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RESEARCH ARTICLE

Machinery for managers: secretaries, psychologists, and 'human–computer interaction', 1973–1983

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Abstract

This article characterizes early research in the field of 'human–computer interaction' (HCI) by analysing the first decade of 'user psychology' research at Xerox's Palo Alto Research Center (PARC). PARC's Applied Information-Processing Psychology Project (AIP) provided an initial theoretical foundation for HCI in the early 1980s. Like researchers in artificial intelligence (AI), researchers at AIP drew from information-processing psychology. However, AIP researchers argued that their focus on human behaviour distinguished their research from AI and other fields allied with computer science. Previous scholarship has shown that United States computer engineers became concerned with 'users' as they sought to commercialize military-funded developments in interactive computing. This paper argues that the decision made by upper management in computerizing workplaces to shift some text production work from clerical workers to middle managers during the 1970s and 1980s led AIP to perceive ambiguities around gender and technical skill. This shaped the initial theoretical foundations that the research group offered to HCI – especially the group's conception of the 'user'. Computer designers went from presenting word-processing programs as clerical machines for women workers to presenting them as tools for masculine thinking. AIP's research diverged from industrial engineering and AI in response to this transformation.

> They just use your mind, and they never give you credit
>
> Dolly Parton, '9 to 5'

During the 1980s, the use of computers in US offices changed dramatically. Once isolated in data-processing centres operated by specialists, computing machines became increasingly common features at the desks of managers and other professionals who lacked a background in computing.[1] Office machinery – previously seen as the ignoble objects of clerical work – became seen as tools to aid intellectual work. A new field of experts came together to study and improve this arrangement. Human–computer interaction (HCI) researchers promised to turn the study of input and output devices, software design and other features of interactive computer use into a science. Initially drawing from

1 Historians of computing have emphasized this as a key change in the application of computers from the 1970s through the 1990s. For a recent overview see Thomas Haigh and Paul E. Ceruzzi, *A New History of Modern Computing*, Cambridge, MA: MIT Press, 2021; esp. Chapters 5, 8.

backgrounds in computer science and psychology, these interdisciplinary researchers claimed that their work would help computer designers improve the usability, and thus the efficiency, of this new office machinery among managers, professionals and other 'users' who lacked technical skills.

This article argues that the reorganization of text-editing work around personal computers during the 1980s shaped the initial theoretical foundations of HCI. As labour historian Jason Resnikoff explains, seeking to cut labour costs in the 1980s, executives and upper-level managers used personal computers to transfer clerical tasks from secretaries and typists to middle-level managers. Convincing managers that they, rather than their secretaries, should use text-editing machinery proved to be a principal challenge for manufacturers of personal computers. Manufacturers sought to redefine the text-editing machine as something which would empower the manager's intellect. To make this happen, computer manufacturers reconceptualized the keyboard – which has been a feminine device for most of its history – and made it into a central part of the new masculine computer. Paradoxically, they argued that personal computers would 'liberate' the middle manager from his secretary by transferring text production work to him.[2] As social scientist Jeanette Hofmann has argued, where designers had once seen word-processing programs as clerical machines for women workers, they now saw them as tools for masculine thinking.[3]

HCI emerged amidst this transformation.[4] As cognitive psychologist Thomas Green remarked in 1984, 'Text editors are the white rats of HCI.'[5] Routine office tasks, especially text editing, were principal subjects of HCI research when the field began to professionalize with journals and conferences in the early 1980s. HCI aimed to present computers as 'user-friendly', as manufacturers hoped to sell machines to managers and professionals who lacked the technical skills of secretaries. Although the typing of manuscripts was once seen as the exclusive domain of the secretary, the 'user' that HCI accommodated after the 1970s was not the pink-collar clerical worker – who could be mandated to

2 Jason Resnikoff, 'The paradox of automation: QWERTY and the neuter keyboard', *Labor: Studies in Working-Class History* (2021) 18(4), pp. 9–38.

3 Jeanette Hofmann, 'Writers, texts and writing acts: gendered user images in word processing software', in Donald MacKenzie and Judy Wajcman (eds.), *The Social Shaping of Technology*, 2nd edn, Buckingham: Open University Press, 1999, pp. 222–43. See also Sonia Liff, 'Information technology and occupational restructuring in the office', in Eileen Green, Jenny Owen and Dan Pain (eds.), *Gendered by Design? Information Technology and Office Systems*, Bristol, PA: Falmer Press, 1993, pp. 95–110; and Juliet Webster, 'From the word processor to the micro: gender issues in the development of information technology in the office', in Green, Owen and Pain, op. cit., pp. 111–123.

4 While scholars have explored themes related to the history of HCI, the origins and changes in the field itself have received little attention from historians. Elizabeth Petrick has summarized several of these contributions while also acknowledging this gap. Elizabeth Petrick, 'A historiography of human–computer interaction', *IEEE Annals of the History of Computing* (2020) 42(4), pp. 8–23, 21. See also Jeffrey Yost 'Of mice and mentalité: PARC ways to exploring HCI, AI, augmentation and symbiosis, and categorization and control', *Interfaces: Essays and Reviews in Computing and Culture* (2021) 2, pp. 12–26. Historical overviews written by HCI practitioners include Jonathan Grudin, *From Tool to Partner: The Evolution of Human-Computer Interaction*, London: Morgan & Claypool, 2016; Brian Shackel, 'Human–computer interaction: whence and whither?', *Journal of the American Society for Information Science* (1997) 48(11), pp. 970–86; Ronald M. Baecker, 'Themes in the early history of HCI: some unanswered questions', *Interactions* (March 2008) 15(2), pp. 22–7; Thomas Erickson and David W. McDonald (eds.), *HCI Remixed: Essays on Works That Have Influenced the HCI Community*, Cambridge, MA: MIT Press, 2008. Non-practitioner accounts of important figures or laboratories in the history of HCI include Michael A. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*, New York: Harper Business, 1999; M. Mitchell Waldrop, *The Dream Machine: J.C.R. Licklider and