[38] SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue of Singer Sewing Machines and Equipment for the Manufacturing Trade* ([n.p.]: Singer Manufacturing Company, [1956(?)]), un-numbered pages.

[39] Hagley Museum and Library, *The Singer Sewing Machine in the Shoe Industry* (New York: Singer Sewing Machine Company Ltd., 1908).

[40] National Art Library, Victoria and Albert Museum (hereafter NAL), *The Singer Handbook for the Hosiery Industry* ([n.p.]: Singer Sewing Machine Company Ltd., [1920(?)]).

[41] Hagley Museum and Library, *Singer Sewing Machines in the Manufacture of Hats and Caps of All Descriptions* ([New York]: Singer Manufacturing Company, 1922).



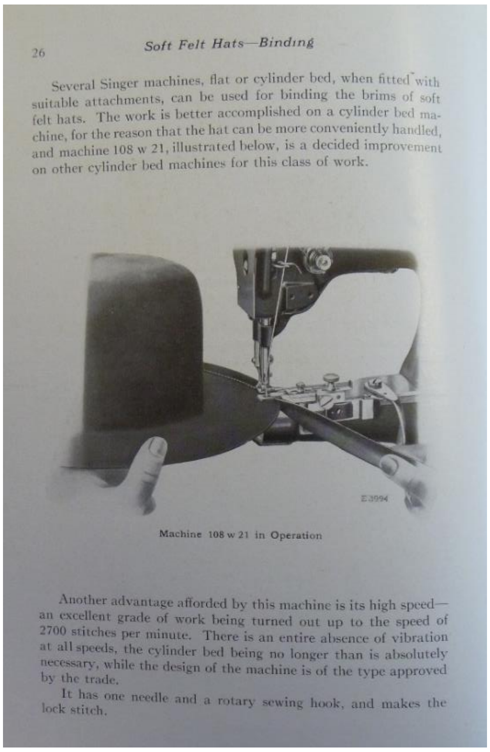
Woman's Button Patent Leather.

Operation.	Singer Machine Used. No.	Daily Capacity (9 hours).
1.—Seaming lining	24-31	1200 prs.
2.—Staying lining	24-36	1200 "
3.—Stitching top facing	61-W-2	300 "
4.—Seaming button fly lining and trimming seam	16-30	360 "
5.—Seaming top	16-30	300 "
6.—Putting on back stay, special attachment	16-46	300 "
7.—Seaming button fly to top and trimming	16-30	270 "
8.—Staying button fly	16-46	360 "
9.—Stitching top and lining together and trimming	16-96	150 "
10.—Stitching buttonholes	23-4	150 "
11.—Cording buttonholes	16-27	240 "
12.—Stitching tip	16-27	252 "
13.—Seaming vamp with welt	44-9	600 "
14.—Seaming toe linings	44-30	1200 "
15.—Vamping	18-2	108 "
16.—Barring button fly	68-16	750 "
17.—Attaching buttons	77-1	600 "

Woman's Lace Oxford.

Operation.	Singer Machine Used. No.	Daily Capacity (9 hours).
1.—Closing lining	24-31	1080 prs.
2.—Closing quarters	62-7	1080 "
3.—Staying quarters	62-13	900 "
4.—Top stitching	44-19	540 "
5.—Stitching tip	16-45	600 "
6.—Stitching tongue	16-27	900 "
7.—Vamping	16-45	200 "

Figure 1-14 Illustration from *The Singer Sewing Machine in the Shoe Industry* 1908 (Hagley Museum and Library)



26 *Soft Felt Hats—Binding*

Several Singer machines, flat or cylinder bed, when fitted with suitable attachments, can be used for binding the brims of soft felt hats. The work is better accomplished on a cylinder bed machine, for the reason that the hat can be more conveniently handled, and machine 108 w 21, illustrated below, is a decided improvement on other cylinder bed machines for this class of work.

E3994

Machine 108 w 21 in Operation

Another advantage afforded by this machine is its high speed—an excellent grade of work being turned out up to the speed of 2700 stitches per minute. There is an entire absence of vibration at all speeds, the cylinder bed being no longer than is absolutely necessary, while the design of the machine is of the type approved by the trade.

It has one needle and a rotary sewing hook, and makes the lock stitch.

Figure 1-15 (Left) Annotated illustration showing recommended machines for specific operations from *The Singer Handbook for the Hosiery Industry* 1920 (NAL. Image © author. Use of photograph courtesy of Victoria and Albert Museum, London.) Image removed due to Copyright restrictions.

Figure 1-16 (Right) Illustration of stitching operation from *Singer Sewing Machines in the Manufacture of Hats and Caps* 1922 (Hagley Museum and Library)

The descriptive detail included in the trade handbooks illustrates the depth of knowledge that Singer had gained about object construction. Whilst the nuance and accuracy of the text provide evidence of the exchange of knowledge that must have occurred between stitched object manufacturers and the Singer Company. These detailed descriptions demonstrate that Singer was capable of distinguishing between product types, quality, and levels of production in a variety of trades, and its awareness of these differences was apparent in the direction of its machine development. Singer's concentration on object construction in the layout of its handbooks demonstrated the importance of construction to machine specialisation during the early twentieth century. I also represented a bold editorial choice. This choice presumes what Boris Emmet and John E. Jeuck, examining the catalogues of Sears, Roebuck and Company, described as, 'an editorial policy over and above presentation of individual items of merchandise.'[42] The illustrations and descriptions found in these trade publications demonstrate that Singer was not only acutely aware of the range of tasks involved in object construction, it was also actively communicating this awareness to its trade customers. Although the purpose of the layout was to display the range and specialisation of its manufacturing models, it could also demonstrate a level of trade and product knowledge that would reassure trades and instil confidence in the Singer Company and its machines.

Task Specific Machine Development

The first example of specialised machine development in response to the division of labour is taken from *Singer Sewing Machines in the Manufacture of Hats and Caps of All Descriptions*, published in 1922. This handbook ran to 80 pages and included illustrations of both Singer machines and a range of hats for both men and women. It was divided into separate sections that concentrated on different types of hat, their materials, and construction. In the preface to the handbook, the Singer Company stated, 'The Singer organization, with its long experience and the great variety of its product, is not only able to supply highly specialized equipment for all manufacturing requirements, but is often able to suggest methods for greater economy in manufacture or improvement in quality.'[43] Although the detailed descriptions of hats featured in this handbook illustrate the depth of knowledge that Singer could acquire about object construction, they also, more significantly, indicate that the Singer Company fully appreciated and responded to the subtle differences among products and businesses within a trade.

The sweatband formed an integral and important part of the hat's structure, and two brief sentences found in the introduction to its handbook summarise the depth of Singer's knowledge about this relatively simple feature. The handbook stated, 'a bias sateen strip is folded over a

[42] Boris Emmet and John E. Jeuck, *Catalogues and Counters*, p. 85.
[43] Hagley Museum and Library, *Singer Hats and Caps* 1922, un-numbered page.

reed or wire, and simultaneously stitched into the hat sweat. If desired, the reed or wire may be omitted from the strip.'[44] In order for the sweat band to be easily sewn into the curve of a hat crown it had to remain supple. Singer was aware of this fact and knew that the sateen strip had to be bias cut. Bias cutting meant cutting cloth at a 45 degree angle in order to use the inherent stretch of the fabric and maximise the flexibility of the cut piece. In addition to recognising the fabric as bias cut, Singer was also aware that a reed or wire was used to maintain the shape of a hat. However, it also knew that, 'in less expensive grades of soft hats the reed is sometimes omitted […].'[45] Singer understood precisely how the sweat band was made Furthermore, it also knew that its construction could vary for different types and qualities of hat.

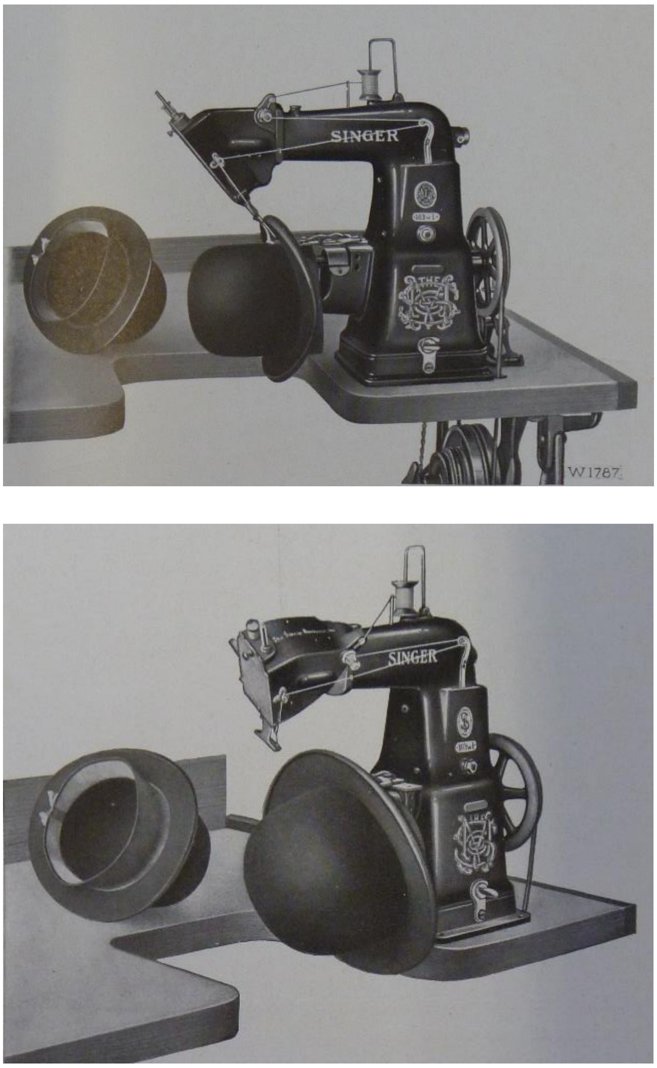


Figure 1-17 Model 103w1 cylinder arm machine with needle at oblique angle for stitching sweat bands, the head could also be swivelled back to accommodate the hat, *Singer Sewing Machine in the Manufacture of Hats and Caps* 1922 (Hagley Museum and Library)

[44] Ibid., p. 8.
[45] Ibid., p. 7.

Singer's awareness of the significance of this single task prompted the development of a variety of machines for the construction and insertion of a sweat band, and two examples demonstrate the influence of this single task on machine development. To make the insertion of the band easier, model 103w1 had a cylinder arm, and the needle was fitted at an oblique angle to prevent the rim of the hat from becoming wrinkled during stitching (Figure 1-17). The head of the machine could also be swung back to make placing and removing the hat easier. Because model 103w1 was designed for a specific purpose, Singer claimed it could substantially increase productivity. The handbook stated that a single operator using this machine could insert up to 60 dozen taped bands in an eight hour day.[46] However, Singer did not develop model 103w1 for stitching any type of sweat band, according to the handbook, model 103w1 was, 'especially designed for sewing reeded or wired taped sweatbands' into hats.[47] Singer used its knowledge of construction to distinguish between types of taped band and make its machine models even more efficient for the task identified.

Another example of machine development influenced by Singer's knowledge of the subtle differences between sweat bands and hats is model 127w3. Singer developed this model specifically to stitch a branded product into only straw hats, a task which prior to the introduction of this machine was performed by hand.[48] In 1921 the patent for a sweat band known as the "Bon Ton Ivy" was renewed by its British manufacturers in America. Its innovation was the inclusion of a channel holding a length of elastic, which meant that the fit of the hat could be easily adjusted to make the hat more secure. Model 127w3 also had a cylinder arm, but instead of angling the needle the machine was fitted with an adjustable support to ensure the angle of the hat remained constant as the band was stitched (Figure 1-18).[49] In addition to the support, the machine also had an attachment to encourage the band into the correct position. Singer also produced another machine for stitching sweat bands into hats, model 107-1, the description of which made no mention of a branded product (Figure 1-19). The development of two models for the same stitching task not only illustrates Singer's awareness of the subtle differences among products manufactured within the same trade, it also demonstrates Singer's supple response to the process of mechanisation and the complexities of object construction.

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[46] Ibid., p. 20.
[47] Ibid., p. 45
[48] Ibid., p. 21.
[49] Ibid., p. 21.

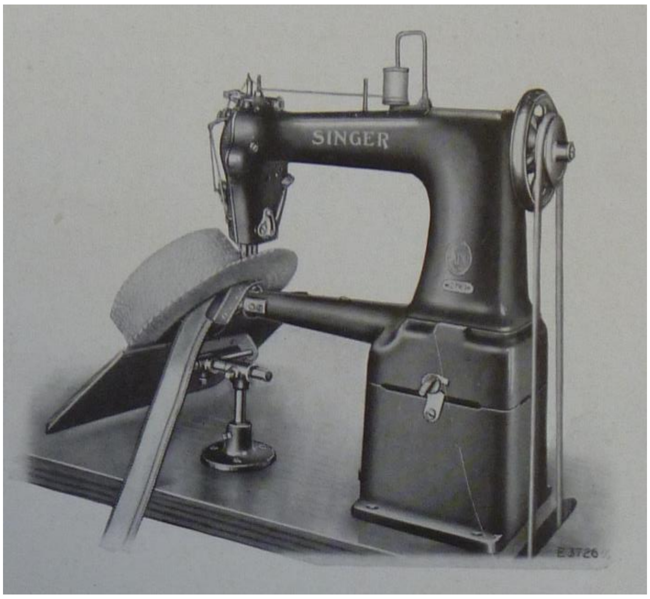

Figure 1-18 Model 127w3 for stitching 'Bon Ton Ivy' sweatbands into straw hats, *Singer Sewing Machine for Hats and Caps* 1922 (Hagley Museum and Library)

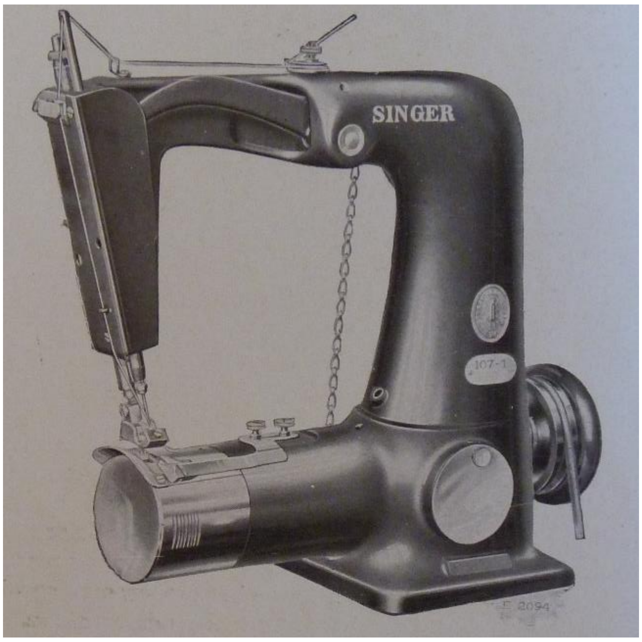

Figure 1-19 Model 107-1 for stitching sweatbands into straw hats, *Singer Sewing Machine for Hats and Caps* 1922 (Hagley Museum and Library)

The detailed descriptions of products, machine specifications, and object construction processes found in Singer's trade manuals and handbooks illustrate how well acquainted Singer was with the construction and production of stitched objects. The degree of familiarity with trades and products that these descriptions betray offers compelling evidence of an exchange of knowledge between Singer and its trade customers. Only through communication with stitched object manufacturers would Singer have been able to recognise and respond to the subtle differences among products made by the same trade or appreciate the significance of a branded product to an industry. Handbooks produced by Singer portray its familiarity with a trade and its products.

This familiarity would instil confidence in Singer's machine products and persuade potential customers that Singer machine models could improve quality and increase productivity. The accurate portrayal of object construction also indicates the level of familiarity required for the successful development of task specific machines.

Alternative Methods of Production

The second example of specialised machine development concentrates on two machine models that Singer developed for the insertion of garment sleeves. Both models, which were featured in its handbook *Singer Sewing Machines Used in the Manufacture of Men's Clothing* published in 1913, demonstrate that Singer was not only able to identify an opportunity to mechanise a single specific task, it was also able to identify opportunities to develop machines that could combine tasks. The insertion of garment sleeves involves two steps. The first step involves putting at least one row of gathering stitches around the head of the sleeve, and the second step involves using these gathering stitches to ease the sleeve into the armhole of the garment. Singer's willingness to provide two alternative methods of production demonstrates not only an understanding of stitched object construction but also reveals that different levels of object quality and production prompted varying degrees of machine specialisation.

Singer's machine model 24-13 specialised only in the first step of sleeve insertion, the making of a gathering stitch. It made a simple chain stitch, and essentially mechanised the task performed by hand. It also demonstrated that Singer was prepared to develop machines that were counter intuitive to the original purpose of the sewing machine, if a useful function for such a machine could be identified. The purpose of the sewing machine was to permanently join materials together with a secure stitch, but model 24-13 was developed to make only a temporary stitch and did not join materials. However, a machine made gathering stitch offered a quick alternative to gathering by hand, and Singer's handbook for the men's clothing trade stated that, 'with a little practice the operator on this machine can do gathering far superior to hand work and at the same time greatly increase production.'[50] Singer claimed that use of this specialised machine would improve both efficiency and production for manufacturers.

Singer's machine model 47w11 offered an alternative approach to the same task, by combining two steps into one. The handbook stated that, 'where a machine of this type is used, it is customary to omit the gathering of the sleeve before inserting, as the alternating pressers with which this machine is equipped make it possible for the operator to so manipulate the garment as to bring it out without fullness or puckering under the arm.'[51] The machine was also fitted

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[50] Hagley Museum and Library, *Singer Machines Used in the Manufacture of Men's Clothing* ([New York]: Singer Sewing Machine Company, 1913), p. 23.
[51] Ibid., p. 25.

with a barrel arm to make the handling of the sleeve easier, and the handbook remarked that, 'the more progressive manufacturers are using a cylinder bed machine for this type of work.'[52] The development of model 47w11 demonstrates that Singer not only understood the individual steps involved in garment construction but also their precise purpose. Because Singer understood how the gathering stitch was used to help ease the sleeve head into position, it was able to offer garment manufacturers alternative mechanical ways to do this.

Singer offered manufacturers alternatives because although the insertion of a sleeve varied little, the quality and volume of garment production could vary significantly, depending upon which part of a market a business sought to serve. Although model 47w11 eradicated a step in construction, which would increase productivity, the successful manipulation of the sleeve head required a certain degree of skill and control. Consequently, the operator would benefit from repeating the same action on garments of the same style and fabric weight. This meant that the machine could be of particular advantage to volume manufacturers. Model 24-13, on the other hand, was, essentially, a fast and efficient replacement for hand sewing that could be inserted into any scale of production. It would benefit those who changed garment styles and fabric weight more frequently or those who simply preferred to continue to use a gathering stitch. Because different levels of production could co-exist within the same trade, one type of specialised machine would not suit all. By offering alternatives, Singer demonstrated that its machine development responded not only to object construction but also to the market for which objects were constructed.

Towards Automation

By the late nineteenth-century, the combination of a specialised stitching task and a high volume of object production prompted Singer to consider automation. Initially, Singer could only automate the stitching sequence, and the machine continued to rely upon an operator to calibrate it correctly and move the garment pieces into position before the sequence started. It was only with the introduction of electronic units in the mid-twentieth century that both the stitching sequence and the movement of the garment could be automatically controlled. The stitching task also had to remain relatively unchanging, otherwise, the difficulties involved in constantly updating the machine would outweigh any of the advantages it could deliver. Consequently, not all stitching tasks were suitable for automation. Moreover, the complexity of automating a stitching task also encouraged Singer to concentrate on developing machines that would have a broad application. Therefore, the earliest automatic machines the Singer Company developed were for the making of buttonholes.

[52] Ibid., p. 25.

An illustrated catalogue published by the Singer Company in 1896 featured a range of 17 automated buttonhole stitching machines, all variations of Class 23.[53] The range could be used with either leather or textiles and could produce buttonholes of up to two and a half inches in length. The catalogue description stated that, 'work is held face down, in a convenient clamping device which secures absolute accuracy; the feed carries the clamp in exact relation to the speed of the stitch forming mechanism.'[54] The machine still relied upon an operator to move the garment pieces, but Singer suggested that because of the automation of the stitching sequence production could be increased if a single operator tended two machines. Beneath an illustration (Figure1-20) of such a set up the catalogue stated:

> these machines stop automatically upon the completion of a button-hole, so that the operator seated in a revolving chair can run both machines. By this method the time occupied by one machine in automatically stitching a button-hole is utilized by the operator in changing the work and starting the other machine. More than 7,500 button-holes have been stitched in one day of ten hours on a pair of these machines arranged as shown above.[55]

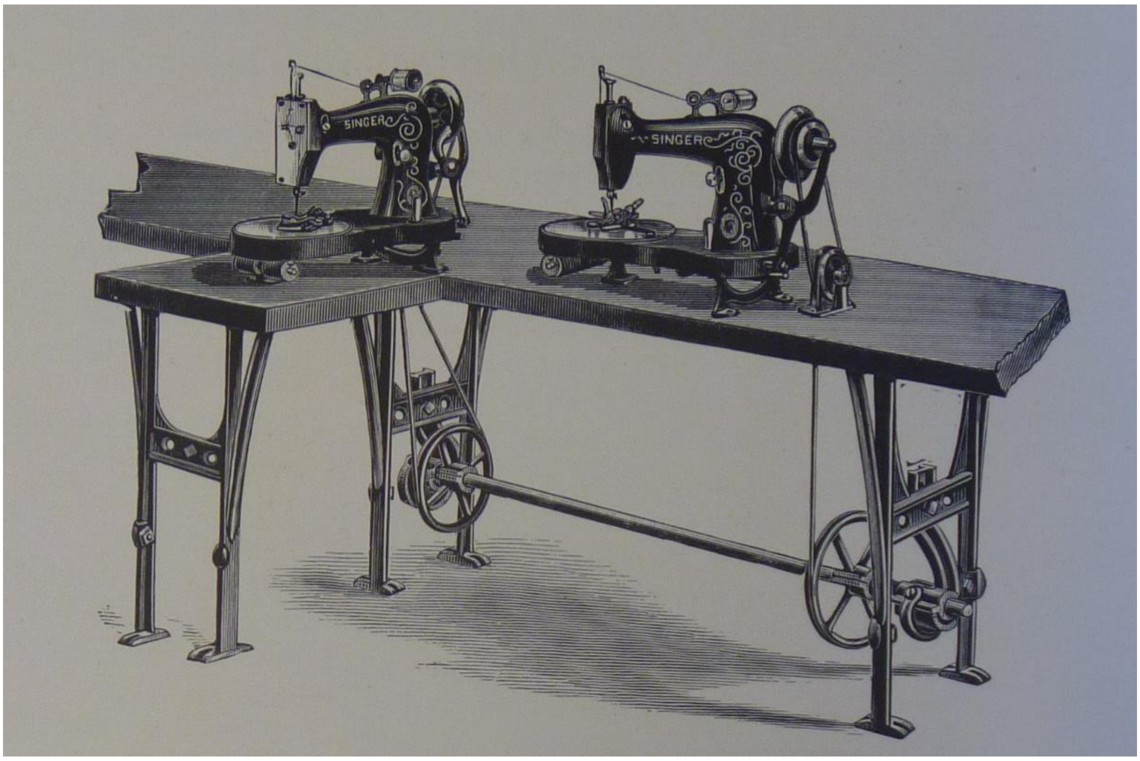

Figure 1-20 Model 23-3 for automatic button holing, set up as a pair to increase production, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

[53] NMAH Library, *Catalogue of Singer Sewing Machines* 1896, pp. 154-159.
[54] Ibid., p. 154.
[55] Ibid., p. 156.

Although Singer was able to automate the stitching sequence, automated buttonhole machines continued to rely on the skill and experience of machinists to calibrate them correctly. In the first half of the twentieth century, Singer reduced the number of automated buttonhole machines but increased the range of each. In 1942 Singer published two separate operating manuals to accompany two sets of automated buttonhole machines. Models 99w100, 99w111, 99w112, and 99w113 made buttonholes that were described as 'cut-after', and models 99w130, 99w131, 99w132, and 99w133 made those that were described as 'cut-first.[56] Buttonholes that were 'cut-first' meant that the entire raw edge was concealed by the stitch, which accurately mimicked how a buttonhole was stitched by hand. Buttonholes that were 'cut-after' meant that the raw edge could be seen, and this type of buttonhole was only ever produced by the sewing machine. These specialised machines required the changeover of machine parts as well as adjustments to machine parameters and mechanisms. Both manuals ran to 64 pages and included detailed descriptions and annotated diagrams to help the machinist correctly calibrate the machine. Despite their mechanical sophistication, these automated machines still relied heavily upon operators to optimise their use and increase productivity.

A product leaflet printed in 1959 described Singer's first fully automated buttonhole stitching machine, the Sequential Buttonholing Unit, model 256w1 (Figure 1-21). The leaflet described it as:

> a complete compact unit which automatically forms, in sequence a series of vertically aligned buttonholes on shirt, blouse, and pajama coat fronts. Each unit consists of 71-201 Lockstitch Buttonhole Machine and Electro Mechanical Indexing Device […] In using the unit…an operator need only place the unfinished shirt front under a clamp, press a button to start automatic cycle, then remove the front on completion of the entire operation.'[57]

The introduction of an electronic guidance system meant that, for the first time, both the stitching sequence and the movement of the garment piece were automatically controlled. Although the operator still had to set the parameters of the stitch length and the spacing between buttonholes, this could now be done more easily using 'an arrangement of electric controls, as

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[56] NMAH Textiles Collection (hereafter TC), box 16 – *Instructions for Using and Adjusting Singer Sewing Machines 99w110, 99w111, 99w112 and 99w113 for Making "Cut-After" Buttonholes in Woven Fabrics* ([New York]: Singer Manufacturing Company, 1942) and *Instructions for Using and Adjusting Singer Sewing Machines 99w130, 99w131, 99w132 and 99w133 for Making "Cut-First" Buttonholes in Closely Woven Fabrics* ([New York]: Singer Manufacturing Company, 1942).
[57] SMCSA, WDC, box GDWD 1/1/3(2) – *Singer Industrial Sewing Equipment* ([New York]: Singer Manufacturing Company, [n.d.]), un-numbered. This is an internal document consisting of printed product leaflets, Form 19100, and typed and hand written addenda. The leaflets and addenda date from 1952 to 1962. Form 19100 – Bridgeport Section for model 256w1 was printed in 1959.

well as conventional type stop-and-start mechanisms.'[58] This automated unit was intended only for use with medium weight fabrics, and although the distance between buttonholes could be altered it could only stitch three to seven on a garment front. These restrictions, however, made it easier to automate the entire stitching process.

Figure 1-21 Model 256w1 Automatic Sequential Buttonholing Unit, *Singer Industrial Sewing Equipment*, Form 19100-Bridgeport Section for model 256w1, 1959 (SMCSA, WDC). Image removed due to Copyright restrictions.

The introduction of electronic units encouraged Singer to automate a variety of other specialised tasks during the 1960s and 1970s. However, although the combination of sewing machine models and programmable units became increasingly inventive and sophisticated, their development could only be justified for stitching tasks that remained stable and for which there was a high level of demand. An American trade catalogue published by the Singer Company during the 1970s included a section on 'mechanised sewing'.[59] This section featured automated stitching units primarily for the garment industry, and included units for sewing on buttons, yoke seaming for shirts and blouses, sewing pockets onto jackets and shirts, and the making up of collars and cuffs.[60] All of these tasks varied little from garment to garment, and the ubiquity of shirts and blouses meant that market demand could support large production runs.

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[58] SMCSA, WDC, box GDWD 1/1/3(2) - *Singer Industrial Sewing Equipment*, Form 19100-Bridgeport Section for model 256w1, 1959.
[59] SMCSA, WDC, box 1/1/3(2) - *Industrial Sewing Catalog* ([New York]: Singer Manufacturing Company, [1978(?)]), un-numbered.
[60] The development of automated units for shirt making will be discussed in more detail in Chapter Four.

Figure 1-22 Automatic Sequential Button Sewing Indexer 2200, *Industrial Sewing Catalog, c.* 1978 (SMCSA, WDC). Image removed due to Copyright restrictions.

A product description of one of these automated units illustrates how Singer combined machines and electronic devices to significantly increase production and make optimum use of an operator’s time. The Automatic Sequential Button Sewing Indexer comprised a button sewing machine and an Indexer and Stacker Unit 2200 (Figure 1-22). The Indexer controlled the movement of garment fronts up to 33 inches long, without the need to re-adjust for different garment lengths; and the spacer bar of the Indexer could be changed to a new style in 30 seconds. As well as the Indexer controlling the movement of the garment, once stitching was complete it then flipped the garment onto a stacker rail that could hold up to a ten dozen garment fronts. The inclusion of the stacker rail gave the operator time to lay out the next garment front which enabled a single operator to tend two machines. The catalogue claimed that it took the unit four and a half seconds to stitch five buttons, and an operator tending two machines could produce 380 dozen shirt fronts in an eight hour day, which is the equivalent to 4,560 shirt fronts per day or 22,800 in a five day week.[61]

[61] SMCSA, WDC, box 1/1/3(2) - *Industrial Sewing Catalog, c.* 1978, un-numbered.

The introduction of automated units altered the relationship between the sewing machine and operator. Essentially, electronic units guiding garment pieces beneath a needle replaced the machinist. Although the operator tending the automated unit was still required to correctly load the machine and match patterns and colours, they no longer needed to have knowledge of construction or learn how to handle a sewing machine. In a product description for its Automatic Pocket Setters, Singer could, therefore, stress the fact that these units required 'Minimal Operator Training – The operator has to learn only the push button control system and can normally become proficient in loading, threading, etc. after about 12 hours operation.'[62] However, these units could only partially make a garment and skilled machinists were still required to completely assemble the garment. Moreover, although machinists operating a sewing machine could not match the speed and accuracy of an automated unit, this very speed and accuracy ultimately demanded more of individual machinists. They had to be able to handle fast machines in order to maintain the pace of production set by high performance automated units. They also had to match their accuracy because the precision of the units greatly reduced the tolerance for error. Despite the sophistication of these automated units, they could not entirely replace the need for skilled and experienced machinists.[63]

Power Distribution and Production Space

With the adoption of steam power during the nineteenth century, the sewing machine became part of an integrated mechanised system of production, and any alteration to that system, or its organisation, contributed to the development of the machine as a manufacturing tool. Descriptions of manufacturing practice found in Singer's trade publications indicate that Singer was not only aware of any changes that took place within mechanised production, it was also willing to encourage and contribute to these changes. Trade catalogues and handbooks published by the Singer Company featured devices and furniture to assist trades with the adoption of power, along with recommendations on the organisation of production and production space. Therefore, the final section of this chapter focuses on how the use, and delivery, of external power sources and the re-organisation of production and production space contributed to the diversification and specialisation of Singer's manufacturing model range during the nineteenth and twentieth centuries.

The introduction and adoption of the sewing machine during the second half of the nineteenth century gave needle trades the opportunity to harness the use of steam power. As the cost of

[62] Ibid.
[63] The relationship of skill to the development of the sewing machine as a manufacturing tool is discussed further in Chapter Six.

steam engines fell, its use became more widespread and proved to be a catalyst for machinery development in a variety of industries. Historians, Ben Forster and Kris Inwood, examining furniture production during the nineteenth century, noted, 'From the vantage point of the 1870s […] steam was of considerable interest, because it made possible the use of a widening array of machinery.'[64] Although every manufacturing machine model produced by Singer could be adapted for use with steam power, an increase in the use of steam during the last quarter of the nineteenth century encouraged Singer to develop machines models that depended upon it.

The illustrated catalogue published by the Singer Company in 1896 features several machine classes specifically developed to exploit the use of an external power source. Models in Classes 6 and 10 required power to punch through cloth and leather up to an inch in thickness, whilst models from Classes 31 and 51 used power to increase the speed of the machines.[65] Models from Classes 5, 8, and 9 were also fitted with 'Adjustable Driven Feed Rolls, for Mechanical Power' because they were, 'especially designed for the strong stitching, in long lengths, of several plies of rubber, canvas, or leather […].'[66] The feed rolls of these machines both controlled the length of material as it was stitched, and supported its weight. Models in Class 9 could stitch material up to 100 inches wide and had 'powerful feed rolls sixteen feet long, capable of carrying material of several tons weight […].'[67] Although, in the first instance, a purpose for these machine models had to be identified, ultimately, their development relied upon the availability and adoption of an external power source.

The introduction and adoption of steam also promoted the sewing machine as part of an integrated and mechanised production system. As Clara Collet, a contemporary observer and reformer of women's working conditions, remarked in 1891, 'the application of steam power to the sewing machine produced another revolution by making the factory system inevitable.'[68] In order to gain maximum benefit from the use of steam, and to absorb the cost of the engine, manufacturing became increasingly centralised in a single production space: a fact that Singer both recognised and encouraged. In its catalogue published in 1896 Singer included everything necessary for the use of steam and stated:

> we invite attention to our latest devices for the power operation of sewing machines. In practical operation these devices have been universally commended as the best for factory use in the Stitching Department. We furnish everything required for a complete,

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[64] Ben Forster and Kris Inwood, 'Diversity of Industrial Experience', p. 349.
[65] NMAH Library, *Catalogue of Singer Sewing Machines* 1896 – the catalogue description of Class 10 states, 'for heavy leather stitching by mechanical power', p. 103; and description of Class 51 states, 'for operation at high speed by mechanical power […]', p. 226.
[66] Ibid., p. 85.
[67] Ibid., p. 90.
[68] Clara E. Collet, 'Women's Work in Leeds', *The Economic Journal*, 1.3 (1891), 460–73 (p. 467) <https://doi.org/10.2307/2956111>.

> up-do-date stitching plant for any class of industry, arranged in exact accordance with the latest and most approved practical methods.[69]

By actively encouraging the needle trades to use steam power, Singer acknowledged the importance of an integrated production system and its growing significance to the development of the sewing machine as a manufacturing tool.

Singer gave further evidence of its commitment to involving the sewing machine in an integrated system by developing sectional worktables for use with its machine models. Power from the steam engine was delivered via long transmission shafts placed along the length of a production space. Although belting from these shafts delivered power to individual machines, the position of the shafts meant that machines had to be placed in long static lines. In response to this, Singer introduced sectional worktables that could carry the transmission shaft beneath them in its catalogue published in 1896. Each table accommodated two machines and could be securely fastened together with others to create any length of table a manufacturer required.[70] In addition, the tables could have troughs to accommodate the different shapes of stitched objects, and the table tops could be adjusted to allow them to be bolted to uneven floors then levelled. The introduction of sectional tables not only made steam power more accessible to the needle trades, it also encouraged the use of steam with the entire range of Singer's manufacturing machine models.

In the early twentieth century motor technology replaced the use of steam power. This replacement prompted a re-organisation of production space, which the Singer Company promoted and encouraged. In its handbook for the hosiery industry published in 1920, Singer included recommendations of how to maximise the use of space and increase productivity through the adoption of motor technology.[71] Singer recommended replacing the long benches of machines, supplied with power by transmission shafts, with several shorter banks of machines, each bank supplied by a single motor (Figures 1-23 and 1-24). The handbook stressed that this re-organisation not only increased the number of machines in the room, it also allowed them to be used more efficiently. If the power supply had to be interrupted in order to repair a machine, then every machine on the bank became idle. By creating shorter banks, any stoppage incurred significantly less disruption to overall production. Moreover, the introduction of shorter benches created wider thoroughfares through the production space, which meant that the distribution and collection of work caused less disturbance to the machinists. And in 1926 an article published by Singer's internal company magazine, *The Red 'S' Review*, featured photographs of a Leeds

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[69] NMAH Library, *Catalogue of Singer Sewing Machines* 1896, p. 232.
[70] Ibid., p. 233.
[71] NAL, *Singer Handbook for the Hosiery Industry* 1920, pp. 138-172.

garment factory before and after Singer's successful implementation of the system it had described in its handbook (Figures 1-25 and 1-26).[72]

Figure 1-23 Diagram of long benches from *The Singer Handbook for the Hosiery Industry* 1920 (NAL. Image © author. Use of photographs courtesy of Victoria and Albert Museum, London.) Image removed due to Copyright restrictions.

Figure 1-24 Diagram of short benches from *The Singer Handbook for the Hosiery Industry* 1920 (NAL). Image removed due to Copyright restrictions.

[72] *The Red 'S' Review*, January 1926, p. 12.

Figure 1-25 Workroom of Messrs Hart and Levy, clothing manufacturers in Leicester, with long benches (*Red 'S' Review*, January 1926). Image removed due to Copyright restrictions.

Figure 1-26 Workroom of Messrs Hart and Levy after the introduction of shorter work benches (*Red 'S' Review*, January 1926). Image removed due to Copyright restrictions.

Whilst the introduction of power had encouraged the expansion of Singer's manufacturing machine range during the nineteenth century, the re-organisation of production space contributed to machine specialisation during the twentieth century. Although the construction of stitched objects had inspired the development of task specific machines, an article published by

The Red 'S' Review in 1927, which promoted the re-organisation of production, stated, 'Doubtless it is at times a matter of wonder […] that manufacturers cannot be persuaded to introduce special machines for operations where they are obviously needed […].'[73] The article highlighted the fact that adoption and diffusion of specialised machinery depended not only upon its fitness for a task, it also relied upon its successful integration into a production space. As Singer had observed in its handbook for the hosiery industry published in 1920:

> no special machine can be introduced into a department without affecting to a greater or lesser degree the working of the existing system […] A new machine, therefore, should be placed in the proper position, fitted in the proper manner, be perfectly component with the other equipment, and its output should be made to balance accurately with connecting operations in order to obtain the fullest benefit from its installation.[74]

According to the article published in 1927, the introduction of shorter banks of machines permitted the creation of small sections or teams. The production from these smaller teams could be more easily controlled and monitored, which made it possible for Singer to advise manufacturers on the best position for task specific machines to ensure optimum efficiency. If re-organisation made the integration of specialised machinery significantly easier, this would increase the likelihood of both its adoption and further development.

By the early twentieth century Singer's machine development was not only influenced by the construction of stitched objects, it was also influenced by the role of the machine within an integrated system of production. In its handbook for the hosiery industry, published in 1920, Singer observed, 'the engineering specialist should be encouraged to submit his views […] if his study of the trade is profound enough to enable him to invent new machinery for that trade, then his knowledge is too valuable to be ignored.'[75] The introduction to the handbook also expressed Singer's holistic attitude towards machine development, it stated:

> There have been many great improvements effected by the careful study of the requirements of each trade, by the invention of special machinery for assisting labour in the manipulation of difficult operations, and also by the help of highly qualified experts in determining the most successful methods of expediting the article manufacture from process to process through the factory from inception to completion […].[76]

These excerpts illustrate the value of trade and system knowledge to the Singer Company and demonstrate its influence upon successful machine development and specialisation.

Trade and system knowledge was regarded as so important by the Singer Company that it saw in its promotion an opportunity to enhance the reputation of both the company and its products.

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[73] *The Red 'S' Review*, October 1927, p. 8.
[74] NAL, *Singer Handbook for the Hosiery Industry* 1920, p. 164.
[75] Ibid., p. 163.
[76] Ibid., p. 5

In an article published by the *Red 'S' Review* in 1927, which discussed the re-organisation of production, Singer stated:

> When he [a trade customer] pays for the machine or other equipment he has purchased from us, he has received full value for his money: but if he receives service of the kind we are advocating, he gets more than value, he receives a service which is inestimable, but nevertheless tangible […] And that is the way future business and bigger business will materialize.[77]

The article suggested that Singer agents offer a tailored service to trade customers, and advised that, 'Hard and fast rules will *not* do […] In forming a plan, be as complete as possible in your ideas, whether they appear likely of acceptance in toto, or not. Be thorough […] You may have to modify it, but likely enough you will be surprised to find that the very ambition of it appeals to the manufacturer.'[78] Singer saw that its reputation could be built not just upon the capabilities of its individual manufacturing machine models, but also upon its ability to deliver the benefits of an entire mechanised system.

However, one of the most significant machine developments influenced by a consideration of power and the organisation of production was the introduction of individually powered machine models. A British government report into the condition of the British shoe industry following the Second World War published in 1946 observed that the Singer Company was concentrating on the introduction of individually driven manufacturing models. The report noted that, 'Visibility will be much improved and supervision made easier by the use of independently motorised machines.'[79] The introduction of individually powered machine models offered enormous flexibility to every type of business and trade. A product leaflet, Form 19100, printed in 1954 and bound into an internal company catalogue stated, 'Individual Industrial Units offer an unusual degree of flexibility in the systemic arrangement of stitching equipment and in the most effective use of factory floor space. They may be placed in convenient locations, easily added to or removed from the production line or relocated to accommodate changes in the customer's products or manufacturing system.'[80] With the introduction of individually driven machines Singer could offer maximum flexibility to every manufacturer, regardless of size or product quality.

Singer's development and introduction of individually powered machines during the mid-twentieth century also illustrates the value of examining machine development through its portrayal in trade literature. Although individually powered machines offered maximum

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[77] *The Red 'S' Review*, October 1927, p. 8.
[78] *The Red 'S' Review*, October 1927, p. 8.
[79] *Boots and Shoes*, Working Party Report for the British Board of Trade (London: HMSO, 1946), p. 96.
[80] SMCSA, WDC, box 1/1/3(2) – *Singer Industrial Sewing Equipment*, Form 19100 Individual Industrial Units Section, 1954.

flexibility to a manufacturer and would eventually replace benches of machines during the 1960s and 1970s, this replacement was by no means immediate. The catalogue produced by the Singer Company during the mid-1950s, which featured individually powered machines, also featured universal power tables to support several machines upon a single table, and sectional tables for use with transmission shafts and motors (Figures 1-27 and 1-28). As Claire L. Jones in her examination of medical catalogues noted, 'in revealing the coexistence of markets for both 'new' and 'older' medical technologies, this […] reemphasizes […] the persistence of existing technologies long after new innovations are introduced.'[81] Trade literature offers the machinery maker's perspective on the process of mechanisation and demonstrates that there can be an overlap not just in the use of new and existing technologies, but also in their production. Although Singer was keen to promote machine models that offered trades a new more flexible method of production, it also recognised and supplied the continued demand for existing methods of production.

Figure 1-27 (Left) Universal Power Benches, *Singer Industrial Sewing Equipment c.*1950s (SMCSA, WDC). Image removed due to Copyright restrictions.

Figure 1-28 (Right) Sectional tables using single motor and transmission shafts, *Singer Industrial Sewing Equipment c.*1950s (SMCSA, WDC). Image removed due to Copyright restrictions.

[81] Claire L. Jones, *The Medical Trade Catalogue in Britain 1870-1914*, p. 9.

Conclusion

Singer’s first sewing machine was conceived as a manufacturing tool, and trade literature published by the Singer Company during the nineteenth and twentieth centuries both captures and summarises the versatile range of its development. These trade publications not only reveal the breadth and ambition of Singer’s machine development, they also demonstrate that the successful expansion of the Singer Company depended upon its familiarity with needle trades and their products. The influence of an object’s shape, size, and construction can clearly be seen in the direction of machine development and in the prominence given to stitched objects in the layout of trade catalogues and handbooks. Singer’s editorial choices and decisions also reveal its perspective on the process of mechanisation and machine development. The inclusion of recommendations and advice on the organisation of production and production space not only demonstrated the Singer Company’s commitment to the mechanisation of needle trades, it also showed its awareness of manufacturing practice and its promotion of the sewing machine as part of an integrated system of production.

The development of the sewing machine as a specialised tool for manufacturing reveals that mechanisation was a responsive process that relied upon communication between Singer and its trade customers. The expansion and diversification of Singer’s manufacturing range as portrayed in its trade literature combined with detailed descriptions of construction processes provides strong evidence of the important dialogue and exchange of knowledge that occurred between Singer and the manufacturers of stitched objects. The nature and significance of this vital exchange of knowledge is examined more fully in the next chapter, which explores the process of mechanisation and machine development through examples of prototype building in the nineteenth and twentieth centuries. These examples illustrate the difficulties involved in mechanising a complex stitching process, the challenge of managing development within a business, and the role of development in the process of mechanisation. A focus on the process of machine development also serves to emphasise the importance of consumer priorities to the development of new technology.

Chapter 2 The Prototype: Exploring the Process of Development

In 1958 an eye-catching headline appeared in an American newspaper, 'Invent a Machine and You'll Be a Millionaire. 52,000 Dozen Baseballs Made Yearly in Natick, Every One Hand Stitched.'[1] The article focused on the manufacture of baseballs by a small, family owned firm, H. Harwood and Sons, in Massachusetts. The article commented on how this small company, which had manufactured baseballs since the invention of the game a century earlier, continued to employ members of the local community to hand stitch baseballs. Moreover, it reveals that as late as the mid-twentieth century not all hand stitching processes had been successfully mechanised. The manufacture of objects on a significant scale could still rely upon hand stitching. The article also highlights the fact that mechanisation was not inevitable. The decision to pursue or accept any new technical challenges remained the choice of the machinery provider. What governed that choice, and how a machine was developed to mechanise a complex stitching process is the subject of this chapter.

As only fragmentary evidence of machine development within the Singer Company has survived, this chapter will combine surviving records from Singer with rich documentary evidence of machine development from another major American machine manufacturer, the United Shoe Machinery Corporation (USMC). By the time the article mentioned above was written, USMC had spent a decade trying to develop a machine to stitch baseballs, and the project file for this development survives in its entirety.[2] Moreover, the USMC file also provides a tenuous link between the Singer Company and the development of a baseball stitching machine. In 1948, USMC staff visited a baseball manufacturer, and in an internal report describing the visit, the author of the report stated:

> Mr Brown [the vice-president of the A.G. Spalding Company] mentioned a story to the effect that Singer Manufacturing Company and/or USMC had spent a million dollars in unsuccessful effort to develop a baseball cover stitching machine. No record of previous attempts by USMC Research Division to develop such a machine has been found.[3]

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[1] NMAH AC, United Shoe Machinery Corporation Records Collection 277 (hereafter USMC 277), box 68, folder 5 - *Boston Sunday Globe*, 30 March 1958.

[2] The USMC Baseball Stitching Machine project file dates from the initiation of the project in 1948 till its conclusion in 1961, and includes both sides of all the internal and external correspondence related to the project during this thirteen year period.

[3] NMAH AC, USMC 277, box 68, folder 5 – internal company report, 8 Nov. 1948.

Although no further evidence of such an attempt by Singer could be found, only companies with the technical expertise and financial resources of either USMC or the Singer Company would have been capable of mechanising such a complex stitching process.

Two significantly different approaches have been used to explore technological development, evolutionary theory and the Social Construction of Technology (SCOT). Recognition of the incremental changes in technology and the influence of environment noted by earlier historians prompted both Joel Mokyr, an economic historian, and George Basalla, a historian of technology, to explore technological development as an evolutionary process.[4] Joel Mokyr concentrated on exploring the application of evolutionary theory to explain the role of technological progress in economic history.[5] George Basalla, on the other hand, used case studies to explore the relationships between, what he defined as 'culturally significant technologies'.[6] However, the linear trajectory of development implied by evolutionary theory prompted an examination of development that focused on the significant contribution of both individuals and society to the shaping and development of technology, which is identified as SCOT analysis.[7] As Wiebe E. Bijker observed, 'Technological development should be viewed as a social process, not an autonomous occurrence.'[8]

Evolutionary theory can provide a valuable metaphorical framework to discuss the relationship between the end products of technological development, and the influence of competition and environment on technological progress. However, in concentrating only on the influences upon, and relationships between the end products of technological progress, evolutionary theory overlooks the significance of the process which delivered those products. As Nathan Rosenberg observed, 'inventive activity itself is never examined as a continuing activity […] It is an activity carried on offstage and out of sight.'[9] An examination of prototype building can emphasise the importance of the process itself and reveal how technology is developed.

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[4] See S. C. Gilfillan, *The Sociology of Invention*, (Cambridge, MA: MIT Press, 1935) and Abbott Payson Usher, *A History of Mechanical Inventions*.
[5] See Joel Mokyr, *Lever of Riches*, Chapter Eleven; for the difficulties faced by economic historians in reconciling technological progress and economic history see the work of Nathan Rosenberg; Nathan Rosenberg, *Perspectives on Technology* (Cambridge University Press, 1976); Nathan Rosenberg, *Inside the Black Box* (Cambridge University Press, 1982); Nathan Rosenberg, *Exploring the Black Box* (Cambridge University Press, 1994).
[6] George Basalla, *The Evolution of Technology* (Cambridge University Press, 1988).
[7] SCOT analysis first explored by Trevor J. Pinch and Wiebe E. Bijker in 'The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other', in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. by Wiebe E. Bijker, Thomas Parke Hughes, and T. J. Pinch, Anniversary edn (Cambridge, Mass. ; London: MIT Press, 2012).); for a further exploration of SCOT, see Wiebe E. Bijker, *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*, Inside Technology.
[8] Wiebe E. Bijker, *Of Bicycles, Bakelites, and Bulbs*, p. 48.
[9] Nathan Rosenberg, *Perspectives on Technology*, p. 67.

Moreover, a focus on end products alone masks the scale and complexity of development within a company, and the significance of commercial initiative to the direction of any type of specialised machine development. Although evolutionary theory acknowledges that the direction of technological progress is neither predetermined nor inevitable, the contribution of machine manufacturing companies, like Singer, to determining the direction of machine development as part of their own business development is often marginalised or overlooked entirely. Consequently, an examination of prototype building offer an opportunity to view the process of development from the rarely considered perspective of the machine maker.

In comparison to evolutionary theory, SCOT analysis recognises the role of the machine maker and both identifies and emphasises the role of all relevant social groups to technological development.[10] SCOT analysis was not the first to consider the role of society in shaping technology, but its influence, although not without criticism, has been far reaching.[11] However, despite its emphasis on the significance of social interaction, it also concentrates on reaction to the end products of technological development. Whereas an examination of the process of development, especially of a technology designed to construct objects, emphasises not only the importance of dialogue between machine maker and object maker but also the influence of a stitched object upon the direction of machine development. Before the technology to make an object has been developed, an examination of the process of development reveals that the priorities of the object maker can only be identified through a discussion of the characteristics of a stitched object. Social construction influences not only the end products of technological development but also the process of development itself.

Evidence of machine development for this chapter comes from two sources, USMC and the Singer Company. Although two rare examples of prototype machine models, made by Singer during the late nineteenth and early twentieth centuries, have survived, very little documentary

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[10] For a discussion of relevant social groups, their value, and identification, see Wiebe E. Bijker, *Of Bicyles, Bakelites, and Bulbs*, pp. 45-54.

[11] See *The Social Shaping of Technology*, ed. by Donald A. MacKenzie and Judy Wajcman, 2nd edn (Buckingham: Open University Press, 1999); for criticism of the failure of SCOT analysis to identify the power structures within relevant social groups, see Hans K. Klein and Daniel Lee Kleinman, ‘The Social Construction of Technology: Structural Considerations’, *Science, Technology, & Human Values*, 27.1 (2002), 28–52; for further discussion of SCOT analysis see also Nick Clayton, ‘SCOT: Does It Answer?’, *Technology and Culture*, 43.2 (2002), 351–60 <https://doi.org/10.1353/tech.2002.0054>; and Bruce Epperson, ‘Does SCOT Answer? A Comment’, *Technology and Culture*, 43.2 (2002), 371–73 <https://doi.org/10.1353/tech.2002.0057>; Susan Douglas acknowledged that a consideration of SCOT analysis prompted her to explore the influence of press opinion and coverage on the development of radio, see Susan J. Douglas, ‘Some Thoughts on the Question “How Do New Things Happen?”’, *Technology and Culture*, 51.2 (2010), 293–304 <https://doi.org/10.1353/tech.0.0478>; and Susan J. Douglas, *Inventing American Broadcasting, 1899-1922*.

evidence of machine development or dialogue with manufacturing customers remains.[12] However, the entire project file for the baseball stitching project, which includes internal reports, reviews, memoranda, and correspondence between engineers and senior USMC staff, as well as correspondence between USMC staff and major American baseball manufacturers, has survived intact. Because USMC was attempting to mechanise a stitching process, a comparison of the project file with surviving Singer records and prototypes enables a more complete picture of machine development to emerge. Moreover, because Singer and USMC were both large and well-resourced companies that developed and relied upon a large network of agents, a comparison of their approaches also reveals similarities in the development of machines and mechanised tools for a competitive market.[13]

The chapter is divided into three sections. The first section emphasises the importance of the dialogue between machine maker and object maker. It examines how USMC and Singer sought opportunities to discuss machine development, and the influence of object construction to the process of mechanisation. The second section examines the building of the USMC experimental prototype baseball stitching machine and compares this method of prototype building with two methods adopted by the Singer Company. This comparison serves to illustrate the variety of approaches that could be adopted in machine development. It also explores how these methods represented ways of managing not only resources but also the speculative risk associated with machine development. The final section addresses the importance of commercial initiative to the process of machine development. It examines how the scale and complexity of development undertaken by a company could affect, and be affected by, its production and commercial objectives.

Identifying Opportunities for Machine Development

Engineering a machine to construct an object meant that it was imperative not only to identify the manufacturers of a stitched object but also to communicate with them directly. In 1948 two members of the Research Division of USMC made a visit to the A. G. Spalding Company to discuss the essential requirements of a mechanically stitched baseball. USMC had already discussed the potential of mechanising baseball stitching with H. Harwood and Sons but

[12] At the Hagley Museum and Library I made a search of correspondence written by Singer agents during the second half of the nineteenth century to staff at the headquarters of the Singer Company in New York, but it yielded very little communication about machine development.

[13] USMC was an amalgamation of three major shoe machinery manufacturers Mackay, Consolidated, and Goodyear in the late 1890s, see Ross Thomson, *The Path to Mechanized Shoe Production*, pp. 229-231. Although USMC monopolised the shoe machinery market, the Singer Company still managed to dominate the provision of sewing machines for the stitching of shoe uppers.

approached A. G. Spalding because of the significance of the company within the baseball industry.[14] A report produced after the visit to the A. G. Spalding Company noted that its baseballs had, 'been specified continuously for one of the big leagues since 1886 and by the other big league since 1900 […].'[15] The success of the company meant that the opinions of its staff were considered reliable and worthy of attention.

These discussions revealed two vital priorities for baseball manufacturers. The first priority was the strength of the stitch. USMC had asked H. Harwood and Sons to mimic a machine lockstitch by hand in order for Spalding to test its suitability.[16] The report, produced in November 1948, observed, 'As balls are traditionally laced the leather commonly fails before the thread. Therefore, if the lock stitched balls which will be tested for us fail by thread breakage prior to cover failure negative conclusions will be indicated.'[17] However, before the lock stitched baseballs were even tested, the second priority was identified: stitch appearance. According to the staff at Spalding, the report noted that, 'They agreed with Harwood that it would be impossible to introduce balls laced mechanically using a lock stitch to the big leagues.'[18] The staff at Spalding, which included its vice-president Mr Brown, did not believe that the appearance of the lock stitch would be acceptable, even if it proved robust enough to survive the impact test. These priorities, especially the appearance of the stitch, were to have far reaching consequences for the technical development of the project.

SCOT analysis identifies and explores the contribution of relevant social groups to the development of technology. However, before a sewing machine with which to interact had been designed, the stitched object provided an invaluable point of discussion: the significance of which cannot be overemphasised. USMC had chosen a lock stitch, not for its appearance, but because it knew that this stitch could be adapted with relative ease to most stitching purposes. However, the choice of a stitch that was mechanically easier to produce reveals that USMC was focused only on increasing production, and assumed that this was the main objective of the technology. USMC was, therefore, surprised that baseball manufacturers were unwilling to sacrifice either stitch strength or appearance for a significant increase in production. The characteristics of a stitched object were not only a point of discussion between object manufacturers and machine makers, their preservation could also, in fact, determine the

[14] NMAH AC, USMC 277, box 68, folder 5 – internal memo written by E. E. Chase about his visit with C. M. Case to Harwood and Sons, 11 Oct. 1948.
[15] NMAH AC, USMC 277, box 68, folder 5 – report written by C. M. Case detailing the visit made by himself and O. Haas to the A. G. Spalding Company, 8 Nov. 1948.
[16] NMAH AC, USMC 277, Box 68, folder 5 – internal memo written by E. E. Chase about his visit with C. M. Case to H. Harwood and Sons, 11 Oct. 1948.
[17] NMACH AC, USMC 277, box 68, folder 5 – report by C. M. Case, 8 Nov. 1948.
[18] Ibid.

direction of technological development. Only through a discussion with object manufacturers could the priorities of any mechanisation process be established: these priorities could never safely be assumed by machine makers.

Stitched objects predated the existence of the sewing machine, and the preservation of their characteristics could prove an important influence on the development of machine technology. Johan Schot and Adri Albert de la Bruheze noted that in the development of innovative technology, 'the consumer does not yet have "precise demand requirements" and a clear view of relevant product attributes.'[19] However, when a stitched object exists the 'relevant product attributes' are often firmly established and technology must often accommodate these. It is a negotiation between machine maker and object manufacturer whether the stitched object can be changed to make the mechanisation process easier. In 1949 USMC began a feasibility study for the baseball stitching project, and on a Request for Work it clearly stated, 'The stitch produced should resemble in external appearance the traditional hand-made stitch as closely as possible. This factor will be a major determinant of the potential market for a baseball stitching machine.'[20] And, in March 1949, S. J. Finn, a member of the USMC Research Division, suggested a mechanism for mechanically replicating the appearance of the hand stitch (Figure 2-1).[21]

The second visit to Spalding in 1948 identified another challenge to mechanising the stitching process. During this visit O. Haas, who had been one of the staff members on the first visit, was permitted a closer inspection of the hand stitching process, and what he observed significantly altered the scope of the project. An internal memo compiled after the second visit to Spalding noted:

> Because of the variable nature of leather and the problem of conforming a flat surface to a round surface, each ball is considered an individual problem. A good operator spends a few seconds rolling the ball around in her hands, observing it carefully and getting the feel of it before starting to stitch.[22]

Haas was an engineer with USMC, and, therefore, critically aware of the technical difficulties and challenges that the project faced. He knew that building a machine that could manipulate

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[19] Johan Schot and Adri Albert de la Bruheze, 'The Mediated Design of Products, Consumption, and Consumers in the Twentieth Century' in *How Users Matter: The Co-construction of Users and Technology* ed. by Nelly Oudshoorn and Trevor Pinch (Cambridge MA: MIT Press, 2003), pp. 229-245 (p. 234).
[20] NMAH AC, USMC 277, box 68, folder 3 – Request for Work, 17 Jan. 1949.
[21] NMAH AC, USMC 277, box 68, folder 2 – a drawing of the mechanism suggested by S. J. Finn was drawn up by Don Hamm on 16 March 1949.
[22] NMACH AC, USMC 277, box 68, folder 2 – Memorandum for the attention of Mr Sedergen of the USMC Research Division, which details the second visit by O. Haas to the A. G. Spalding Company, 3 Dec. 1948.

the two halves of a curved ball whilst stitching edges that did not overlap was already a difficult proposition, but realised, after the second visit, that this difficulty would be compounded if the surface and shape of every ball differed, even in small ways.

Figure 2-1 Suggestion for a stitching mechanism to replicate a hand stitch by S. J. Finn, 16 March 1949 (NMAH AC, USMC 277, box 68, folder 2). Image removed due to Copyright restrictions.

Figure 2-2 Preliminary idea for preparation of baseball cover by O. Haas, 3 November 1948 (NMAH AC, USMC 277, box 68, folder 3). Image removed due to Copyright restrictions.

Haas knew that problems would arise if balls, which were uneven in surface and shape, were introduced to a mechanised stitching process that was precisely calibrated and could not compensate for these differences. An internal letter composed in 1949 acknowledged the problem, and proposed a radical solution. The letter stated:

> Due to the condition that the ball and cover are in, it presents a real problem to machine sew it. Consequently, study had been given to the preparation of the ball and cover as a means to aid the stitching operation […]. Therefore, the following is suggested as a method of preparing (Lasting) the ball and cover prior to sewing.[23]

USMC was being asked to consider extending the scope of the project to include the development of machines that could prepare the ball halves, to ensure uniformity, before their introduction to a stitching process. Haas submitted a preliminary idea for baseball cover assembly in November 1948 (Figure 2-2).[24] The following year W. L. Abel, the Assistant Director of the Research department, suggested that Haas be allowed to develop, 'a rough model to illustrate in physical form his idea.'[25]

The engineer was the intermediary between a hand stitching process and its mechanisation, and observation of the process could permit an opportunity to identify the scale and complexity of the technical challenge. As Ross Thomson observed, technical change 'can hardly be independent of users and the knowledge they provide.'[26] Observation of baseball stitching by hand revealed that materials and earlier preparation would cause difficulties for the mechanisation of the stitching process. Although USMC had the expertise and experience to find solutions to these challenges, the preparation of ball halves might have been a challenge that sewing machine manufacturers were reluctant to accept. An observation of the entire process allowed an engineer to assess the scope of the challenge. This assessment gave the machine maker an opportunity to decide whether it was a project it wished to pursue or indeed was capable of pursuing.

Dialogue between the Singer Company and Its Trade Customers

From its inception, the Singer Company recognised the significance of a stitched object to the process of mechanisation and sought every opportunity to discuss object construction with its manufacturing customers. It understood that it would not be able to increase its range of manufacturing models, and subsequently, expand its business without knowing exactly what potential customers required. As Ross Thomson observed, 'The largest new reaper, sewing

[23] NMAH AC, USMC 277, box 68, folder 5 – internal letter from O. Haas to H. B. Kimball, 26 Sept. 1949.
[24] NMAH AC, USMC 277, box 68, folder 3 – drawing of preliminary idea by O. Haas, 3 Nov. 1948.
[25] NMAH AC, USMC 277, box 68, folder 3 – internal letter from W. L. Abel to the Director of the Research Division, R. M. Bigelow, 5 Dec. 1949.
[26] Ross Thomson, *The Path to Mechanized Shoe Production in the United States*, p. 243.

machine, and machine tool firms all invented. In such sectors inventions provided powerful competitive advantages.'[27] Singer astutely realised that the best way to ascertain customer priorities and yield the information necessary to innovate and improve machine technology was to place those who made the machine in the same room as those who made stitched objects. According to the historian Andrew Jack, Singer sent one of its 'top experimental machinists' to New Haven in 1857 to develop Singer machine models for stitching applications in the carriage industry.[28] Even though machinists were vital to the manufacture of sewing machines during the mid-nineteenth century, Singer was prepared to send these valuable members of staff to manage its agencies and acquire the information necessary for the expansion of both its machine range and business.[29]

By the last quarter of the nineteenth century agents had also become vital conduits of information between engineers and customers. During the last quarter of the nineteenth century Singer's most successful European agent, George B. Woodruff, recognised the advantage of providing agents with useful technical knowledge in order to make them better salesmen.[30] Moreover, providing agents with a practical understanding of the machine also allowed them to hold useful and meaningful conversations with trade customers about what they required from a sewing machine.[31] In a catalogue printed in 1896, Singer acknowledged the role of its agents and stated:

> Different manufacturers demand different attachments to perform the same process, others wish to perform certain processes, or effect a desired economy, and require the invention of an attachment that will accomplish it. These wants are made known to the company through its agents all over the world so that the Department becomes a universal clearing house for ideas relating to this subject.[32]

Moreover, agents who were in constant contact with customers could relay back useful information about product and trade development. Singer did not concentrate on a single trade, and mechanisation occurred at different rates within even the same trade. This continuous communication meant that Singer's engineers could take advantage of the valuable information acquired by agents to manage and prioritise machine development.

In the twentieth century, the Singer Company continued to create opportunities to bring knowledgeable staff and its trade customers together. Singer's large Scottish factory in

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[27] Ross Thomson, *Structures of Change in the Mechanical Age*, p. 143.
[28] Andrew B. Jack, 'The Channels of Distribution for an Innovation: The Sewing-Machine Industry in America, 1860-1865', *Explorations in Entrepreneurial History*, 9.3 (1957), 113–141 (p. 122).
[29] Ross Thomson, *The Path to Mechanized Shoe Production*, p. 99.
[30] Robert B. Davies, '"Peacefully Working to Conquer the World"', p. 310.
[31] Ross Thomson, 'Learning by Selling and Invention: The Case of the Sewing Machine'.
[32] NMAH Library, *Catalogue of Singer Sewing Machines* 1896, p. 35.

Clydebank boasted a showroom that contained an extensive range of its manufacturing models. In its internal publication, the *Red 'S' Review*, Singer described the value and popularity of this showroom. It stated, 'practically every manufacturing trade representative throughout the country has recently paid a visit to Singer, and that this room proved an education and an inspiration to them all is evidenced by their eulogistic remarks regarding it.'[33] As well as using information gathered by agents, Singer had also established a permanent showroom within the factory. Although a showroom was not a new idea, placing it within the factory was a shrewd commercial move. This let trade customers and representatives see the range of machine models whilst also providing them with an opportunity to discuss any new requirements with engineering staff who would be onsite.

In 1929 the Thirtieth International Shoe and Leather Fair was held in London, and because of the rules governing the exhibition Singer chose to use products as a catalyst for useful discussion and a prompt for new machine ideas and improvements. The Shoe and Leather Fair was held every year, but machinery was only permitted to be run every other year. Singer chose not to exhibit during these years, however, in 1929, despite that fact that machinery could not be run, Singer decided to occupy a small stand in order to 'at least answer enquiries and greet a few of our manufacturing friends.'[34] Although Singer did bring some machine models, most of its stand was occupied by a wide selection of boots and shoes for men, women, and children loaned from its shoe manufacturing customers. Products revealed how trade customers prioritised production volume and production quality, and the valuable discussion that these could prompt appear to have impressed Singer. The *Red 'S' Review* commented, 'the experiment, if such it could be called, was justified, and we have no doubt that on the next occasion when we are not able to have our working exhibit, we shall seriously consider an extended arrangement of a similar character.'[35]

Machine development depended upon the interaction and dialogue between object makers and machine makers to establish the priorities of the mechanisation process. As Nelly Oudshoorn and Trevor Pinch observed, 'Users and technology are too often viewed as separate objects of research.'[36] However, in an examination of the process of machine development, the interaction between the two proves integral to the development of the sewing machine as a manufacturing tool. A focus on the marketable end products of technological development can only assess the influence of the relevant social groups once a technology exists. Whereas an exploration of the

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[33] *Red 'S' Review*, November 1926, p. 11.
[34] *Red 'S' Review*, November 1929, p. 8.
[35] *Red 'S' Review*, November 1929, p. 9.
[36] Nelly Oudshoorn and Trevor Pinch, 'Introduction: How Users and Non-Users Matter' in *How Users Matter: The Co-Construction of Users and Technology*, ed. by Nelly Oudshoorn and Trevor Pinch, pp. 1-25 (p. 2).

process of development demonstrates that the social construction of technology can begin with dialogue and observation.

Building a Prototype

After opportunities had been identified, and the technical challenges established, the next stage of machine development often required the building of a prototype. This was an invaluable stage of development, especially for complex and technically challenging machine models. Prototype building gave machine makers an opportunity to solve technical problems, test functionality, and evaluate machine suitability for purpose through factory trials. However, development could only deliver machines that were candidates for adoption. The success of any machine development was, by no means, guaranteed. An examination of three examples of prototype building demonstrates that it was not only a method to solve technical problems, but was also a way to manage the speculative risk that accompanied machine development.

Innovation

Building a prototype for which there was no technical precedent, which was the case for the USMC baseball stitching project, represented not only the greatest technical challenge but also the greatest risk for a machine maker. Discussion with baseball manufacturers and observation of the baseball stitching process had identified that the entire process, including preparation of the ball halves, needed to be mechanised. The scope of the project had grown considerably, and now several new machines were needed. Each machine had to perform a specific function, and all the machines had to become part of an integrated system. Although USMC had experience of creating machinery that worked with leather, the scale and originality of the project meant that the engineer responsible for it, Joseph Fossa, required a little over three years just to complete the preparatory design work.

Figure 2-3 Experimental model of pin inserting machine, 1954 (NMAH AC, USMC 277, box 68, folder 4). Image removed due to Copyright restrictions.

Figure 2-4 (Left) Experimental drilling, milling and cover assembling fixture, 1954 (NMAH AC, USMC 277, box 68, folder 4). Image removed due to Copyright restrictions.

Figure 2-5 (Right) Prototype baseball stitching machine, c.1954 (NMAH AC, USMC 277, box 68, folder 4). Image removed due to Copyright restrictions.

A further consequence of the ambition and novelty of the machine meant it required the design of entirely new parts. In order to create these original parts, new attachments for machine making tools had to be created, and an internal company letter disclosed that, 'special machine tools have been required to build our lasting elements.'[37] In 1953, with the aid of only a single technician, Joseph Fossa began the arduous task of making the newly designed parts to build the prototypes: a task that he estimated would, 'consume approximately two years.'[38] The scale of the task was outlined in a departmental document, 'Lacing Machine 470 details, 500 parts; Pin Inserting Machine 210 details, 250 parts; Lasting Fixture 30 details, 40 parts; Assembly Fixture 50 details, 55 parts.'[39] Photographs of the prototype models assembled in 1954 survive in the USMC project file and illustrate the full complexity of the task which Fossa faced (Figures 2-3, 2-4 and 2-5).[40]

Although this ambitious project required a high degree of innovative technical design before assembly and testing could even begin, it highlights the resources that any machine development required. Most machine parts had to be custom made and were not easily obtained. The challenges associated with the design of machine parts and assembly of a prototype are neglected if only the marketable products are considered, the significance of these challenges only becomes apparent through observation of the development process. A single prototype needs only a single set of parts, but if the prototype proves successful the design and production of a commercial model will require further resources. The tooling of a number of new parts and the assembly of new models would have to be fully planned and integrated into production schedules.

Although Joseph Fossa could estimate the amount of time it would take to assemble the prototype system, it was much more difficult to predict how long it would take for the system to successfully stitch baseballs. In September 1955 W. Gerould, the president of the A.G. Spalding Company, inquired about the progress of the machine, and R. M. Bigelow, the Director of the USMC Research Division, made this response, 'as is usual in a complicated development such as this, we have not yet been able to bring it along as fast as we had hoped.'[41] In September 1956, the prototype was operational but encountered difficulties with the stitching mechanism, which required further modifications and refinements.[42] In August 1957, an internal update on

[37] NMAH AC, USMC 277, box 68, folder 5 – internal letter from W. J. Stringer to W. L. Abel, 20 Sept. 1955.
[38] NMAH AC, USMC 277, box 68, folder 5 – internal letter detailing the progress of the projects from W. J. Stringer to the Director of the Research Division, R. M. Bigelow, 14 Sept.1953.
[39] NMAH AC, USMC 277, box 68, folder 5 – Research Division document, 4 March 1957.
[40] NMAH AC, USMC 277, box 68, folder 4 – photographs dated 20 May 1954.
[41] NMAH AC, USMC 277, box 68, folder 5 – letter from R. M. Bigelow to W. Gerould, 21 Sept. 1955.
[42] NMAH AC, USMC 277, box 68, folder 5 – letter from R. M. Bigelow to W. Gerould, 19 Sept. 1956.

the project revealed that, 'for the first time lacing needles have been passed by turning the machine over by hand.'[43] In October 1958, the department acknowledged that the prototype machine to prepare the balls for stitching had, 'satisfactorily demonstrated functional ability', but the stitching mechanism was still not entirely successful.[44] Finally, in July 1959, four years after the testing of the prototypes had begun, the department could state that, 'the model machine is a first working model suitable for laboratory operation and testing, but not suitable for factory trial.'[45]

Building a prototype that could not capitalise on any existing technology carried the most risk because it could prove challenging, unpredictable, and expensive to undertake. USMC had formally initiated the project in July 1950, but it had taken until July 1959 to build working experimental models at a cost of $318,273.[46] Although the prototype system had proven that mechanically stitching baseballs was possible, USMC estimated that it could take a further two years to convert the experimental system into a system suitable for factory trial.[47] USMC could apply considerable levels of technical expertise to this ambitious project, but the risk associated with such complex projects meant that they were not undertaken lightly or often. As Nathan Rosenberg remarked, 'Development activities at any time are not devoted to the introduction of entirely new products […] undoubtedly the bulk of such activities, at any time, is devoted to efforts to improve existing products […].'[48]

Adaption and Variation

A significantly easier way to build a prototype, and one which involved considerably less risk, was to exploit existing technology. An example of this method of prototype building can be found in an adapted Singer model, which has survived from the late nineteenth century. In 1895, to lengthen the stitch of a machine Singer crudely adapted a complete and ornamented model 45K1, which was designed for heavy textile and leatherwork. Although the machine retained its original serial number plate, it was also given a second number plate to reclassify it as model 45K SV8. The only obvious alterations are the brutal cut into the body of the machine and the addition of a longer lever to control the stitch length (Figures 2-6). The cut made into the body also cut through the ornamentation, and the raw edges were crudely finished with narrow metal

[43] NMAH AC, USMC 277, box 68, folder 5 – Research Division report compiled by R. A. Unger, 8 Aug.1957.
[44] NMAH AC, USMC 277, box 68, folder 5 – Research Division Project Proposal, 27 Oct. 1958.
[45] NMAH AC, USMC 277, box 68, folder 5 – Research Division memo, 22 July 1959.
[46] NMAH AC, USMC 277, box 68, folder 5 – Research Division document stated, 'expense through June 30, 1959 is $318,273, or net costs after taxes to United of $152,769', 22 July 1959.
[47] NMAH AC, USMC 277, Box 68, Folder 5 – internal letter from W. L. Abel to R. M. Bigelow, 27 May 1960.
[48] Nathan Rosenberg, *Exploring the Black Box*, p. 14.

plates that were neither painted nor varnished. The original short lever, used to control the length of the stitch, was replaced by a much longer lever with a large wooden handle. No attempt was made to disguise the alteration, it was brutally efficient, and the modification extended the length of the stitch to almost three quarters of an inch.[49]

Figure 2-6 Detail of adaption to Singer model 45K1, reclassified as model 45K SV8, *c*.1895 (SMCSA, WDC, WDBCS 2004.1921)

The efficiency and effectiveness of this method of prototype building, in comparison to building a prototype that had no mechanical precedent, can be seen by the speed at which new models capable of a longer stitch appeared in catalogues. Although the 45K class was introduced in 1895, it only appears in the second edition of an unillustrated catalogue and price list printed that year.[50] The first edition simply states, 'Supplement, descriptive of this Machine, in preparation.'[51] Although the second edition does not mention a specific stitch length, an illustrated catalogue published by Singer in 1907 stated that, 'the maximum length of stitch of

[49] Although the model can no longer be threaded to make a stitch, measurement of the distance the needle moved established a maximum stitch length of approximately three quarters of an inch.
[50] SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue and Prices for the Singer Manufacturing Company*, 2nd edn ([Glasgow(?)]: Singer Manufacturing Company, 1895), p. 14.
[51] SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue and Prices for the Singer Manufacturing Company*, 1st edn 1895, p. 14.

machines [45k] with flat bed is ⅜″ unless otherwise specified.'[52] This catalogue entry suggests that the maximum stitch length in 1895 was three eighths of an inch. Only a year later, Singer introduced four machines in the 45K Class that were specifically described as capable of making a longer stitch of half an inch.[53] It had taken USMC almost a decade to design and build highly original experimental prototypes, whereas Singer by exploiting an existing technology had managed to introduce and promote a new model within a year of building a crude prototype. Although both companies had Research and Development departments, and the ambition and objective of the two projects were entirely different, existing technology provided a valuable resource for machine adaption and development.[54]

Adaption also allowed prototypes to be more quickly submitted for factory trials, and the condition of the prototype model and the stitch length described in the catalogue suggest that it was submitted for such a trial. Factory trials were an important aspect of machine development because they provided machine engineers with an opportunity to test models under manufacturing conditions. These trials helped to determine whether technical problems had been effectively solved. They also provided engineering staff with valuable feedback from the manufacturers who tested the prototypes. The wear on the handle of the prototype suggests use, and despite the crude nature of the adaption, it does appear robust enough to survive the rigours of a factory trial. Moreover, the fact that the prototype could produce a stitch length of three quarters of an inch whilst the four new models produced a stitch length of half an inch suggests that the optimum length of stitch for the purpose required was established during factory trial.

Although lengthening a stitch was a modest adaption in comparison to building an entirely new machine for a new application, such modest adaptions and refinements represented a shrewd and effective way to develop technology. As adoption and diffusion of any new model were not guaranteed, variations that improved and extended the repertoire of a machine or class, which was already established, reduced the speculative risk that accompanied development. As Ross Thomson observed, a company's 'own past innovations influenced their present profits, organization, and personnel in a way that facilitated ongoing technical change.'[55] Not least, exploitation of existing resources reduced the technical challenge and permitted a quicker response when opportunities for improvement were identified.

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[52] SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue of "Singer" Sewing Machines Manufactured at Kilbowie, Clydebank* ([Glasgow(?): Singer Manufacturing Company, 1907), p. 78.
[53] SMCSA, WDC, box GDWD 1/1/3/2 – *Catalogue and Prices for the Singer Manufacturing Company*, 3rd edn ([Glasgow(?)]: Singer Manufacturing Company, 1896), p. 10.
[54] Singer set up a Research and Development department in America as early as 1868, see Ross Thomson, *The Path to Mechanized Shoe Production*, p. 153.
[55] Ross Thomson, *The Path to Mechanized Shoe Production*, pp. 222-223.

Adaption was practically and technically easier to accomplish than innovation, and examples of models in the 45K class illustrate how Singer could modify the range of a class to accommodate changes in both materials and products. The 45K Class, according to a description in a 1907 Singer catalogue, was, 'specifically designed for heavy textile and leather work.'[56] Leatherwork often required the use of a waxed thread, and in 1898 a heating apparatus, necessary to warm the thread and ease it through the stitching mechanism, could be added to any model upon request.[57] In 1907, model 45K53 extended its range from general saddlery work to footballs and portmanteau.[58] And in 1922, model 45K80 increased the thickness of leather that could be stitched from half an inch to almost three quarters of an inch.[59]

Adaption shrewdly exploited existing technology and represented a rational approach to machine development. A heating apparatus to warm waxed thread was offered as an attachment to every model in the 45K class, but only four models offered a longer stitch. Singer identified opportunities for improvement, but also knew that not every machine improvement was applicable to every manufacturing operation. Machine development was inextricably linked to products and trades, and Singer could only identify opportunities for improvement and rationalise their application because of the attention it paid to its diverse range of manufacturing customers. Variations demonstrate how closely products and trades were scrutinised, and the value, and necessity, of constant dialogue with manufacturing customers. Adaption and refinement illustrate the continual influence of object construction upon machine development.

Exploiting Shared Knowledge

Another adaptive method of building a prototype, which also reduced speculative risk, was to exploit mechanical solutions that were already known and shared amongst several sewing machine manufacturers. In 1929, the Singer Company chose to reverse engineer a Willcox and Gibbs model, which used a rotary thread take-up mechanism to significantly increase the speed of a machine. Although the Singer Company had already used rotary take-up technology for its machine model 64-3, featured in a catalogue published in 1905 (Figure 2-7), it chose to reverse engineer the Willcox and Gibbs machine because it represented the most successful use of this technology.[60] By 1919, Willcox and Gibbs had achieved such success with the rotary take up

[56] SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue of "Singer" Sewing Machines* 1907, p. 78.
[57] SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue and Prices for the Singer Manufacturing Company's Sewing Machines Manufactured at Kilbowie, by Clydebank* ([Glasgow(?)]: Singer Manufacturing Company, 1898), p. 25.
[58] SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue of "Singer" Sewing Machines* 1907, p. 80.
[59] SMCSA, WDC, box GDWD 1/1/3(2) – *List of Singer Sewing Machines Manufactured at Singer, Clydebank* ([Glasgow(?)]: Singer Manufacturing Company, 1922), p. 100. The length of stitch was specified as eleven sixteenths of an inch.
[60] NMAH Library, *List of Singer Sewing Machines* ([New York(?)]: Singer Manufacturing Company, 1905),

mechanism that it could boast, 'Since its introduction the W. & G. High-Speed Lockstitch Machine has become recognized as the leader in its class and an acknowledged standard of excellence in construction.'[61] Singer was, therefore, not 'stealing' a new mechanical innovation, but attempting to find out how a competitor had managed to exploit shared knowledge so successfully.

Figure 2-7 Singer Model 64-3 with rotating hook and take up, *List of Singer Sewing Machines* 1905 (NMAH Library)

Although Willcox and Gibbs, one of Singer's American competitors, was the first to patent a machine employing this mechanism, its patent, registered in 1889, clearly acknowledged that this mechanism was already familiar to other manufacturers. The patent stated, 'Rotary take-ups of various kinds have been devised; but they have not gone into common use, although the advantages in point of speed and ease and smoothness of running of rotary over reciprocating mechanism have long been recognized.'[62] Rotary take-up helped solve problems that machines encountered when speed was increased. As all machine movement was converted from the rotation of the internal shaft, as speed increased the ubiquitous perpendicular, or reciprocating, movement that controlled thread take up endured increased friction and excessive wear on parts. Rotary take-up replaced this perpendicular movement and substantially reduced vibration and wear because it exploited the rotation of the internal shaft. Singer's model 64-3 in 1905 could reach a maximum speed of 3,000 stitches per minute using this technology, whereas Willcox and Gibbs models in 1919, exploiting a similar technology, could manage speeds of 3,500 to 4,000 stitches per minute.[63]

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p. 217.

[61] NMAH TC, box 6, folder 0 – product leaflet for Willcox and Gibbs High-Speed Lockstitch Machine, *c*. 1919.

[62] United States Patent and Trademark Office Patent Full-Text and Image Database (hereafter USPTO PatFT), U.S. Patent 415,814 registered by James Gibbs, 26 Nov. 1889.

[63] NMAH Library, *List of Singer Sewing Machines* 1905, p. 94; NMAH TC, box 6, folder 0 – product leaflet for Willcox and Gibbs High-Speed Lockstitch Machine, *c*. 1919.

Figure 2-8 Singer version of a Willcox and Gibbs High-Speed Lockstitching Machine, 1929 (SMCSA, WDC, WDBCS 2004.1726)

Figure 2-9 Willcox and Gibbs High-Speed Lockstitching Machine, Willcox and Gibbs product leaflet *c*.1919 (NMAH TC, box 6, folder 0). Image removed due to Copyright restrictions.

Figure 2-10 (Left) Willcox and Gibbs rotary take up model – arrow on wheel points to a small dial that can adjust machine to stitch different thicknesses of material (Image courtesy of NeedleBar Picture Library Archive). Image removed due to Copyright restrictions.

Figure 2-11 (Right) Identical arrow and small dial on prototype replica made by Singer (SMCSA, WDC, WDBCS 2004.1726)

Figure 2-12 (Left) Detail of stitch regulator, product leaflet for Willcox and Gibbs Type 10 Improved High Speed Lockstitch Machine, *c*.1940 (NMAH AC, SIL 10-547. Image courtesy of NMAH). Image removed due to Copyright restrictions.

Figure 2-13 (Right) Identical button to control stitch length on prototype replica made by Singer, *c*.1929 (SMCSA, WDC, WDBCS 2004.1726)

It was not unusual for sewing machine manufacturers to take apart competitors' models to check for any patent infringements. However, this practice also provided manufacturers with a means of gaining knowledge of a rival's technical expertise and manufacturing capabilities. Reverse engineering a machine not only yielded precise technical information, it also enhanced commercial awareness. As all machine development carried a certain level of risk, knowing precisely how a competitor had achieved technical success could provide both a commercial advantage and a business incentive. As Joel Mokyr observed, 'Each species has to change if only because others do.'[64] Sewing machine development was a competitive business, and awareness of a competitor's capability would help to determine where to place resources and whether it was worthwhile to compete over certain trades or machine applications.

Singer chose to go a step further and not only reverse engineered the Willcox and Gibbs model but also built a prototype replica of it (Figure 2-8 and 2-9). Singer made no attempt to disguise the source of the prototype, the original label, which is still attached, described it as, 'Singer Factory Experimental Machine with Rotary Take Up (Willcox and Gibbs Class) 18/3/1929.'[65] This experimental machine bears a striking resemblance to the original Willcox and Gibbs model. Both models have the same half-moon shaped plate on the bed, although the one found on the Singer model is slightly larger. Both models have a button to control the stitch length (Figures 2-10 and 2-11), and a small dial to adjust the machine to stitch different thicknesses of fabric (Figures 2-12 and 2-13). Model 64-3, Singer's earlier attempt at using rotary take up technology (Figure 2-7), has none of these features. Therefore the experimental machine demonstrates that Singer was extracting very precise technical information.

Although reverse engineering a machine yielded precise technical information, which considerably reduced the amount of time and effort spent on making new mechanisms function correctly, building a replica also allowed this technical information to be quickly converted into valuable production data. By building the replica within its own workshops using its own tools, Singer knew exactly how many new parts were needed, how the machine was assembled, and where any future manufacture could be fitted into its own production schedule. However, Singer could not simply reproduce the Willcox and Gibbs model, as that would have infringed the patent rights of its competitor. Instead, Singer used the technical and production data extracted from the building of the experimental machine to determine how it could distinguish a Singer model from a competitor's model. Singer could make the best uses of its resources by assessing whether it could make a model that was cheaper, faster, or suited to a new application.

[64] Joel Mokyr, *The Lever of Riches*, p. 282.
[65] SMCSA, WDC – WDBCS 2004.1726.

Although an examination of prototype building reveals that machine variations were an effective way to manage resources and the speculative risk that accompanied machine development, the language and metaphor of evolutionary theory advocated replacement rather than variation. Joel Mokyr observed, ‘By the time the new species has replaced the old one, new mutations may have occurred creating an even more successful form.’[66] Evolutionary theory seeks to establish relationships between the marketable end products of technological development, which suggests that every technological solution will inevitably be usurped by a better solution. However, no single machine could meet the demands of every manufacturing application or dilemma, consequently, the ‘successful form’ of a machine took many guises. Because a single trade could contain both large and small scale manufacturers, machine development had to respond to both the need to improve production levels and the need to preserve product quality. Variations in machine classes not only demonstrated a strategic response by machine makers to a variety of industry practices, they also emphasised that manufacturing could support several machine types simultaneously.

Commercial Initiative

In the late 1940s, USMC investigated the possibility of applying its technical expertise to projects beyond shoe machinery, and one of the projects this investigation generated was the baseball stitching project. In 1949, W.W. Prichard, a senior member of staff in the Research Division of USMC outlined what he described as ‘outside ideas for trade projects’, and explained not only how the expertise of the company’s research staff could be exploited, but also how projects could justify resources.[67] He stated:

> they range from ideas which can be reasonably easily investigated, to determine if we can accomplish them, to ideas which envisage a complete machinery development program. Our job consists in evaluating the potential profit to be obtained from the development of these ideas and balancing this against probable cost, difficulty of development and the estimated capital required to commercialize the project and, on this basis, select those which have the greatest appeal for the Corporation.[68]

The process of mechanisation was also a business opportunity, and machine development was a combination of commercial risk and technical ambition. Therefore, the final section explores the role of technical development in the commercial assessment, planning, and execution of a project. Although Joel Mokyr concluded, ‘In the final analysis, both biological reproduction and

[66] Joel Mokyr, *The Lever of Riches*, p. 278.
[67] NMAH AC, USMC 277, box 68, folder 5 – internal letter from W. W. Prichard to the Director of the Research Division, R.M. Bigelow, 15 March 1949.
[68] Ibid.

economic activity are dynamics of nature constrained by the finiteness of resources', a concentration on the end products of technological development fails to capture the significance of resource management to the process of mechanisation.[69]

Figure 2-14 Artist's impression of Man-Machine System for Lacing Baseballs, 1959 (USMC Collection NMAH AC, USMC 277, Box 68, folder 4). Image removed due to Copyright restrictions.

Development was rarely assessed only on its technical merit. In 1957, two years into the testing of the baseball stitching prototype system, the Research Division of USMC submitted a status report that also included an estimate of the commercial value of the project to the company.[70] The report estimated that the design and development of the first integrated system (Figure 2-14), capable of preparing and stitching baseballs, could cost $750,000.[71] The cost of manufacturing each system was estimated at $10,500, and, based upon that figure, an initial production run of 100 systems would cost $1,050,000. The report concluded that the total estimated cost of completing the project and producing 100 systems would be $1.8 million, and the projected annual income from the leasing of these systems would be $1million. Consequently, USMC stood to recoup the entire cost of development and production within less

[69] Joel Mokyr, *The Lever of Riches*, p. 283.
[70] NMAH AC, USMC 277, box 68, folder 5 – status report, 'Baseball Cover Stitching EX 16279', compiled by E. M. Wadsworth, 12 March 1957.
[71] This estimate included the $188,231.31 spent on the project by 21 Feb. 1957.

than two years. The originality of the project had made it technically ambitious and challenging, but this document reveals that the difficulty and cost of the project were justified by its potential commercial value.

The extraordinary scale of development undertaken by USMC, and the resources that were committed to it, are revealed by a card system that USMC used to record information about all of its development projects. The system divided development into two categories: Experimental (EX) described new inventions or innovations, and New Development (ND) described adaptions or refinements to existing machine models. Every development, no matter how modest or ambitious, was categorised and numbered. Each card recorded a brief description of the development, and how much time and money had been spent upon it. Although the card for EX 4857 simply requested 'experimental work' on an existing machine model, it took just over two years to complete and cost \$8038.85.[72] The brevity of the project description belied the technical challenge, which could only be inferred from the length of the project and its total cost. The card for ND 2922, by contrast, describes a less ambitious task that took less than six months to complete and cost only \$9.95.[73] Development described as Experimental was generally more technically ambitious and, consequently, received more time and a larger share of the budget than that described as New Development.

Although no complete and continuous record of machine development for the Singer Company has survived, the fragments that do exist reveal that Singer also divided and classified machine development.[74] Singer would make adaptions to existing machines and reclassify them as Special Variety (SV) models. And a selection of brief typed notes made by the List Department of Singer's factory in Clydebank during 1941 describes the nature of these adaptions.[75] A note describing model 114SV69 states, 'For sewing two and four-hole buttons on shirts. Makes cross stitches in four-hole buttons. Note: This is the 114SV59 Machine fitted to make cross stitches in four-hole buttons instead of parallel bars.'[76] Another note stated that model 79SV25 was adapted from model 79-101 for the specific purpose of stitching chin straps to helmets.[77] SV

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[72] NMAH AC, USMC 277, box 35, EX cards from 28 March 1916 to 15 June 1918.
[73] NMAH AC, USMC 277, box 59, ND cards from 18 June 1924 to 1 Nov. 1924.
[74] The Luftwaffe bombed Clydebank on the nights of the 13th and 14th March 1941. Although the Singer factory suffered remarkably little damage the records room was destroyed, which meant the loss of many documents describing the cost and range of machine development undertaken at the factory.
[75] The correspondence describing SV adaptions is fragmentary. However, surviving records from the Clydebank factory appear to record all SV adaptions made in the Singer factories at Elizabethport, Bridgeport, and Clydebank, presumably to avoid duplication.
[76] SMCSA, WDC, box GDWD 1/1/2, folder 'List 41/11, Special Variety Manufactures SV, KSV, WSV' – note from Lists Department, Clydebank Factory, 3 Sept. 1941.
[77] SMCSA, WDC, box GDWD 1/1/2, folder 'List 41/11, Special Variety Manufactures SV, KSV, WSV' – note from Lists Department, Clydebank Factory 11 Nov. 1941.

models adapted existing technology, and the modest scope and ambition of adaptions described in the notes reflected that described as New Development by USMC.

Singer, like USMC, was also involved in developing new and experimental models, and addenda to catalogues in the 1950s and 1960s include references to these new models. Addenda were lengthy typed descriptions of new models, which included full specifications for both engineering and ornamentation. By the post-war period the range of Singer manufacturing models could no longer be published within a single catalogue. Instead, product leaflets, known as Form 19100, were placed in a robust, ring bound volume so that new models could be included and discontinued models could be removed. One such bound catalogue, *Singer Industrial Sewing Equipment*, found in the The Sewing Machine Collection and Singer Archive of West Dunbartonshire Council proved to be an internal document that included both typed addenda describing new machines and printed Form 19100 product leaflets.[78] An addendum for new machine model 256w2 described it as a ‘complete unit for automatically spacing and sewing buttonholes on a garment […] consists of Machine No. 71-202 and Automatic sequential Buttonhole Electro Mechanical Device No. 257300. Formerly Experimental Machine No. 1094.’[79]

Categorisation highlights the scale of development and emphasises the importance of development to machine manufacturers like USMC and the Singer Company. This level of record keeping, and the breadth of development it displays, reveals that development was not undertaken on an ad hoc basis. Machine development was planned, managed, and resourced, and every project, no matter how modest, was defined and recorded. Development was vital to sustain business and keep machine products relevant, which meant it had to be continuously undertaken and synchronised with production. As James B. Jefferys observed, ‘Organisation of […] experiments, designs, prototypes, planned ordering of tools, drawings and gauges became as important as production itself.’[80]

[78] SMCSA, WDC, box 1/1/3(2) – *Singer Industrial Sewing Equipment* ([n.p.]: Singer Manufacturing Company, [n.d.]). Internal copy of catalogue, which comprised separate Form 19100 product leaflets and typed addenda describing new models. Dates of product leaflets and addenda range from mid-1950s to mid-1960s.
[79] SMCSA, WDC, box 1/1/3(2) – *Singer Industrial Sewing Equipment*, internal copy including typed addendum for Machine No. 256w2, Elizabeth Machine Adoption No. 767, 16 February 1961.
[80] James B. Jefferys, *The Story of the Engineers, 1800-1945* (New York ; London: Johnson Reprint, 1970), p. 203.

Figure 2-15 Estimate of time and labour costs to produce first USMC experimental system, 4 March 1957 (NMAH, USMC 277, box 68, folder 5). Image removed due to Copyright restrictions.

Figure 2-16 Diagram showing estimated time needed to finish and build USMC experimental system, one square equals three weeks, March 1957 (NMAH, USMC 277, box 68, folder 5). Image removed due to Copyright restrictions.

Two documents generated by a request for a review of the baseball stitching project in 1957 reveal the level of planning required to synchronise development and production.[81] The first document provided an estimate of how many hours the experimental system would take to complete; the number of staff and amount of time required to produce technical drawings for new machine parts; the time to build a system suitable for a factory trial; and an estimate of time required for redesign following feedback from the trial (Figure 2-15).[82] The second document blocked out the time scale and sequence of these production details on a sheet of squared paper, with every box representing a three week period (Figure 2-16).[83] These documents reveal the extent of planning required and the number of departments that had to absorb development into their production schedules and budgets.

The documents also highlight the difficulties associated with complex and innovative development and emphasise the value of the accurate technical information that working prototype models could produce. Even after two years of testing, the prototype system was not fully operational. This meant that it could not yield the valuable technical data needed to create accurate production schedules. Therefore, the calculation of time and resources to complete the prototype system, and build a factory model, had to rely upon estimates. However, because of the complexity of the factory system, its design and integration into production could not wait until the prototype was fully functional. A review of the project, two years earlier in 1955, stated that, 'many small and difficult problems still exist. No drawings have been made of many small parts used.'[84] As the sequence of production reveals (Figure 2-15), accurate technical drawings were required to engineer machine parts, and without these, the design and assembly of the factory system could not begin. The innovative nature of the project meant that the lack of even small details could have a significant impact on production and planning.

The synchronisation of development and production played a significant role in the direction of machine development and the management of resources, which a focus on commercial end products often overlooks. Complex and innovative development could potentially disrupt production. Philip Scranton, discussing innovative weapons development during the Cold War, stated, 'redesigns and technological uncertainty directly dislocated production dynamics, maintenance practices, and the management of logistics and supply […] Production lot sizes shrank as flurries of changes had to be integrated into fabrication planning […].'[85] Development

[81] NMAH AC, USMC 277, box 68, folder 5 – request from the Assistant Director of Research Division to provide details on the project for Mr Roberts, the vice-president of USMC, 26 Feb. 1957.
[82] NMAH AC, USMC 277, box 68, folder 5 – Research Division document, 4 March 1957.
[83] NMAH AC, USMC 277, box 68, folder 5 – un-dated hand written document.
[84] NMAH AC, USMC 277, box 68, folder 5 – baseball stitching system project review, 26 Jan. 1955.
[85] Philip Scranton, 'The Challenge of Technological Uncertainty', *Technology and Culture*, 50.2 (2009), 513–18 (p. 516) <https://doi.org/10.1353/tech.0.0266>.

was integral to business expansion, but the risks that accompanied it meant it had to be carefully managed. Adaption of existing technology proved attractive because it was already integrated into production schedules, and had successfully identified a market and consumer need. The potential of complex development to disrupt production meant it had to have strong justification and support from both within and without the company. Consequently, the cost and commercial value of a project proved to be important influences on the direction of machine development.

The baseball stitching system, which had taken USMC more than a decade to develop at a cost of more than $300,000, never moved beyond the prototype stage. The complexity and cost of the project eventually prompted USMC to seek financial investment from baseball manufacturers, a decision it took for two reasons. First, it wanted to diffuse the financial risk of further development; and secondly, it needed to encourage baseball manufacturers to adopt the mechanised system. During the time it had taken to build the experimental prototype, American baseball manufacturers had found an alternative to the rising cost of labour in America by moving production abroad. Although they had witnessed demonstrations of the experimental prototype, and were convinced of its potential to replace hand stitching, the baseball manufacturers proved unwilling to invest in the project. In 1961, senior management at USMC decided that the project could not be taken further without financial support from the baseball industry, and the project was abandoned. This project demonstrates the risks involved in machine development and the resources that could be invested in a project that never becomes commercially available. Although development was a vital and necessary part of the business for machine manufacturers like USMC and the Singer Company, its success remained unpredictable.

Conclusion

Focus on the process of technological development from the rarely considered perspective of the machinery maker emphasises the social construction of technology, and the importance of consumer priorities to the direction of machine development. It also reveals the difficulties involved in mechanising a complex stitching process and the risks that accompanied it. An examination of prototype building demonstrates that because the management of speculative risk heavily influenced the direction of machine development, variation and adaption rather than replacement typified specialised sewing machine development. Variations served to expand the range of machine products by exploiting existing technology and already established uses, whilst only potentially lucrative commercial opportunities encouraged new and innovative technical development. Not least, a focus on the process of development demonstrates the value of knowledge exchange to the mechanisation of any stitching process.

The importance of the relationship between stitched object manufacturers and machinery makers is apparent in the specialised development of the sewing machine. An examination of prototype building emphasises the significance of this relationship to the process of mechanisation, and the business of the machinery maker. The importance of this relationship meant that its influence extended beyond technological development and could also be seen in the changing appearance of machine models. The influence of this relationship encouraged the Singer Company to use machine appearance to not only establish and maintain separate identities for its domestic and trade products but also to communicate technical improvements to its trade customers. The next chapter, therefore, explores the ways in which Singer used machine appearance to distinguish between its products and foster the important relationships it had with its customers.

Chapter 3 Consumer Influence on the Appearance of the Machine

A comparison of the first Singer Company manufacturing model introduced in 1851 with its first domestic model introduced five years later demonstrates that from the outset the Singer Company endeavoured to give its product ranges distinctly different appearances (Figures 3-1 and 3-2). A comparison of these early models shows that the mechanical function of the manufacturing model was celebrated by exposure, whilst that of the domestic model remained discreetly concealed; and although decoration was applied to the surfaces of both, the richness of the decoration applied to the domestic machine far exceeded that applied to its manufacturing counterpart. The focus of this thesis remains upon the development of the manufacturing model, however, only a comparison of how Singer treated the appearance of both its model ranges can reveal the effort taken to create distinct product identities. It is the effort taken to distinguish the product ranges that most clearly reflects the influence of the consumer. An examination of how Singer treated the appearance of its machines over a century can reveal that the influence of the consumer extended beyond mechanical specialisation.

Figure 3-1 (Left) First patent sewing machine model produced by Singer for manufacturing purposes, 1851 (Image courtesy of NMAH)

Figure 3-2 (Right) Singer 'Turtleback' domestic sewing machine model, 1856-1859 (WDBCS 2004.1617. Image courtesy of West Dunbartonshire Council Library and Cultural Services)

There has been no consideration of the appearance of the sewing machine as a manufacturing tool in either the nineteenth or the twentieth century; indeed any consideration of the appearance of machinery or mechanised tools has been rare.[1] Only the appearance of the domestic sewing machine and its integration into the home and domestic lives of women during the nineteenth century has provoked any examination.[2] However, as Ettore Sottsass, the influential twentieth century industrial designer, commented, those who manufacture machines must, ‘assume the responsibility for all the reactions that can arise when machines invade the environment, men and their lives […].’[3] A comparison of domestic and manufacturing model appearance reveals that the Singer Company made a conscious effort to relate the sewing machine to both domestic and working lives during the nineteenth and twentieth centuries.

Design history now seeks to offer more than a sequence of aesthetic change, but place design in relationship to both production and consumption, manufacturer and consumer.[4] As Clive Dilnot, in his influential article, stated, ‘The conditions surrounding the emergence of a designed object or a particular kind of designing involve complex social relations. The fact that these relations are frequently described *only* in design terms obscures their social or socioeconomic aspects.’[5] The effort expended in altering the appearance of the sewing machine to reflect the lives and conditions of those who used it demonstrates that the values and priorities of consumers played

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[1] For aesthetic appearance of machinery as an expression of American nationhood and progress see John F. Kasson, *Civilizing the Machine* (New York: Grossman Publishers, 1976), pp. 139-180; and for rare evidence of design education and the changing role of design within engineering see Tim Putnam, ‘The Theory of Machine Design in the Second Industrial Age’, *Journal of Design History*, 1.1 (1988), 25–34.
[2] For discussion of the external appearance of the domestic sewing machine, see Jeffrey L. Meikle, *Design in the USA*, (Oxford ; New York: Oxford University Press, 2005), pp. 44-45; John Heskett, *Industrial Design*, (Thames and Hudson, 1980), pp. 56-57; Adrian Forty, *Objects of Desire: Design and Society since 1750* (London: Thames and Hudson, 1986), pp. 96-99; Nicholas Oddy, ‘A Beautiful Ornament in the Parlour or Boudoir: The Domestication of the Sewing Machine’, in *The Culture of Sewing: Gender, Consumption and Home Dressmaking*, ed. by Barbara Burman (Oxford: Berg, 1999), pp. 285-302 <http://dx.doi.org.ezproxy.lib.gla.ac.uk/10.2752/9781847888884/CULTSEW0024>.
[3] Ettore Sottsass quoted from John Heskett, *Industrial Design*, p. 140.
[4] For examples of this approach, see John Heskett, *Industrial Design*; John Heskett, ‘Past, Present, and Future in Design for Industry’, *Design Issues*, 17.1 (2001), 18–26; John Heskett and Clive Dilnot, ‘Design from the Standpoint of Economics/Economics from the Standpoint of Design’, *Design Issues*, 31.3 (2015), 88–104 <https://doi.org/10.1162/DESI_a_00341>; Arthur J. Pulos, *American Design Ethic: A History of Industrial Design To1940* (Cambridge, Mass. ; London: MIT Press, 1983); Edward Lucie-Smith, *A History of Industrial Design* (Oxford: Phaidon, 1983); Grace Lees-Maffei and Rebecca Houze, *The Design History Reader* (Oxford: Berg, 2010); Hazel Clark and David Brody, ‘The Current State of Design History’ in *Journal of Design History*, Vol.22, No. 4 (2009), pp. 303-308; and for a comprehensive examination of design history, see Kjetil Fallan, *Design History: Understanding Theory and Method* (London: Bloomsbury Academic, 2013).
[5] Clive Dilnot, ‘The State of Design History, Part I: Mapping the Field’, *Design Issues*, 1.1 (1984), 4–23 (p. 18) <https://doi.org/10.2307/1511539>.

an important role in its design.[6] And a comparison of domestic and manufacturing model appearance offers an opportunity to consider the role of machine appearance in the formation, and preservation, of relationships between the sewing machine and those who used it.

Surviving machine models, made by both the Singer Company and its competitors, offer the opportunity to compare the appearance of domestic and manufacturing machines during the nineteenth and twentieth centuries. The use of material from the Singer Industrial Designs Collection, which includes photographs of full scale clay models of machine shells, offers valuable insight into how the Singer Company used industrial design principles to alter the appearance of its machines during the twentieth century. Examples taken from this collection combined with surviving machines and registered patent drawings, available from the United States Patent and Trademark Office (USPTO) online database, also offers an opportunity to compare design commissions which were adopted with those which were rejected. And an examination of designs that were commissioned but never put into production can provide a rare insight into how Singer regarded both its product ranges and its consumers.

The chapter is divided into two sections. The first section examines the appearance of manufacturing and domestic models before the formal introduction of industrial design principles. It begins by considering how the separate values and priorities of trade and domestic consumers influenced the initial and vivid differences between manufacturing and domestic machine appearance during the mid-nineteenth century. And it ends with a brief consideration of how familiarity with the sewing machine in both home and workplace led to shared characteristics by the close of the nineteenth century, with only the ornamentation of machine ranges revealing the influence of separate consumers. The second section considers the appearance of the machine after the formal introduction of industrial design principles during the second quarter of the twentieth century. It considers how the relationships fostered between consumers and sewing machines during the nineteenth century encouraged the Singer Company to make strategic use of industrial design principles during the twentieth century.

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[6] For a consideration of how design could reflect the needs and aspirations of consumers, see Regina Lee Blaszczyk, *Imagining Consumers: Design and Innovation from Wedgwood to Corning*, (Baltimore, Md. ; London: Johns Hopkins University Press, 2000); Judy Attfield, *Wild Things: The Material Culture of Everyday Life*, (Oxford: Berg, 2000); Kjetil Fallan, ‘Form, Function, Fiction – Translations of Technology and Design in Product Development’, *History and Technology*, 24.1 (2008), 61–87 <https://doi.org/10.1080/07341510701616949>.

Negotiating Style: The Shape and Ornamentation of the Sewing Machine, 1851 - 1920

The sewing machine is a complex object. It can be a mechanised tool for manufacturing, destined for the workroom or factory floor, or it can be a consumer durable, occupying a place within the family home. Singer recognised this dichotomy and used the appearance of the sewing machine to distinguish its distinct product ranges. Singer's choice of machine form and ornamentation reveals how it endeavoured not only to forge product identities but also to integrate new technology into both the home and workplace. An examination and comparison of its design choices demonstrate that Singer recognised the very different spaces that the sewing machine would occupy, and acknowledged the very different roles and identities of those who would use it.

Styling the Manufacturing Machine Model, 1851-1865

The first sewing machine that the Singer Company introduced in 1851 was solely intended for manufacturing purposes, and its combination of ornamentation and undisguised functionality set the precedent for the appearance of its early manufacturing models. Although the working mechanism of this first model remained exposed, the outlines of the body and base were emphasised with gilt lines and scrolls (Figure 3-1). In addition to the time and effort required to engineer the machine, considerable effort was also invested in its decoration, as a description of the process reveals:

> skilful workmen pencil out, with a fine camel's hair brush, the designs of flowers and scroll work […] without the least guide for hand or brush […] As quickly as the pencilling is done the machine is seized by another man, holding in his hand a book of gold leaf, which he deftly lays over every pencil line. The gold leaf firmly adheres to the "sizing" laid on by the brush and the rest is rubbed off by […] a piece of soft cotton batting […] The whole is then varnished with the best quality of white varnish.[7]

In the appearance of its first model, the Singer Company displayed an intention to blend function with ornamentation.

[7] John Scott, *Genius Rewarded* (New York: John J. Caulon, 1880), pp. 48-49, although this account of machine decoration is taken from a description of production in the Singer factory in Elizabethport published in 1880, it would still be an accurate account of the process involved in decorating models during the mid-nineteenth century.

Figure 3-3 Singer model no.6, hand painted industrial model revealing working mechanism, *c*. 1863 (SMCSA, WDC, WDBCS 2005.6023)

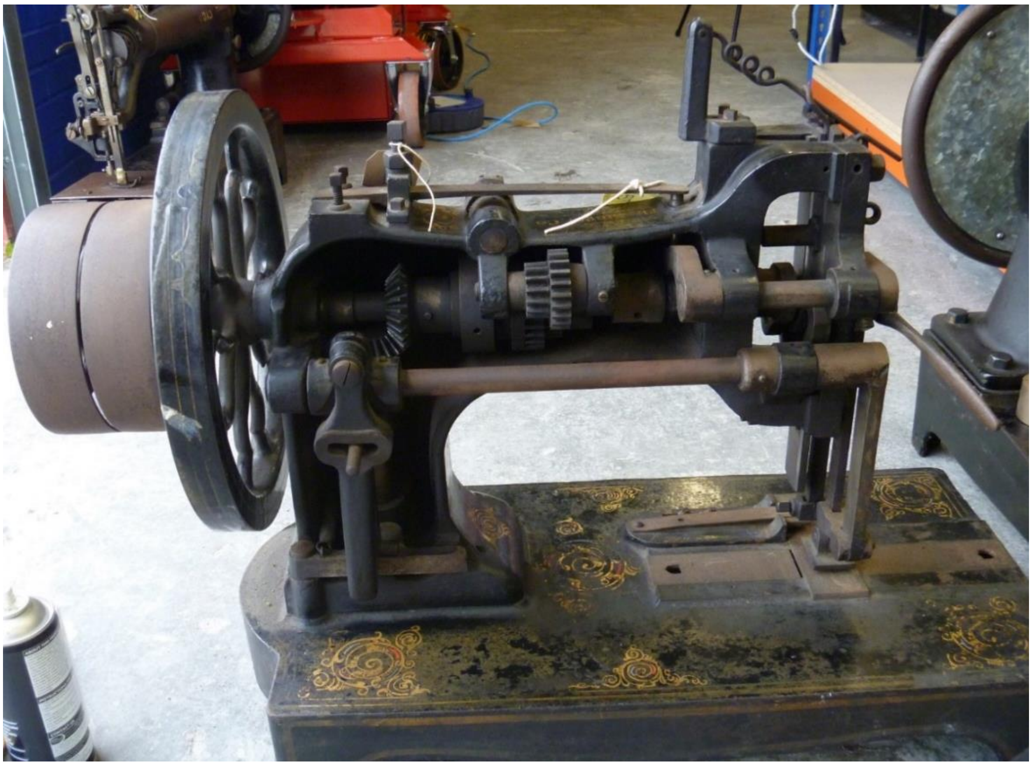

Figure 3-4 Reverse of Singer model no.6, shows access to internal working mechanism (SMCSA, WDC, WDBCS 2005.6023)

Figure 3-5 Singer model no.6, showing the application of a balanced decorative scheme (SMCSA, WDC, WDBCS.2005.6023)

Figure 3-6 Singer industrial model no. 6, detail of hand painted decoration (SMCSA, WDC, WDBCS.2005.6023)

The same intention is evident in the appearance of another of its early manufacturing machines, model no.6 (WDBCS 2005.6023) made prior to 1863. No attempt is made to disguise the function of the machine, and ornamentation is used as an embellishment rather than as camouflage. The robust cast iron body of model no.6 not only reveals the mechanism controlling the needle head (Figure 3-3), it also exposes the shaft and gear system that controlled the entire machine (Figure 3-4). Moreover, Singer did not just apply simple decorative flourishes to accessible parts of the machine; it also chose to apply a decorative scheme that considered the object as a whole. Decorative details were applied to the entire bed of model no.6, including the space behind the arm of the machine (Figure 3-5). Decorative details were applied to the top of the model, even though they would remain partially obscured. They were also applied to the inner arm of the machine, even though this part of the machine was awkward to reach (Figures 3-5 and 3-6). This degree of ornamentation was no mere afterthought, its quality and execution required skill and preparation.

This blend of ornamentation and undisguised function was not unusual during the nineteenth century. A variety of decorative styles and forms was exploited among Singer's competitors. The Glasgow firm of Kimball and Morton produced a range of heavy industrial machines for stitching canvas and tarpaulin, and although the interior working mechanisms of the machines remained exposed, the contours were hand painted with bold yellow stripes edged with red (Figures 3-7 and 3-8). Another British firm, Bradbury and Company, which also made no effort to disguise the functioning of its manufacturing range, chose to cover the black enamelled surface of one of its hat stitching machines with a small, simple gilt pattern (Figure 3-9). Although sewing machine manufacturers knew that their trade customers prioritised the performance of a machine, they obviously believed that the investment of time and money in the appearance of a manufacturing model was worthwhile.

Figure 3-7 (Left) Hand painted industrial model made by Kimball and Morton, *c*.1880-1890 (SMCSA, WDC, WDBCS.2004.1719)

Figure 3-8 (Right) Reverse of Kimball and Morton machine showing access to working mechanism (SMCSA, WDC, WDBCS.2004.1719)

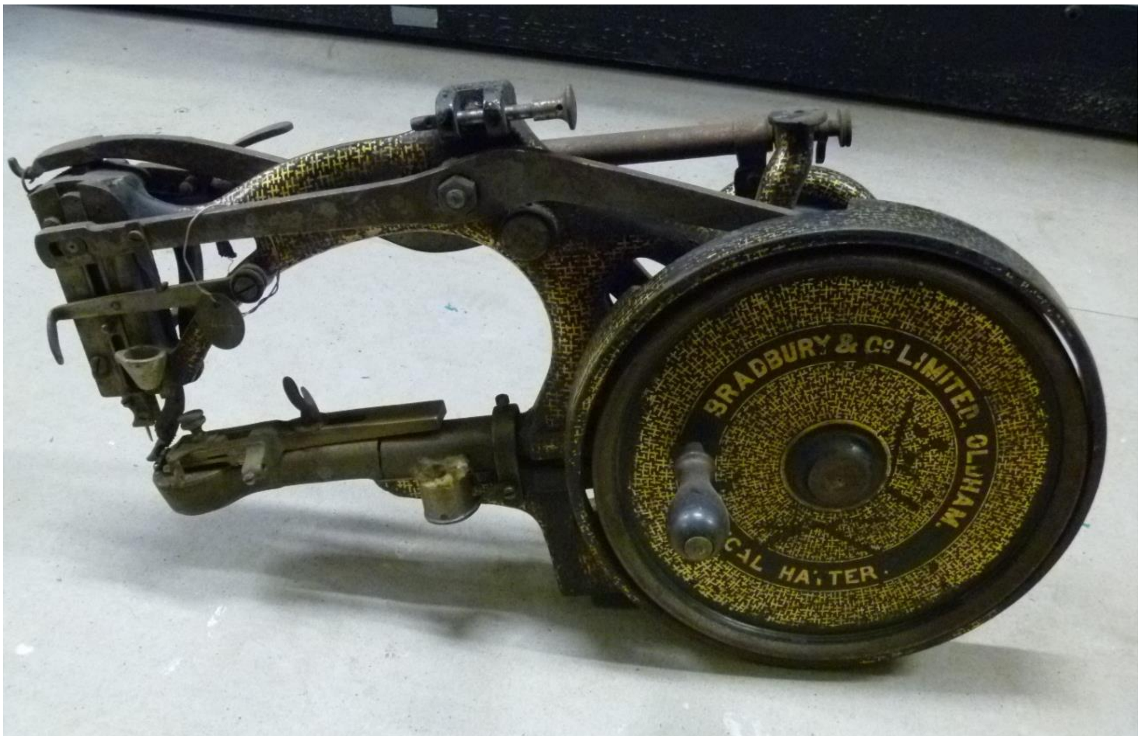

Figure 3-9 Bradbury Hatter, gilt patterned and partially revealing working mechanism, *c*.1876-1898 (SMCSA, WDC, WDBCS.2004.1601)

Figure 3-10 Illustration of I. M. Singer and Co. showroom in New York featuring only manufacturing models, mid-1850s (Figure 30 from Grace Rogers Cooper, *The Invention of the Sewing Machine*)

Machinery was a symbol of technological progress during the nineteenth century, and ornamentation lent a pleasing public face to new technology. Whilst engineering critics in the mid-nineteenth century placed an emphasis on an appearance of utility and practicality, machine manufacturers found that audiences responded more favourably to aesthetically pleasing machines. [8] Contemporary differences of opinion over the form and ornamentation of technology expressed both the anxieties and hopes that progress stimulated.[9] However, a civil engineer, Samuel Clegg, writing in 1852 about the use of ornamentation upon machinery, commented that, 'first impressions are always the most lasting, and it is evidently prudent that they should be pleasing.'[10] Attractive machines garnered attention, and this could help to promote and diffuse their use. The Singer Company took every opportunity to exhibit its machines, which included opening elegant showrooms in major cities across America.[11] An illustration of its New York showroom printed in 1857 featured only its industrial models

[8] John Kasson, *Civilizing the Machine*, pp. 155-157.
[9] Ibid., pp. 146-165.
[10] Samuel Clegg, *Architecture of Machinery: An Essay on Propriety of Form and Proportion, With a View to Assist and Improve Design* (London: W. Hughes, 1842), p. 2.
[11] According to Grace Rogers Cooper, 'Singer enjoyed demonstrating the machine and showed it to church and social groups and even at circuses', see Grace Rogers Cooper, *The Sewing Machine*, p. 33.

(Figure 3-10).[12] Although these plush showrooms did not mirror the intended destination of manufacturing models, their ornamentation perfectly matched their handsome retail surroundings.

However, it can also be argued that the blend of ornamentation and function was influenced by the important relationship that existed between object makers and their tools. A consideration of the balance and ornament of tools was not a new phenomenon in the mid-nineteenth century. It was preceded by a long tradition of tools being produced with skill and care. As R. A. Salaman observed, 'tool making seldom produces an ugly object […] and, as if by instinct, experienced tool-smiths tend to produce tools of graceful appearance.'[13] In the sixteenth and seventeenth centuries even relatively simple, ubiquitous tools like saws and planes had decorated handles.[14] Although the decoration served no useful function, its application demonstrated respect for those that used the tools. A consideration of the entire form and decoration of the manufacturing machine model in the mid-nineteenth century projected the pride and skill of those who made the machines, but it could also be regarded as a subtle recognition of the long standing value and significance of tools to those who used them.

More importantly, the appearance of early manufacturing models acknowledges the influence of the human role in the process of mechanisation. In 1876 the British periodical *Engineering* questioned the value of decorating any machine destined for a manufacturing space, and stated, 'there is something so anomalous in attempting to ornament a machine which is to be covered in grease and dirt and operated where no one cares for or ever notices decoration […].'[15] However, machines and mechanised tools were destined to come into contact with humans on a daily basis, and ornamentation could not be appreciated by other machines: it could only be observed by human operators. Karl Marx feared that the human had been reduced to no more than an 'appendage of the machine'.[16] But, the time and effort expended upon the ornamentation of early manufacturing sewing machine models demonstrated that the Singer Company, and many of its competitors, both recognised and respected the human presence in the process of mechanisation.

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[12] Grace Rogers Cooper made this observation about the models featured in the illustration of Singer's showroom in New York, see Grace Rogers Cooper, *The Sewing Machine*, p. 32.
[13] R. A. Salaman, 'Tradesmen's Tools *c.* 1500-1850', in *A History of Technology*, vol. 3, ed. by Charles Singer et al (Oxford: Clarendon Press, 1954), pp. 110-133 (p.120).
[14] Ibid., p. 121.
[15] "Machine Tools at the Philadelphia Exhibition," *Engineering*, 21 (May 26, 1876) quoted from John Kasson, *Civilizing the Machine*, p. 158.
[16] Karl Marx quoted from Paul Greenhalgh, 'Introduction', in *Modernism in Design* ed. by Paul Greenhalgh (London: Reaktion, 1990), pp. 1-24 (p. 8); for further discussion of Marx and technology, see Donald MacKenzie, 'Marx and the Machine', *Technology and Culture*, 25.3 (1984), 473–502 <https://doi.org/10.2307/3104202>.

Styling the Domestic Sewing Machine Model, 1856-1865

In comparison, the choice of appearance for the Singer Company's early domestic model was influenced by rather different considerations than those that had governed the appearance of the manufacturing model. Although the performance of the machine remained important, unless domestic consumers could be persuaded to accept the machine into their homes, there would be no opportunity for them to assess the value of its performance. Moreover, the domestic consumer was a woman. Therefore, the Singer Company concentrated on making the appearance of the sewing machine attractive to women and compatible with domestic interiors.[17] The first three incarnations of its domestic model met with varying degrees of success as Singer struggled to combine performance with a suitable appearance for the home.

In 1856, Singer introduced its first machine model intended solely for domestic use and consciously chose to exaggerate the decorative rather than the mechanical aspects of the object. The Family Machine, or the Turtle-Back as it became commonly known, differed significantly in shape and appearance from the manufacturing model introduced in 1851. The Turtle-Back was significantly smaller than its manufacturing counterpart and its working mechanisms were entirely concealed. Its black varnished body was also ornately decorated with gilt scrolls, painted flowers, and inlays of mother-of-pearl (Figure 3-14). The quality of its appearance was designed to attract wealthy middle class consumers, but, unfortunately, its performance was not as impressive as its ornate shell. The concentration on appearance had proven to be at the expense of efficient mechanical function, and it was withdrawn from production only three years after its introduction.

In 1859, it was replaced by Singer's second domestic model, the Letter 'A' (Figure 3-11). The performance of the machine was improved, but its appearance betrayed its adaption from the original Singer manufacturing model. Although the small body of the machine is decorated with mother-of-pearl inlay and sits on a decoratively shaped bed, the working mechanism in the head of the machine remained partially exposed. The performance of the machine was significantly better than that of the Turtle-Back. However, its obvious mechanical function meant it was not ideal for a domestic interior. An increased focus on the mechanical performance of the machine

[17] For further discussion of gender and technology, see Nina E. Lerman, Arwen Palmer Mohun, and Ruth Oldenziel, 'Versatile Tools: Gender Analysis and the History of Technology', *Technology and Culture*, 38.1 (1997), 1–8 <https://doi.org/10.2307/3106781>; for discussion of gender and sewing machine appearance, see Nicholas Oddy, 'A Beautiful Ornament in the Parlour or Boudoir: The Domestication of the Sewing Machine', pp. 285-302.

had improved sales, but Singer had not yet achieved a balance between performance and an appropriate machine appearance for a female consumer within a domestic environment.[18]

In 1865, the Singer Company replaced the Letter 'A' with its third version of a domestic model, the New Family Machine (Figure 3-12). This model perfectly combined effective mechanical function with a suitable decorative appearance. The small body of the machine, placed upon a decoratively shaped 'fiddle' base, entirely concealed its working mechanisms, and its black varnished surface provided an opportunity to apply rich gilt ornamentation. The machine proved very popular, and shortly after its introduction the Singer Company finally exceeded the domestic sales of its closest rival, Wheeler and Wilson.[19] Nine years after its first attempt, the New Family Machine can be regarded as the Singer Company's first successful domestic model, and it remained in production for 20 years.

The performance of Singer's early domestic models certainly contributed to their eventual success, but the importance of their appearance to the domestic consumer should not be underestimated.[20] A review of sewing machines in *The Englishwoman's Domestic Magazine* in 1867 pointedly referred to their appearance, and described them as, 'so pretty that they are fitted for a boudoir and a drawing room.'[21] If domestic consumers were concerned only with machine performance then the ornate decoration of the Turtle-Back would have been unnecessary, and either the original manufacturing model or the Letter 'A' would have initially sufficed. The historians who have considered the appearance of nineteenth-century domestic sewing machines agreed that altering the appearance of the domestic model was a necessary step towards its acceptance into a middle class home.[22] As John Heskett remarked, 'presentation conformed to the conception of what was aesthetically appropriate to the social context in which the machines were used.'[23]

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[18] The Letter 'A' sold 4 times as many as the Turtle-Back, see Nicholas Oddy, 'A Beautiful Ornament in the Parlour or Boudoir', electronic version has no individual page numbers within the chapter.
[19] In 1867 Wheeler and Wilson produced 38,055 machines and Singer produced 43,053. In 1870 Wheeler and Wilson produced 83,208 machine and Singer produced 127,833 machines, see David Hounshell, *From the American System to Mass Production*, p. 70 and p. 89.
[20] Nicholas Oddy, 'A Beautiful Ornament in the Parlour or Boudoir'.
[21] *The Englishwoman's Domestic Magazine*, December 1867 quoted from Janet Arnold, *Patterns of Fashion: Englishwomen's Dresses and Their Construction*, Corrected edn (London: Macmillan, 1972), p. 4.
[22] Jeffrey Meikle stated that the sewing machine, 'had to be naturalized and domesticated for the parlour', see Jeffrey Meikle, *Design in the USA*, p. 45; see also Adrian Forty, *Objects of Desire*, pp. 96-97.
[23] John Heskett, *Industrial Design*, p. 57.

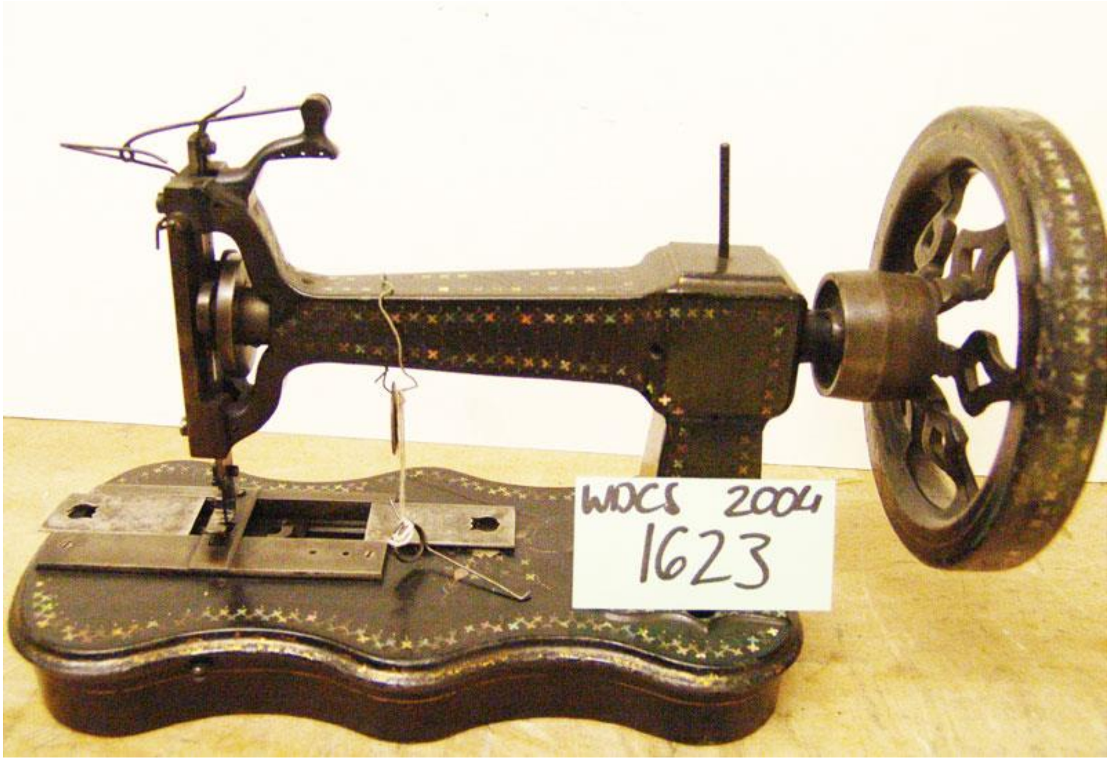

Figure 3-11 Singer Letter ‘A’ domestic machine model, *c*.1859-1865. (WDCS 2004.1623. Image courtesy of West Dunbartonshire Library and Cultural Services)

Figure 3-12 Singer New Family Machine, *c*.1865-1885 (Image courtesy of Science Museum Group)

Figure 3-13 (Left) Papier mâché workbox with watered silk lining made in Birmingham by Jennens and Bettridge, *c*.1850 (W.150-1919. Image © Victoria and Albert Museum, London). Image removed due to Copyright restrictions.

Figure 3-14 (Right) Singer 'Turtleback' domestic machine with mother-of-pearl inlay, 1856-1859 (SMCSA, WDC, WDBCS 2004.1617. Image courtesy of West Dunbartonshire Council Library and Cultural Services)

Figure 3-15 Photograph of domestic machine design submitted by Kimball and Morton to the British Design Register, 1868 (Figure 36.5 from Geoff Dickens, *Nineteenth Century British Sewing Machine Companies*).Image removed due to Copyright restrictions.

The introduction of a machine into the public rooms of a home in the mid-nineteenth century was without precedent, and an attractive appearance would obviously help make this introduction more palatable. Although the machine technology was entirely new, the decorative treatment of the machine's surface, gilt and painted decoration on black, bore a resemblance to the decorated surface of varnished papier- mâché objects and furniture. A comparison of Singer's earliest domestic model, the Turtleback, and an English mid-nineteenth century papier-mâché sewing box shows the similarities (Figures 3-13 and 3-14). Varnished papier- mâché had been popular in middle class homes since the eighteenth century, and it had been used to make a variety of objects, including glove boxes, sewing boxes, console tables, mirror mounts, and clock cases.[24] It was a decorative style that had resonance within the home and with objects associated with women.

Although the similarity between these decorative styles has already been noted, little significance was attached to it.[25] But these varnished papier- mâché items were very popular and available in Europe and America. They were exhibited at the Great Exhibition in 1851, and immigrant English craftsmen had established their manufacture in New York and Connecticut by the mid-nineteenth century.[26] So although the similarity between these objects and early machine models might be coincidental rather than pre-meditated, Singer's early domestic models would have benefited from public familiarity with their decorative style. Moreover, any resemblance would have helped make the new machine technology more accessible, as well as increasing its likelihood of co-ordinating with objects already found within the home.

In a further concession to the domestic interior, the Singer Company also offered the means to disguise the sewing machine as a piece of furniture. An advertisement placed by the Singer Company in the 1859-1860 edition of the *Glasgow Post Office Directory* stated that, 'as an elegant piece of furniture, nothing can be purchased for a like sum of money so ornamental as one of our Cabinet machines.'[27] And an advertisement placed by the Singer Company in the 1864-1865 edition makes it clear that despite its rich ornamentation, the Letter 'A' was, 'designed to be inclosed, when desired, in a highly finished and richly decorated cabinet case.'[28] Disguising the sewing machine as furniture obviously made it easier to place within the home,

[24] Shirley Spaulding DeVoe, *English Papier Mâché of the Georgian and Victorian Periods* (London: Barrie and Jenkins, 1971), p. 181.
[25] Nicholas Oddy, 'A Beautiful Ornament in the Parlour or Boudoir'.
[26] Shirley Spaulding DeVoe, *English Papier Mâché,* p. 15.
[27] *Glasgow Post Office Directory 1859-1860*, p. 155.
[28] *Glasgow Post Office Directory 1864-1865*, p. 161.

but it also began to identify the machine with furniture in the mind of the domestic consumer and blur its association with technology.[29]

In 1868, one of Singer's competitors, the Glasgow firm of Kimball and Morton, chose to employ a more extreme form of domestic camouflage when it introduced a domestic model housed within the shape of an ornamental lion (Figure 3-15). The use of such ornamental disguise solicited criticism from Pugin, who commented:

> It is impossible to enumerate half of the absurdities of modern metal-workers […] but all these proceed from the false notion of disguising instead of beautifying articles of utility. How many objects of ordinary use are rendered monstrous and ridiculous simply because the artist, instead of seeking the most convenient form, and decorating it, has embodied some extravagance to conceal the real purpose for which the article has been made![30]

However, despite its novelty, the introduction of Kimball and Morton's lion design demonstrates that a company that had produced robust and practical manufacturing models strenuously believed the appearance of a domestic model demanded concessions to its intended environment. Even the photograph of the machine used to register the design, shows it surrounded by the soft furnishings and upholstered furniture to be found in a middle class home (Figure 3-15).

The use of decoration, disguise, and novel forms of concealment demonstrated an ambition to not only distinguish the early domestic machine model from its manufacturing counterpart but also to generate a separate product identity for it. An identity that made it suitable for middle class female use, and preserved what could be described as 'bourgeois respectability'. Emphasis on the decorative potential of the early domestic model not only aimed to integrate the sewing machine into the home but also into the life and role of the woman within it. As Judith Coffin observed, 'Advertisements exaggerated the machine's femininity, as if it were trying on gender for the first time.'[31] Altering the appearance of the early domestic model was a conscious effort by the Singer Company, and its competitors, to obscure the associations that the sewing machine had with manufacturing and female employment. Indeed, Ruth Oldenziel and Mikael Hård noted that it was only after 1900 that many middle class women in Europe, 'no longer regard using the sewing machine as beneath their dignity.'[32] The changing appearance of the

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[29] Less than a century later a similar exercise in domesticating technology was undertaken with early models of television and radio sets.

[30] A. W. N. Pugin quoted from John Gloag, *Victorian Taste: Some Social Aspects of Architecture and Industrial Design, from 1820-1900* (London: Black, 1962), p. 151.

[31] Judith G. Coffin, *The Politics of Women's Work*: *The Paris Garment Trades, 1750-1915* (Princeton, NJ: Princeton University Press, 1996), p. 91.

[32] Ruth Oldenziel and Mikael Hård, *Consumers, Tinkerers, Rebels: The People Who Shaped Europe* (Basingstoke: Palgrave MacMillan, 2013), p. 37.

early domestic model reflected the influence of the middle class household and the domestic roles of the women within it.

Early Twentieth Century Machine Styles

Although the ambition to retain separate product identities for the domestic and manufacturing models continued into the twentieth century, the Singer Company took a more subtle approach to distinguishing appearances. By the late nineteenth century the sewing machine had become a much more familiar object within the home, and no longer needed to be concealed or disguised, having proven its worth as a labour saving device.[33] Consequently, the domestic and manufacturing models of the Singer Company began to share the same robust, cast curved form. And by the start of the twentieth century, the choice of ornamentation became the feature that most obviously separated the domestic and manufacturing model ranges.

Figure 3-16 (Left) U.S. Patent D13,879. Ornamental design transfer print by William Haehnel for Wheeler and Wilson, 1883 (NMAH AC, TLC Singer, box 4. folder 15). Image removed due to Copyright restrictions.

Figure 3-17 (Right) Photograph of decorated machine shell attached to U.S Patent D13,879 (NMAH AC, TLC Singer, box 4, folder 15). Image removed due to Copyright restrictions.

[33] Nicholas Oddy, ‘A Beautiful Ornament in Parlour or Boudoir’.

Figure 3-18 Rich floral transfer print design on Singer domestic model *c*.1890 (SMCSA, WDC, WDCS 2004.1831. Image courtesy of West Dunbartonshire Council Library and Cultural Services)

Figure 3-19 Ornamental transfer print for Singer domestic model 15K which mimics mother-of-pearl, *c*. 1890s (SMCSA, WDC, WDBCS 2008.5573)

Figure 3-20 Singer Model 34K SV1 with example of ornamental transfer design shared by industrial models, *c*.1900 (SMCSA, WDC, WDBCS 2004.1715)

Figure 3-21 Singer Model 34K SV1 detail of shared transfer design, *c*.1900 (SMCSA, WDC, WDBCS 2004.1715)

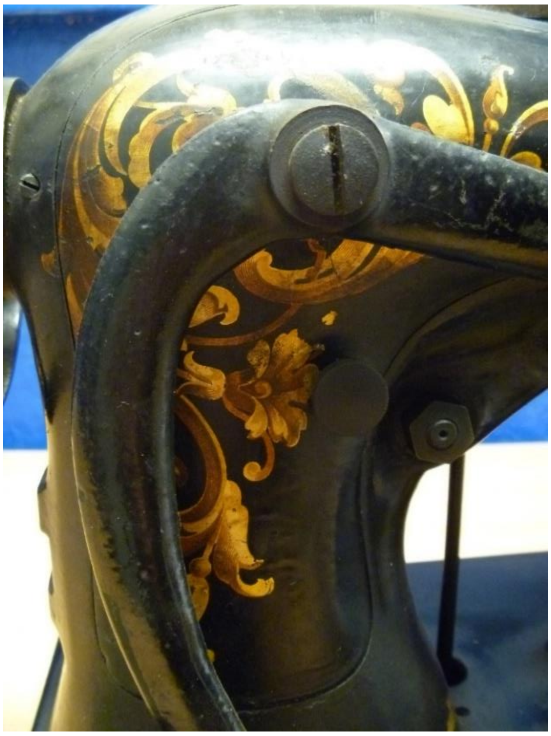

Figure 3-22 Singer Model 33-12 with example of ornamental design shared by industrial models, c.1900 (SMCSA, WDC, WDBCS.2004.1784)

Figure 3-23 Singer Model 33-12 detail of shared design on inner arm, *c*.1900 (SMCSA, WDC, WDBCS.2004.1784)

The increase in sewing machine production by the last quarter of the nineteenth century demanded a quicker and more economical method of applying decoration to both ranges. The solution was the adoption of transfer printing, which was a method of transferring decoration to objects that had proved successful in the pottery industry.[34] The decoration was printed onto sheets of paper, and then carefully applied to the black surface of the machine before being sealed and protected by layers of clear varnish. The method was adopted throughout the sewing machine industry, and designs were commissioned from freelance decorative artists who could receive commissions from a variety of manufacturers. In 1883, the New York based artist William Haehnel was commissioned to produce decorative designs by both Wheeler and Wilson and the Singer Company.[35] Sewing machine manufacturers chose to patent their decorative designs, and the patent applications were often accompanied with samples of the transfer print and even a photograph of the machine shell bearing the decoration (Figures 3-16 and 3-17).[36]

By the turn of the twentieth century a variety of patterns had been designed for the domestic model, and these were updated to reflect changes in taste and fashion. Transfer printing did not limit the shape or complexity of designs. Floral motifs continued to be popular, especially as they lent themselves well to the curves of the machine body (Figure 3-18). Transfer printing also supported the use of a variety of colours in one design. The popularity of mother-of-pearl encouraged Singer to create a transfer print that effectively mimicked the iridescence of the shell (Figure 3-19). By offering a choice of fashionable patterns, Singer recognised the individuality of the domestic consumer and permitted the expression of personal taste.

However, in contrast to the domestic model, by the early twentieth century Singer had chosen to apply only a single decorative pattern to almost all of its manufacturing models (Figures 3-20 to 3-23). Although only a single pattern was chosen, its quality and the degree of application was no less than that found on the domestic models. The gilt pattern had great depth and was applied to the entire bed and body of the machine, including the awkward to reach inner arm. The appearance of the manufacturing model continued to project the pride of the Singer Company in its product, and show respect for those who used them. However, Singer regarded its trade customers as universally focused upon the performance of the machine, and replaced the individuality of pattern designs with trade specific mechanical specialisation and innovation.

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[34] Wedgewood adopted the use of transfer printing during the late eighteenth century, see Adrian Forty, *Objects of Desire*, p. 40.
[35] NMAH AC, TLC Wheeler and Wilson, box 4, folder 15 – U.S. Patent D13,879 registered by William Haehnel for the Wheeler and Wilson Company, 1 May 1883; USPTO PatFT, U.S Patent D13,662 registered by William Haehnel for the Singer Manufacturing Company, 27 February 1883.
[36] The use of photography indicates the interest of manufacturers in this new technology, and many of these patent application photographs represent the earliest photographic records of either sewing machines or consumer products.

A comparison of Singer's domestic and manufacturing models during the nineteenth century reveals not only the effort it took to distinguish its product ranges but also the significant influence of the priorities and expectations of Singer's domestic and manufacturing consumers on machine appearance. Singer's choices of design signalled domestic accessibility to families and technical efficiency to manufacturers. The visual identity of the machine helped to integrate an unfamiliar technology into both domestic and working lives. It also began to create positive associations with the Singer brand. Machine appearance proved to be a valuable form of communication between the Singer Company and its consumers.

The Strategic Adoption of Industrial Design, 1936-1959

The formal introduction and adoption of industrial design principles were responsible for the distinct and often dramatic change in product appearance during the twentieth century. Therefore, this section focuses on how the Singer Company chose to make strategic use of this new approach to object design for both its domestic and manufacturing machine models. The section concentrates on a selection of designs that the Singer Company commissioned from a freelance industrial designer, Malcolm S. Park, between 1936 and 1959. This selection of designs reveals that although the Singer Company chose to adopt industrial design principles to highlight technical improvements made to its manufacturing range, it also chose to reject their use in order to preserve the values that domestic consumers associated with the domestic machine. Singer's strategic adoption of industrial design principles demonstrated the value that Singer placed on the priorities and expectations of its customers, and that these could prove more influential than any major shift in prevailing style.

The method of designing objects that considered and exploited manufacturing methods was not original to the industrial design of the twentieth century; its efficiency had been recognised and employed by manufacturers during the eighteenth and nineteenth centuries.[37] However, by the early twentieth century mechanised production had dramatically increased the number of products available to consumers, and industrial design evolved from the need to fashion and style them. As Arthur J. Pulos observed, 'These pioneering industrial designers and others like them were the results of this phenomenon, not its originators.'[38] Production was a collaborative process, which involved design, engineering, and advertising, and the early pioneers of industrial design often came from backgrounds where communication and collaboration played

[37] For eighteenth-century examples, see Adrian Forty, *Objects of Desire*, pp. 29-41; for nineteenth-century examples, see Clive Wainwright, 'The Legacy of the Nineteenth Century' in *Modernism in Design*, ed. by Peter Greenhalgh, pp. 26-39.
[38] Arthur J. Pulos, *American Design Ethic*, p. 324.

important roles.[39] Manufacturers benefitted from this experience, and the formalised professional role of the industrial designer permitted these early pioneers to exploit their knowledge in the design of a variety of products.[40]

Although the Singer Company had recognised the value of machine shape and appearance during the nineteenth century, both were to become major preoccupations of manufacturers and consumers during the twentieth century.[41] Industrial design could embrace the engineering of an object, or be used solely to alter its appearance. Its adoption imposed new shapes on consumer products which communicated refinement, modernity, and progress. Restyling not only became a way of forging brand identity and awareness to differentiate products in a competitive market place, it also became a way to embody customer ideals and aspirations. As Edward Lucie-Smith remarked, 'the industrial designer had to deal with the way things were perceived, as well as the way in which they objectively exist. He must take into account psychology and sociology.'[42] By the post-war period, industrial design had become an integral part of production and a valuable marketing tool.

Rejecting a Restyle of the Domestic Model, *c.* 1936

In 1936 the Singer Company commissioned Malcolm S. Park, a freelance industrial designer based in New York, to update the appearance of one of its domestic machine models. A surviving photograph of Park's clay model (Figure 3-24) shows that he proposed to replace the familiar body of the Singer sewing machine with the streamlined curves that had become popular for the restyling of American consumer products during the 1930s.[43] In order to maintain an unbroken silhouette for the body of the machine, he also proposed moving the thread take-up lever from the side of the machine to its head. In a handwritten note attached to the reverse of the photograph, Malcolm S. Park described his choice of construction and materials:

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[39] Early pioneers of industrial design often came from the fields of architecture and theatre design, see John Heskett, *Industrial Design*, p. 105.

[40] For an overview of their careers and an insight into their design ethos, see Henry Dreyfuss, *Designing for People* (New York: Paragraphic Books, 1967); and Raymond Loewy, *Industrial Design* (London: Faber, 1979).

[41] For the adoption and diffusion of industrial design principles in the U.S., see Arthur J. Pulos, *American Design Ethic: A History of Industrial Design To1940*, pp. 251-333; and Jeffrey L. Meikle, *Design in the USA*, pp. 89-129.

[42] Edward Lucie-Smith, *Industrial Design*, p. 10.

[43] NMAH AC, Singer Industrial Designs Collection 169 (hereafter SID 169), box 5, folder 1 – photograph, 1936; for a discussion of the introduction and popularisation of streamlining, see Nicholas P. Maffei, 'The Search for an American Design Aesthetic: From Art Deco to Streamlining', in *Art Deco 1910-1939*, ed. by Charlotte Benton, Tim Benton, and Ghislaine Wood (London: V&A Publications, 2003), pp. 360-369; John Heskett, *Industrial Design*, p. 121; Jeffrey Meikle, *Design in the USA*, pp. 121-129.

> the design is based on the concept of a cast iron or die cast grid supporting all bearings in both arm and bed, which would be one integral casting. After assembly of moving parts in this frame, moulded plastic covers would provide the exterior form and finish.[44]

The Singer Company had always cast the shell of its machines in iron. Therefore, Park was proposing not only a significant change to the shape of the domestic model but also an audacious change in materials.

Figure 3-24 Photograph of clay prototype of Singer domestic model restyled by Malcolm S. Park, 1936 (NMAH AC, SID 169, box 5, folder 1). Image removed due to Copyright restrictions.

In the note attached to the photograph, Malcolm S. Park had also included the reason for the commission, ‘A family sewing machine – First attempt at an approach to problem of appearance design.’[45] The shell of the Singer sewing machine had remained virtually unchanged since the last decade of the nineteenth century, and its appearance was likely conspicuous among the welter of restyled consumer products available on the market by the 1930s. Park’s full-scale clay model permitted senior staff to see the radically new design for the first time. It also gave them an opportunity to decide whether this was the design direction that the Singer Company wished to pursue. However, despite the fact that Park’s restyle provided a bold, modern, and contemporary shell for the domestic machine, and his note confirmed that Singer perceived a

[44] NMAH AC, SID 169, box 5, folder 1 – photograph, 1936.
[45] Ibid.

problem with the current model's appearance, there is no evidence that his design was ever adopted.

Although it could be argued that the Singer Company did not like the design, it is more likely that it was the concept of change that was more challenging. If Singer had been unhappy with any aspect of the design: it could have been altered. A full scale model provided a valuable point of discussion and negotiation, and as Henry Dreyfuss observed:

> too much emphasis cannot be placed upon the importance of the three-dimensional model […] It not only represents an accurate picture of the product for executives, but it also gives the tool makers and production men an opportunity to criticize and to present manufacturing problems.[46]

Park had proposed a mechanical change to accommodate a cleanly defined silhouette. And although this change was easy to accomplish on a model, only the engineering staff could assess whether it was mechanically feasible or justified. Moreover, the boldness of the design suggests that Park was given scope to create a modern and contemporary look for the domestic model. The existence of the commission suggests that the Singer Company was not opposed to the idea of a restyle, and was willing to consider a radical change to the appearance of its domestic model.

Any rejection of a restyle was more likely due to the fact that changing the appearance of the domestic model would risk changing what that appearance conveyed to Singer's domestic consumers.[47] During the late nineteenth and early twentieth centuries, the Singer Company had managed to forge a strong visual identity for its domestic model, one which had achieved international recognition and associated the Singer domestic sewing machine with reliability, durability, and family economy. As John Lienhard, a professor of mechanical engineering and history, recollected, 'I remember American home life as it was so powerfully affected by these beautiful and complex engines of our ingenuity.'[48] These were associations that the Singer Company undoubtedly wished to maintain, especially in the face of a world recovering from economic depression. Although Park's design offered a bold and fashionable appearance for the domestic model, one intended to project modernity and aspiration, Singer may have concluded that a restyled domestic model risked displacing the valuable and intangible associations that the machine's appearance had already generated among its domestic consumers.

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[46] Henry Dreyfuss, *Designing for People*, pp. 59-60.

[47] Raimonda Riccini suggested that 'stasis [in design of the domestic sewing machine] is the reluctance of the industrial system to modify a device that has attained a high degree of stability and popularity', see Raimonda Riccini, 'History from Things: Notes on the History of Industrial Design', *Design Issues*, 14.3 (1998), 43–64 (p. 58) <https://doi.org/10.2307/1511893>.

[48] John H. Lienhard, *The Engines of Our Ingenuity: An Engineer Looks at Technology and Culture* (New York: Oxford University Press USA, 2000), p. 234.

The influence of how a consumer perceived product restyling could not be underestimated, as Arthur J. Pulos noted, ‘manufacturers would have to learn to balance faddism and permanence.’[49] Raymond Loewy, one of the twentieth century’s most significant and prolific industrial designers, acknowledged the risk involved in changing the appearance of a familiar product.[50] And in recognition of the important relationships that people established with objects, Henry Dreyfuss even suggested that an element of the original design be preserved to foster acceptance of a product’s new style.[51] Nostalgia was a powerful inducement to retain an established and popular product appearance. And underlying the adoption of Modernist style, a strong taste for the familiar and nostalgic survived.[52] Although the visual representation of Modernism in product design and architecture is entirely accurate, edited from contemporary sources it can present a biased image of the period; an image that obscures the enduring taste for earlier styles.[53] The value placed upon familiarity may have convinced Singer that a restyle of the domestic model was unnecessary. Contemporary restyling could be an effective marketing tool, but it might not always be warranted, or desirable.

Discretionary Use of Industrial Design

Although the Singer Company rejected the use of industrial design to restyle its domestic machine model, it did choose to adopt industrial design to restyle a selection of its manufacturing models during the 1940s and 1950s. Because the Singer Company relied upon the mechanical specialisation and performance of its manufacturing machine models to establish and maintain successful relationships with its trade customers, any alteration to the appearance of these models was unlikely to disrupt the important relationships that had already been established. For this reason, the Singer Company could capitalise upon any attention that a restyled manufacturing model would generate and focus that attention on the performance of the machine. The priorities of its trade customers encouraged Singer to make discretionary use of industrial design and alter the appearance of manufacturing models to signal improvements to machine performance.

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[49] Arthur J. Pulos, *American Design Ethic*, p. 332.
[50] For his discussion of risk see Raymond Loewy, *Never Leave Well Enough Alone* (Baltimore: Johns Hopkins University Press, 2002), pp. 278-281.
[51] Henry Dreyfuss, *Designing for the People*, p. 57.
[52] For interest in Colonial style and styles from the past, see Arthur J. Pulos, *American Design Ethic*, pp. 296-300; and Terry Smith, *Making the Modern: Industry, Art, and Design in America* (University of Chicago Press, 1994), pp. 353-361.
[53] For an ambitious discussion of Modernism and the construction of a pervasive visual imagery, see Terry Smith, *Making the Modern: Industry, Art, and Design in America*.

Figure 3-25 (Left) Model 71-101 before re-styling, Singer product leaflet *c*.1944 (NMAH AC, SID 169, box 5, folder 2). Image removed due to Copyright restrictions.

Figure 3-26 (Right) Photograph of clay prototype of Singer Model 71-101 after re-style by Malcolm S. Park, 1944 (NMAH AC, SID 169, box 5, folder 2). Image removed due to Copyright restrictions.

Figure 3-27 U.S. Patent D139, 712 for re-style of Singer model 71-101 by Malcolm S. Park, 12 December 1944 (NMAH AC, SID 169, box 5, folder 2). Image removed due to Copyright restrictions.

In 1944, Malcolm S. Park was commissioned by the Singer Company to redesign the shell of model 71-101, a buttonhole stitching machine. The original design of the machine was configured around its complex engineering, which remained partially exposed to allow the operator access for mechanical adjustment (Figure 3-25). A photograph of Park's clay model shows that he chose to conceal the complex mechanisms in a tall, robust box, which simplified and elongated the original squat profile of the machine (Figure 3-26). The drawings attached to the patent application also show that he made further refinements to the shape of the box, and granted access to the internal mechanisms via strategically placed hinged doors (Figure 3-27).[54] Park described the restyle as 'a "cover up" design permitting access to adjustment needs.' [55]

However, despite the registration of a design patent, there is no evidence that Park's design was ever adopted. Twelve years after its design and registration, a product leaflet for the machine is illustrated with an image of the original model before its restyle.[56] Although Park's improvements to the shell might have increased productivity, because his design was less visually confusing and, therefore, easier for the operator to use, this represented only a modest improvement in performance. The Singer Company constantly offered modest increases in performance by improving machines mechanically in response to feedback from their trade customers and agents. However, the expense of minor mechanical improvements was small in comparison to the cost of producing an entirely new shell.[57] Singer weighed the cost of a modest improvement in performance against the cost of putting a new shell into production, and appear to have concluded that what was primarily a cosmetic improvement was not cost effective.

In contrast, the design of model series 451K was adopted because it was accompanied with significant improvements in machine performance. Model series 451K employed a new mechanical innovation that enabled machines to operate at significantly higher speeds: the rotary thread take-up. In most sewing machine models, once the thread had passed through the tensioning disc it was then controlled by a lever on the side of the machine, which moved in a perpendicular motion. This method of tensioning the thread worked extremely well until the speed of the machine was increased. Once the speed increased, the lever mechanism endured significant wear and the thread would catch upon itself during the perpendicular movement. The rotating mechanism of the rotary take-up, which was placed in the head of the machine,

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[54] NMAH AC, SID 169, box 5, file 2 – U.S. Patent D139, 712 registered by Malcolm S. Park on behalf of the Singer Manufacturing Company, 12 December 1944.
[55] Ibid.
[56] SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue of Singer Sewing Machines and Equipment for the Manufacturing Trade* ([New York]: Singer Manufacturing Company, [n.d.]), un-numbered. This catalogue comprises Form 19100 product leaflets for machines produced at various Singer factories. Each individual leaflet includes a date of publication, Form 19100-Elizabethport for models in Class 71 is dated 1956.
[57] Chapter Two discussed the cost of small incremental changes in USMC development.

replaced the lever and its perpendicular movement. This mechanism cut down on wear because it exploited the rotation of the internal shaft, and the thread no longer became caught because it was under constant control. Machines fitted with the rotary take-up mechanism could reach speeds of up to 5,000 stitches per minute. This delivered a significant improvement in machine performance and a distinct production advantage to manufacturers.

Figure 3-28 Singer Model 451K105 restyled by Malcolm S. Park, 1957 (SMCSA, WDC, WDCS 2004.1627)

To signal the advantage that model series 451K could deliver, Park was tasked with providing it with a distinctive shell. He chose to accentuate the head of the machine, where the mechanism was housed, and replace cast curves with a narrow, elongated body (Figure 3-28). The removal of the lever on the side of the machine also enabled Park to achieve the sleek, unbroken silhouette that he had attempted for the domestic model several years earlier. Park also chose to treat the surface of the machine differently, replacing the ubiquitous black sheen of the Japan varnish with a warm toned, matt, textured surface. In 1951, he registered a design patent on behalf of the Singer Company, and the design was adopted and successfully entered into production.[58] Park's design represented a dramatic change of appearance for a model in Singer's manufacturing range, and Singer acknowledged its boldness by describing it as 'advanced styling.'[59]

[58] USPTO PatFT, U.S. Patent D164,709 registered by Malcolm. S. Park on behalf of the Singer Manufacturing Company, 2 October 1951; SMCSA, WDC, box GDWD 1/1/3(2) – *Catalogue of Singer Sewing Machines and Equipment for the Manufacturing Trade,* un-numbered. Form 19100-Singer Section for Class 451K is dated 1957.
[59] SMCSA, WDC, box GDWD 1/1/3(2) – *Singer Industrial Sewing Equipment c.* 1950s-1960s, internal copy which comprised separate Form 19100 product leaflets and typed addenda describing new models.

Figure 3-29 Singer promotional leaflet for model 236w100, restyled by Malcolm S. Park, c. 1957 (SMCSA, WDC, box GDWD 1/1/5, item 23). Image removed due to Copyright restrictions.

The Singer Company would appear to have made the decision that only a significant improvement in machine performance should be accompanied by a significant change in machine appearance. In a promotional leaflet for model 263w100, a machine restyled by Park in 1957, Singer matched the bold visual style of the machine with equally bold claims for its performance (Figure 3-29).[60] The text of the leaflet proclaimed that the machine was, 'Now – The Finest Shoe-Upper Stitcher Available!' and emphasised that it was the, 'First In The Industry With […].'[61] Because it was all but impossible for industrial designers to reflect specific technical improvement by a change in appearance alone, a striking appearance was intended to convey the precision and modernity of a high performance tool. As Henry Dreyfuss

Addendum - Bridgeport Adoption Order 739 for Machine No. 451w25 (to be made as 451K25 at Singer, Clydebank, Scotland), authorised 7 May 1956.

[60] SMCSA, WDC, box GDWD 1/1/5, item 23 - promotional leaflet for model 263w100 published by the Singer Manufacturing Company, 1957; USPTO PatFT – U.S Patent D183,107 registered by Malcolm. S. Park on behalf of the Singer Manufacturing Company, application 26 June 1957, patent granted 24 June 1958.

[61] SMCSA, WDC, box GDWD 1/1/5, item 23 – promotional leaflet for model 263w100 published by the Singer Manufacturing Company, 1957.

observed, 'The product must express quality through unity of design […] Soundlessly, it proclaims the excellence of its concealed mechanism and the integrity of its manufacturer.'[62] An intention perfectly captured in a remark once made to Henry Dreyfuss, 'If it works as well as it looks, I'll buy it.'[63]

The Singer Company appreciated the value of combining mechanical improvement with aesthetic appearance. However, it also realised that this was only of real benefit when all who used the machine were considered. Although manufacturers invested in machinery and mechanised tools, they rarely operated or maintained them. Consequently, the trade consumer represented a complex customer profile, which the promotional leaflet for model 263w100 acknowledged. The leaflet stated:

> Why MANUFACTURERS Like It. *Better Quality Stitching. Even Plies, Improved Product Appearance* […] operating dependability minimizes maintenance, reduces costly down time.
>
> Why OPERATORS Like It. *Easy to Look At, Even Easier To Sew With!* Clean lined modern design is safer, more attractive looking […] *Fewer Service Interruptions. Better Earnings*. Improved design and construction provides dependable day-after-day operation.
>
> Why MECHANICS Like It. *Adjustments are Simple, Quick* […] More Dependable Operation, Fewer Service Problems.[64]

A striking design succeeded in drawing attention to a machine model, but the emphasis remained on performance. The inclusion on a promotional leaflet of all who could benefit from a well-designed and improved machine recognises their influence on both its engineering and its appearance.

Singer's discretionary use of industrial design to highlight improved machine performance meant that it was prepared to relinquish the homogeneity of appearance within its manufacturing range at a time when other companies were actively seeking to establish this.[65] Although the sheer number of products in its manufacturing range would have posed a significant challenge to entirely restyle, there is no evidence of any attempt to establish a new set of corporate design characteristics among the classes that were submitted for restyle. Malcolm S. Park was commissioned to restyle 22 of the 28 designs registered by the Singer Company between 1939 and 1959. And although this placed him in a unique position to impose

[62] Henry Dreyfuss, *Designing for the People*, p. 164.
[63] Ibid., p. 136.
[64] SMCSA, WDC, box GDWD 1/1/5, item 23 – promotional leaflet for model 263w100 published by the Singer Manufacturing Company, 1957.
[65] Eliot Noyes set up a department and standards of design for IBM in 1947, see John Heskett, *Industrial Design*, p. 140.

shared design characteristics, he chose to treat the design of each class separately. The result was a variety of styles in simultaneous production. This variety can be seen in the illustrations of models featured in *Singer Industrial Sewing Equipment*, which consisted of product leaflets printed between the mid-1950s and mid-1960s (Figures 3-30 and 3-31).[66] The Singer Company was, therefore, prepared to sacrifice an established and coherent design signature within its manufacturing range in order to promote the machine improvement expected by its trade customers.

Figure 3-30 (Left) Illustration of Singer model 7-33 from product leaflet, Form 19100 printed in 1962, in *Singer Industrial Sewing Equipment* (SMCSA, WDC, box GDWD 1/1/3(2)). Image removed due to Copyright restrictions.

Figure 3-31 (Right) Illustration of model 452K1 from product leaflet, Form 19100 printed in 1963, in *Singer Industrial Sewing Equipment* (SMCSA, WDC, box GDWD 1/1/3(2)). Image removed due to Copyright restrictions.

Sensitivity towards the relationships and attachments that consumers had formed with the sewing machine encouraged the Singer Company to simultaneously adopt and reject the use of industrial design to alter the appearance of its machine models. Although Singer's complex and strategic approach to industrial design disrupted the visual coherence of its model ranges, the decision to commission and adopt bold new styles continued to be driven by its ambition to create and maintain distinct product identities. The strategic use of industrial design demonstrated that although the Singer Company appreciated the attention that dynamic restyling could command, it also chose not to disregard, or underestimate, the value of familiarity and nostalgia.

Conclusion

An examination of the shape and ornamentation of Singer's sewing machine ranges reveals a complex and sophisticated approach to machine appearance that often prioritised the expectations of its customers over prevailing design style. The decision of the Singer Company

[66] SMCSA, WDC, box GDWD 1/1/3(2) – *Singer Industrial Sewing Equipment c.* 1950s-1960s.

to use the appearance of a machine to distinguish between its domestic and manufacturing machine models during the mid-nineteenth century anticipated industrial design principles by almost a hundred years. But, the decision not to relinquish the successful, although essentially nineteenth-century, design of its domestic model during the twentieth century exposed the influence of its customers' priorities over the company's design choices. The Singer Company chose to create and promote distinct product identities for its trade and domestic ranges, and in the twentieth century made strategic use of industrial design principles to maintain and strengthen these identities. Ultimately, the Singer Company used machine appearance to create product identities that recognised, and reflected, the separate physical and psychological spaces the sewing machine had come to occupy.

The attention that the Singer Company paid to the appearance of its machine models demonstrates the level of influence exerted by its customers over every aspect of machine development. However, whilst the Singer Company was responding to the expectations of its trade customers, the needle trades were responding to their own customers. Trades responded to changes in fashion, consumption patterns, and consumer taste. The significance of these to the production of stitched objects and their manufacturers meant that Singer's development of the sewing machine, as a manufacturing tool, had to be equally sensitive to these changes. A chain of influences affected the direction and scope of machine development, and this is explored more fully in the second part of the thesis. The consumption of stitched objects proved to be as important to the direction of machine development as their construction and production.

Part II

The Stitched Object, Trade Structure, and Human Skill

The process of mechanisation did not occur in a vacuum. Therefore, the second part of this thesis explores the dynamic relationships that both surrounded and influenced technological development. Stitched objects witness these relationships and provide tangible evidence of the extent of their influence. Objects capture the interplay between production and consumption, which emphasises the cultural significance of technology. An overlapping of material culture and economic analyses offers a multi-dimensional approach to machine development. One that reveals the roles that construction, trade structure, fashion, and taste played in the process of mechanisation. Furthermore, as this chain of influences is examined, the significance of the human role in the process of mechanisation becomes increasingly apparent.

Chapter 4 Construction and Style: Shirt Manufacture and the Development of the Sewing Machine

Figure 4-1 (Left) Hand stitched cotton shirt, *c*.1850s (Glasgow Museums, E.1985.659)

Figure 4-2 (Right) Machine stitched cotton shirt, *c*.1941 (Glasgow Museums, E.1975.61.18)

A hand sewn shirt made *c*.1850s (Figure 4-1) and a machine sewn shirt made *c*.1941 (Figure 4-2) share the same basic garment features, despite being made almost a century apart. The fact that these features survived for more than a hundred years (and can still be found in shirts made in 2018) demonstrates that they remained important to a shirt's construction. The preservation of these features was undoubtedly an influence on the development of the sewing machine for shirt manufacture. As Judith McGaw keenly observed, 'the intrinsic character of product and process imposed constraints on the machine builders as they had on craftsmen.'[1] Therefore, this chapter traces the construction and fashionable style of men's shirts made between 1850 and 1980 to illustrate how these influenced the technological development of the sewing machine. Focus on a single garment over a century serves to demonstrate that the features, style, and consumption of a stitched object continued to exert an influence over machine development even after its adoption.

[1] Judith A. McGaw, *Most Wonderful Machine: Mechanization and Social Change in Berkshire Paper Making, 1801-1885*, p. 57.

Because clothing manufacturers were among the first to adopt the sewing machine upon its introduction, and its use has become synonymous with garment making, any examination of the development of the sewing machine as a manufacturing tool must acknowledge its significance to the garment industry. However, because of the range and diversity among garments, this chapter will concentrate on machine development in relation to a single garment. Shirt manufacture was a thriving industry before mechanisation, and Irish shirt manufacturers were among the first to adopt the sewing machine upon its introduction in the mid-nineteenth century.[2] Consequently, an examination of shirt manufacture also permits an opportunity to observe the influence of garment construction on the development of the sewing machine from its introduction to an industry.

Despite its economic significance, the clothing industry and the machinery associated with it has not generated the same level of interest as the textile industry. Andrew Godley observed that, 'the ready-made clothing industry is, perhaps, the single most important industry in the economic history of the western world which has not yet yielded to a comprehensive academic investigation of its development.'[3] He also noted that although, 'technological developments in textiles manufacturing often appear as proxies for British economic health in standard economic histories, the industrialization of clothing is conventionally seen as the by-product of a single invention: the sewing machine'.[4] Yet, despite the significance of the sewing machine to the industrialised production of clothing, its relationship to the clothing industry has received little scrutiny beyond initial adoption and diffusion.[5] Those economic historians who have considered the production of clothing discerned little change in the dependence of the industry on the basic model of sewing machine and the cheap, often abused, labour of women as operators that

[2] For description of the Ulster linen and clothing industry, 1850-1914, see Andy Bielenberg, *Ireland and the Industrial Revolution: The Impact of the Industrial Revolution on Irish Industry* (London; New York: Routledge, 2009), pp. 42-46.
[3] Andrew Godley, 'The Development of the Clothing Industry: Technology and Fashion', *Textile History*, 28.1 (1997), 3–10 (p. 3) <https://doi.org/10.1179/004049697793711067>.
[4] Andrew Godley, 'Singer in Britain: The Diffusion of Sewing Machine Technology and Its Impact on the Clothing Industry in the United Kingdom, 1860–1905', *Textile History*, 27.1 (1996), 59–76 (p. 59) <https://doi.org/10.1179/004049696793711725>.
[5] For early adoption of the sewing machine in the clothing industry, see Philip Scranton, 'The Transition from Custom to Ready-to-Wear Clothing in Philadelphia, 1890–1930', *Textile History*, 25.2 (1994), 243–73 <https://doi.org/10.1179/004049694793711989>.; for early diffusion of the sewing machine in the clothing industry, see Andrew Godley, 'Singer in Britain', and Godley, 'The Emergence of Mass Production in the U.K. Clothing Industry', in *Restructuring within a Labour Intensive Industry: UK Clothing Industry in Transition*, ed. by Ian M. Taplin and Jonathan Winterton (Aldershot: Avebury, 1996), pp. 8-23.

accompanied it.[6] Despite the accuracy of this analysis, it only provides evidence of machine adoption: it does not reflect the development that actually occurred.

An examination of machine development in relationship to shirt manufacture and consumption can reveal that machine makers did seek opportunities to develop and promote specialised and ambitious products for the clothing industry. However, such an examination also demonstrates that any subsequent lack of adoption was not due to a lack of initiative on the part of machinery makers, but was more likely due to the complex economic conditions that existed within the clothing industry. As Michael Piore and Charles Sabel observed, 'which technologies develop and languish depends crucially on the structure of the markets for the technologies' products […].'[7] A consideration of machine development in relation to the shirt industry permits an opportunity to assess how the indecision within the industry affected the choices and decisions of machinery makers; and demonstrates that technological development does not follow a predetermined path, but must react and respond to the industry of which it is part.

The complex interaction between a garment's design and technological development is rarely considered because a focus on the cultural significance of fashion to the individual and society has overshadowed the impact of fashion delivery on technology.[8] As Adam Briggs remarked, 'the actual material object and the manner and consequences of its making are rarely foregrounded in academic studies.'[9] However, garments remain the most tangible witnesses to the relationship between clothing and technology, and can yield vital evidence of their production heritage.[10] Moreover, an examination of shirts is the only method of tracing the construction of the garment over a century of production, and relating this construction to the specialised development of the sewing machine. For this reason, object studies of shirts made between 1840 and 1980 are used to reveal how the continuity of garment construction

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[6] Katrina Honeyman, *Well Suited: A History of the Leeds Clothing Industry, 1850-1990*, Pasold Studies in Textile History, 11 (Oxford ; New York: Oxford University Press, 2000); Jonathan Zeitlin, 'The Clothing Industry in Transition: International Trends and British Response', *Textile History*, 19.2 (1988), 211–37 <https://doi.org/10.1179/004049688793700519>; Katrina Honeyman, 'Following Suit: Men, Masculinity and Gendered Practices in the Clothing Trade in Leeds, England, 1890-1940', *Gender & History*, 14.3 (2002), 426-46 <https://doi.org/10.1111/1468-0424.00276>; James A. Schmiechen, *Sweated Industries and Sweated Labor: The London Clothing Trades 1860-1914* (London: Croom Helm, 1984).

[7] Michael J. Piore and Charles F. Sabel, *The Second Industrial Divide: Possibilities for Prosperity* (New York, N.Y: Basic Books, 1984). p. 5.

[8] For a rare example, see Phyllis G. Tortora, *Dress, Fashion, and Technology: From Prehistory to the Present* (London: Bloomsbury Academic, 2015).

[9] Adam Briggs, '"Capitalism's Favourite Child" The Production of Fashion' in *Fashion Cultures: Theories, Explorations and Analysis*, ed. by Stella Bruzzi and Pamela Church Gibson, Rev. edn (London: Routledge, 2013), pp. 186-199 (p. 186).

[10] For the use of machine stitched objects to establish sewing machine adoption and diffusion, see Amy Breakwell, 'A Nation in Extremity: Sewing Machines and the American Civil War', *Textile History*, 41.sup1 (2010), 98–107 <https://doi.org/10.1179/174329510X12646114289662>.

influenced machine development over more than a century, and also to explore how changes in fashion during the 1960s created complex consumption patterns that influenced the choice of production method during the latter part of the twentieth century.

In addition to object analyses, two reports published in the early 1970s also provide a contemporary perspective on the condition of the British shirt and garment industries. The *Technology and the Garment Industry* report was undertaken by the Programmes Analysis Unit (PAU) in 1969 and published in 1971 after consultation with the Economic Development Committee for the Clothing Industry (EDC).[11] The purpose of the report was to evaluate the role of machinery in the garment industry, and information was drawn from discussions with 'garment machinery manufacturers (31 companies), garment manufacturers (30), garment industry consultants (6), garment associations (3), Research Associations (6), garment designers (2), colleges (5), fibre producers (2), and Government Departments (7).'[12] The report aimed to tackle the causes of low levels of investment in the British clothing industry, and to set up liaison groups between the Clothing EDC and representatives of sewing machine manufacturers. The initial findings of this report also prompted a second study to examine the conditions within the shirt industry.

The second report, *Shirts in the Seventies: A study of the strategic future of the United Kingdom shirt industry*, was commissioned by the EDC in 1969, and published in 1970.[13] The British industry was under threat from the import of shirts, and the object of the study was to 'specifically consider the international competitiveness of the industry', and make recommendations for both industry and government initiatives to strengthen its position.[14] The timing of the study did not allow for the collection of new data, therefore, findings and recommendations were based on information already collected from existing reputable sources.[15] The cost of the study was £16,000, and companies within the industry met 25 per cent

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[11] NEDO, *Technology and the Garment Industry: A report by the Programmes Analysis Unit on the role of machinery in the garment industry which has been made available by the Clothing EDC* (London: HMSO, 1971). The PAU was set up in 1967 to benefit the Department of Trade and Industry and the United Kingdom Atomic Energy Authority as an 'internal but independent advisory unit on the value of research and development programmes', see *Technology and the Garment Industry*, p. iv.

[12] NEDO, *Technology and the Garment Industry*, p. 4.

[13] *Shirts in the Seventies: A Study of the Strategic Future of the United Kingdom Shirt Industry* ed. by W. S. Atkins and Partners and the National Economic Development Office (NEDO) for the EDC (London: HMSO, 1970). The EDC was an independent, publicly financed body comprised from representatives from management, trade unions, and government.

[14] NEDO, *Shirts in the Seventies*, p. vii.

[15] The study was compiled from data acquired from the Ministry of Technology Business Monitor, HM Customs and Excise returns on imports and exports, the National Board for Prices and Incomes report on Pay and Conditions in the Clothing Manufacturing Industries, and the Department of Employment. Information was also gathered from the Shirt, Collar and Tie Manufacturers Federation, the National

of this cost. The Singer Company is listed as one of only two machinery companies to contribute to the cost of the study, and both reports acknowledged that the Singer Company was the dominant supplier of sewing machines to the British shirt and garment industries.

The chapter is divided into two sections. The first section focuses on the influence of garment construction upon the technological development of the sewing machine. It begins with a comparison of shirts made between 1850 and 1950 to illustrate that features found in a hand sewn garment survived the introduction and adoption of the sewing machine for more than a century. These object studies are then followed by an examination of how the stability of the garment's construction influenced machine development and culminated in the production of automated stitching units during the second half of the twentieth century. The second section focuses on how fashion influenced the consumption and production of shirts during the 1960s and 1970s, and the effects of changes in fashion to the course of model development that Singer chose to pursue. It concentrates on the radical changes that occurred in men's fashion during the 1960s and compares boutique shirts with high street shirts. This comparison illustrates how changes in fashion were interpreted and absorbed by large retailers, and the implications of this for the direction of machine development.

The Influence of Shirt Construction on Machine Development

Seams

The enclosed seam is one of the most distinctive features found in a mid-nineteenth century shirt. They were used because the seams of a shirt had to remain strong if the garment was to survive the constant friction associated with washing and wearing. If the raw edges of fabric in a seam allowance are left exposed, they unravel quickly and weaken the integrity of the garment. For this reason, mid-nineteenth century shirt makers chose to use seams that enclosed the raw edges of fabric. For additional strength, the seam allowance was also stitched securely to the garment which created a visible line of stitching on both the interior and exterior of the shirt. A printed cotton shirt (E.1985.69.9 GM) stitched by hand *c*.1850-1860 provides an example of a robust enclosed seam with the seam allowance slip stitched to the garment (Figure 4-3).

Union of Tailors and Garment Workers, the Shirt Federation of Northern Ireland, and the Clothing and Textile Institutes.

The introduction and adoption of the sewing machine did not eradicate the need for seams to be robust. Consequently, shirt makers had no reason to abandon existing methods of construction. Although a linen shirt (E.1992.6.19 GM) made *c*.1890-1900 has only simple machine sewn seams, the seam allowance has been stitched down securely for added strength (Figures 4-4 and 4-5). By the turn of the century, however, manufacturers had adopted a top stitched enclosed seam, as can be seen in a white cotton dress shirt (1968.470 NMS) made *c*.1900-1910 by the Scottish Co-operative Wholesale Society (Figure 4-6).[16] This cotton dress shirt and a blue woven shirt with a Utility label (E.1975.61.18 GM) made in 1941 also show that shirt manufacturers had begun to use two parallel lines of top stitching over enclosed seams (Figure 4-7). The necessity of stitching these seams at least twice certainly made the shirts more robust, but it also represented a labour intensive method of production, whether by hand or machine.

Figure 4-3 Enclosed seam stitched down on interior of sleeve, hand sewn shirt *c*.1850 (Glasgow Museums, E.1985.659)

[16] S. C. W. S. is on the label of the shirt, and this organisation, the Scottish Co-Operative Wholesale Society, was set up in the West of Scotland in 1868 for the production and supply of goods to local Co-Operative Societies.

Figure 4-4 (Left) Visible line of top stitching on exterior of machine stitched shirt, *c*.1890s (Glasgow Museums, E.1992.6.19)

Figure 4-5 (Right) Detail of machine stitched seam with line of machine top stitching catching down seam allowance on interior of shirt, *c*.1890 (Glasgow Museums, E.1992.6.19)

Figure 4-6 (Left) Machine stitched white cotton dress shirt, with top stitched seams *c*.1900-1910 (NMS, 1968.470)

Figure 4-7 (Right) Machine stitched striped shirt with Utility label, with top stitched seams, 1941 (Glasgow Museums, E.1975.61.18)

Figure 4-8 Hand stitched cotton shirt with two part collar attached and top stitching around collar edge, *c*.1850 (Glasgow Museums, E.1985.659)

Figure 4-9 Machine stitched cotton dress shirt with separate collar, c.1900-1910 (NMS, 1966.864)

Figure 4-10 Detail of top stitching on machine stitched collar, 1941 (Glasgow Museums, E.1192.7.1c)

Figure 4-11 (Left) Linen shirt with visible top stitching by machine attaching stand to neck of shirt, *c*.1890s (Glasgow Museums, E.1992.6.19)

Figure 4-12 (Right) Linen shirt with slip stitching by hand on interior of collar stand, *c*. 1890s (Glasgow Museums, E.1992.6.19)

Collar

By the mid-nineteenth century, a shirt collar consisted of two parts: the shaped collar visible around the neck of the garment, and the stand, or band, into which it was set (Figure 4-8). Although the shape and size of the collar underwent modest fashionable changes during the nineteenth and twentieth centuries, its two part construction remained unaltered. The shaped collar was constructed from two identical fabric pieces stitched together right side to right side, with the long, straight edge left open. It was then turned through to place the seam allowances on the inside and pressed flat. The stand of the collar was made in a similar way except both the long edges were left open. The shaped collar was inserted into the top edge of the stand, and the neck of the shirt was inserted into the bottom edge thereby joining the collar to the garment. The most significant change by the last quarter of the nineteenth century was the increased use of a detachable collar, which lessened the need to launder the entire garment so frequently. And by the close of the nineteenth century, most shirts were made with only a collar stand to which a separate collar could be attached (Figure 4-9).

A visible line of stitches can be seen close to the collar edge of the mid-nineteenth century hand sewn shirt (E.1985.69.9 GM), and although this contributed a decorative appearance to the garment its function was entirely practical (Figure 4-8). In order to prevent the collar edges from rolling during washing, a line of stitches was made through both layers to hold them securely together and make the collar significantly easier to press. Separate shirt collars made during the first half of the twentieth century continued to be top stitched for the same practical reasons (Figure 4-10). Top stitching by machine also became a quick and practical, albeit more visible, way of attaching a stand to either the neck of the garment or to the separate collar. The collar stand of a linen shirt (E.1992.6.19 GM) made *c*.1890-1900 shows the use of both machine stitches and discreet slip stitches by hand to join the collar (Figures 4-11 and 4-12). Despite the decorative possibilities of a top stitch, shirt manufacturers exploited it primarily for practical reasons.

Cuffs

A mid-nineteenth century hand sewn shirt cuff was constructed in exactly the same way as a collar, and top stitching was used for the same practical rather than decorative purpose (Figure 4-13). By the close of the century, however, a stand for the cuff was abandoned, and instead the cuff was attached directly to the sleeve, as this example of a linen shirt (E.1992.6.19 GM) made *c*.1890-1900 illustrates (Figure 4-14). By the first half of the twentieth century, cuffs could be either single or double length and closed with either buttons or cuff links (Figures 4-15 and 4-16). Like collars, cuffs also underwent modest fashionable changes of shape and length, and could also be made up and attached separately.

Figure 4-13 Hand stitched shirt with top stitched cuff, slip stitched to sleeve, *c*.1850s (Glasgow Museums, E.1985.659)

Figure 4-14 Linen shirt with machine stitched cuff, *c*. 1890s (Glasgow Museums, E.1992.6.19)

Figure 4-15 (Left) Machine stitched white cotton dress shirt with top stitched single cuff, *c*.1900-1910 (NMS, 1968.469)

Figure 4-16 (Right) Machine stitched cotton shirt with top stitched double cuff, 1941(Glasgow Museums, E.1975.61.18)

Yoke

During the mid-nineteenth century, the shirt became more tailored with the addition of a yoke across the shoulders of the garment. Prior to this, the shirt had been an unstructured and voluminous garment, and the purpose of the yoke was to control the volume so that it sat more easily and comfortably beneath a tailored jacket.[17] The yoke consisted of two layers of fabric, and the fullness of the back was either gathered or pleated and then sandwiched between these two layers. Moreover, because the yoke pieces were flat it made it much easier to attach the collar stand. The hand sewn shirt made *c*.1850 shows the addition of a yoke across the shoulders of the garment, with the volume of the back gathered into it (Figure 4-17). The double layer of fabric also provided additional strength to the garment. This was particularly useful if there was no fullness in the back of the shirt, as this late nineteenth-century linen shirt illustrates (Figure 4-18). By the first half of the twentieth century the volume of fabric in a shirt back had been significantly reduced and was generally pleated rather than gathered into the yoke (Figures 4-19 and 4-20).

[17] Despite their volume, shirts made from fine, lightweight linen still sat unobtrusively beneath the close fitting jackets of the early nineteenth century.

Figure 4-17 Hand stitched cotton shirt with fullness of the back gathered into the yoke, *c*.1850 (Glasgow Museums, E.1985.659)

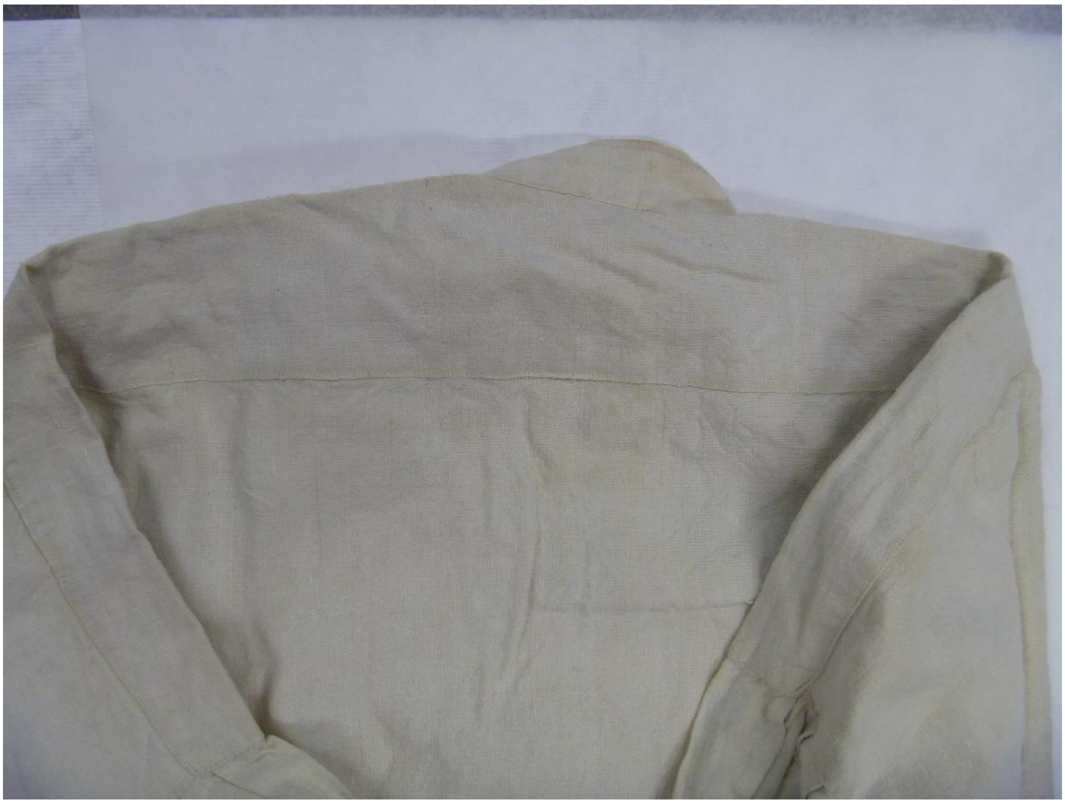


Figure 4-18 Machine stitched linen shirt, yoke provides additional strength across the shoulder particularly when there is no fullness in the back of the shirt, *c*.1890s (Glasgow Museums, E.1992.6.19)

Figure 4-19 (Left) Machine stitched shirt with fullness of back pleated into yoke, *c*.1890-1900 (NMS, K.2006.228)

Figure 4-20 (Right) Machine stitched shirt with fullness of back pleated into yoke, 1941 (Glasgow Museums, E.1975.61.18)

Front Facing

The opening of the left shirt front needed to be particularly robust because it supported buttonholes. It could be simply turned back and stitched, like the right side, but to provide additional support and a neater finish a facing would be added. A facing consisted of a narrow strip of fabric that was folded around the edge of the shirt front and completely enclosed the raw edge of the garment (Figure 4-21). And although the hand sewn shirt only opens partially, the front opening has been faced (Figure 4-22). The visible lines of top stitching, like those found on the collar and cuffs, were also used for practical purposes. The facing, as well as adding strength and additional layers of support to the garment front, also provided a neat decorative finish and continued to be used by manufacturers throughout the twentieth century (Figures 4-23 to 4-25).

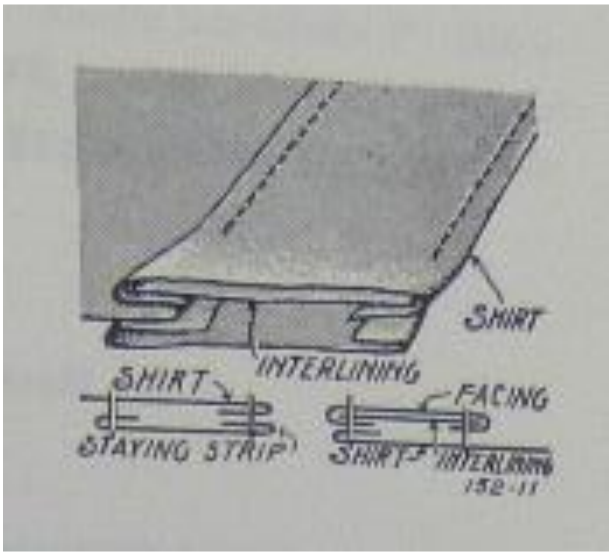


Figure 4-21 Illustration of shirt front facing

Figure 4-22 (Top left) Front facing on hand stitched shirt, *c*.1850s (Glasgow Museums, E.1985.659)

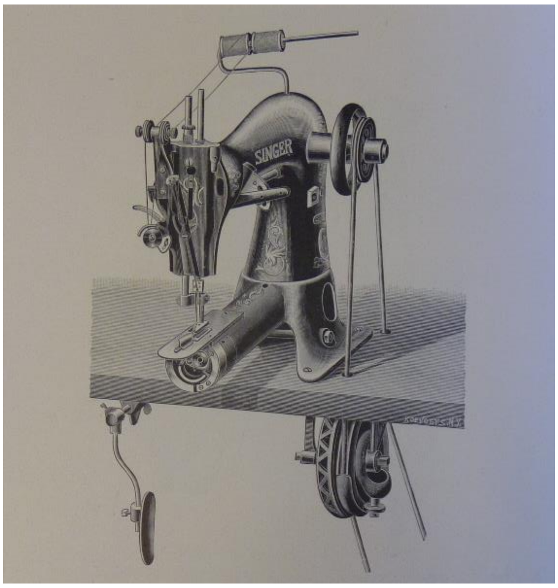
Figure 4-23 (Top right) Front facing on machine stitched linen shirt, *c*.1890s (Glasgow Museums, E.1992.6.19)

Figure 4-24 (Top left) Front facing on machine stitched white cotton dress shirt, *c*.1900-1910 (NMS, 1968.469)

Figure 4-25 (Top right) Front facing on machine stitched Utility label cotton shirt, 1941 (Glasgow Museums, E.1975.61.18)

Although it is difficult to establish whether these examples of nineteenth-century shirts were made in commercial or domestic circumstances, the fact that that the features found in a mid-nineteenth century hand sewn garment survived, essentially unaltered, for more than a century emphasises their practical significance to the garment, irrespective of its place or method of production. Moreover, the presence of these features in a shirt made under the Utility label in 1941 demonstrates their practical value, as the purpose of Utility production was the rationalisation of design through the removal of all superfluous detail in order to maximise the use of materials and production methods.

Machine Adaption and Specialisation



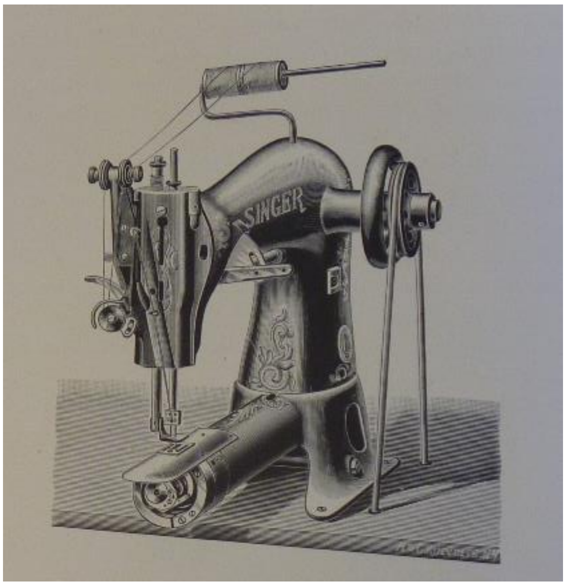
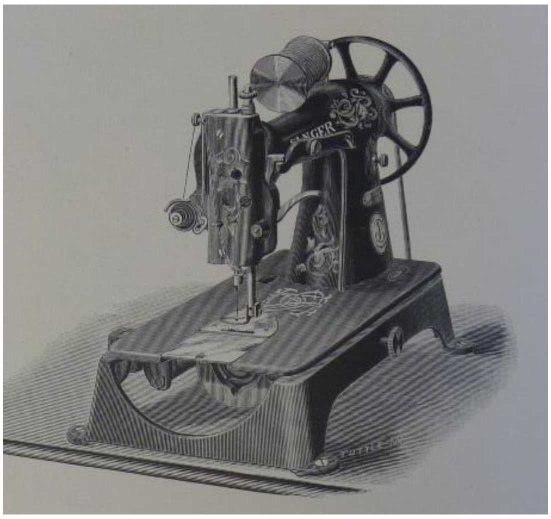


Figure 4-26 (Left) Machine model 19-16 with felling attachment and barrel arm, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

Figure 4-27 (Right) Model 19-5 with twin needles and barrel arm, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

The stability of the shirt's construction over a century encouraged the Singer Company to introduce specialised models for the garment's production by the close of the nineteenth century. The striking modifications that Singer made to machines reflected the continued influence of the shirt's construction on machine development. An illustrated catalogue published by Singer in 1896 features models 19-16 and 19-5, both modified to stitch the enclosed seams that were integral to the construction of a shirt. Model 19-16 was supplied with a felling attachment, which encouraged the seam allowance to roll under and become enclosed. Model 19-5 was fitted with twin needles, which made it quicker and easier to produce the two parallel lines of top stitching commonly found on shirt seams for added strength (Figures 4-26 and 4-27).[18] However, what made these machines most innovative was not the addition of attachments or twin needles, which Singer had made available on earlier models, but rather, it was the shape and orientation of the machine. Both models had cylindrical arms 16 ½ inches long that had been turned to face the operator. The repositioning of this long barrel arm made it significantly easier, and more efficient, to stitch the enclosed seams in tubular shapes like the sleeves of shirts.

The repositioning of the machine head was also effectively used for another model featured in the 1896 catalogue, but on this occasion to accommodate the distinctive shape and construction of collars and cuffs. Although model 15-42 still had the familiar flatbed associated with most machines, the head of the machine had been turned to face the operator (Figure 4-28). The repositioning of the head was also cleverly combined with a change in stitch direction that took into consideration the long narrow shapes of collars and cuffs. Instead of stitching away from the body of the operator at a right angle, model 15-42 stitched from left to right, parallel to the body of the operator. The ingenious combination of repositioning the head and changing the direction of stitching was inspired by the specific shape and construction of these garment pieces.



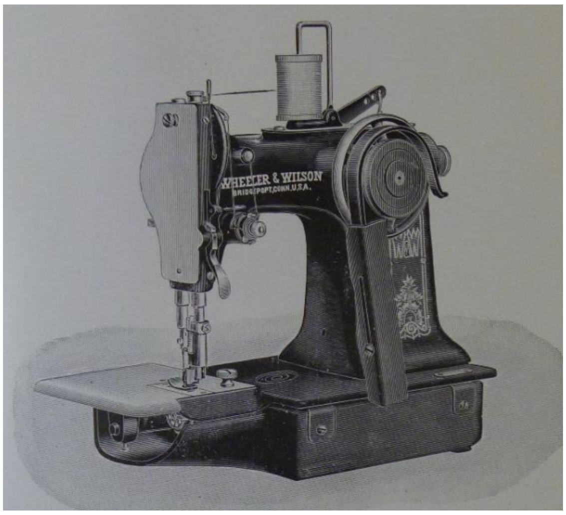


Figure 4-28 (Left) Model 15-42 stitches from left to right and machine head faces operator, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

Figure 4-29 (Right) Model 65w2 for the construction of collars and cuff, *Catalogue of Singer Sewing Machines* 1896 (NMAH Library)

These modifications of machine models not only reflected the willingness of the Singer Company to adapt models to specific types of manufacture, they also provide evidence of the knowledge that Singer had gained about garment construction. Models featured in an illustrated catalogue published by Singer in 1908 fully demonstrate the depth of this knowledge. Models

[18] NMAH Library, *Catalogue of Singer Sewing Machines* 1896, pp. 148-149.

65w2 and 65w5 shared similar features to model 15-42, in that the position of the machine head and the direction of stitching had been specifically altered to accommodate the construction of collars and cuffs (Figure 4-29).[19] However, in addition to these models suitable for general production, the catalogue also included machines designed for precise stages of production. Model 108w1 (Figure 4-31) was described as suitable for 'plain sewing and close edge stitching on collars and cuffs etc. Especially adapted for two or more pieces of material of equal length without puckering'; and model 108w2 was described as suitable for 'inserting the body of a collar within the collar band.'[20] The ability of the company to not only accurately distinguish between these two processes of production, but also its decision to adapt machines accordingly demonstrates the level of influence that garment construction had on machine development.

The level of sophistication and precision that machines intended for shirt production had attained by the turn of the century was almost certainly due to the industry's early adoption of the sewing machine. The Irish shirt industry was among the first British garment trades to recognise the potential of the sewing machine and adopted it in 1856, a full decade before its diffusion among the significantly more developed garment trades of London.[21] The production of shirts was established in Ireland in 1831, twenty years before the invention of the sewing machine, and the trade benefitted from the skills and labour of women previously involved in the local linen industry.[22] The production of shirts and collars relied on close links with manufacturers and distributors from the British mainland, particularly Glasgow, and by 1856, fourteen factories and agencies had been set up in Londonderry.[23] By 1889 Derry was producing 3.8 million shirts and 7.5 million collars and cuffs for export to the United Kingdom and the British Empire.[24] By the close of the nineteenth century the Irish industry employed 62,000 outworkers and 18,000 factory workers.[25]

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[19] SMCSA, WDC, box GDWD 1/1/3(2) – *Singer Sewing Machines Manufactured at Bridgeport, Connecticut* ([n.p.] Singer Manufacturing Company, 1908), p. 183. In 1905 Singer had acquired one of its main rivals, Wheeler and Wilson, and although these models are featured in a catalogue published by the Singer Company, the majority of models in this catalogue were originally designed by Wheeler and Wilson.
[20] SMCSA, WDC, box GDWD 1/1/3(2) – *Singer Sewing Machines Manufactured at Bridgeport* 1908, p. 202.
[21] Brenda Collins, 'The Organization of Sewing Outwork in Late Nineteenth-Century Ulster', in *Markets and Manufacture in Early Industrial Europe*, ed. by Maxine Berg (London: Routledge, 1991), pp. 139-156 (pp. 148-149).
[22] For employment of outworkers from the linen industry, see Brenda Collins, 'The Organization of Sewing Outwork in Late Nineteenth-Century Ulster'; and K. J. James, 'Handicraft, Mass Manufacture and Rural Female Labour: Industrial Work in North-West Ireland, 1890–1914', *Rural History*, 17.1 (2006), 47–63 <https://doi.org/10.1017/S0956793305001597>.
[23] Andy Bielenberg, *Ireland and the Industrial Revolution*, p. 45.
[24] Ibid., p. 45.
[25] Ibid., p. 45.

Figure 4-30 Derry workroom, *c*.1910. Model 108w1 is the machine in the foreground to the left (Image courtesy of Tower Museum, Derry City Council). Image removed due to Copyright restrictions.

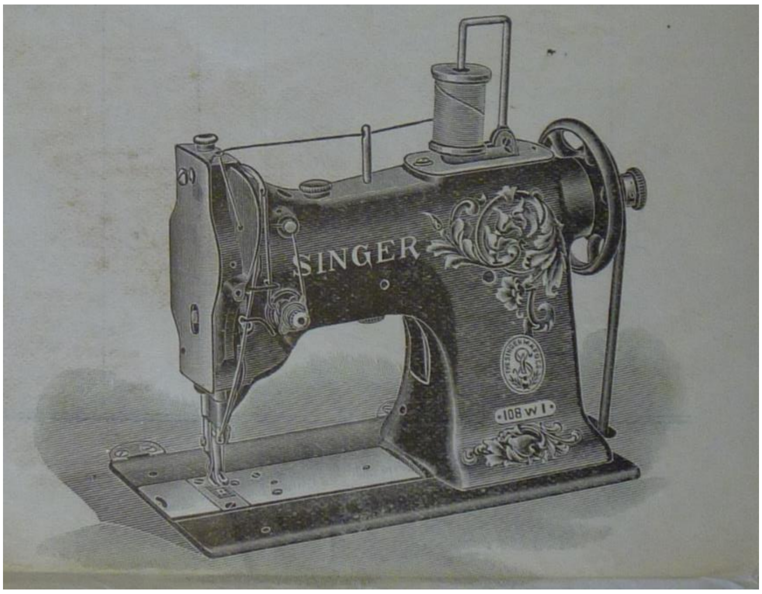

Figure 4-31 Model 108w1 specifically adapted for the stitching of collars, *Singer Sewing Machines Manufactured at Bridgeport* 1908 (SMCSA, WDC, box GDWD 1/1/3(2))

Fast, specialised machines, however, really only provided profitable advantage to factory production. Evidence given to a Committee considering the application of the National Insurance Act to Irish outworkers in 1912 stated that the number of outworkers involved in the industry had dropped due to the introduction and adoption of these specialised machines in factories.[26] Models in class 65 and 108 could run at speeds of 3000 stitches per minute, which encouraged shirt manufacturers to harness the power that only factories could provide. The distinctive silhouette of model 108w1, which specialised in collar construction, can clearly be seen in a photograph of a Derry factory workroom taken *c*.1910 (Figure 4-30). However, outworkers manufactured the bulk of British clothing during the nineteenth and early twentieth centuries, and these garment workers depended on the flexibility of a basic sewing machine model. Although specialised models represented creative mechanical solutions and improved production efficiency, their task specificity made them less suitable options for outworkers.

As the twentieth century progressed, garment production in factories overtook production by outworkers, and Singer's development and promotion of machines reflected this. A separate index of machines published by Singer in 1928 included a range of models suitable for the production of a variety of items, including shirts.[27] It divided shirt making into several detailed tasks and accompanied each task with a recommended model and an estimate of how long it would take to complete the task with a specified machine. For example, the company estimated that model 108w2, which was specifically developed 'for inserting and stitching double collar bands', could stitch a dozen collars in twenty minutes; and model 112w120, which was specifically developed for attaching shirt sleeves, could attach a dozen sleeves in ten minutes.[28] By offering precise and timed descriptions of specific stages of shirt manufacture, Singer was both demonstrating its knowledge of factory production and deliberately relating garment construction to production levels within that environment.

The level of descriptive detail contained in the index published in 1928 provides evidence of the impressive depth of knowledge that the Singer Company had attained about shirt construction. It also reveals the stability of the garment's construction since the introduction of the sewing machine. The detailed descriptions of tasks in the index demonstrate that Singer not only understood the sequence of tasks involved in shirt making, including those that did not require a sewing machine, but could also distinguish between different types of seam. The manual descriptions separately itemised seaming a shirt, joining a shirt front to a shirt back, and even

[26] Report of the Committee Appointed to Consider and Advise with regard to the Application of the National Insurance Act to Outworkers in Ireland, vol. II, [Cd. 7678], HC 1914-16, vol. xxxi, referenced in K. J. James, 'Handicraft, Mass Manufacture and Rural Female Labour', p. 61.
[27] SMCSA, WDC, box GDWD 1/1/5, item 28: *Singer Sewing Machines Recommended for Use in Various Industries* 1928.
[28] Ibid., p. 85.

'attaching yoke to back body.'[29] This level of familiarity with shirt construction continued to stimulate the production and development of specialised machine models. In 1962 Singer promoted model 152-11 with fittings specifically for 'stitching facings, bluff centres and button stays on men's shirts […] speed up to 4000 [stitches per minute], depending on material and operation performed'.[30] A century earlier the opening of a hand sewn shirt had been strengthened with a facing, and its continued use by shirt makers along with Singer's awareness of this fact had inspired this specialised machine adaption.

Automated Stitching Units

Although the stability of the shirt's construction for more than a century had encouraged Singer to adapt machines for specialised tasks, only the stability of a garment's construction combined with volume production would prompt Singer to develop automated stitching units in the mid-twentieth century. During the late 1950s, Singer began to experiment with units that combined a sewing machine model with electronic devices to guide garment pieces, which in effect replaced the guidance of the human hand. This combination of Singer's mechanical and electronic capabilities represented a significant development in both machine technology and garment production for the period. However, in order to offset the risk of developing such specialised machinery, Singer, initially, concentrated on units that would have applications for several garments.[31] By the 1970s, the report, *Technology and the Garment Industry,* could state that the machine industry was moving 'cautiously' towards an operator able to tend two or three machines, but noted that to achieve this would require considerable technological development.[32]

Because Singer had gained enough familiarity with the construction of a shirt by the mid-twentieth century, it was able to combine what it could mechanically achieve with what it considered would be of the most productive benefit to the shirt manufacturer. In the 1970s Singer introduced an Automatic Profile Stitcher, the Formatic 2501-1 (Figure 4-32).[33] This unit was suitable for the production of collars and cuffs and was described as:

> a simple means of sewing intricate shapes accurately and at the same time giving the facility of making quick changes for size and style. The operator has only to learn to

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[29] Ibid., p. 83.

[30] SMCSA, WDC, box GDWD 1/1/3(2) – *Singer Industrial Sewing Equipment c.* 1950s-1960s, Form 19100-Elizabeth Section, Machines of Class 152. Although this form is dated June 1962, the form states that it replaces a Form 19100 printed in September 1956, which suggests an earlier date for the model's introduction.

[31] In 1959 Singer introduced a Sequential Buttonholing Unit, model 256w1, see Chapter One for description of this machine model and its introduction.

[32] NEDO, *Technology and the Garment Industry,* p. 10.

[33] SMCSA, WDC, box GDWD 1/1/3(2) - *Industrial Sewing Catalog, c.* 1978, un-numbered.

> place the materials in the tracker with the desired accuracy and to understand the simple controls and threading procedures. Training time is, therefore, minimal.[34]

The Formatic 2501-1 used plastic profiles to hold the garment pieces in place and an electronic system to guide them beneath the needle of the machine. According to the *Technology and the Garment Industry* report, automatic profile stitching had been a preoccupation of clothing machinery makers for some time and the Formatic 2501-1 represented Singer's contribution to the market.[35]

Singer also used its knowledge of shirt construction to identify the joining of shirt backs to yokes as a suitable process to be automated. And in the 1970s Singer introduced a Shirt Yoke Seaming Unit, model 5910-2 (Figure 4-33).[36] Unlike previous units, the sole application for model 5910-2 was the production of shirts. The unit could sew straight or curved yokes up to twenty-two inches in length, in a variety of materials. Once the operator had sandwiched the shirt back between the two yokes, 'all that is now required is a press of the button to start the fully automatic cycle – clamping of work, sewing, chain cutting and stacking […] the operator […] can of course start to make up the next yoke assembly […].'[37] The programmable device could be altered for different styles in less than five minutes, and the catalogue claimed that under factory conditions this unit with a single operator could produce between 180 and 200 dozen shirt backs in an eight hour day. Furthermore, the company stressed that 'the sewn yokes from the Singer 5910-2 present a fine flat appearance which distinguishes the highest quality garment.'[38] Singer had succeeded in developing high performance machines that did not compromise quality.

Because the shirt had to be a robust garment, its construction remained relatively unchanged for more than a century. The stability of the shirt's construction encouraged Singer to develop task specific machines for its production, which led to the development of automated stitching units by the last quarter of the twentieth century. However, although the construction of the shirt remained relatively stable, fashion did not. The shirt was not immune to changes in style and material, and these changes had consequences for both the shirt industry and those who supplied the industry with specialised manufacturing tools.

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[34] Ibid.

[35] The report mentioned a range of automatic profile stitchers that varied in sophistication and included the Sewprima, which sandwiched garment pieces between two layers of shaped Perspex and then required the Perspex profile to be manipulated beneath the needle by a machinist; the Trumatic profile stitcher produced by Trubenised (Sales) Ltd., worked on the same principles as the Singer model, see *Technology and the Garment Industry*, pp. 95-98.

[36] SMCSA, WDC, box GDWD 1/1/3(2) - *Industrial Sewing Catalog, c.* 1978, un-numbered.

[37] Ibid.

[38] Ibid.

Figure 4-32 Automatic Profile Stitcher-Formatic 2501-1, electronically guided system with a selection of Perspex profiles, *Industrial Sewing Catalog*, *c*. 1978 (SMCSA, WDC, box GDWD 1/13(2)). Images removed due to Copyright restrictions.

Figure 4-33 Shirt Yoke Seaming Unit 5910-2, automatic sitching unit with illustrations of it in use with operator, *Industrial Sewing Catalog c*.1978 (SMCSA, WDC, box GDWD 1/1/3(2)). Images removed due to Copyright restrictions.

The Influence of Fashion

What makes clothing fashionable can be quixotic and unpredictable. Unlike the construction of a garment, the construction of fashion has no mechanical solution. Changes in fashion created complex and shifting consumption patterns that required flexible approaches to production from garment manufacturers. This diversity of product range and style created a difficult market for any clothing machinery maker. Once manufacturers and retailers were aware that any improvement in style gave their products an advantage in a competitive market, this pursuit of fashionable style influenced machinery makers in two distinctive ways. First, fashionable ideas from boutique garments were absorbed by the high street retailers, which had an immediate impact on production and existing machine technologies. Secondly, the need for manufacturers to be able to respond quickly to new trends required a balance between productivity and flexibility, which influenced the direction of machine development. Singer was acknowledged as the dominant supplier of machines to both the shirt industry and the garment industry. Therefore, this section considers how Singer approached machine development for this complicated production environment. It offers a view of the shirt industry from the perspective of the machinery maker, and provides an insight into the complex relationship between consumption and production.

Although men's clothing appeared conservative during much of the nineteenth and twentieth centuries, this did not imply that men were disinterested in either fashion or their appearance. [39] Men's clothing reflected society's perception of male identity, and as Tim Edwards noted, 'men's fashion is indeed something to take seriously in itself, and as a microcosm of the macrocosm of men, masculinity and society.'[40] The shirt had been a ubiquitous male garment for centuries, and had become a garment that communicated the class and occupation of its wearer.[41] In the shifting work and leisure patterns of the nineteenth and twentieth centuries the

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[39] For an overview of the relationship between masculinity and fashion prior to the nineteenth century, see 'Part I: A Brief History of Men's Fashion' in *Men's Fashion Reader*, ed. by Peter McNeil and Vicki Karaminas (Oxford: Berg, 2009); for an examination of male attitudes towards, and perceptions of fashion during the late nineteenth century, see Christopher Breward, *The Hidden Consumer: Maxculinities, Fashion and City Life 1860-1914* (Manchester: Manchester University Press, 1999); for a consideration of the subtle implications of colour in male clothing, see John Harvey, *Men in Black* (London: Reaktion Books, 1995); for a discussion of the relationship between the male consumption of fashion and the creation of gender identity, see Laura Ugolini, *Men and Menswear: Sartorial Consumption in Britain* (Aldershot: Ashgate, 2007).

[40] Tim Edwards, *Men in the Mirror: Men's Fashion, Masculinity and Consumer Society* (London: Cassell, 1997), p. 3.

[41] The quality of the fabric and the making of the shirt, rather than its unchanging style signified the class of the wearer. For an overview of the history of the shirt, see Penelope Byrde, *The Male Image: Men's Fashion in Britain, 1300-1970* (London: B.T. Batsford, 1979), pp. 97–110.

shirt provided tangible evidence of a man's position in society. [42] However, as the result of significant economic and social change, the mid-twentieth century saw a radical transformation of fashion that could not have been predicted.[43] An unprecedented fusion of youth culture and sub-culture stimulated the creation of boutiques that provided highly original garments for an exclusively young consumer.[44] These garments did not aspire to signal class or occupation but were instead a means of self-expression that dramatically articulated the preferences of the individual.

The Boutique Shirt

The first example of this radical change in style is a synthetic silver lamé shirt (E.1984.116.42 GM) made and sold by Paul's Boutique on Carnaby Street in London during the late 1960s (Figures 4-34 and 4-35).[45] A zip fastening at the back of the shirt replaces the familiar buttoned front opening present in earlier shirts, and a simple rolled collar replaces the two piece collar. The only recognisable feature from earlier shirts is the top stitched double cuff, with button holes for cufflinks. The seams of the lamé shirt are also treated very differently. Instead of seams enclosing raw edges for neatness and strength, the raw edges of the lamé shirt remain visible and an overlocking, or overseaming, stitch is used to prevent fraying (Figure 4-36). Both the construction and style of the lamé shirt display significant differences from earlier shirts.

The boutique shirt privileged originality over practicality and its style was intended to be immediate and fleeting. Unlike earlier shirts, which were designed to denote class and occupation, the boutique shirt was designed as a mode of individual personal expression. Its style drew upon popular cultural references for inspiration. The simple styling of this boutique shirt and the choice of silver lamé suggests the contemporary interest in space travel. The original series of Star Trek was broadcast between 1966 and 1969; Stanley Kubrick's influential

[42] For an excellent analysis of the changing cultural significance of the collar, see Carole Turbin, 'Fashioning the American Man: The Arrow Collar Man, 1907-1931', in *Material Strategies: Dress and Gender in Historical Perspective*, ed. Barbara Burman and Carole Turbin (Oxford: Blackwell, 2003), pp. 100-121.
[43] Christopher Breward, *Fashioning London: Clothing and the Modern Metropolis* (Oxford ; New York, N.Y: Berg, 2004), pp. 125–48; Mark P. Donnelly, *Sixties Britain: Culture, Society, and Politics* (Harlow, England ; New York: Pearson Longman, 2005), pp. 28–47.
[44] Colin Campbell, 'Beatniks, Moral Crusaders, Delinquent Teenagers and Hippies: Accounting for the Counterculture' in *The Permissive Society and its Enemies*, ed. by Marcus Collins (London: Rivers Oram Press, 2007), pp. 97-111.
[45] The label has two addresses, and according to the collector and Sotheby's auctioneer, Richard Lester, Nathan and Susie Spiegel opened Paul's Boutique at 47 Carnaby Street in London in 1959 and added a second branch during the late 1960s, see Richard Lester, *Boutique London. A History: King's Road to Carnaby Street* (Woodbridge: ACC Editions, 2010), p. 29.

film *2001: A Space Odyssey* was released in 1969; and in the same year, the first moon walk captured the public's imagination.

Figure 4-34 Silver lamé shirt, with rolled collar and double cuffs, *c*.1960s (Glasgow Museums, E.1984.116.42)

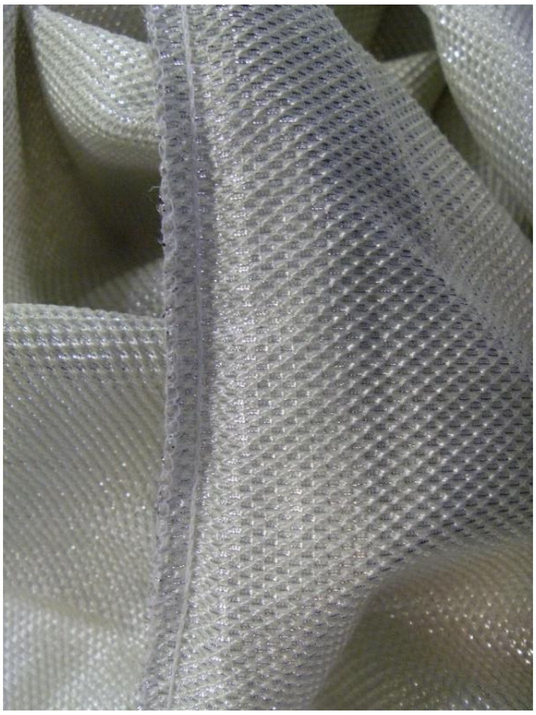

Figure 4-35 (Left) Label and detail of zip on back of shirt (Glasgow Museums, E.1984.116.42)

Figure 4-36 (Right) Detail of overlocking stitch on shirt seam (Glasgow Museums, E.1984.116.42)

Figure 4-37 (Left) Floral patterned cotton boutique shirt, with a loose fitting silhouette and raglan sleeves, *c*.1960s (Glasgow Museums, E.1984.116.41)

Figure 4-38 (Right) Characteristic shirt cuff but closed with press studs (Glasgow Museums, E.1984.116.41)

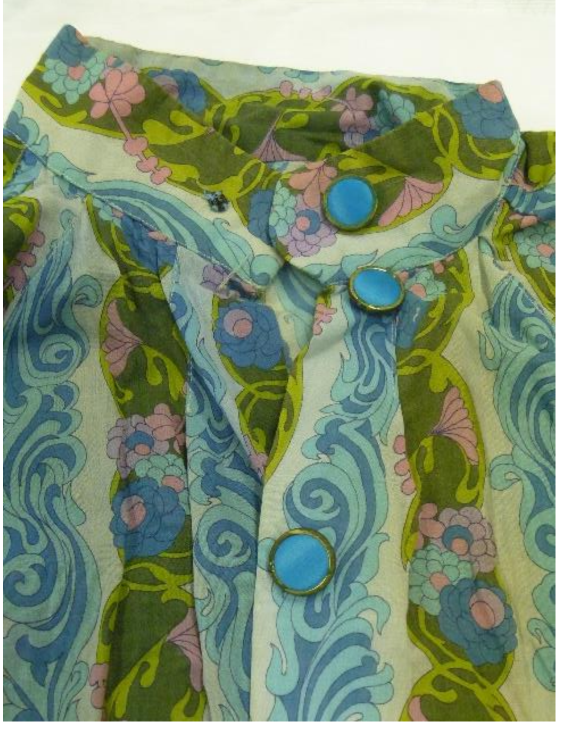

Figure 4-39 (Left) The fullness of the garment is gathered into a simple band at the neck closed and closed with press studs, decorative buttons on neck front, collar, and cuffs (Glasgow Museums, E.1984.116.41)

Figure 4-40 (Right) Simple overlocked seams instead of an enclosed seams (Glasgow Museums, E.1984.116.41)

Silver lamé projected the glamorous ideal of space travel and represented a highly original and distinctive choice of fabric for a shirt. However, it also proved a supremely impractical choice of fabric for any garment that required laundering, as lamé tarnishes easily with any application of heat or friction. Despite the brief fashionable relevance of the shirt's design and the frailty of its fabric, the retail prices of men's shirts in Paul's Boutique during the mid-1960s exceeded 49 shillings.[46] The high cost of the garment demonstrated that customers seeking distinctive, fashionable products were prepared to pay for vibrant originality.

The second example, which illustrates the radical change of style that boutiques promoted, is a bold floral patterned shirt (E.1984.116.41 GM) also made during the 1960s. The silhouette of the patterned shirt varies significantly from earlier shirts (Figure 4-37), and overlocking replaces the enclosed seam (Figures 4-40). It has raglan sleeves, which slope away from the body, and the fullness in the body of the garment is not gathered into a yoke but is instead gathered into two simple bands, one at the neck, which replaces the two piece collar, and another around the hem of the shirt. Although the shirt has the front opening and cuffs associated with earlier shirts, these are closed with press studs (Figures 4-38 and 4-39). The gilt and turquoise plastic buttons are decorative rather than functional. One of the most original features of this shirt is the use of a bold stylised floral print. Stripes, checks, and geometric patterning had been used for shirting fabric at various points during the nineteenth and twentieth centuries, but the mid-twentieth century saw the first adoption of floral patterns for men's shirts.[47] Boutique fashion was distinguished not only by original garment silhouettes but also by audacious fabric choices.

The originality of boutique fashion relied on versatile and flexible production methods. Although both the lamé shirt and the floral patterned shirt were produced during the same decade and differed greatly from earlier shirt styles, they were also markedly different from each other. The originality of their design was the product of fashionable creativity rather than efficient garment production. The production of these garments relied upon direct interaction with customers and quick, intuitive responses from boutique owners. In 1967, Mary Quant observed, 'the secret of successful designing is to anticipate changes in mood before they happen'.[48] The delivery schedules associated with ordering samples from representatives of larger manufacturers was abandoned in favour of an almost guerrilla approach to manufacture and retail. Boutiques created small, limited ranges so that their stock was constantly changing and updating. Mary Quant notoriously bought fabric retail from London department stores and initially made up garments herself on a domestic sewing machine.[49] Although the quality of

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[46] Richard Lester, *Boutique London*, p. 29.
[47] Penelope Byrde, *The Male Image: Men's Fashion in Britain, 1300-1970*, p. 110.
[48] Christopher Breward, *Fashioning London: Clothing and the Modern Metropolis*, p. 154.
[49] Ibid., p. 155.

manufacture could be erratic, customers appeared prepared to accept some inconsistency in quality if it afforded them highly original and distinctive garments that were unavailable elsewhere.

Importance of Style

The shirt was no longer a garment that solely distinguished the class and occupation of the wearer. It had become a fashionable product and a means of expressing personal taste and individuality. The study, *Shirts in the Seventies*, observed that, 'Shirts are among the 'trendiest' of all menswear items […] Few men will take a chance in fashion with an item costing £15 or more, but many feel able to risk buying a shirt at a fifth of the price, even though it may become out of fashion fairly soon.'[50] The fashionable variety of garments introduced by boutiques had increased consumer choice. However, an increased choice also complicated the customer profile and made them more challenging to define. As Rachel Worth remarked, 'while companies may define their market according to customer age and level of income (and increasingly lifestyle), the reality is that customers don't always 'conform' to these categories in the way that marketing companies and retailers might hope or expect.[51] Style was now a defining characteristic of the shirt and this created complex consumption patterns.

Although fashionable style was recognised as important, it proved difficult to quantify or define. Therefore, the study, *Shirts in the Seventies*, chose to relate style to volume and retail price as a way of discussing and describing the industry's products. The study divided shirts into three categories, which it described as:

> the commodity shirt is simple in design and cheap to produce in long runs, and sells on price alone […] The medium-quality shirt is made of better material than the commodity shirt and is designed to last longer. Design and production do not allow fancy variations in style, and it sells on a basis of value for money rather than cheapness […]The specialist shirt comes in a wide variety of styles and designs, and its production costs allow for minute attention to detail and quality. Price is not of major importance to the consumer who is more interested in its style and individuality.[52]

Consumers had a greater choice of garment styles, quality, and price, which reflected the fact that there was a greater difference between shirts worn for work and those worn for leisure. The increased consumption of clothing also meant that shirts were less robustly made. The style of a garment often proved to be more important than its durability. Shirt categorisation in the study reflected how the garment was being adapted to suit these new fashion and consumption patterns.

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[50] NEDO, *Shirts in the Seventies*, p. 47.
[51] Rachel Worth, *Fashion for the people: A History of Marks and Spencer* (Oxford: Berg, 2007), p. 69.
[52] NEDO, *Shirts in the Seventies*, p. 26.

Larger retailers also recognised the advantages of producing fashionable products. However, because of their size and dependence on long production runs they could not adopt the same supple approach to manufacturing and retailing that had made small boutiques so successful. By the 1970s, department stores and large retail multiples had come to dominate British clothing sales, and clothing manufacture and retail were separated.[53] As a consequence of this separation, large retailers had to manage complex production schedules that could involve several manufacturers.[54] In order to create a varied product range that offered fashionable choices to their customers, large retailers chose to exploit the bold fabric choices and simpler construction techniques found in boutique garments, but keep the basic original design features of the shirt. Two examples of shirts made by prominent British retailers during the 1970s illustrate how they managed to combine fashionable boutique trends with large scale manufacture.

The High Street Shirt

The first example is a shirt made by Marks and Spencer (K.2000.155 NMS), which by 1970 had captured almost a third of the British medium price shirt market. [55] The familiar features of a two piece collar, cuffs, yoke, and a buttoned and faced front opening (Figures 4-41 and 4-42) are still. However, the choice of a bold floral print, darts to shape the body of the garment, and the use of an overlocking stitch to finish the raw edges of seams (Figure 4-43) indicate the successful absorption of boutique trends and production methods.

The second example of a branded product was made by Pringle in the 1970s (K.2002.549 NMS). Although Pringle was a more prestigious label than the ubiquitous high street retailer, Marks and Spencer, the scale of its production still demanded efficient manufacturing methods. This shirt also retains the familiar features of a two piece collar, cuffs, and a buttoned front opening (Figures 4-44 and 4-45), but the adoption of boutique trends is evident from the choice of a knitted jersey fabric and the use of an overlocking stitch on the raw edges of seams (Figure 4-46).

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[53] Ruth Winterton and Alison Barlow. 'Economic Restructuring of U.K. Clothing' in *Restructuring within a Labour Intensive Industry*, ed. by Ian M. Taplin and Jonathan Winterton, pp. 25-60.
[54] The study, *Shirts in the Seventies*, identified a group of unrelated British shirt factories whose only customer was Marks and Spencer, and whose combined production represented 15 per cent of the total shirt market by value, see NEDO, *Shirts in the Seventies*, p.15.
[55] NEDO, *Shirts in the Seventies*, p. 48.

Figure 4-41 Cotton floral shirt made by Marks and Spencer *c*.1970s (NMS, K.2000.155)

Figure 4-42 Yoke on back of Marks and Spencer shirt (NMS, K.2000.155)

Figure 4-43 Detail of floral pattern and overlocking on seam (NMS, K.2000.155)

Figure 4-44 Cotton jersey shirt made by Pringle *c*.1970s (NMS, K.2002.549)

Figure 4-45 Detail of cuff (NMS, K.2002.549)

Figure 4-46 Detail of overlocking on seam of sleeve (NMS, K.2002.549)

Figure 4-47 (Left) Value for money products using fabrics that don't require pattern matching, 1975 (Image courtesy of Advertising Archives). Image removed due to Copyright restrictions.

Figure 4-48 (Middle) Rael Brook branded product with large stripe creating distinctive style, *c*.1970s (Image courtesy of Advertising Archives). Image removed due to Copyright restrictions.

Figure 4-49 (Right) Selection of Rael Brook products all using distinctive stripes, *c*.1970s (Image courtesy of Advertising Archives). Image removed due to Copyright restrictions.

Boutique fashion had introduced bold fabric patterns and colours, and fabric choice continued to play a key role in creating stylish diversity for retailers. The summary and recommendations of the study noted that, 'the shirt industry has shown itself responsive to the introduction of new fabrics and fashion ideas, and the increasing fashion awareness among consumers gives further opportunities in this direction.'[56] By the 1970s a variety of woven and knitted fabrics, in both natural and synthetic fibres, were employed in the manufacture of shirts.[57] Major retailers were also prepared to invest time and resources in developing new fibres and creating fashion oriented colour ranges.[58] But, because pattern matching made production more costly and time consuming, fabric designs that were effective without the need for matching were chosen for low and mid-priced garments. A large busy floral was used for the mid-priced Marks and Spencer shirt, and low cost shirts used small floral patterns or simple geometric designs (Figure 4-47). Only the more expensive ranges could afford to distinguish their products with the use of distinctive patterns that required matching (Figures 4-48 and 4-49).

Although boutique styles and changes in fashion encouraged the adoption of coloured and patterned fabrics, this adoption had consequences for Singer's automated technology. In a Salesmen's Newsletter dated June 1970 and headed '256-5 Machines – Colored Shirts', agents of Singer Industrial Products were warned that, 'the increase in the quantities of colored shirts

[56] NEDO, *Shirts in the Seventies*, p. xv.
[57] The study, *Shirts in the Seventies*, summarised the product range and potential contribution of knitted and woven fabrics to the shirt industry, and the increased use of polyester cotton blends in shirt manufacture, see NEDO, *Shirts in the Seventies*, p. 12.
[58] For a description of textile and colour development at Marks and Spencer from the 1930s, see Rachel Worth, *Fashion for the People: A History of Clothing at Marks and Spencer,* pp. 43-66.

being produced has resulted in problems for customers using Sequential Buttonhole Machines.'[59] The thread delivery system for the machine had been designed for volume production in a single colour, but the division of large production runs into several colours now required the use of smaller individually wound cones of thread. However, because there was significantly less thread wound on these smaller cones, the tension of thread delivery was altered and when the cones ran out they were not activating a cutting device on the machine. The failure of this automated system to engage was causing damage to garments, and the letter provided technical solutions to overcome this problem for agents to share with any customers who encountered the same difficulty. Changes in fashion and consumption patterns had consequences for automated production machinery.

The simpler production methods used in boutique garments also proved to be one of the most significant adoptions by retailers and the manufacturers who supplied them. For more than a century the raw edges of a shirt's seams had been enclosed to strengthen them during washing and wearing. However, the raw edges of boutique shirts were finished with an overlocking stitch. Shirt manufacturers realised that exceptionally robust seams for fashion garments were not such a priority and this simpler method of production was adopted. The study described both the commodity shirt and the medium-quality shirt as having 'seams overlocked'.[60] The overlocking stitch was a variation on the chain stitch and was used solely to enclose the raw edges of fabric. The machines had been available since the turn of the century and had been developed for use with knitted fabrics, which were vulnerable to unravelling when cut because they were a single thread construction.[61] The boutique shirt highlighted further uses for the overlocking machine. Despite the fact that manufacturers needed to purchase another machine for this treatment of seams, it was widely adopted by both the shirt and garment industries. Fashionable change presented both technical problems and marketing opportunities for the Singer Company.

Industry Dilemma and the Direction of Machine Development

Changes in fashion and industry structure did not only have consequences for Singer's existing machine models, they also had an impact on the direction of machine development. By the 1970s, 70 per cent of clothing sales in Britain could be attributed to the retail multiples and

[59] SMCSA, WDC, box GDWD 1/1/3(1) – Singer Industrial Products Salesmen's Newsletter, Volume 9, No.13, June 1970.

[60] NEDO, *Shirts in the Seventies*, p. 78.

[61] NMAH TC, box 20, folder 0 – *"Overlock" Machine Catalogue* ([n.p.]: Willcox and Gibbs Sewing Machine Company, 1903). Willcox and Gibbs were among the first sewing machine manufacturers to develop an 'overlocking' machine.

department stores that had come to dominate clothing sales in Britain.[62] Although clothing manufacturers could benefit from the economic stability that orders from large retail multiples could offer, in exchange retailers demanded flexible production responses that placed all capital investment costs with the manufacturer.[63] Clothing manufacturers, therefore, needed to increase productivity whilst maintaining flexibility. Consequently, in response to the industry's dilemma, the Singer Company chose to take its machine development in two very different directions. In the 1970s the Singer Company developed and promoted advanced automated technology, which it featured in its *Industrial Sewing Catalog*, whilst also simultaneously introducing model 660, a simple, fast, straight stitch machine without any special attachments or calibrations. Singer's introduction of two highly contrasting methods of production reflected not only the influence of garment variety and fashion, but also the complex relationship that had arisen between garment manufacturers and retailers.

The company developed automated technology because it allowed manufacturers to significantly increase garment production. However, it was not an easy accomplishment. The *Technology and Garment Report* described the first attempts to automate the production of shirts, and stated:

> The factors that resulted in the failure of the Pfaff shirt machine are likely to affect the prospects for the highly complex Sew 'N' Sew equipment developed by the Jacobs Machine Corporation for the automatic production of shirts. After nine years of development effort and $1.5 million expenditure Jacobs have available a unit for production of 200 dozen right shirt fronts per 8 hour day at a leasing charge of $600 per month. It is hoped to follow this 'soon' by other separate automatic modules for production of the left-hand fronts, backs, and sleeves of shirts at about the same leasing charge per module. The machine clearly demands a very high production throughput to be economic.[64]

These descriptions reveal that automation was a challenge for any company that chose to undertake it, and success was by no means guaranteed.

Although Singer had the necessary resources and expertise to attempt automated machine development, it was aware of the challenges that it represented and was initially reluctant to commit resources to what the *Technology and the Garment Industry* report described as 'automated apparel production systems.' [65] In an effort to lessen the risks and complications involved Singer focused on single, stable elements of garment construction. This approach

[62] Jonathan Zeitlin, 'The Clothing Industry in Transition: International Trends and British Response', p. 212.
[63] Adam Briggs, '"Capitalism's Favourite Child"', p. 192.
[64] NEDO, *Technology and the Garment Industry*, p. 138.
[65] It was not until 1968 that the Singer Company showed any real enthusiasm for the development of automated systems, see NEDO, *Technology and the Garment Industry*, p. 94.

enabled them to eradicate some of the complications associated with the development of automated production. And in the 1970s the Singer Company introduced two automated units suitable for shirt production. A profile stitcher, the Formatic 2501-1, and the Shirt Yoke Seaming Unit, model 5910-2, which were both featured in its *Industrial Sewing Catalog*.

The development and introduction of these ambitious and sophisticated automated units demonstrated the initiative of the Singer Company. However, unless models could be proven to be reliable and beneficial, shirt manufacturers in a volatile and competitive market remained sceptical of their value to their business. Consequently, the report, *Technology and the Garment Industry,* concluded that, ‘the expansion in the development effort is largely internally generated within the machinery industry […] Little pressure is being applied by the garment manufacturers themselves and their contribution seems to be somewhat passive and is limited to co-operation in field trials.’[66] The report, therefore, suggested, ‘co-operative research involving the operation of experimental production lines’ to reassure garment manufacturers, without which it feared they would be unable to ‘accept machine and systems that do not exactly duplicate an established practice’.[67] Singer’s concentration on units that focused on single features of a shirt’s construction no doubt reflected its awareness of the industry’s caution.

Although Singer was willing to develop high volume production units, their introduction did not guarantee adoption. The British shirt industry was composed of relatively small manufacturing units. These smaller manufacturers chose to concentrate on flexible and versatile manufacture and remained reluctant to commit to the production capacity that automation offered. The product description for model 5910-2 claimed that a single operator, under factory conditions, could stitch between 180 to 200 dozen shirt backs in an eight hour day, which is the equivalent of 2160 – 2400 shirt backs a day or 10,800 – 12,000 shirt backs a week.[68] However, the study, *Shirts in the Seventies*, noted that there were few British manufacturers engaged in what it described as ‘long run production’ as the country did not have ‘the same heritage of […] highly efficient, large scale manufacturing units as Hong Kong […].’[69] Instead, shirt manufacture was concentrated in 750 manufacturing units across the United Kingdom, 85 per cent of which employed fewer than 100 people.[70] Moreover, the study noted that, ‘much of the management in the UK industry is not skilled, or interested in the techniques of large scale production, being more interested in variety and design innovation.’[71]

[66] NEDO, *Technology and the Garment Industry*, p. 124.
[67] Ibid., p. 179.
[68] SMCSA, WDC, box GDWD 1/1/3(2) - *Industrial Sewing Catalog, c.* 1978, un-numbered.
[69] NEDO, *Shirts in the Seventies*, p. 45.
[70] Ibid., p. 13.
[71] Ibid., p. 45.

Figure 4-50 Promotional leaflet for model 660, emphasising its speed and value, *c*.1970s (SMCSA, WDC, box GDWD 1/1/5, item 20). Images removed due to Copyright restrictions.

Singer recognised the dichotomy within the industry, and responded by developing, alongside its advanced automated units, model 660 (Figures 4-50). Singer described this model as an economic, lockstitch machine capable of speeds of up to 4,500 stitches per minute, and suitable for a variety of garment weights. It was recommended for, 'hemming, binding, edge stitching, stitching pockets, collars, cuffs and similar applications on shirts, blouses, dresses, shorts, slacks, men's clothing, heavy woollens, overcoats, ladies' coats, jackets and work clothing.'[72] However, the most significant aspect of this model was not its relative simplicity in comparison to the ambitious development of automated units, but the fact that Singer chose to emphasise the fact that the machine was cheap and fast. This approach surprised the authors of *Technology and the Garment Industry*, who commented that, 'the new 660 high speed lock stitch machine […] is being marketed as an economy unit of high speed with no attachments, a policy which is markedly different from that adopted by several of the other main manufacturers.'[73]

Singer's decision to develop a cheap, simple, fast machine, and pointedly promote it as such, was an astute response to the economic conditions and pressures that the company observed

[72] SMCSA, WDC, box 1/1/3(2) – *Singer Industrial Products Catalog, 1973-74* ([New York]: Singer Manufacturing Company, [1973]), p. 29.
[73] NEDO, *Technology and the Garment Industry*, p. 95.

within the clothing industry.[74] Manufacturers who chose to focus on variety and design innovation in an unpredictable and fashion conscious market needed flexible production methods. And although Katrina Honeyman rightly concluded that much of the industry's lack of investment in sewing machine technology was due to its reliance on low paid female labour, a not insignificant factor was the need for versatility in production.[75] *Technology and the Garment Industry* also acknowledged that the adoption of advanced technology was constrained by the fact that the garment industry was, 'shaped by its main tool in a way that loads its management heavily with the task of maintaining production by established methods and leaves little consideration of alternatives.'[76] To maintain flexibility and versatility the report observed that management was only likely to adopt automated units that could be effectively fitted into existing production systems, and suggested that any adoption of advanced technology would depend upon a more progressive management outlook.[77] Subsequently, improvements in technology would have to be matched by improvements in management.[78]

Because fashion was unpredictable, clothing manufacturers were vulnerable to the constantly fluctuating demands of retailers and the changing tastes of their consumers. The vulnerability of this position made it difficult for manufacturers to forward plan or integrate automated technology. Consequently, they chose to depend upon reliable and versatile production methods. One operator and one machine as a method of production could not match the production volume of automation, but as Adam Briggs observed, 'the individually operated and labour intensive sewing machine […] does not need retooling as product specification changes […].'[79] In an unpredictable manufacturing environment, one machine and one operator still offered shirt and clothing manufacturers maximum flexibility.

The complex interaction between consumption and production created difficulties for clothing manufacturers that had no easy solutions. Singer had offered shirt manufacturers a choice of production methods, but manufacturers proved reluctant to relinquish their reliance upon human versatility. Moreover, planned investment required clear business objectives, and as Tony Manwaring and Stephen Wood reflected, 'it does leave one wondering whether any development of industry is shaped less by fundamental forces than by a mosaic of short-term

[74] For discussion of the application of Fordist mass production techniques and the approach of flexible specialization to the UK clothing industries, see Alison Barlow and Jonathan Winterton, 'Restructuring Production and Work Organization', in *Restructuring of a Labour Intensive Industry,* ed. by Ian Taplin and Jonathan Winterton, pp. 176-198.
[75] Katrina Honeyman, *Well Suited*. *A History of the Leeds Clothing Industry, 1850-1990,* p. 129.
[76] NEDO, *Technology and the Garment Industry*, p. 6.
[77] Ibid., p. 89.
[78] Ibid., p. 89.
[79] Adam Briggs, '"Capitalism's Favourite Child"' p. 192.

resolutions as firms muddle through in a bid to survive.'[80] The Singer Company had demonstrated that it was prepared to take the initiative and explore opportunities to modernise the shirt industry. But, by introducing two such diverse machine products simultaneously it also demonstrated that it could not, and would not, ignore the status quo within the clothing industry.

Conclusion

Object studies of shirts have demonstrated that the construction of a stitched object by hand, and the reasons for that choice of construction, have a perceptible influence on the development of the sewing machine as a manufacturing tool. The unchanging nature of the garment's construction, combined with the industry's early adoption of the sewing machine, encouraged the Singer Company to make significant adaptions to the machine for more efficient shirt production, which culminated in the introduction of automated stitching units by the 1970s. However, object studies do not only reveal the significance of object construction to the direction of machine development, they also illustrate the importance of changes in fashion, clothing consumption, and consumer taste to the process of mechanisation. The changing taste of consumers demanded flexibility from both clothing manufacturers and their machinery providers. And as the dominant supplier of machines to the British clothing industry, the Singer Company attempted to find solutions to the industry's dilemmas. Although this prompted sophisticated machine development, this was not always translated into universal adoption and diffusion within the industry.

Object studies not only demonstrate the importance of an object's construction and style to machine development, they also highlight the significance of trade structure and the relationship between manufacture and retail to the process of mechanisation. Therefore, the following chapter uses another set of object studies to look in more depth at how the structure of a trade was affected by the introduction and adoption of mechanised tools. Using object studies of women's shoes, it focuses on the relationship between product manufacturer and consumer within the British shoe trade. It explores how this important relationship influenced sewing machine development. Object studies are also used to examine the challenges that the co-existence of both large and small businesses within the same trade, catering for different consumer tastes, presented to the Singer Company. Focus on a trade's adoption of the sewing machine permits a further examination of the relationship between object makers and their tools.

[80] Tony Manwaring and Stephen Wood, 'The Ghost in the Labour Process', in *Job Redesign: Critical Perspectives on the Labour Process*, ed. by David Knights, Hugh Willmott, and David Collinson (Aldershot, Hants: Gower Publishing Company Limited, 1985), pp. 171-196 (p. 192).

Such an examination can reveal how innovative use of the sewing machine created distinctive products and prompted new machine development.

Chapter 5 Production and Product: Making the Shoe by Machine


Figure 5-1 (Left) Lilac silk shoes made by A. L. Scott, *c*.1920s (Glasgow Museums, E.1976.112.1 and 2)
Figure 5-2 (Right) Embossed leather shoes, unknown manufacturer, *c*.1920s (Glasgow Museums, E.1981.150a and b)


Figure 5-3 (Left) Black suede beaded shoes, *c*.1920s (Glasgow Museums, E.1971.41.1 and 2)
Figure 5-4 (Right) Tan leather shoes, unknown manufacturer, *c*.1920s (Glasgow Museums, E.1979.15.5.1 and 2)

A comparison of four pairs of shoes, made by four separate manufacturers under very different manufacturing conditions during the 1920s, serves to illustrate the complex demands of the shoe industry, and the challenges that these posed for sewing machine manufacturers. Each pair of shoes is an interpretation of a single style of woman's shoe. An examination of each reveals the range of product qualities that shoe manufacturers could create in response to consumer demand (Figures 5-1 to 5-4). The design and quality of a shoe reflected the important relationship between shoe manufacturers and their customers. A relationship that ultimately determined the structure of the trade. As Giorgio Riello observed, 'it is not the quantitative aspects of consumer behaviour which influence the structuring of the product's provision system but its qualitative aspects.'[1]Therefore, this chapter will use object studies of shoes to explore how product quality and trade structure influenced the direction of Singer's machine development for the British shoe industry.

The trade in ready-made shoes was already well established in both Britain and America before the invention of the sewing machine, and its introduction encouraged rather than stimulated the production of shoes through the sub-division of tasks and labour.[2] In 1852, I. M. Singer adapted his first sewing machine model to stitch leather, and this early adaption encouraged shoe manufacturers to adopt the machine. The sewing machine was used for the second of the three principle stages of boot and shoe making, the stitching and joining of shoe uppers and linings. The first stage, which determined the design and quality of the shoe, involved the cutting out of the shoe upper and its separate lining, and the third and final stage involved the stitching of the lined shoe upper to the sole and heel. By the close of the nineteenth century every stage of shoe production had become mechanised.[3] Although the second and third stages of shoe construction

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[1] Giorgio Riello, *A Foot in the Past: Consumers, Producers and Footwear in the Long Eighteenth Century*, Pasold Studies in Textile History, 15 (Oxford: Oxford University Press, 2006), p. 187.

[2] Beverly Lemire identified that 'copious quantities of shoes, hosiery, and hats, were basic [British] exports from the seventeenth century onwards […]', see Lemire, *Dress, Culture and Commerce: The English Clothing Trade before the Factory, 1660-1800* (Basingstoke, London: MacMillan Press Ltd., 1997), p. 3. For ready-made shoe production through a division of labour in America during the first half of the nineteenth century, see Nancy E. Rexford *Women's Shoes in America, 1795-1930* (Kent, Ohio; London: Kent State University Press, 2000), pp. 11-15; for ready-made shoe production through a division of labour in Britain during the early nineteenth century, see Giorgio Riello, *A Foot in the Past*, pp. 172-186; for British ready-made shoe production through division of labour after the introduction of the sewing machine, see R. A. Church, 'Labour Supply and Innovation 1800–1860: The Boot and Shoe Industry', *Business History*, 12.1 (1970), 25–45 <https://doi.org/10.1080/758533830> ; and Harriet Bradley, *Men's Work, Women's Work*: *A Sociological History of the Sexual Division of Labour in Employment* (Cambridge, England: Polity in association with Basil Blackwell, 1989), pp. 146-158.

[3] Most of the major innovations were developed in the eastern states of America, and Ross Thomson uses meticulous research of nineteenth-century patents to trace not only the chronology of innovations, but also the institutional changes that were necessary for a craft to become mechanised. He rightly observed that craftspeople do not intuitively conceive complex machinery to replace hand tools. For comprehensive analysis and chronology of the development of these innovations during the nineteenth century, see Ross

required stitching processes, this chapter will concentrate on only the development of the sewing machine for the second stage, the stitching and decoration of shoe uppers.[4] The economic history of the shoe trade in Britain and America, the design of shoes, and the mechanisation of shoe production in the nineteenth century have all been examined. However, there has been little consideration of how the design of a shoe was influenced by the structure of the trade or the significance of this interaction to the adoption and development of mechanisation within the shoe industry. An observation of the quality and style of a shoe illustrates the importance of the relationship between shoe manufacturer and customer. Such an observation also reveals that maintaining this important relationship proved to be as important to the adoption and development of the sewing machine as increasing shoe production. Moreover an exploration of the relationship between shoe design and trade structure emphasises the significance of the relationship between object makers and their tools. It also highlights the influence of trade and human initiative on the process of mechanisation. Object studies of shoes illustrate that the quality and style of a product can reveal more than a sequence of fashionable change. They can also provide valuable evidence of the complex network of commercial relationships that prompted technological development.

Object studies of shoes are placed at the core of this chapter because they provide tangible evidence of product quality and style. Shoes are not simply a by-product of the machine's technological development: their construction, production, and decoration inspired and encouraged it. Consequently, an examination of shoes provides a valuable perspective on the development of the sewing machine. As archaeologists Heather Lechtman and Arthur Steinberg noted, 'every object retains, at least in part, the history of its own manufacture.'[5] An examination of women's shoes made between 1870 and 1980 illustrates the constantly changing response of shoe manufacturers to their customers' demands and the necessary machine developments that these provoked. Moreover, the decoration of shoes also reveals the influence

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Thomson, *The Path to Mechanized Shoe Production in the United States*; for a brief synopsis, see Jose Antonio Miranda, 'American machinery and European footwear: technology transfer and international trade, 1860-1939', in *Business History*, 46.2 (2004), 195-209.

[4] The Singer sewing machine was used to construct shoe uppers, separate machines were devised for attaching the upper to the sole. The McKay sole sewing machine was successfully developed in America during the 1860s and became the dominant machine for this purpose throughout the industry. For an examination of how development and diffusion of the McKay machine were further stimulated by the American Civil War, see Ross Thomson, 'The Continuity of Innovation: The Civil War Experience', *Enterprise & Society*, 11.1 (2010), 128–65. Caroll W. Pursell stated that 'between 1864 and 1870, the number of shoes worked on McKay machines increased from 5 million pairs per year to more than 25 million. By 1895 this total had reached 120 million pairs', see *Technology in Civilization*, ed. by Melvin Kranzberg and Caroll W. Pursell, p. 405.

[5] Heather Lechtman and Arthur Steinberg, 'The History of Technology: An Anthropological Point of View,' in *The History and Philosophy of Technology*, ed. by George Bugliarello and Dean B. Doner (Urbana: University of Illinois Press, 1979), p. 140.

of an object maker's creative ingenuity on the development of the sewing machine, which provides an insight into the important relationship between stitched object makers and their tools. Not least, scrutiny of machine sewn objects provides a tactile reminder of the purpose of the sewing machine that can never be fully realised by technical descriptions or economic analyses alone.

The chapter is divided into two sections. The first section analyses four interpretations of a single style of woman's shoe made during the 1920s to illustrate the diversity of products, and place them within the complex manufacturing and retail environment of the British shoe industry. Each object study relates an element of the shoe's style to an aspect of this complex environment and considers how these influenced Singer's development of the sewing machine for specialised use in the shoe industry during the twentieth century. The second section concentrates on the use and development of the sewing machine for decorative purposes. It uses examples of women's shoes made between 1870 and 1960 to illustrate how the creative manipulation of the sewing machine in ways that could not have been anticipated by the Singer Company influenced the development of new sewing machine models for the shoe industry.

Interpretation of Style

This section combines object studies and economic analyses to explore the diversity of the British shoe industry, and the challenges that this diversity created for the Singer Company's machine development. Wherever possible shoes that were made, or sold, in Glasgow have been chosen in order to supplement material insight from object studies with business case studies. These case studies, reconstructed from entries in the Glasgow Census and *Glasgow Post Office Directories*, can then be used to place local trade structures within the larger economic landscape of the British shoe industry. In addition to existing economic analyses, a British Board of Trade Working Party Report, *Boots and Shoes*, published in 1946, will provide contemporary analysis of the British shoe industry. This report concluded that the Singer Company was the dominant supplier of sewing machines for the construction and decoration of shoe uppers in the British Shoe Industry.[6]

[6] *Boots and Shoes*, Working Party Report for the British Board of Trade (London: HMSO, 1946), p. 102.

Figure 5-5 (Left) Lilac silk shoes, detail of side seam and strap, *c*.1920s (Glasgow Museums, E.1976.112.1)

Figure 5-6 (Right) Detail of back seam (Glasgow Museums, E.1976.112.1)

Figure 5-7 (Left) Evidence of dyeing on interior strap of shoe (Glasgow Museums, E.1976.112.1)

Figure 5-8 (Right) Detail of label (Glasgow Museums, E.1976.112.1)

Example 1: The Mass Produced Shoe

The first example is a pair of lilac silk shoes lined with leather and fabric (E.1976.112.1 and 2), bearing the label of the Glasgow manufacturer and retailer, A. L. Scott and Son (Figure 5-8). The silk upper consists of three parts, seamed together at the sides and heels by machine. One of the side pieces incorporates a narrow strap with a machine made buttonhole, and the heel of the shoe is also covered in matching silk (Figures 5-5and 5-6). The silk upper and its lining have been made separately and joined around the top edge of the shoe with a visible line of machine stitches. Although the silk of the shoe is now lilac, it was originally made in ivory and was dyed at a later date. Evidence of dyeing can be seen on the interior of the shoe (Figure 5-7).

The simple construction of this classic style and the economic use of ivory silk signify that this is a well-made mass produced shoe. The use of a single colour meant that bundles of linings and uppers could have been easily assembled without the need to make the shoes in discrete pairs. The uncomplicated construction of a large number of uppers and linings also meant that they could have been easily dispersed among several machinists concentrating on a single part of construction. The Singer Company was well aware of the range of shoes produced by shoe manufacturers and had developed models which specialised in a variety of tasks. In its manual *Singer Sewing Machine in the Shoe Industry*, which the company published in 1908, the company stated that the 'Singer sewing machine has been improved steadily year after year, until it is now a marvel of perfection, and in its scores of different forms will perform every operation of connecting the parts of a shoe upper.'[7] The company also appreciated the efficiency of sub-dividing construction for volume production, and the manual noted that, 'each worker has the advantage of not only continually working on the same thing, but of working with a machine having special advantages and conveniences for turning out rapidly that particular part of the shoe.'[8]

The evidence for large scale mass production also comes from the label, which identifies that the shoes were made in Czechoslovakia. Although it is impossible to state with certainty who the manufacturer was, one of Europe's largest shoe manufacturers was the Czechoslovakian firm of Bata.[9] According to an article printed in the Singer Company's internal magazine, *The Red 'S' Review*, the Bata factory was capable of manufacturing 40,000 pairs of shoes per day, equal to more than 12 million pairs per annum.[10] This article confirmed Bata was using precise sub-division of construction to achieve this level of production. It observed that, 'the manufacturing process is divided into a number of simple operations, which are carried out by specially expert workers on the most efficient machines, occupying a time which is calculated to the second.'[11] The article also confirmed that Singer had supplied machines and expertise to the Bata Company, stating that:

> the relations between our Singer Organization and the Bata management are of the very best, and have been maintained for a number of years, during which we have spared no

[7] Hagley Museum and Library, *Singer Sewing Machine in the Shoe Industry* (New York; London: Singer Sewing Machine Company, 1908), p. 4.
[8] Ibid., p. 6.
[9] For a brief outline of the Bata Shoe Company, see Jonathan Walford, *The Seductive Shoe: Four Centuries of Fashion Footwear* (London: Thames & Hudson, 2007), p. 253.
[10] *The Red 'S' Review*, October 1927, p. 12.
[11] *The Red 'S' Review*, October 1927, p. 12.

> exertion called for in our desire to fulfil every possible requirement of his [Mr Bata, the company's founder] vast works.' [12]

The combination of a simple design and efficient large scale production methods enabled the manufacture of an affordable silk shoe. Although A. L. Scott and Son had its own manufacturing site in Glasgow, which could have feasibly produced these silk shoes, the decision to import them suggests that the company could not have made them for less than it cost to buy them from such a large volume manufacturer.[13] As the Singer manual noted:

> the development of special stitching appliances for use in the factory has been not only of tremendous benefit to the world at large, by causing a great reduction in the cost to the consumer, but it has brought commercial success to the shoe manufacturer, who could not have achieved modern results without these special sewing machines.[14]

The volume production of this ivory silk shoe benefited retailers, like A. L. Scott and Son, in two ways. First, it permitted retailers to offer an affordable silk shoe to its customers. And secondly, because the shoe could be easily dyed to a customer's preference, it significantly increased the consumer's choice of colours without retailers having to purchase, or manufacture, a range of coloured shoes and risk being left with unwanted stock. These lilac silk shoes illustrate how sewing machines contributed to product affordability and consumer choice through volume production. They also demonstrate how smaller manufacturers involved in retail could capitalise on this.

Example 2: The Manufacturing Environment of the British Shoe Industry

The second example is a pair of printed and embossed leather shoes, lined with fabric and leather, made by an unknown manufacturer (E.1981.150 a and b). The expensive and distinctively patterned leather of the uppers has been cut in a single piece and seamed at the back. The upper and its lining have been joined by a narrow gilded leather trim around the edge of the shoe, which incorporates a narrow strap (Figure 5-9). The heels have also been covered in embossed leather to match the uppers. The intricacy of the pattern has meant that the upper has been cut in a single piece to avoid the need to match separately cut pieces. The uppers of each shoe have been carefully cut to ensure that once they are made up they match exactly, and the distinctive pattern appears in precisely the same place on each shoe, including the heel (Figures 5-10 and 5-11).

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[12] *The Red 'S' Review*, October 1927, p. 13.

[13] A. L. Scott and Son record manufacturing addresses in *Glasgow Post Office Directories* at 88 Dunlop Street (1894-1898), 20 Campbellfield Street (1899-1907), and 96-98 David Street (1908-1955).

[14] Hagley Museum and Library, *Singer Sewing Machine in the Shoe Industry* 1908, p. 5.

Figure 5-9 (Left) Embossed leather shoes, detail of gold leather trim incorporating narrow strap, *c*.1920s (Glasgow Museums E.1981.150 a and b)

Figure 5-10 (Right) Detail of pattern match on side of shoe Glasgow Museums, (Glasgow Museums, E.1981.150 a and b)

Figure 5-11 Detail of pattern matching on heels (Glasgow Museums, E.1981.150a and b)

The choice of such a distinctive quality of leather indicates that these shoes would have been made up in small batches, which meant that they were likely the product of a small manufacturer who specialised in fashionable and expensive footwear. The meticulous matching of the pattern demonstrates the aptitude of the manufacturer and indicates that these shoes could only have been made as discrete pairs. The shoes, which are impeccably made and machine sewn throughout, illustrate how a simple style can be elevated by the choice of materials and the capabilities of the manufacturer. The cutting of the upper in a single piece meant that the shoe could be made up in other intricately patterned leathers and fabrics, with contrasting trims. The use of this deceptively simple cutting technique would have allowed the manufacturer to increase consumer choice whilst also maintaining the distinctiveness of the product. The production of these embossed shoes relied upon creative flexibility, which suggests that the manufacturer prioritised distinctive style over volume production. Creative flexibility allowed smaller manufacturers to distinguish their products in a competitive market place. Although they produced fewer shoes, the choice of this versatile approach to manufacturing permitted them to respond more quickly to market trends and customer demands.

The versatility of small manufacturers had enabled them to survive in the shadow of larger manufacturers since the eighteenth century, and the coexistence of both large and small manufacturers was a phenomenon of the British shoe industry that continued well into the twentieth century.[15] H. C. Hillmann identified that of the 1057 British firms in 1930, 48% of them had between 10-50 employees, which represented 10% of the entire workforce of the trade, and that 1.9% of firms employed more than 750 employees, which represented 18% of the entire workforce.[16] The fact that almost half of the shoe manufacturers in Britain could survive as small or mid-sized companies demonstrates that the choice of versatile and flexible production over volume production was a sustainable business model. The survival of smaller manufacturers also indicates that the adoption of the sewing machine did not alter the structure of the British shoe industry, but that it was developed to meet the needs of the existing business models.[17]

The complex manufacturing environment, which the British shoe industry represented, would have presented significant challenges to the Singer Company. Volume, variety, and distinction of product was directly linked to a manufacturer's choice of tools and materials. A working party report, *Boots and Shoes*, published by the British Board of Trade in 1946, identified that:

> The layout of a shoe factory depends primarily upon the nature and quantity of the product. One factory may be laid out to produce continuous output and a few styles only: another may be required to produce a large variety in comparatively small

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[15] See Giorgio Riello, *A Foot in the Past*, pp. 221-243.

[16] H. C. Hillmann, 'Size of Firms in the Boot and Shoe Industry', *The Economic Journal*, 49.194 (1939), 276-293 (p.276) <https://doi.org/10.2307/2225090>.

[17] For a discussion of mechanisation and its effect on British shoe manufacturers, see R. A. Church, 'Labour Supply and Innovation 1800–1860: The Boot and Shoe Industry'; R. A. Church, 'The Effect of the American Export Invasion on the British Boot and Shoe Industry 1885-1914', *The Journal of Economic History*, 28.2 (1968), 223–54; and Jose Antonio Miranda, 'American machinery and European footwear: technology transfer and international trade, 1860-1939'.

> numbers. One may produce slippers and the like, entailing a small number of operations and simple machinery; another may specialise in ladies' shoes of a high quality and complicated design, calling for many machines and highly flexible processes.[18]

Philip Scranton, writing about the American machine tool industry, noted that 'clearly the choice between variety and volume had strong technical correlates, built into the structures of production.'[19] It would appear that the development of the sewing machine as a mechanised means of production was subject to the same choices.

The choice between volume and variety generally determined the shoe manufacturer's choice of production method, and, ultimately, models of sewing machine. Manufacturers could choose to adopt either of two sequences of production, departmental or line. Departmental production, which was the method used to make the embossed shoes in discrete pairs, was the most flexible method. This method placed all of the machines for stitching uppers in a single space or room, and this particular arrangement encouraged the development of versatile models capable of specific stitching tasks on several types of product or material. Line production, which was more suitable for volume production and produced the lilac silk shoes, relied on a highly organised sub-division of tasks specific to a single product type. Line production encouraged the development of machines that combined specific tasks. However, to maximise efficiency these machines were generally only suitable for a specific product type. Line production prioritised speed and efficiency over versatility. The working party report concluded that line production was more conducive to volume production because although it 'reduces the technical supervision of each stage of the process, [it] lays a high emphasis on organisation and output, and makes the production of varied articles difficult.'[20]

Example 3: Combining Manufacture with Retail

The third example is a pair of beaded black suede shoes lined in leather, with a label from McDonalds department store in Glasgow (E.1971.41.1 and 2). The suede upper has been cut in three pieces and seamed at the back and sides (Figure 5-12). A narrow strap with a machine made buttonhole is incorporated into the side of the shoe, and the heels are also covered in black suede. The suede upper and lining, which were made separately, have been joined together by a visible line of machine stitching around the entire outside edge of the shoe and strap. A folded cutwork piece in matching suede, lined with leather, has been attached separately, and the strap of the shoe passes through this fold (Figure 5-13). The shoe has been embellished by hand with

[18] *Boots and Shoes*, Working Party Report 1946, p. 191.
[19] Philip Scranton, 'Diversity in Diversity: Flexible Production and American Industrialization, 1880–1930', *Business History Review*, 65.01 (1991), 27-90 (p. 51) <https://doi.org/10.2307/3116904>.
[20] *Boots and Shoes*, Working Party Report 1946, p. 14.

beads and sequins after the shoe upper was joined to its lining and the separate cutwork piece attached, but before the upper and lining were joined to the sole.

Figure 5-12 Black suede beaded shoes, detail of hand beaded cutwork piece attached to shoe, labelled McDonalds department store, Glasgow *c*. 1920s (Glasgow Museums, E.1971.41.1)

Figure 5-13 Detail of side seam (Glasgow Museums, E.1971.41.1)

Although the shoe upper and its lining would have been quickly and easily constructed, the pause in construction to bead the upper would indicate that it was made in small batches rather than mass produced. The amount of time involved in decorating the shoe by hand is offset by the speed of its initial construction. This example illustrates how a simple machine sewn shoe could be distinguished by hand embellishment. It also demonstrates that shoe manufacture was not entirely mechanised even by the interwar period. The addition of a cutwork piece was also a versatile design feature because it could be changed to offer alternative variations, or the shoe could be made up without it. The beading design could also be varied, and the shoe could be made up in other colours or materials with matching or contrasting beadwork to increase consumer choice. McDonalds was a department store that had been present on one of Glasgow's most fashionable shopping streets since the early nineteenth century, and although McDonalds could have specified the design, it is more likely that the shoes would have been made by an outside manufacturer rather than within the store.

The addition of hand embellishment and cutwork pieces illustrates how shoe manufacturers sought to distinguish their products in response to customer demand. Stylish distinction in any price range was vital to sustaining a business in a competitive market. [21] In addition, fashion in women's footwear was notoriously unpredictable compared with the conservatism of men's footwear.[22] This unpredictability encouraged manufacturers, both large and small, to enter into retail. As retailers they gained valuable direct contact with their customers, which enabled them to control their productivity and choice of production methods. Small manufacturers could respond quickly with their own distinctive product range, whilst stock purchased from larger manufacturers enabled them to benefit from the profit margins of mass production without the need to enter into it. Larger manufacturers who supplied their own chain of outlets could increase their direct contact with their customers, whilst also synchronising production and distribution more efficiently. As Giorgio Riello noted:

> A growing market complexity was faced through the division of production, distribution, and retailing. The footwear industry did not fit within this ideal model. Even today many of the most important shoe producers are also retailers. There seems to be a direct link between knowledge of the market and consumers' tastes, and the capacity to be active and efficient in production.[23]

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[21] R. A. Church, 'The Effect of the American Export Invasion on the British Boot and Shoe Industry 1885-1914', p. 231; H. C. Hillmann, 'Size of Firms in the Boot and Shoe Industry', p. 287.

[22] For a discussion of shoes in male fashion, see Christopher Breward, 'Fashioning Masculinity: Men's Footwear and Modernity' in *Shoes: A History from Sandals to Sneakers* ed. by Giorgio Riello and Peter McNeil, English edn (Oxford: Berg, 2006), pp. 206-223.

[23] Giorgio Riello, *A Foot in the Past*, p. 187.

Figure 5-14 Central city location of A.L. Scott and Son at 92 Argyle St. shop sign just visible on the far right, *c*.1912 shop sign just visible on the far right (Mitchell Library, C1121). Image removed due to Copyright restrictions.

Figure 5-15 A. L. Scott and Son at 601 Great Western Road, *c*. 1940, it opened its first branch in this suburb in 1910 at 533 Great Western Road (Mitchell Library, C6166). Image removed due to Copyright restrictions.

Shoe manufacturers recognised the value of contact with their customers and chose retail locations in both the city centre and close to dense residential areas. A. L. Scott and Son, who began manufacturing in 1894, opened its first retail branch in central Glasgow at 64 St. Enoch's

Square in 1899, and added a second central location at 92 Argyle Street in 1914 (Figure 5-14).[24] However, it also recognised the value of expanding into the city's suburbs, and in 1910 opened a suburban branch at 533 Great Western Road, close to one of the city's most fashionable residential areas (Figure 5-15).[25] Two of the city's largest shoe manufacturers, E. J. Scott and Son and A&W Paterson, also began to strategically locate branches across the city's suburbs in addition to central city locations. E. J. Scott and Son began trading in 1852 with a single branch in central Glasgow at 8 Jamaica Street, and by the turn of the century it had not only opened a second central location at 192 Argyle Street, but also six more branches close to residential areas in the north, south, and west of the city.[26] The shoe manufacturing firm of A&W Paterson, which was reputedly the first manufacturer to purchase a sewing machine from the Singer Agency when it opened in Glasgow, began trading at a central city location in 1825.[27] By 1908, it had become the city's largest shoe retailer with 35 branches throughout Glasgow.[28]

The direct contact with consumers that retail permitted was an important influence on the British shoe trade. It supported the coexistence of large and small businesses in the industry, by allowing small and mid-sized businesses established during the nineteenth century to survive, through inheritance, into the mid-twentieth century. The survival of two small Glasgow businesses illustrates the value of direct customer contact to small shoe manufacturers. Peter Dickson began trading in the north of the city in 1863, and his business, under the management of his son John continued to trade in central and suburban locations until 1950 (Table 1).[29] William Vernal, who was a 16 year old apprentice in 1851, started his business on the south side of the city in 1886, aged 45; and the business, inherited by his son, continued to trade until 1958 (Table 2). [30] Contact with suburban customers proved valuable to these smaller manufacturers, and during the interwar period A. L. Scott and Son, Peter Dickson, and William Vernal and Son all had retail outlets within a mile of each other on the Great Western Road, close to one of the city's most fashionable suburbs.

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[24] *Glasgow Post Office Directory 1894-1895*, p. 556; *Glasgow Post Office Directory 1899-1900*, p. 585; *Glasgow Post Office Directory 1914-1915*, p. 1109.
[25] *Glasgow Post Office Directory 1910-1911*, p. 1104.
[26] *Glasgow Post Office Directory 1852-1853*, p. 288; *Glasgow Post Office Directory 1900-1901*, p. 541.
[27] 'The Rise and Progress of the Sewing Machine Trade', *Glasgow Herald*, 18 April 1868, p. 3; *Glasgow Post Office Directory 1825-1826*, p. 181.
[28] *Glasgow Post Office Directory 1908-1909*, p. 1114.
[29] Entry in the Glasgow Census 1891, 644(9), Bk. 2, p. 19 records Peter Dickson aged 55 and his son John aged 18.
[30] Paisley Census 1851, 575, Bk.4, p. 8.

Table 1: Peter Dickson Shoe manufacturer and retailer 1863-1953 Retail Locations in Glasgow	
1863-1879	317 Parliamentary Road (north)
1880-1887	406 Parliamentary Road (north)
1888-1898	66 Renfield Street (central)
1899-1933	66 Renfield Street (central) 451 Great Western Road (west)
1934-1939	66 Renfield Street (central)
1940-1943	75 Bath Street (central)
1944-1953	58 West Regent Street (central)

Source: *Glasgow Post Office Directories*

Table 2: William Vernal and Son Shoe manufacturer and retailer 1886-1959 Retail Locations in Glasgow	
1886-1889	153 Crown Street (south)
1890-1894	406 Parliamentary Road (north)
1895-1898	17 Sauchiehall Street (west)
1899-1905	17 Sauchiehall Street (west) 317 Parliamentary Road (north)
1906-1918	629 Great Western Road (west)
1919-1959	597 Great Western Road (west)

Source: *Glasgow Post Office Directories*

It was the product and the consumer that ultimately determined a shoe manufacturer's choice of production method and retail location, and the emphasis on these underpinned the complexity and diversity of the British shoe trade. As the working party report stated, 'boots and shoes are a highly diversified product, made with the object of fitting the feet of individual people and of meeting their many other requirements as to material, colour, style and purpose.'[31] The decision of shoe manufacturers to enter into retail compounded the complexity of the shoe industry and created complicated customer profiles for the Singer Company. Shoe manufacturers, irrespective of business scale, adopted the sewing machine only as it enabled them to continue to distinguish their products and businesses, and the Singer Company developed its range of models in response to these circumstances.

[31] *Boots and Shoes*, Working Party Report 1946, p. 2.

Example 4: The Significance of Product Style

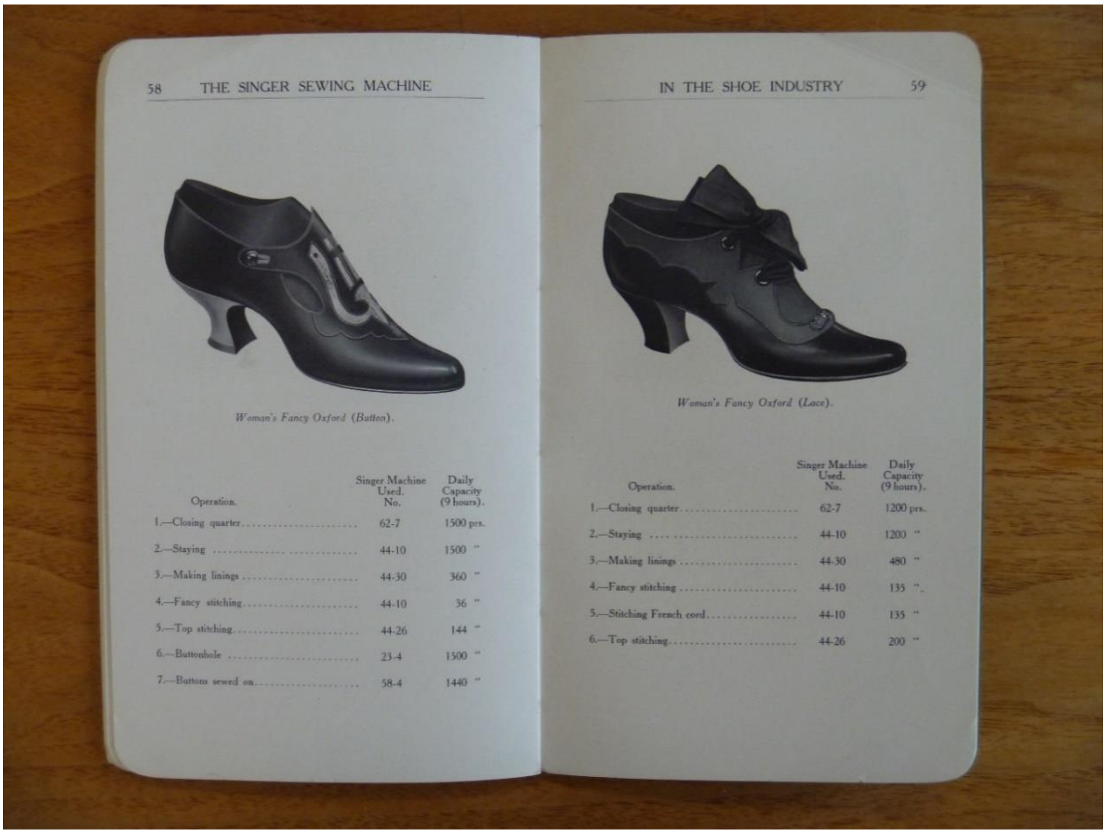
The final example is a pair of tan leather shoes, lined with leather and fabric, made by an unknown manufacturer in the 1920s (E.1979.15.5.1 and 2). The upper is in three pieces, and one of the side pieces incorporates a narrow strap with a machine made buttonhole (Figure 5-16). The side seams and toe cap of the upper have all been seamed together with parallel lines of stitches placed a centimetre apart, and the leather upper has then been joined to its lining with the same method. The edge of the toe cap has also been decorated with a simple perforated design between the lines of stitching, and this decorative device does not appear anywhere else on the shoe (Figure 5-17).

Figure 5-16 (Left) Tan leather shoes, detail of side seam and strap, *c*. 1920s (Glasgow Museums, E.1979.15.5.1)

Figure 5-17 (Right) Decorative punch detail on toe tip (Glasgow Museums, E.1979.15.5.1)

Even with the addition of simple decorative design details, this shoe would not need to be made in discrete pairs and could have been easily manufactured in large batches. However, despite the uncomplicated construction of the shoe, production would require consistency of execution between machinists to ensure the width between the parallel lines remained the same. The parallel lines have been stitched separately, and the addition of this second line of stitching would make large scale mass production impractical. The parallel lines of stitching illustrate how the manufacturer has chosen to exploit the sewing machine for decorative as well as constructive purposes. The inclusion of simple design details relieves the plainness of the leather. Moreover, without significantly increasing the cost of the product, they also distinguish a classic style. The discreet style of the shoe would increase its appeal, and the same design could be made up in other neutral tones to increase consumer choice.

Four very different interpretations of the same style of shoe illustrate that development of the sewing machine was influenced not only by a desire to increase production but also by the style choices of shoe manufacturers and their relationships with their customers. Singer recognised the significance of product type and style, and in 1908 published a manual for the Boot and Shoe Trade that shrewdly based the company's model ranges around individual products.[32] This 64 page manual, *Singer Sewing Machine in the Shoe Industry*, included detailed descriptions of stitching processes for a range of men's and women's footwear, accompanied with illustrations and diagrams. Each illustration was of a specific type of footwear, and beneath each illustration was listed suggested machine models and their production capabilities (Figure 5-18). In the introduction to the manual Singer acknowledged that the choice of model depended, 'largely on individual judgement and experience, as well as the quality of the shoe to be made […]'[33]


58 THE SINGER SEWING MACHINE

Woman's Fancy Oxford (Button).

Operation.	Singer Machine Used. No.	Daily Capacity (9 hours).
1.—Closing quarter	62-7	1500 prs.
2.—Staying	44-10	1500 "
3.—Making linings	44-30	360 "
4.—Fancy stitching	44-10	36 "
5.—Top stitching	44-26	144 "
6.—Buttonhole	23-4	1500 "
7.—Buttons sewed on	58-4	1440 "

IN THE SHOE INDUSTRY 59

Woman's Fancy Oxford (Lace).

Operation.	Singer Machine Used. No.	Daily Capacity (9 hours).
1.—Closing quarter	62-7	1200 prs.
2.—Staying	44-10	1200 "
3.—Making linings	44-30	480 "
4.—Fancy stitching	44-10	135 ".
5.—Stitching French cord	44-10	135 "
6.—Top stitching	44-26	200 "

Figure 5-18 Page from *Singer Sewing Machine in the Shoe Industry* 1908, featuring model ranges based around shoe type (Hagley Museum and Library)

Singer's range of specialised sewing machine models matched the diversity of production methods found within the British shoe trade and allowed the company to dominate the provision

[32] Hagley Museum and Library, *Singer Sewing Machine in the Shoe Industry* 1908.
[33] Ibid., p. 6.

of sewing machines to the industry. . In 1946 the working party report concluded that at least 150 types of machine were used for the construction and decoration of uppers, and that the Singer Company was responsible for the exclusive supply of almost all of these.[34] Although one of the Singer Company's largest factories was based at Clydebank in Scotland, the majority of machines supplied to the shoe trade were imported from America.[35] The report warned that 'it is politically undesirable for an essential industry to have to rely on import from another country for essential machines of any kind.'[36] Political considerations aside, the fact that the report identified the dependence of the British shoe industry on the Singer Company reveals that the company had not only achieved unrivalled dominance of the industry, but had, more significantly, chosen to serve, and be influenced by, the entire British shoe industry, in all its complexity.

The Singer Company had gained a unique vantage point of the British shoe industry, which enabled the company to appreciate the range and depth of the trade and its diverse needs. Singer not only met the challenges that this presented but also saw an opportunity to serve the industry by diffusing the knowledge and experience that this unparalleled position granted. In the article describing shoe manufacturer Bata, the Singer Company observed:

> we attach much greater importance to giving the fullest satisfaction to our client, than merely making a profit on sales, as it is only by the most efficient service that in the long run we can convince the manufacturer that we are not just the suppliers of machines, but his best counsellors.[37]

Although there is certainly an element of promotional hyperbole in the company's statement, Singer could not have achieved its unique position in a complex manufacturing and retail environment without closely observing its diverse customers' production requirements and product ranges. The Singer Company developed a symbiotic relationship with the British shoe trade and chose not to ignore any aspect of production. The various interpretations of a single shoe style illustrate how the choices and decision of shoe manufacturers could influence Singer's development of specialised sewing machine models.

Object studies reveal that all machine sewn shoes are not the same, nor are they made under the same conditions. The structure of the British shoe industry remained unaltered by the

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[34] *Boots and Shoes*, Working Party Report 1946, p. 102.

[35] The report noted that Clydebank concentrated on the production of domestic machines for export, and needed to produce at least 200 types of the same machine model per week to be economical. The report stated that no more than 200 of the most popular types of model for the shoe industry were purchased annually, therefore, production of the models at the British factory would prove uneconomical for the company, see *Boots and Shoes*, Working Party Report, 1946, p. 102.

[36] Ibid., p. 18.

[37] *The Red 'S' Review*, October 1927, p. 13.

introduction and adoption of the sewing machine. Instead, shoe manufacturers chose to insert the use of the sewing machine into existing flexible business models that had proven successful since the eighteenth century. Models that often combined manufacture with retail. Four interpretations of a single style of shoe illustrate the diversity of production scales and variety of production methods that shoe manufacturers employed to distinguish their products and businesses in a competitive market. Singer, as the dominant supplier of machines for the British industry, responded to the challenges of this complex manufacturing environment with a range of machines that provided both versatility and speed. The quality and style of shoe that a manufacturer wished to produce influenced the choice of machines and materials. These choices and decisions played a significant role in the development of the sewing machine for specialised use in the shoe industry.

Decorative Styles and Machine Innovation

The sewing machine had been created to aid in the construction of objects, and the Singer Company could not have anticipated how shoe manufacturers would creatively manipulate the simple machine stitch to their decorative advantage. Each machine model delivered the same technical advantage to every manufacturer, but it was how these advantages were exploited that prompted innovation and model development. The constant need to distinguish their products encouraged shoe manufacturers to think of new ways to make the design and decoration of their shoes more distinctive than their competitors. The design of a woman's shoe presented countless decorative possibilities. This section uses object studies of women's shoes made between 1870 and 1980 to explore how the versatility and creative ingenuity of shoe makers stimulated the adaption and development of machine models to perform decorative tasks. These studies also provide an opportunity to witness the important relationship between makers and their tools, which lies at the core of any manufacturing business. They also demonstrate that this vital relationship continued to influence the development of the sewing machine after its initial introduction and adoption.

Figure 5-19 Silk and leather shoe made by Samuel Winter, detail of machine top stitching, and hand slip stitching on interior edge, *c*.1912 (Glasgow Museums, E. 1985.7.4)

Figure 5-20 Kid leather bridal shoe, detail of machine top stitched bound edge, *c*.1881 (Glasgow Museums, E.1953.23b)

Top Stitching as a Functional Stitch

An examination of how the ubiquitous straight machine stitch evolved into a decorative stitch, with numerous applications, illustrates both the creative imagination of shoe manufacturers, and emphasises the initiative that design required. Although top stitching, which is a visible stitch on an object used for decorative effect without any functional purpose, was popularised by the use of the sewing machine: it was not a use anticipated by sewing machine manufacturers. Prior to the invention of the sewing machine, top stitching by hand was used solely for functional purposes. In appliqué, top stitching was used to attach pieces of material on top of another material to create a decorative pattern, and in quilting, top stitching formed a decorative stitch pattern whilst holding the quilted layers together. Top stitching was also occasionally used to reinforce the strength of seams under particular stress. Because hand sewing was such a labour intensive activity, all stitch lines had to perform a useful function. The exception was embroidery stitches and Singer chose to develop separate machines to replicate a selection of these. Although the introduction of the sewing machine significantly reduced the labour involved in making a single object, sewing machine manufacturers would have regarded the sewing machine stitch as serving a solely functional purpose.

An elegant shoe (E.1985.7.4), manufactured by Samuel Winter in London *c*.1912, provides two examples of top stitching by machine: the appliqué design and reinforcement of seams (Figure 5-19). The leather around the top of the shoe has been shaped and decoratively punched, then top stitched in place by machine using a contrasting thread. Shoe manufacturers could choose to try and make the use of top stitching less noticeable by using the same colour of thread as the material being sewn, but many realised that a contrasting thread provided an additional decorative effect. The side seams of the shoe, which are just visible, have also been strengthened with top stitching.

This shoe also has an example of a hand stitch, the purpose of which stimulated shoe and garment manufacturers to expand the use of top stitching. A narrow metallic thread binding around the edge of the shoe joins the shoe upper and lining. The binding is caught down on the inside of the shoe with a simple hand stitch known as a slip stitch. Using a binding of matching or contrasting material to the shoe was a popular way to join the shoe upper to its lining. The narrow binding was first sewn to the outside of the shoe upper, and then folded tightly over the top edge of the shoe and securely stitched to the lining inside with small, discreet hand stitches. The slip stitch was used to secure the binding because the needle could be easily manipulated by hand to pass only through the lining of the shoe and remain unseen on the outside of the shoe.

The discreet appearance of the slip stitch could not be replicated by machine, but the popularity of binding the edges of shoes encouraged shoe manufacturers to experiment with other ways to visibly bind a shoe by machine. An ivory leather bridal shoe (E.1953.23 b) made by an unknown manufacturer in Ayrshire *c*.1881, clearly shows a narrow, open weave tape folded over the top of the shoe and attached by a single, visible line of machine stitching in ivory thread (Figure 5-20). Singer recognised the increasing use of the sewing machine for binding shoes, and developed a range of machine attachments that controlled the binding strips whilst they were being sewn. Binding was also a popular way to finish the edge of a shoe and join the upper to its lining because it enclosed the raw edges of fabric and prevented them from fraying. However, if the upper and its lining were made of leather, the edges would not fray, and shoe manufacturers could dispense with the use of binding. Consequently, leather shoes with a visible line of machine stitches joining the upper to its lining became increasingly familiar.

Top Stitching as a Decorative Stitch

Having used their initiative to replace a discreet hand stitch with a machine stitch, shoe manufacturers then explored the potential of visible lines of machine stitching not for functional purposes, but to create entirely decorative effects. A use for the simple machine stitch that sewing machine manufacturers could not have anticipated. A pair of black shoes with a single strap (E.1989.65.10a and b) made in Glasgow by William Vernal and Son *c*.1910, illustrate the effective use of parallel stitch lines for decorative effect (Figures 5-21 and 5-22). Vernal has chosen to follow the entire contour of the shoe edge and strap with not one, but two parallel lines of stitches placed only a few millimetres apart. The two close lines of stitches, which are in black thread to match the leather of the shoe, are placed about a centimetre from the bound edge of the shoe. These stitches have not been used to join the upper to its lining because they are not visible on the inside of the shoe, which means they were stitched whilst the upper and lining were still separate (Figure 23). These close parallel lines of stitches are entirely decorative and brought a subtle and discreet distinction to shoes made by a small Glasgow manufacturer.

Shoe manufacturers found a variety of ways to use parallel stitching to great effect. A pair of shoes made in the 1950s (E.1974.89.21.1 and 2) with a label from McDonalds department store Glasgow illustrate an effective combination of two textures and parallel stitching (Figures 5-23 and 5-24). The toe of the shoe is either a synthetic or patent leather and has been simply, but effectively, decorated with several angled lines of parallel stitching set evenly apart. The shoe is entirely made and stitched in black, but the black suede against the sheen of the stitched toe provides an effective contrast. A pair of moss green shoes made in the early 1960s (E.1979.233.1a and b) with the label of Miss Rayne, illustrate how mass produced shoes could also make simple and distinctive use of a single line of top stitching (Figures 5-25 and 5-26). Although the colour of the thread matches the colour of the shoe, the manufacturer has used a slightly thicker thread for added effect. Top stitching had evolved into a popular and effective design option for manufacturers of all sizes.

 

Figure 5-21 (Left) Black leather shoes with decorative top stitching made by William Vernal and Son, *c*.1910 (Glasgow Museums, E.1989.65.10a and b)

Figure 5-22 (Right) Detail of parallel lines of decorative top stitching (Glasgow Museums, E.1989.65.10a and b)

Figure 5-23 Detail of parallel top stitching along side seam and onto strap (Glasgow Museums, E.1989.65.10a and b)

Figure 5-24 (Left) Suede and patent leather department store shoe, c.1956 (Glasgow Museums, E.1974.89.21 2)

Figure 5-25 (Right) Detail of decorative top stitching detail (E.1974.89.21.2 Glasgow Museums)

Figure 5-26 (Left) Green suede shoes by Miss Rayne featuring top stitching, *c*.1950s (Glasgow Museums, E.1979.233.1a and b)

Figure 5-27 (Right) Detail of top stitching in thicker thread (Glasgow Museums, E.1979.233.1a)

The elegant shoe made in London *c*.1912 by Samuel Winter (E.1985.7.4) also contains another design feature that shoe manufacturers chose to ingeniously combine with top stitching to great effect. The appliqued leather detail is decorated with a simple design of punched holes (Figure 5-19). Although the manufacturer of the London shoe has chosen to apply a pattern of punched holes to the appliqued leather detail, a smart pair of shoes manufactured by William Vernal and Son (E.1989.65.8b), made in *c*.1910, illustrate how effective a simple line of punched holes placed between two parallel rows of stitches could be (Figure 5-28). This simple decorative device is placed around the edges of navy leather applied to navy suede. Vernal has chosen to match thread, leather, and ribbon rather than use any contrasting colour, but the contrast in the textures of the leather and the use of this simple device create a distinctive and well balanced decorative effect (Figures 5-29 and 5-30). This simple device proved very versatile, and shoe manufacturers began to use it to great advantage. In the 1930s another Glasgow manufacturer, Bouyant, used the same device to great effect by increasing the size of the punched holes. In this pair of leather shoes (E.1980.188.3.1) Bouyant used only large punched holes and top stitched lines around the edge of the shoe, the strap, and side seams to create a bold and distinctive decorative effect (Figures 5-31 and 5-32).

The creative use of top stitching, punching, and combinations of each not only offered shoe manufacturers a wealth of decorative possibilities, they also influenced the adaption of sewing machine models for these specific applications. By 1922 the Singer Company had developed models 'Fitted with Two Needles and Automatic Punch Mechanism for Stitching and Perforating Leather Shoe Tips, Etc.'[38] Machine models 22w26, 22w27, 22w31, and 22w32 were designed to stitch parallel lines whilst simultaneously punching a design between them. A selection of fifteen designs was included with the machine, and the operator could modify both the length of the stitch and the distance between perforations. The punch mechanism could also be thrown in or out by a lever, permitting the machine to be used solely for stitching parallel lines. The punch mechanism could also be adjusted to punch through only a single layer of leather, which was 'especially appreciated when it is desired to perforate only the upper piece of leather, when two or more pieces are being sewn together.'[39] Punching designs proved so popular that Singer even developed a non-stitching machine, model 504w1, solely for punching a design in shoe tips in a single operation.[40]

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[38] NMAH TC, box 10, folder 0 – Form 9708 describing Singer machine models 22w36, 22w37, 22w31 and 22w32 published by the Singer Manufacturing Company, May 1925. Form 9708 includes the original copyright date of 1922, which suggests that the models had been developed at that date.
[39] Ibid.
[40] NMAH TC, box 10, folder 0 – Form 9417 describing Singer machine model 504w1, published by the Singer Manufacturing Company, May 1916.

Figure 5-28 (Left) Navy leather shoe by William Vernal and Son, *c*.1910 (Glasgow Museums, E.1989.65.8b)

Figure 5-29 (Right) Detail of punched detail between two parallel lines of top stitching (Glasgow Museums, E.1989.65.8b)

Figure 5-30 Detail of shaped edges with decorative punched detail between parallel stitching (Glasgow Museums, E.1989.65.8a and b)

Figure 5-31 (Left) Leather shoe made by Buoyant, *c*.1930s (Glasgow Museums, E.1980.188.3.1)

Figure 5-32 (Right) Punched holes and parallel stitching detail shaped around side seam and strap (Glasgow Museums, E.1980.188.3.1)

Figure 5-33 Details of punched holes on strap which show discrepancies in spacing between punch holes indicating they were punched individually (Glasgow Museums, E.1980.188.3.1 and 2)

These machines were designed for the large scale production of shoes. The opportunity to reduce three operations to one was obviously a great advantage to large manufacturers, and Singer stated that ‘in shoe factories where these machine are installed […] manufacturers are highly pleased with the economy which is effected by their use.’[41] Singer even offered a separate blower attachment with model 22w36 and model 22w37 to maintain the efficiency of the machine, which included a fan that ‘revolves quietly at high speed and sends air through a flexible tube with ample force to blow the punchings away from the needles.’[42] Although these machines offered large-scale production economic ways of creating decorative details, they still limited the originality of designs. A small selection of punch designs shared amongst so many manufacturers risked becoming standardised and reducing the distinction of a product. Although original designs could be commissioned, a quantity of products with the same design would reduce its distinction. The use of twin needles also limited design options. The distance between the parallel lines of stitching could not be varied, and the shape and contour of pieces to be stitched had to be curved because the fixed needles could not accommodate acute angles or sharp changes in direction. However, the advantages of these machines to large-scale production far outweighed their limitations especially if shoe manufacturers continued to be inventive and original in their choices of materials, colours, and textures.

Volume production was not the goal of smaller manufacturers. They chose not to adopt these machines, and their limitations, in order to maintain their design flexibility and originality. The leather shoes by Bouyant (E.1980.188.3.1) illustrate the originality of the smaller manufacturer. The parallel lines of top stitching could only have been made individually because of their distinctive angles and the width between them (Figure 5-32 and 5-33). Moreover, each perforation has been punched separately because of the discrepancies in the distance between the holes (Figure 5-33). Although machines that combined these operations undoubtedly increased the speed and efficiency of production, smaller manufacturers distinguished their own product lines by varying the widths between lines, and altering the size and dispersion of perforations. In this way, they could produce small batches of distinctive and original designs. For them, the benefits realised in production efficiency did not justify the sacrifice of originality.

[41] NMAH TC, box 10, folder 0 – Singer Form 9708 describing Singer machine models 22w36, 22w37, 22w31 and 22w32 published by the Singer Manufacturing Company, May 1925.
[42] Ibid.

Figure 5-34 Leather shoe by Peter Dickson showing punched holes and ridged detail, *c*. 1940 (Glasgow Museums, E.1980.207.1.2)

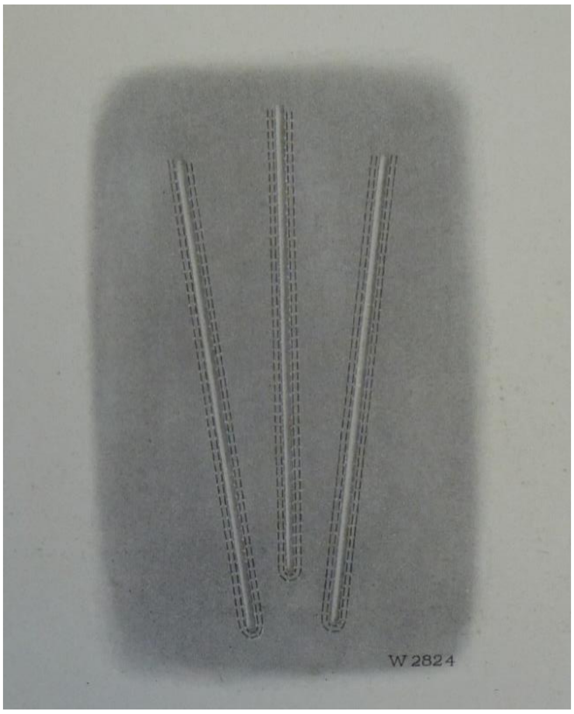

Figure 5-35 (Left) Detail of ridge created by Singer machine model 16w7, additional rows of parallel stitching created by a separate machine, and illustration of detail on gloves from *Singer Sewing Machines in the Manufacturing of Gloves of all Descriptions* 1917 (Hagley Museum and Library)

Figure 5-36 (Right) Illustration of ridged effect on the back of leather gloves from *Singer Sewing Machines in the Manufacturing of Gloves of all Descriptions* 1917 (Hagley Museum and Library)

However, smaller manufacturers were prepared to purchase machine models capable of only a single decorative task if it offered distinctive and original design permutations. A pair of brown leather lace up shoes made in Glasgow by Peter Dickson in the 1950s (E.1980.207.1.2) illustrates a design feature that demonstrates how smaller manufacturers continued to creatively use sewing machines in unexpected and original ways. The individually punched holes of the simple perforated design have been edged not by top stitching alone, but also with narrow continuous ridges of leather (Figure 5-35). The ridge was created by two needles set very close together, which encouraged the leather between them to rise up. The effect was intended to mimic cording or piping, and Singer had designed a machine, model 16w7, to create this effect on the backs of gloves (Figures 5-36).[43] Although the machine will only perform this single task, its use offered many potential design applications. The ridge can form lines or simple curved patterns and shapes. The size of the ridge depended on the thickness of the leather. But even though the width between the needles could not be varied, the ridge formed was still the optimum scale for decorating shoes. Consequently, this type of machine did not have the same limitations as other types of twin needle machines.

The fact that a shoe manufacturer adopted a machine initially designed for decorating leather gloves also reveals the range of decorative possibilities that the creative ingenuity and experimentation of small manufacturers could yield. Despite their mechanical sophistication, sewing machines were still mechanised tools. The design, construction, and decoration of a shoe still required the knowledge, experience, and creative ingenuity of makers and manufacturers. Despite the fact that Singer could not have foreseen the variety of decorative applications found for the sewing machine by shoe manufacturers it did manage, through careful observation and engagement with the shoe industry, to successfully develop models that exploited those creative uses.

Conclusion

Object studies emphasise that all machine-sewn shoes are not the same, nor are they made under the same manufacturing conditions. Although the British shoe industry was a mosaic of large and small businesses, which were involved in both batch and mass production, the introduction of the sewing machine did not alter its structure. The British shoe industry was based upon flexible business models that had proven successful since the eighteenth century, and which allowed manufacturers to maintain close relationships with their customers by combining manufacture with retail. After the adoption of the sewing machine British shoe manufacturers continued to employ a variety of production methods to distinguish their products and businesses in a competitive market. The Singer Company, as the dominant supplier of sewing

[43] Hagley Museum and Library, *Singer Sewing Machines in the Manufacturing of Gloves of all Descriptions* ([New York]: Singer Sewing Machine Company Incorporated, 1917), pp. 36-37.

machines to the British shoe industry, responded to the challenges of this complex market with a range of machines that provided both versatility and speed.

The structure of a trade can reveal the importance of the relationship between object makers and their tools, and emphasise the significance of this relationship to the development of the sewing machine. Small manufacturers in the British shoe industry competed successfully with larger manufacturers by producing distinctive products. The sewing machine could be exploited for decorative as well as constructive purposes. The creative manipulation of the sewing machine in ways that could not have been anticipated by the Singer Company produced distinctive and original products for smaller manufacturers and prompted the development of machines for solely decorative purposes. The creative manipulation of the sewing machine highlights human initiative and emphasises the significance of the relationship between makers and tools to the development of the sewing machine. The next chapter, therefore, looks more closely at the human role in the process of mechanisation, and identifies the importance of human skill and proficiency to machine development. The sewing machine depended upon human operators, and their varying degrees of skill and proficiency proved to be important considerations in the development of new technology.

Chapter 6 Exchanging the Needle for the Sewing Machine: The Human Role in the Process of Mechanisation

> The sewing machine is no mere toy, and the prospective machinist will find that there is a great deal to be learnt before becoming a competent machinist; and he who now classes himself as a competent will discover how much he does not yet know of the instrument upon which he is operating.
>
> *The Tailor and Cutter*, 25 January 1912

> It is a measure of the desirable properties of the join produced by a sewing machine that this machine, and its associated operator, has remained unchallenged for so long.
>
> *Technology and the Garment Industry*, 1971[1]

Despite its mechanical sophistication, the sewing machine is a mechanised tool that relies entirely upon human operation to optimise its productive capabilities and exploit its potential. The sewing machine and operator represent a single, and indivisible, unit of production. Yet, despite the fact that the operator is integral to machine operation, their influence on development has rarely been considered or acknowledged. This final chapter, therefore, focuses on the varied skills and competencies of the machine operator to reveal the influence of human ability and versatility on the development of the sewing machine for manufacturing purposes. Object studies reveal the range of human proficiency, and descriptions of machine operation in Singer catalogues and manuals serve to underline the significance of the human role in the process of mechanisation.

Mechanical sophistication has veiled the dependence of machine operation on human skill, dexterity, and versatility. And although the impact of mechanisation on human skill has received much scrutiny and attracted considerable debate, there has been little consideration of the influence of human skill on technological development.[2] Industrial sewing machines are

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[1] NEDO, *Technology and the Garment Industry*, p. 10.

[2] The discourse on capitalism and labour history continues to be influenced by the work of Karl Marx, for his discussion of the process of mechanisation and its impact on machinists, see Marx, 'The Division of Labour and Manufacture' (pp. 455-491) and 'Machinery and Large-Scale Industry' (pp. 492-562), in *Capital: A Critique of Political Economy. Vol. 1*; for an examination of nineteenth century industrialisation, see Berlanstein, *Industrial Revolution and Work in Nineteenth Century Europe*; for an early contemporary consideration of the impact of technology, which stated in its introduction, 'technology is not a vessel into which people are to be poured and to which they must be molded', see *Technology and the American Economy*: *Report* ed.by the National Commission on Technology,

mechanised tools, which though they vary considerably in scale, speed, and complexity still rely upon a range of human skills for operation. However, focus on the impact of mechanisation has marginalised the role of the machinist, and undervalued the tacit knowledge that is so vital to efficient and effective machine use.[3] What is also overlooked is the fact that not all machinists are alike. The diversity of product quality, construction, and output created a range of manufacturing conditions that demanded different levels of skill and flexibility. Consequently, this range of human aptitude had to be considered when developing new machine models for manufacturing. Machinists had no formal control over the direction of machine development However, their versatility stimulated the design of new models, which had consequences for the business of both machine production and stitched object manufacture.

A discussion of how human skill influenced development of the machine relies upon evidence of skill in relation to machine use, and there has been considerable debate among historians and sociologists over how this evidence can be identified and usefully measured.[4] Skill has been appraised through observation, questioning of machinists, and even participation.[5] However,

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Automation, and Economic Progress (Washington: U.S. Govt Print Off, 1966), p. xiii; for an early discussion of technology and skill, see Robert Blauner, *Alienation and Freedom: the factory worker and his industry* (Chicago; London: Chicago University Press, 1964); for a philosophical viewpoint, see Arthur Koestler, *The Ghost in the Machine* (London: Arkana, 1967); the seminal work of Harry Braverman, which argued that human operators had become deskilled and passive victims of mechanisation and industrialisation, prompted further economic and sociological debate on the impact of mechanisation on human skill during the twentieth century, see Braverman, *Labour and Monopoly Capital*: *The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974); although Braverman has been lauded for the pertinence and scope of his work, his deskilling hypothesis has been discussed and refuted by several historians, see *The Degradation of Work? Skill, Deskilling and the Labour Process*, ed. by Stephen Wood (London: Hutchinson, 1982); William Form, 'On the Degradation of Skills' in *Annual Review Sociology*, 13 (1987), 29-47; *Technology and the Future of Work* ed. by Paul Adler (New York; Oxford: Oxford University Press, 1992); *Skill and Occupational Change*, ed. by Roger Penn, Michael Rose and Jill Ruberry, (Oxford: Oxford University Press, 1994); Keith Grint and Steve Woolgar, *The Machine at Work: Technology, Work and Organisation*, (Cambridge: Polity Press, 1997); Francis Green, *Skills and Skilled Work* (Oxford: Oxford University Press, 2013).

[3] Tony Manwaring and Stephen Wood stated, 'management must draw upon and harness the tacit skills of workers in all labour processes to maximise productive efficiency', see Manwaring and Wood, 'The Ghost in the Labour Process', p. 181; for a detailed empirical analysis of tacit skills see Ken C. Kusterer, *Know-How on the Job: The Important Working Knowledge of "Unskilled Workers"* (Boulder, Colarado: Westview Press Inc., 1978).

[4] Paul Attewell discusses the difficulties in conceptualising skill using a comparison of four current approaches, and states 'like so many common sense concepts, skill proves on reflection to be a complex and ambiguous idea', see Attewell 'What is Skill?" in *Work and Occupations*, 17.4 (November 1990), pp. 422-448 (p. 422); for an analysis of current methodologies and their value to the measurement and identification of skill, see Kenneth I. Spenner, 'Skill: Meanings, Methods, and Measures' in *Work and Occupations*, 17.4 (November 1990), pp. 399-42.

[5] For the use of both qualitative and quantitative data, see *Skill and Occupational Change*, ed. by Roger Penn et al; Ken C. Kusterer both observed workers in situ, and questioned workers about their own perceptions of their work and level of skill, see Kusterer, *Know-How on the Job*; in a comparison of approaches to tacit skill, Devinatz observed workers and recorded interviews with them. He also chose to

although all of these methods can provide assessments of skill, the tangible evidence of skill apparent in the construction of machine sewn objects has been overlooked. The proficiency of the machinist, and their ability to control the machine, is revealed in both the construction of an object and in the level of accuracy and consistency of its stitching. As Heather Lechtman and Arthur Steinberg observed, '[because] there is no intermediary between the individual and the artifact during the actual process of manufacture, we can certainly gain some insights into individual skill and craftsmanship […].'[6] Moreover, a comparison of stitched objects distinguishes the different levels of skill among machinists, which was an important factor in the development of new models. Not least, objects can provide reliable evidence of skill when it is no longer possible to collect testimony from machinists or observe the operation of machines under manufacturing conditions.

In addition to object studies, evidence of the relationship between human skill and the use and development of Singer machine models can be found in a variety of documents published by the Singer Company during the twentieth century. Observations about the role of the operator appear in both Singer catalogues and its manuals for machine operation. Whilst commentary on the role of skill in relation to the use of Singer machine models can be found in articles published in Singer's internal company magazine, the *Red 'S' Review*. Although the purpose of the articles in this publication was to provide staff with information about the range and success of Singer products, they can also offer an insight into how Singer machines were integrated into production and how operators were trained. In addition to Singer publications, in 1912 a series of articles published in a prominent British trade journal, *The Tailor and Cutter*, described how to use a sewing machine, and the machine featured was a Singer model 31K15.[7] The level of detail and approach to the subject found in these articles indicate that the author had practical experience of both machine sewing and the construction of tailored garments. Consequently, they can provide reliable evidence of the skill set required to operate a Singer sewing machine.

The chapter is divided into three sections. The first section establishes the importance of human skill to machine operation by using detailed descriptions of what machine adoption entailed from the series of articles published in *The Tailor and Cutter* in 1912.[8] This series of articles, and the identifiable need for them, demonstrated that the adoption of the sewing machine

work full time for six months as a participant/observer, see Victor G. Devinatz, 'Kusterer or Manwaring and Wood on the High-Tech Labor Process? Analyzing the Nature of Skill, Deskilling and Managerial Control of Labor in a U.S. Medical Electronics Factory', *Employee Responsibilities and Rights Journal*, 17.1 (2005), 3–17 <https://doi.org/10.1007/s10672-005-1810-2>.

[6] Heather Lechtman and Arthur Steinberg 'The History of Technology: An Anthropological Point of View', p. 151.

[7] An early article in the series familiarised the reader with the sewing machine, and the model described was a Singer model 31 K15, see *Tailor and Cutter*, 1 February 1912, pp. 80-81.

[8] The articles were consulted in yearly bound volumes, 1912 was Vol. XLVII.

required more from an individual than a simple exchange of tools. The second section uses samples of stitching from object studies to illustrate the range of human proficiency, and demonstrate that individual use of the machine varied significantly. The final section discusses how differences in human ability influenced the development of new models for manufacturing purposes. A combination of machine models and contemporary analysis and commentary will be used to explore the influence of human flexibility and versatility on three separate aspects of machine development: speed, calibration, and automation.

A Unit of Production: Machinist and Machine

In 1912, a series of articles titled 'The Art and Science of the Sewing Machine' appeared in the reputable British trade journal, *The Tailor and Cutter*. These articles, written by an author known only by the initials L. L. provide a rare written account of the competencies required for successful machine operation and its integration into the business of tailoring. They also reveal that use of the sewing machine was not intuitive and required the acquisition of new skills. The need for these articles also demonstrates that the process of mechanisation was not a fait accompli by the close of the nineteenth century. Resistance to machine adoption, at some level of the needle trades, persisted well into the twentieth century.[9] Consequently, machine adoption had to overcome both the dichotomies within a trade and its lack of familiarity with this new technology. *The Tailor and Cutter* was first published in 1866. It was widely circulated among tailors at every level of the trade and its articles described both changes in fashion and the conditions of the trade. The active encouragement of sewing machine use by a trusted trade journal 60 years after the machine's invention is notable because it demonstrates that exchanging the needle for its mechanised counterpart was neither a simple nor straightforward task.

Stitching with a needle and stitching with a sewing machine are significantly different tasks. Those capable of stitching with one tool are not automatically able to stitch with the other. The series of articles in *The Tailor and Cutter* acknowledged these differences and provided detailed advice about how machine proficiency could be acquired. The author described to readers what adoption of the sewing machine entailed, and emphasised that machine proficiency was neither quickly nor easily accomplished. The series covered the physical and technical adjustments that

[9] In 1910 *The Tailor and Cutter* asked several tailoring firms about their adoption of the sewing machine, and one of the firms replied, 'whilst one may expect to find the fullest use of the machine in the cheaper trades, yet when we come to those few firms whose customers are to be found amongst kings and princes, then its use will be very strictly limited, and, as a rule, it will not be used at all.' *The Tailor and Cutter*, 24 November 1910, p. 1016 (Vol. XLV).

sewing by machine demanded, and explained how to combine existing knowledge of garment construction with the use of a new mechanised tool. The articles, which appeared every week, were intended to accompany physical use of the sewing machine because they constantly encouraged repetitive practice of new skills. The author assumed no prior knowledge of machine use and warned readers of the difficulties associated with each new machining task. The circulation of the journal would have guaranteed wide dissemination among the employees of tailoring firms across the country, but whether they were intended for use in conjunction with onsite training is not clear.

The first subject of the articles was the choice of machine and a description of how it operated. The author chose a Singer model 31K15 because it was regarded as, 'the most popular one in use in tailors' workshops all over the world, and which expert machinists have accepted as the most durable and reliable for all purposes of garment making.'[10] The article was illustrated with a photograph of the machine, which included a detailed description of all the machine parts. This level of detail was no doubt included because most potential users would have been unfamiliar with the machine, and entirely unaware of how it would have functioned. The author even admitted that the full potential of the machine was rarely realised because, 'the operator or machinist has not got the grip, or the knowledge of the uses of the various mechanical appliances […].'[11] This observation emphasised that the most effective use of a sewing machine would always rely entirely upon the knowledge and experience of its operator, rather than the engineering sophistication of the machine.

The next subject that the author introduced was the distinctive physical differences between sewing with a needle and sewing with a machine. The most crucial of these was transferring control of the needle from the hand to the foot. The control and speed of a sewing machine needle were governed by the movement of the machinist's feet upon a treadle rather than by the hand of the machinist. However, despite the fact that effective use of the machine relied upon this significant transfer of control, the author noted that:

> this important factor is overlooked by nine out of every ten machinists […] the proper treadling of the machine has been entirely neglected, whilst in reality it is the first thing the machinist should be trained to do, so that his feet should become accustomed to propelling the needle bar, which is known amongst experts as "timing". [12]

Moreover, the author advised that 'timing' was vital for control of a power-driven machine, and observed that:

[10] *Tailor and Cutter*, 1 February 1912, p. 80.
[11] *Tailor and Cutter*, 18 January 1912, p. 44.
[12] *Tailor and Cutter*, 1 February 1912, p. 81.

> no person should be placed on a power-driven machine without first having had at least 12 months training with a foot treadle. It is on a power driven machine where knowledge of "timing" is required, as only one foot is used to touch the treadle to connect the driving shaft.[13]

The author's emphasis on 'timing' demonstrated that transfer of control from hand to foot was not instinctive. The suggestion that this control could take a year to learn underlines the fact that sewing with a machine was not intuitive for someone who had learned to sew with a needle.

Because stitching with a machine was entirely counter-intuitive to stitching by hand with a needle, a machinist also had to learn how to handle and manipulate object and garment pieces whilst operating the sewing machine. In sewing with a needle, the item to be stitched remains stationary, whilst the needle passes through it in a direction running parallel to the body. In machine sewing, the needle position remains fixed, and the object pieces have to be manipulated beneath the needle in a direction moving away from the body. For this reason, the author admitted that, initially, sewing certain complex shapes by machine would prove, 'very difficult for the first time; but all things are difficult when first being practised: however, it has to be done, otherwise none of us would gain experience and become experts.'[14] No matter how proficient someone might be with a needle, their ability could not simply be transferred because of the physically different way objects had to be manipulated when using a sewing machine.

In addition to the physical adjustments that the sewing machine demanded from the machinist, the author also drew attention to the technical adjustments that the sewing machine required. Although the machine could automatically make a stitch, the author stressed that it was still the responsibility of the machinist to correctly regulate the length and tension of that stitch. As the author pointed out, 'the practical hand-sewing tailor knows what size needle to use upon different materials, and so the machinist must know how to regulate his machine to produce similar results.'[15] The author claimed that 'bad sewing' was often blamed on the machine, when in fact it was the fault of the machinist and their failure to use the correct needle and tension the stitch accurately.[16] The sewing machine was a mechanised tool, and its correct calibration depended entirely upon the choices and decisions of the machinist.

This series of articles not only described the differences between sewing by hand and sewing with a machine, it also emphasised that machine proficiency required time and practice. Six months into the series, the author remarked, 'even the most sceptical hand sewing tailor, must admit, from what has already appeared under this heading, and what is to appear in the future,

[13] *Tailor and Cutter*, 1 February, 1912, p. 81.
[14] *Tailor and Cutter*, 18 July 1912, p. 566.
[15] *Tailor and Cutter*, 18 January 1912, p. 44.
[16] *Tailor and Cutter*, 1 February 1912, p. 81.

that the sewing machine is a science, and to acquire practical knowledge of this takes a longer time […] than some people anticipate.'[17] Moreover, the author believed that to become fully competent would take years rather than months. The author observed that, 'It has been stated that machine work can be learnt in six months. I believe those who have followed these articles are already convinced that the science of machine work cannot be learnt, and experience gained on all kinds of garments, under six years.'[18] Although this level of knowledge and experience was not required by every workshop, the fact that the author believed that it could take almost six years to become highly proficient with a machine acknowledges the challenges that accompanied its adoption.

The first articles in the series emphasise that machine adoption did not constitute a reduction of skill, but, in fact, required the acquisition of new skills by the machine operator. C. & J. Clark had been making shoes by hand for more than 20 years before the purchase of their first sewing machine in the mid-nineteenth century. After its purchase, William S. Clark had to spend three months mastering the use of the machine before the company could begin to train its employees.[19] The operator was integral to effective machine use, and the adoption of mechanised tools challenges the argument of both Marx and Braverman that capitalist control reduced human agency in the workplace.[20] Adoption of the sewing machine demonstrates that the introduction of mechanisation did not erode either craft or skill, but instead, as the historian, Mary Freifeld, astutely observed, 'provided in many instances the foundation for the reconstitution of skill on a new basis […] One highly complex task had been substituted for another […].'[21] The author of the articles in *The Tailor and Cutter* emphasised the value of a well-trained machine operator, and believed that, 'next to the practical cutter the expert machinist is the man of the future in the clothing industry.'[22]

Having described in detail how to operate the sewing machine, the author used the remaining articles in the series to discuss how to combine knowledge of garment construction with

[17] *Tailor and Cutter*, 11 July 1912, p. 544.
[18] *Tailor and Cutter*, 8 August 1912, p. 621.
[19] George Barry Sutton, *C. & J. Clark 1833-1903: A History of Shoe Making in Street* (York: William Sessions Ltd., 1979), p. 33.
[20] This perspective of Marx and Braverman has been criticised by several historians, see Tony Elger, 'Braverman, Capital Accumulation and Deskilling' in *The Degradation of Work*, ed. by Stephen Wood, pp. 25-53; Paul Adler also stated 'even its partisans, however, had some difficulties with this de-skilling thesis. In particular, doubts began to crystallize around the implicit assumption of managerial omniscience and omnipotence. Moreover, none of the larger statistical studies offered any support for the de-skilling diagnosis', see Adler, *Technology and the Future of Work*, p. 7.
[21] Mary Freifeld, 'Technological Change and the "Self-Acting" Mule: A Study of Skill and the Sexual Division of Labour', *Social History*, 11.3 (1986), 319–43 (p. 322) < http://dx.doi.org/10.1080/03071028608567661>.
[22] *Tailor and Cutter*, 22 February 1912, p. 149.

machine operation. Although knowledge of construction could be transferred from sewing with a needle to sewing with a machine, it still needed to be adapted. As the author remarked:

> some people have a notion that the sewing machine is only an instrument or some kind of mechanical appliance for plain sewing, but the most important fact has been overlooked […] that the machinist has to have a great store of knowledge of tailoring, apart from actual knowledge of how to use the sewing machine so as to fit it in with his knowledge of tailoring.[23]

The remainder of the series explained how to construct every part of a garment, from the internal layers to the external decoration, by machine. The author admitted that it was impossible to include every type of garment's construction, but aimed to include as many of the basic principles and methods as possible.

The fact that the author took time to carefully describe how tailoring could be adapted to machine use demonstrated that a description of how to calibrate and operate a machine was not enough to make a machinist fully proficient. As Ben Fine and Ellen Leopold observed, 'the manufacturing of clothing was based upon the mechanisation of tailoring practices rather than on the wholesale transfer of the production process to machinery […] mechanisation in this case served to reinforce rather than undermine the craft basis of production.'[24] Even after the adoption of mechanised tools, stitched object production still relied upon both knowledge of construction and experienced use of tools. The series of articles in *The Tailor and Cutter* emphasised the pivotal role of the machine operator, and demonstrated that what was required from the machine operator for successful machine adoption should not be underestimated. The process of mechanisation demanded more than the purchase of the machine.

Revealing the Machinist

Despite the mechanical ingenuity of the sewing machine, exploitation of its potential depended entirely upon the knowledge, proficiency, and experience of the machinist. However, not all operators were alike. The sewing machine could be calibrated to create a uniform stitch, but consistent, even lines of stitching were entirely due to the proficiency of the machinist rather than the engineering of the machine. Only an examination of machine sewn objects can provide tangible evidence of the range of human proficiency. Therefore, this section will use examples of stitching from shirts and shoes to illustrate the different levels of machine control, object manipulation, and knowledge of construction. Examples are selected from a range of time periods rather than following any strict chronology in order to demonstrate that although the

[23] *Tailor and Cutter*, 27 June 1912, p. 506.
[24] Ben Fine and Ellen Leopold quoted from Adam Briggs, '"Capitalism's Favourite Child"', p. 191.

sewing machine became an increasingly familiar and more sophisticated mechanised tool, each succeeding generation and each individual operator still had to learn how to use it. This selection of samples emphasises that the quality of the stitched item depended entirely upon the proficiency of the machinist and the standards to which they were held. And evidence of the different levels of ability distinguishes the human presence in the process of mechanisation.

Figure 6-1 (Left) Detail of even stitching on binding, *c*.1892 (Glasgow Museums, E.1977.97.5.2)

Figure 6-2 (Right) Ivory kid leather pump, *c*.1892 (Glasgow Museums, E.1977.97.5.2)

Figure 6-3 *(*Left*)* Detail of uneven top stitching on shoe binding, *c*.1881 (Glasgow Museums, E.1953.23b)

Figure 6-4 (Right) Ivory kid leather pump with silk bow, *c*.1881 (Glasgow Museums, E.1953.23b)

Control of the machine remains one of the most significant challenges for any machinist. If a machinist could not control the speed and operation of a machine, whilst simultaneously manipulating garment or object pieces, knowledge of construction would prove of little value. Even the construction of simple objects or the stitching of long straight lines demanded a certain level of ability, as well as familiarity with a sewing machine. Although the machine was calibrated to create a uniform stitch, only a machinist who could control a machine could stitch an even stitch line. An examination of stitched objects reveals the proficiency level of the machinist and demonstrates that control of the machine could vary widely.

A comparison of the top stitching on two pairs of nineteenth-century women's pumps provides evidence of the different levels of machine control. Both pairs of shoes were made of ivory kid leather, with a narrow cotton tape binding the shoe upper to its lining, and decorated with a large silk bow (Figure 6-2 and 6-4). However, despite the similar methods of construction, a comparison of the bound edges shows that the stitch line is much more even on the shoes made *c*.1892 (E.1977.97.5.2) than those made *c*.1881 (E.1953.2.3.b). The machinist in 1892 demonstrated much better control of the machine and was able to evenly stitch the binding around the entire edge of the shoe (Figure 6-1). Whilst the machinist in 1881 appeared to have had difficulty maintaining an even distance from the edge of the shoe, especially as the shoe turned at the front (Figure 6-3). Because the design of the shoes is so similar, the uneven stitching becomes more obvious and reveals the individual ability to control the machine whilst manipulating the shoe.

A comparison of two pairs of shoes made during the interwar period serves to illustrate that good control of the machine was not restricted to the production of high quality products but could be found at every level of manufacture. The visible top stitching on a pair of ivory silk shoes (E.1981.128.1 a and b) made by the Scottish shoe manufacturer and retailer James Allen and Sons during the 1930s is extremely even, especially around the distinctively shaped textured fabric, and shows that the machinist had excellent control of the machine (Figure 6-5). Although the shoes were made under factory conditions, the choice of contrasting fabric textures and the elegant details on the shoe laces suggest that these shoes were produced in small batches for discerning middle class customers. In contrast, a pair of lilac silk shoes (E.1976.112.1 and 2) made for the Glasgow shoe manufacturer and retailer A. L. Scott during the 1920s was almost certainly mass produced, possibly by the Bata Company in Czechoslovakia, one of Europe's largest shoe manufacturers. Despite their much simpler design, the even top stitching around the edge of the shoe bears favourable comparison with the stitching found on the ivory silk shoes (Figure 6-6). Although working on very different styles of shoes and at very different levels of production, machinists in both factories displayed excellent control of the machine.

Figure 6-5 (Left) Ivory silk shoe made by James Allen and Sons, *c*.1930s (Glasgow Museums, E.1981.128.1a)

Figure 6-6 (Right) Lilac silk shoe made by A. L. Scott, *c*. 1920s (Glasgow Museums, E.1976.112.1)

Manufacturers desired product uniformity and would set precise standards to ensure this. For this reason, machinists had to have good control of the machine in order to maintain consistency between products. In 1953 a British clothier, David Black, secured a contract to manufacture blouses for female military personnel from the Ministry of Supply. The contract was accompanied with detailed and precise manufacturing instructions for every aspect of the garment's construction. This instruction included 20 separate points, some of which had additional sub-clauses.[25] The Ministry even specified the number of machine stitches to be used. It advised that there should be no fewer than 9 stitches nor more than 11 stitches to the inch. It also advised that the top stitching should be ¼ of an inch from the edge of the collar, breast pocket flaps, and shoulder straps, but to the edge of the pockets, waistband, and cuffs. The precision of these instructions demanded a high level of accuracy and consistency from machinists. Although the machine could be calibrated to produce the desired stitch length, consistency in production was due to the proficiency of the machinist rather than the machine.

In order to ensure consistency in production manufacturers frequently provided staff with training. An article published in the *Red 'S' Review* described the process of handkerchief making at a factory owned by the Tootal Company, and highlighted the level of accuracy that

[25] Mitchell Library Special Collection TD 1422/26/9 – Contract 6/CLO/25035 from the Ministry of Supply, 1 September 1953.

training had secured. The article observed that, ‘comparing one operator’s work with another it can be seen that the uniformity is kept up the whole time. One can even go so far as to scrutinize the stitching through a magnifying glass. No difference is shown from one week’s end to another.’[26] Although the article mentioned the valuable contribution of several Singer machine models, it underlined the importance of the machinist and the training that they had received. It stated:

> the manipulation by the various operators is expert in the extreme, and calls for ample recognition. Indeed, throughout the whole factory the ease with which the girls perform their duties bespeaks remarkable adeptness and competence. It offers wonderful tribute to the efficiency of the instructors through whose hands every worker passes before commencing her duties.[27]

The challenge for the machinists was not the hemming of handkerchiefs, which was a relatively simple machining task, but the maintenance of such a high level of stitching accuracy to ensure product consistency.

Achieving this level of accuracy and product consistency was not easily accomplished and, despite training and quality control, human abilities still varied. A comparison of two army shirts made by the same manufacturer *c*.1939-1945 illustrates that although each shirt has been constructed in an identical way, most likely on the same model of machine, small inconsistencies in stitching can still be observed. A closer look at the cuffs shows that although the distance between the top stitching and bottom edge of the cuff is almost identical on each shirt, the top stitching is more erratic around the top edge where the cuff is joined to the sleeve (Figures 6-7 and 6-8). A comparison of the collar stand also reveals that the top stitching around the front edge, closest to the button hole, is uneven on each garment (Figures 6-9 and 6-10). It is likely that separate parts of the shirts were produced by different machinists, and eventually machined together in the finished garment. These small inconsistencies reveal not only the individuality of the machinist but also the difficulties involved in maintaining overall product consistency. Although a machine could be mechanically calibrated to produce identical stitches, product consistency still depended on individual human aptitude.

[26] *Red ‘S’ Review*, November 1926, p. 8.
[27] *Red ‘S’ Review*, November 1926, p. 8.

Figure 6-7 (Left) Uneven stitching on the join between cuff and sleeve, army shirt 1939-1945 (Glasgow Museums, A.1975.6.r.1.1)

Figure 6-8 (Right) Uneven stitching on a duplicate shirt shows the inconsistencies between garments (Glasgow Museums, A.1975.6.r.1.2)

Figure 6-9 (Left) Uneven top stitching around collar edge, army shirt 1939-1945 (Glasgow Museums, A.1975.6.r.1.1)

Figure 6-10 (Right) Uneven top stitching around collar of duplicate shirt shows inconsistencies between garments (Glasgow Museums, A.1975.6.r.1.2)

The sewing machine could be used to make both high and low quality products. However, although it was the manufacturer who determined a product's quality and standard of finish, these were executed by the machinist. And, like machine proficiency, these standards could vary significantly. A comparison of two underarm shirt seams illustrates that machinists could be held to very different standards. The seam that joins the sleeve to the body of a cotton army shirt (A.1975.6.r.1.1 GM) made *c*.1939-45 although not perfectly matched, is much more evenly matched than the same seam of a navy cotton shirt (E.1979.17.2 GM) made *c*.1951 (Figures 6-

11 and 6-12). Although both shirts are nearly identical in construction, the standard of finish between the garments varies visibly. The unevenness of the seams singles out the proficiency of the machinist and the standards of the manufacturer rather than the machine.

Figure 6-11 (Left) Army shirt 1939-1945, underarm seam almost matches, (Glasgow Museums, A.1975.6.r.1.1)

Figure 6-12 (Right) Navy mine watcher's shirt *c*.1951, underarm seam does not meet (Glasgow Museums, E.1979.17.2)

Different standards can also be seen in a comparison of shoes made using similar materials and simple designs. A pair of yellow synthetic patent shoes (E.1989.45.1a and b) made during the 1970s have been very evenly stitched with a fine thread and a small stitch (Figure 6-13). Whereas a pair of orange synthetic patent shoes (E.1984.116.5) made during the 1960s, although relatively evenly stitched, have been stitched with a much thicker thread and a longer stitch (Figure 6-15). The treatment of raw edges is also very different. The stitching around the raw edge of the strap of the yellow shoes is neatly finished making it barely visible (Figures 6-14), but the stitching around the raw edge of the strap of the orange shoes is much more untidy and the ends of thread can still be seen (Figure 6-16). Both pairs of shoes have a simple and stylish design, but the choice of thread and standard of finish has made a significant difference to their overall quality. Although both pairs of shoes were most likely mass produced, and could even have been made using the same model of machine, the manufacturers held the machinists to different standards.

Figure 6-13 (Left) Yellow synthetic patent leather women's shoes, *c*.1970s (Glasgow Museums, E.1989.45.1a and b)

Figure 6-14 (Right) Detail showing use of a fine thread and clean finish of raw edge on strap (Glasgow Museums, E.1989.45.1a)

Figure 6-15 (Left) Orange synthetic patent leather women's shoes, *c*.1960s (Glasgow Museums, E.1984.116.5)

Figure 6-16 (Right) Detail showing use of thicker thread and untidy seam (E.1984.116.5 Glasgow Museums)

Figure 6-17 (Left) Silk uppers with appliqué decorative leather, *c*.1912 (Glasgow Museums, E.1985.7.4)

Figure 6-18 (Right) Navy leather tongue inserted between upper and lining, *c*.1930s (Glasgow Museums, E.1985.103.2a and b)

Figure 6-19 (Left) Gathered and overlapped fabric upper, *c*.1940s (Glasgow Museums, E.1984.78.21a and b)

Figure 6-20 (Right) Gold lamé strips overlapped and inserted between upper and lining, *c*.1970s (Glasgow Museums, E.1981.52a and b)

Examples of stitching demonstrate that the human remained the versatile and flexible element in production, much as they had been before the introduction of mechanised tools. The sewing machine offered stitched object manufacturers valuable increases in productivity. However, these could only be realised through effective use of the machine. And effective use of the machine depended entirely upon the skill and proficiency of each individual machinist. No matter how sophisticated the sewing machine became, only good machinists could ever exploit its full potential.. Clara Collet, who had observed and written about female employment throughout the late nineteenth century, noted in 1891 that, 'smaller clothiers endeavour to get experienced workers who can get a greater quantity of work out of one machine.'[28] A reliance on skill and experience did not diminish during the twentieth century. The historian, Andrew Finlay, observed that Derry shirt manufacturers preferred 'women to be competent in two or three operations', and German shirt manufacturers in the 1970s, concentrating on the batch production of fashionable garments, relied upon their machine operator's ability to adapt quickly to different styles.[29] The advantage of skilled and experienced machinists was acknowledged and exploited by manufacturers.

Knowledge of construction was an important part of the machinist's role, and examples of women's shoes and men's shirts from across a century of mechanised production provide evidence of why this knowledge was so valuable. Stitched objects not only illustrate the changing variety of styles and the introduction of new materials, they also emphasise that the purpose of the sewing machine was to construct objects. Knowledge of construction is arguably as important as knowing how to operate a sewing machine successfully because even modest adjustments to the style of a stitched object required the machinist to adapt. Competitive markets and changes in fashion encouraged constant changes to the style of objects. Only machinists willing and able to update their knowledge of construction could accommodate this constant change.

Four examples of women's shoes illustrate the variety of ways the shoe upper could be attached to its lining. The first example of shoes (E.1985.7.4) made *c*.1912 has a simple contour and the fabric upper has been bound to its lining. However, despite the relatively simple construction, the silk has a decorative appliqué design of shaped, top stitched and punched contrasting leather (Figure 6-17). The second example (E.1985.103.2a and b) made during the 1930s shows a

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[28] Clara Collet, 'Women's Work in Leeds', p. 469.

[29] Andrew Finlay, 'The Cutting Edge: Derry Shirtmakers' in *Gender and Irish Society* ed. by C. Curtin, P. Jackson, and B. O'Connor (Galway: Galway University Press, 1987), pp. 87-107 (p. 92); Hilary Steedman and Karin Wagner, 'Productivity, Machinery and Skills: Clothing Manufacture in Britain and Germany', *National Institute Economic Review*, 128.1 (1989), 40–57 <https://doi.org/10.1177/002795018912800104>.

tongue of navy leather inserted between the decoratively shaped edges of the upper and lining of the shoe (Figure 6-18). The third example (E.1984.78.21a and b) made during the 1940s required the shoe upper of separate fabric pieces to be gathered and overlapped before joining to a single lining (Figure 6-19). And the final example (E.1981.52a and b) made during the 1970s has separate narrow fabric strips interwoven before insertion between the shoe upper and lining (Figure 6-20). Each example, although, taken from different periods demonstrates that shoe styles and materials underwent continuous fashionable changes.

Four examples of men's shirts illustrate the different ways the single feature of a garment could be treated. The first example of a striped cotton shirt (K.2006.228 GM) made *c*.1850s has an attached facing to the front of the shirt to support the buttonholes, but the opening does not run down the entire front (Figure 6-21). The second example of a white cotton evening shirt (1968.470 NMS) made *c*.1900-1910 has a flat inserted panel instead of a front facing. The opening of the shirt also does not run the entire length of the front of the garment (Figure 6-22). The third example of a nylon evening shirt (E.1986.21.3 GM) made during the 1950s also does not open entirely down the front. Moreover, the buttonholes have been concealed because of decorative ruffles, which means that the shirt opening required a more complicated construction than an attached facing (Figure 6-23). In the final example of a boutique shirt (E.1984.116.46 GM) made during the 1960s, a zip in the back of the shirt has entirely replaced a button front opening, and Velcro replaces the button holes and buttons of the cuff (Figure 6-24). The first three examples demonstrate that there could be a number of variations for a single garment feature, and the final example demonstrates that new fashionable ideas could completely replace features that had survived for a century.

These examples illustrate the variety of styles and materials used in object production, and every alteration, no matter how modest, required the machinist to adapt. Even if a machinist was responsible for making only part of an object, it was still necessary to be familiar with how it was constructed in order to maintain product consistency and quality. Machinists also had to become familiar with handling new synthetic materials in the twentieth century. The introduction of new types of fastenings, like Velcro and buckles, would have affected how an object was constructed. Knowledgeable and flexible machinists made the sewing machine more versatile which expanded the range of products that a manufacturer could produce. Stitched object manufacturers relied upon this versatility to optimise production and maintain product quality.

Figure 6-21 (Left) Cotton shirt with partial front opening and faced button stand, *c*.1895 (NMS, K.2006.228)

Figure 6-22 (Right) White cotton dress shirt with flat front insert, *c*.1900-1910 (NMS, 1968.470)

Figure 6-23 (Left) Nylon evening shirt with ruffle front and concealed front opening, *c*.1950s (Glasgow Museums, E.1986.21.3)

Figure 6-24 (Right) Synthetic shirt with Velcro on cuffs and zip in the back, *c*.1960s (Glasgow Museums, E.1984.116.46)

The Influence of Human Ability on the Development of the Machine

Because machinists were integral to machine operation, their diverse range of abilities had to be considered in the development of new machine models. The development of faster machines and models that required complex calibration could only be sustained if individuals with skill and dexterity could be found and trained to operate them. This final section, therefore, focuses on the influence of human proficiency on the development of the sewing machine. Three aspects of machine development in the twentieth century will be considered: speed, complexity, and automation. Although no substantive records of machine development undertaken by the Singer Company have survived, machine operation manuals and articles from its internal company magazine, the *Red 'S' Review*, give some indication of how human ability influenced machine development. These publications offer an insight into what was required of machine operators, and how an operator's skill and tacit knowledge could contribute to technological development. And finally, the section ends with a discussion of automation as a replacement for, rather than a displacement of skilled human labour in the 1970s, using evidence from the report, *Technology and the Garment Industry*, published in 1971.

Machine Speed

In an effort to increase production throughout the nineteenth and twentieth centuries, machine makers continually sought to improve the speed and efficiency of their sewing machine models. However, despite the fact that increasingly sophisticated mechanical engineering could produce faster models, machine makers were aware that human aptitude was crucial for their successful operation. In the text of a product leaflet for Singer machine model 112w115, published in 1917, Singer openly acknowledged the vital role of the machinist:

> the output of the work by this machine is entirely dependent on the skill of the operator as the machine can be driven continuously at the high speed of 3000 stitches per minute, which on some grades of work is much faster than operators can handle the goods.[30]

Although faster machines could increase production, Singer was aware that if product quality was to remain consistent operators would have to be able to control these machines.

In a short article published in the *Red 'S' Review* in 1926, Singer offered further acknowledgement of the importance of operators capable of working at speed. The article described how Dublin manufacturers during the 1920s were struggling to find 'learners capable

[30] NMAH Library, Form 9462 *Singer Machine No. 112w115 for Two Line Lock Stitching in the Manufacture of Corsets, Cloaks and Clothing Generally*, published by the Singer Manufacturing Company, July 1917.

of operating "power" machines.'[31] In an effort to improve this situation the Singer Company provided a technical college in Dublin with two benches of ten machines, one for garment manufacture and one for shirt manufacture. This provision offered potential candidates an opportunity to familiarise themselves with the machines before applying to factories. Once suitable instructors had been selected, 24 young women from over 300 applicants to the college were chosen to begin training. Singer's provision of power-driven machines demonstrated that fast machine models were more difficult to operate and control. Operators often required more time than factory training permitted to become proficient.

But it was not only machine makers who recognised the importance of having machinists capable of manufacturing at speed, product manufacturers also acknowledged their value. Andrew Finlay observed that by the post-war period 'working at the speed now required is itself recognised as a skill.'[32] Moreover, he noted that in a rare experiment in the 1960s when 20-30 men were employed as machinists in a Derry shirt making factory, after only a couple of years none remained because 'the factory had been re-engineered and the men did not have sufficient 'confidence' to keep up with the faster pace of work.'[33] Although there were almost certainly instances of women who could not keep up with the pace of production, it is telling that failure to manage the speed of production was singled out as the reason why men left or were asked to leave.[34] The ability to manufacture at speed had become a prerequisite of machine operation. The fact that both machine makers and product manufacturers acknowledged this demonstrates the importance of this human ability to successful and efficient production.

Machine development had to consider the capabilities of the machinist because machine makers were astute enough to realise that if machinists could not handle new models then they would not be purchased. The article in the *Red 'S' Review* in 1926 actually stated that adoption of, and subsequent investment in power driven machinery and benching was stalled due to a lack of suitable machinists.[35] Singer's provision of power-driven machines was an acknowledgement that these machines were more difficult to operate. It was also a shrewd economic move. An operator's ability influenced the development of new industrial models and had a direct impact on the business of machine production. Capable human operatives played a pivotal role in the

[31] *Red 'S' Review*, June 1926, p. 23.
[32] Andrew Finlay, 'The Cutting Edge: Derry Shirtmakers', p. 92.
[33] Ibid., p. 93.
[34] Andrew Finlay stated that aside from older tailors with stitching skills, few men applied to be machinists because the employment was regarded as 'women's work'. However, despite the fact that women were bemused by the fact that any men wanted to be machinists, both sexes worked well enough together, see Finlay, 'The Cutting Edge: Derry Shirtmakers', pp. 93-94.
[35] *Red 'S' Review*, June 1926, p. 23.

process of mechanising the needle trades because they were vital to the successful operation, development, and, ultimately, sale of industrial sewing machine models.

Machine Complexity

The capabilities of machinists also had to be considered in the development of machines that required complex calibration to perform a stitching task. In 1942, Singer published two instruction manuals to accompany sets of machine models developed to automatically stitch buttonholes.[36] The only significant difference between the two sets of machine models was that one set cut the hole before stitching the buttonhole, and the second set cut the hole after stitching.[37] Although the stitching sequence was automated, the machines still required accurate calibration to set up the stitching and cutting mechanisms, alter the parameters of the buttonhole, and select the correct tension and length of stitch. The manuals ran to 64 pages and included detailed instructions and diagrams. The fact that these models needed such comprehensive manuals indicates that their calibration was neither obvious nor straightforward, and required significant input from the machinist.

Although the machines could automatically stitch a buttonhole, any changes to its style or length required not only a recalibration but also a change of parts. As the manual stated, ‘it will be necessary to change the pattern wheel (U5, Fig.9), buttonhole cutting block (T2, Fig.5) and the cutting knife (D3, Fig.5).’[38] Operation of the machines required the machinist to both regulate the stitching and cutting mechanisms, and be able to disassemble and reassemble parts of the machine during a changeover. An excerpt taken from one of the descriptions of these tasks illustrates that it required careful and delicate manipulation, ‘to reassemble the mechanism, insert the cutting driving wheel lock (X4) in the slot on the driving wheel (G4, Fig.8) and make sure it is a free sliding fit. With the tweezers, insert the driving wheel […].’[39] Although the manual provided diagrams and annotated illustrations to indicate how each separate part fitted into the machine’s mechanisms, the machinist would still have to become familiar with these, and be dexterous enough to handle them.

The machinist’s job was further complicated by the fact that the machine relied upon the precise integration of two separate mechanisms, one for stitching and one for cutting. Under a section

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[36] NMAH TC, box 16, folder 0 – *Instructions for Using and Adjusting Singer Sewing Machines 99w110, 99w111, 99w112 and 99w113 for Making “cut-after” Buttonholes in Woven Fabrics* ([New York(?)]: Singer Manufacturing Company, 1942) and *Instructions for Using and Adjusting Singer Sewing Machines 99w130, 99w131, 99w132 and 99w133 for Making “cut-first” Buttonholes in Closely Woven Fabrics* ([New York(?)]: Singer Manufacturing Company, 1942).
[37] Cutting buttonholes after stitching was a sewing machine innovation, all hand stitched button holes enclosed any cut edges.
[38] NMAH TC, box 16, folder 0 – *Instructions for Making “cut-first” Buttonholes*, p. 24.
[39] Ibid., p. 50.

titled 'Caution', the manual stated, 'as the sewing mechanism and buttonhole cutting mechanism are driven separately, the relative timing of either must not be disturbed, or damage to the machine will result.'[40] The machinist had to be able to thread two separate stitching mechanisms, which worked in unison, and ensure that the timing of both the stitching and cutting mechanisms remained perfectly synchronised. As the manual warned:

> failure to have the feed wheel bevel gears and pattern wheel shaft gears in proper time will cause a distorted shape to the buttonhole and throw the stopping position out of time with either the movement of the work plates or the stitch rotating mechanism.[41]

Successful operation of the machine relied upon the complex interaction between these two mechanisms. And it was the machinist's responsibility to not only maintain them but also be able to correct them.

In addition to learning how to calibrate, thread, assemble, and integrate the mechanisms of the machine, the machinist also had to be able to distinguish the quality of a buttonhole. Although the machine followed a sequence of operations, the correct calibration of the machine for each step was determined by the choices and decisions of the machinist. Furthermore, these decisions were based upon the machinist's tacit knowledge of how fabric and thread interacted and responded to variations in stitch length and tension. The manual wisely suggested making trial buttonholes to determine if fabric was suitable for 'cut-first' buttonholes. However, only experienced machinists would know if the trial was successful. Despite the sophistication of these machines, and the wealth of instruction that accompanied them, the quality of the final buttonhole rested upon the tacit knowledge of the machinist. Accurate calibration was vital. The quality of any buttonhole was only guaranteed by a machinist who actually appreciated what a good buttonhole was and knew how to subtly adjust the machine to construct it.

The value of tacit knowledge to mechanised production cannot be underestimated. Machinists had to appreciate the intention and purpose of a machine in order to operate it effectively and efficiently. Tony Manwaring and Stephen Wood observed that, 'tacit skills refer to the feel and discretion which forms the basis of subjectivity in even non-skilled work and are vital to efficient performance in all work situations.'[42] And this remained relevant to any type of mechanised production. Yarn spinners after the adoption of the self-acting mule in the nineteenth century still had to check if the staple of the rovings were suitable for spinning before their introduction to the machine. Letters from mill foremen described the difficulties in finding individuals who could not only recognise the quality of spun yarn but were also capable

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[40] Ibid., p. 60.
[41] Ibid., p. 61.
[42] Tony Manwaring and Stephen Wood, 'The Ghost in the Labour Process', p. 177.

of adjusting the calibration of spinning machinery to deliver it.[43] Specialised sewing machines like those developed for making buttonholes relied not only on the ability of the machinist to calibrate it correctly but also on their ability to understand how those calibrations affected the quality of the buttonhole. Complex machinery depended upon the tacit knowledge of machinists, a trait that could not be mechanised.

Automation

Although the development of automated stitching units in the 1960s and 1970s was certainly an attempt to increase production, it was also motivated by a need to replace, rather than displace, skilled human labour. In 1971, the report, *Technology and the Garment Industry*, concluded that the 'garment industry in the United Kingdom is essentially a craft industry which depends upon a supply of highly skilled female operatives.'[44] Moreover, it admitted that, 'no manufacturing industry has a higher proportion of operatives in the 15-19 group, and it is doubtful whether any other industry demands the same level of skill from this age group.'[45] The report added that a combination of government initiatives to encourage capable young women to remain in education, and the raising of the school leaving age to 16, which would come into effect in 1973, could create a significant skill shortage for the industry.[46] As the report observed, 'if the motive for staying on at school is to enter a job with higher educational standards with presumably higher pay, the spectrum of intelligence available to the garment industry will be curtailed […].'[47] The report stressed that the garment industry needed machinists with 'intelligence and dexterity' to remain productive and competitive.[48]

The potential shortage of skilled labour prompted the authors of the report to recommend the development of automated garment stitching systems. Although automated systems for profile stitching and pocket setting, which used electronic units, mechanical guides, and templates to replicate human accuracy and consistency, had been developed: no automated system could seam garments with the same flexibility and versatility as a skilled machinist. Therefore, the report recommended:

> Conversion of the sewing machine from a craft tool to a machine tool, the aim being to produce a sewing head that will adjust itself to the workpiece and to the type of feed required and capable of incorporation in seaming units which are either guided or, preferably, edge following. The time scale should be approximately 5 years from the

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[43] Mary Freifeld, 'Technological Change and the "Self-Acting" Mule: A Study of Skill and the Sexual Division of Labour'.
[44] NEDO, *Technology and the Garment Industry*, p. 175.
[45] Ibid., p. 36.
[46] Ibid., pp. 42-49.
[47] Ibid., p. 46.
[48] Ibid., p. 45.

> present and the development is urgently needed to reduce dependence of the garment industry on a decreasing and ever more expensive supply of skilled labour.'[49]

This ambitious recommendation demonstrated the significance of human skill to the industry, and its influence on the direction of machine development.

However, matching human flexibility was not an easy technical accomplishment. Any machine that relied upon templates or fixed guidance systems could not accommodate the sheer range and number of garment silhouettes that existed, and which were constantly being adapted by changes in fashion. As the report commented, 'developments in garment making technology are likely to be hampered by a number of sociological factors such as tradition in design and the necessity to indulge fashion.'[50] The report suggested that government intervention might be required to co-ordinate any British research and development because there was no combined commercial initiative capable of such an ambitious project in Britain, only the American owned Singer Company was identified as having the necessary resources to undertake such a project.[51] In addition to the technical difficulties, the scale and potential cost of development also proved challenging.

Moreover, machine manufacturers also had to choose how much of a commitment they would make to developing an automated system that could match human versatility because any such success could potentially jeopardise the sale of their existing model ranges. Skilled and flexible machinists remained the most effective way to quickly adapt the construction of a garment, especially if it was only a modest adaption or only for a small production run. As one British manufacturer bluntly stated, 'with every pair of hands a brain comes free.'[52] Subsequently, new foreign markets for machine models were created because cheaper skilled labour abroad became increasingly attractive to garment retailers. The report suspected that the development of an automated seaming unit might prove unsuccessful:

> partly by the ill-defined demands of the garment industries in all countries, partly by their own dilemma as to whether to pursue developments that will ultimately reduce or eliminate the demand for sewing machines or simply to follow the market as it shifts from developed to developing countries.[53]

[49] Ibid., p. 182.
[50] Ibid., p. 180.
[51] Ibid., pp. 124-126,
[52] Alison Barlow and Jonathan Winterton, 'Restructuring Production and Work Organization' in *Restructuring Within a Labour Intensive Industry*, ed. by Ian M. Taplin and Jonathan Winterton, p. 192.
[53] *Technology and the Garment Industry*, p. 177

Machine makers could choose to make models that depended upon human skill and flexibility or develop automated models that sought to emulate human versatility. Whichever direction was chosen only emphasised the pivotal role that human skill played in machine development.

Although the emphasis in this discussion has been upon the skill of the machinist, the historic exploitation of skilled female labour cannot be ignored. Women in the Derry shirt industry initially spent four years in training and were acknowledged as skilled by both factory managers and the local press. However, because it was an export industry, the women working in the industry were persuaded that low wages were needed to offset the cost of export and keep the industry's products competitive.[54] One of the rare occasions when women did manage to improve their employment status was the result of a strike in May 1968 by female machinists at the Dagenham Ford car plant. The women challenged the definition of skill in the grading of their employment and succeeded in getting it re-graded. A consequence of their actions was a government inquiry that resulted in the 1970 Equal Pay Act.[55] Machine operation relied upon skilled and flexible labour, and women continued to provide a vital alternative to the complex, and expensive development of highly sophisticated, versatile automated systems.[56] The complex relationship between gender and skill also played a significant role in the development of technology and the process of mechanisation.[57]

Conclusion

An examination of stitched objects demonstrates that the adoption of the sewing machine required more than a simple exchange of tools, and the introduction of mechanisation was not always a de-skilling process. Stitched objects reveal that both knowledge of object construction and the ability and experience to manipulate tools were required. Consequently, stitched objects represent tangible witnesses to the skills needed for machine operation and illustrate the value of tacit knowledge to machine use. Effective machine operation depended on the adaption of any

[54] By 1950, 87 per cent of shirts made in Derry were sold in Britain and its colonies, see Andrew Finlay, 'Trade Unionism and Sectarianism Among Derry Shirt Workers 1920-1968 With Special Reference to the National Union of Tailors and Garment Workers' (unpublished doctoral thesis, University of London, 1989) pp. 73-74.
[55] Jonathan Moss, '"We Didn't Realise How Brave We Were at the Time": The 1968 Ford Sewing Machinists' Strike in Public and Personal Memory', *Oral History,* 43.1 (2015), 40–51.
[56] The Singer Company did introduce automated Contour Seaming Units in the 1970s, however, they could only sew a limited number of garment silhouettes, and because they used fixed guide systems could only sew flat garment pieces.
[57] Cynthia Cockburn, *Machinery of Dominance: Women, Men, and Technical Know-How*, (London: Pluto Press, 1985); Sarah Horell, Jill Rubery and Brendan Burchell, 'Gender and Skill' in *Skill and Occupational Change* ed. by Roger Penn et al, pp. 189-220; *Women Workers and Technological Change in Europe in the Nineteenth and Twentieth Centuries*, ed. by Gertjan de Groot and Marlou Schrover (London: Taylor and Francis, 1995).

existing knowledge of construction, as well as the ability to control the sewing machine whilst manipulating object pieces beneath its needle. Object studies and published advice on machine operation emphasise the importance of human skill and proficiency to the successful use and development of the sewing machine as a manufacturing tool.

The impact of mechanisation on human labour and skill is irrefutable, but a concentration on impact obscures the significance of human skill to the development of new technology. Because the sewing machine is a mechanised tool that depends upon human operation, any machine development has to consider the range and variation in human skill and proficiency. The machine development of the Singer Company relied upon the flexibility, competency, and versatility of machine operators, and its development of automated stitching units during the mid-twentieth century was stimulated by a lack of skilled labour rather than as a means to replace it. An examination of human skill and proficiency emphasises the complexity of machine development and foregrounds the significance of the human role in the process of mechanisation.

Conclusion

An examination of the range of manufacturing models produced by the Singer Company over the century after the machine's introduction in 1851 provides a comprehensive assessment of the sewing machine as a manufacturing tool. It also provides a rich case study for the process of mechanisation. One that reveals the analytical value of situating technological development within the dynamic relationships which surround it. Technological development did not occur in isolation, and this multi-dimensional approach to the examination of sewing machine development has revealed the influence of these relationships to the process of mechanisation. An interleaving of material culture and economic history, which places object studies at its core, has not only served to situate the process of mechanisation within a cultural framework, it has also offered an original interpretative approach to the history of technology. Moreover, this study, for the first time, reveals the scope and diversity of the Singer Company's development of the sewing machine as a manufacturing tool during the nineteenth and twentieth centuries. It also highlights the significance of the relationship between object maker and machinery maker to the direction of the sewing machine's technological development.

An examination of sewing machine development emphasises the importance of product characteristics and construction to the process of mechanisation. Trade literature produced by the Singer Company both summarised the development of the sewing machine as a manufacturing tool and illustrated the influence of the stitched object on the direction of its development. Initially, Singer responded to the size, shape, and material of a stitched object, but by the early twentieth century, its machine development showed a more sophisticated response to object construction. The descriptions of products and processes found in trade literature produced by the Singer Company provide evidence of the dialogue and vital exchange of knowledge that took place between stitched object maker and machinery maker. The detail of the descriptions also demonstrate that Singer could distinguish between product types and levels of production within a single trade. Singer's subsequent development of task specific machines both demonstrated the depth of its familiarity with these complex manufacturing environments and proved that an awareness of this complexity could prompt more than one technological solution to mechanising production. The preservation of the quality and characteristics of a stitched object might prove to be a more important priority to a manufacturer than an increase in production, and Singer's development of the sewing machine as a manufacturing tool acknowledged this.

Trade literature produced by the Singer Company also serves to illustrate the perspective of the machinery maker on the process of mechanisation. The layout and editorial choices of Singer's trade catalogues and handbooks illustrate how Singer chose to focus on the priorities of the object manufacturer, the structure of their trade, the construction and quality of their products, and insinuated the sewing machine into these. Singer sought to create productive relationships with manufacturers. It did not presume or coerce, but aimed to provide manufacturers with a valuable service, not just machines. Singer regarded the sewing machine as part of an integrated system of production that could be affected by both the delivery of power and the organisation of production space. It used trade literature to both demonstrate and communicate its familiarity with stitched object construction and production, and to encourage its trade customers to exploit Singer's own knowledge and expertise to their mutual advantage. The success and expansion of Singer's business depended upon the development and adoption of the sewing machine as a manufacturing tool across almost all sectors of industry where stitching was required. Moreover, success also relied upon the acquisition of knowledge about trades and their products. Singer's trade literature illustrates how Singer sought to instil confidence in its machine products, whilst also fostering the important relationships with manufacturers that would generate the valuable information needed to sustain and improve its business.

An examination of sewing machine development also reveals that variation and adaption rather than replacement typified the development of the sewing machine as a manufacturing tool. All machine development was speculative, with no guarantee of adoption. Consequently, adapting existing technology and exploring established uses served to expand the range of a machine class and extend Singer's product lines, whilst also minimising the risks associated with speculation. Not least, adaption also helped to limit the risks that accompanied innovative development, the challenges and difficulties of which were exposed by the attempt made by USMC to mechanise the complex process of stitching baseballs. Adaption and variation also emphasise the importance of dialogue between object maker and machinery maker. Opportunities to extend the scope of a machine class could only be identified through this dialogue, and successful development relied upon this vital exchange of knowledge. A single machine model could never satisfy all the diverse stitching demands of the needle trades. Therefore, specialised adaption of the sewing machine had to continue after its invention and adoption to meet new demands and exploit new opportunities.

Records of development kept by both USMC and the Singer Company captured not only the diversity and scope of machine specialisation but also the significance of development to the business of machinery makers and the process of mechanisation. These records, though only fragmentary in the case of the Singer Company, described the ambition of any development, along with its cost, and the time it took to complete. They were kept to monitor the progress of development and to help manage the integration of continuous development with machine production. The management of successful integration also offers another reason for the use of machine adaption. This method of development enabled more accurate estimates of time and materials to be made, which meant less disruption to overall production. Although innovative development was undertaken, its unpredictability made it harder to schedule and, therefore, integrate. The baseball stitching project highlighted the planning difficulties associated with designing new technology. It also demonstrated the incentive that potential commercial value could provide. Examples and records of machine development illustrate the important role of research and development in the process of mechanisation. They also emphasise that the process was conducted as a business.

This study has revealed the importance of the relationship between machinery maker and object maker. The influence of this relationship could be seen in every aspect of sewing machine development and promotion. The Singer Company used the appearance of the sewing machine to create and maintain distinct product identities for its domestic and manufacturing machine ranges, which reflected the very different priorities and expectations of its trade and domestic customers. During the nineteenth century, the working mechanisms of the machine were disguised within the home, but exposed within the factory. Machine embellishment also played a complex role. Its application not only made the machine more palatable for domestic interiors, it also acknowledged and respected the human presence within the factory. With the formal introduction of industrial design principles during the early twentieth century, the appearance of the machine became no less complicated. Designs that were commissioned but never put into production demonstrated that Singer continued to be influenced by the expectations of its customers and their perception of modernity. New designs identified technical improvement and high performance tools that matched the expectations of Singer's trade customers. Whilst the unchanging and familiar shape of the domestic model reflected both stability and nostalgia for its domestic customers. Singer had forged complex relationships with its customers and used the appearance of the machine to recognise, reflect, and preserve them.

However, the most important aspect of the relationship between machinery maker and object maker was the object itself. The making of stitched objects was the primary purpose of the sewing machine and the reason for its development as a manufacturing tool. Consequently, this study includes an examination of objects made with the sewing machine to illustrate their importance to its development, and to offer an original interpretative approach to the history of technology and the process of mechanisation. Objects sit at the nexus between production and consumption. The inclusion of machine stitched objects in this study serves to place technological development in context and illuminate the complex and dynamic relationships that surround and influence it. Mechanical development responded to an object's construction, but construction could be altered by changes in fashion. Because objects can capture these changes, they can reveal the roles that consumer choice, taste, and expectation played in the process of mechanisation. Changes to the construction and style of an object can provide evidence of the relationship between a stitched object and its consumer. They can also provide evidence of the relationship between a stitched object and its maker, a needle trade and its consumers, and a needle trade and its machinery provider. Objects emphasise the cultural significance of technology. They also illustrate the chain of influences that affect technological development.

Although trade catalogues provide a rich summary of machine development, only a comparison of stitched objects, made before and after the introduction of the sewing machine, can demonstrate the significance of a stitched object's style and structure to the direction of technological development. A close examination of men's shirts illustrates how much the process of mechanisation responded to separate and specific tasks involved in an object's construction. Such a close examination also illustrates the influence that preserving an object's features exerted over machine development and specialisation. Tracing the production heritage of a shirt is the only way to identify that garments made more than a century apart shared the same features. Features that were preserved to maintain the robust nature of the garment. And only a close examination of shirts can reveal how these robust methods of construction could be displaced by conspicuous changes in fashion. During the 1960s, fashion and consumer taste significantly altered the style and construction of a shirt. Its production heritage bears witness to the stylistic changes that had consequences for existing production methods and the direction of machine development.

The inclusion of objects in a history of technology emphasises the role of the consumer and the influence of consumer taste on a trade and its choice of production method. An examination of women's shoes made in the same style during the 1920s illustrates the difference in product quality and levels of production that could co-exist within a single trade in response to consumer taste. In addition, a reconstruction of the business profiles of Glasgow shoe manufacturers reveals the connection between manufacture and retail that allowed manufacturers to respond quickly to changes in taste and fashion. The value of this proximity to the consumer was also echoed in the success of boutique stores during the 1960s, where fashionable garments were both manufactured and sold in order to permit garment styles to respond quickly to changes in fashion and consumer taste. Object studies highlight the significance of the consumer and the influence of the relationship between production and consumption on the process of mechanisation.

Moreover, overlapping material insight and economic analyses helps to reveal the complex influences that can affect the structure of a trade, and the dilemmas that this can pose for its machinery providers. The relationship between manufacture and retail within an industry created different challenges for the Singer Company, which affected its machine development in a variety of ways. In the British garment industry, manufacture and retail became separated, which meant that garment manufacturers were one step removed from consumers and were responding instead to the large retailers that had come to dominate the British clothing market. Although the Singer Company demonstrated its ability and willingness to provide complex, automated machinery for the industry, the structure of the trade fostered indecision. This indecision encouraged Singer to concentrate on providing the industry with flexible production methods. In the British shoe industry manufacture and retail remained closely linked. These close ties permitted manufacturers to respond quickly to changes in consumer taste, which allowed smaller manufacturers to survive and compete successfully with larger manufacturers well into the twentieth century. The co-existence of large and small manufacturers within the shoe industry provided Singer with a different type of dilemma: did they provide machinery for every scale of business or concentrate on only one scale of business? Proximity to the consumer affected the structure of a trade, its choice of production method, and, ultimately, the direction of machine development.

A combination of object studies and economic analyses has illuminated the differences between needle trades, and demonstrated that because of these differences mechanisation had to be a responsive process. The Singer Company had to observe both stitched object construction and style; appreciate the differences between quality of product and level of production; and understand the nature of the relationship between production and consumption for every needle trade. An examination of only two types of stitched objects reveals the complexity and diversity that existed among needle trades and the difficulties that Singer faced in mechanising their production. An exploration of this complexity underlines the necessity and value of dialogue between machinery maker and object maker. It also reveals something of the relationship between mechanised tool and hand tool. Neither the construction of the shirt nor the structure of the British shoe industry was altered by the introduction and adoption of the sewing machine. Both industries absorbed mechanisation and had an influence on the direction of the machine's technological development. An observation of garment construction and trade structure underlines the fact that the sewing machine was a mechanised tool that entered established trades. This meant that its development and specialisation had to respond to the trades of which it became part.

Stitched objects also emphasise the human role in the process of mechanisation. A role that is often underestimated or overlooked. The sewing machine was a mechanised tool that relied upon human operation, and stitched objects provide valuable evidence of human skill, proficiency, versatility, and initiative. Object production required more from a maker than the skill and experience of using tools, it also required knowledge of how to construct an object.

Because of this, adoption of the sewing machine required makers to acquire new skills and adapt their existing knowledge of construction to use with a new mechanised tool. Stitched objects capture changes in style, construction, and taste, and highlight the need for human flexibility and versatility to accommodate these changes. A machine powered by its own motor proved to be the most flexible and valuable unit of production. These machines could exploit the skill and versatility of machine operators and allow any scale of business to benefit from the adoption of the sewing machine.

A garment industry report undertaken during the 1970s clearly identified the reliance of the garment industry on a skilled female workforce. It warned that the industry would struggle without this valuable human resource. The report also noted that opportunities for women created by changes to education and employment would greatly reduce the number of women entering the garment industry. For this reason, the report recommended the development of sophisticated and versatile stitching units. These units were seen as a replacement for, rather than a displacement of skilled and flexible machine operators. The Singer Company was identified as one of the few machinery makers that had the engineering and financial acumen to attempt such development. However, although Singer did produce several automated units, the quixotic nature of fashion made it impossible to develop an automated system that could match human versatility and cope with the frequent changes to garment construction and silhouette.

Automation proved more successful for repetitive, and relatively, unchanging tasks in large scale production. In turn, the use of automated stitching units made greater demands on individual machine operators who were tasked with completing garments and matching the pace of production and accuracy achieved by automation. The complexity of garment construction encouraged Singer to concentrate on a single machine and operator combination, which could both exploit and benefit from human flexibility.

Objects are not only tangible witnesses to human skill, they are also witnesses to the important, and creative, relationship between makers and their tools. This important relationship emphasised that the sewing machine was a mechanised tool and its development could benefit from human initiative. Examples of women’s shoes illustrate the creative use of the sewing machine’s straight stitch for decorative purposes. A use which could not have been anticipated by machinery makers. Shoe manufacturers initially used visible top stitching on the binding of a shoe to replace slip stitching by hand, but eventually recognised and expanded upon the decorative qualities that visible lines of stitching offered. Small shoe manufacturers used parallel lines of top stitching combined with punched holes to create distinctive products that allowed them to survive in competitive markets. This creative use of the sewing machine prompted the Singer Company to develop sewing machines for solely decorative purposes, which could mimic a selection of the decorative effects achieved by smaller manufacturers. Human initiative and the creative relationship between makers and their tools demonstrated that the basic stitch of a sewing machine could be exploited for decorative as well as productive purposes. Recognition of this fact provided Singer with further opportunities for machine development.

The quality of objects also illustrates that human skill and proficiency could vary significantly. Human aptitude proved to be an important influence on the direction of machine development. Although the impact of mechanisation on human skill has been identified and explored, what is often overlooked is the impact of human proficiency on technological development. The variation in human proficiency not only influenced the development and adoption of specialised machines, it also affected the business of machinery makers. Put simply, if machine operators could not handle fast machines or correctly calibrate complex machinery, manufacturers would not purchase them. Singer warned manufacturers about the speed of new models. It even went as far as providing technical colleges with fast machine models to equip machine operators with the skills needed to enter factories. The correct calibration of complex buttonhole machines not only required the comprehension of annotated technical diagrams, it also depended, fundamentally, upon the tacit knowledge of machine operators. The human element in production proved to be an important consideration for both object manufacturer and machinery provider.

The intention of this thesis was to examine the development of the sewing machine as a manufacturing tool and situate this development within the complex and dynamic relationships that surrounded it. Although this multi-dimensional approach to machine development does not sit comfortably within any single academic discipline, its aim was to demonstrate that technological development does not occur in isolation. A cross disciplinary approach was used to illuminate the diverse network of influences that affected it. This study has revealed the extraordinary range and scope of machine development undertaken by the Singer Company during the nineteenth and twentieth centuries. It has also used object studies as an original interpretative source for a history of technology. These studies provide a cultural framework for machine development and emphasise the significance of the stitched object to the development of the sewing machine as a manufacturing tool. However, one of the most surprising conclusions drawn from a holistic examination of technological development has been the significance of the human role in the process of mechanisation, but perhaps this should not have been so unexpected. For ultimately, the invention and development of the sewing machine were prompted by the desire to mechanically replicate the hand plying the needle. It was this seemingly simple gesture that stimulated a global industry and the development of a ubiquitous mechanised tool.

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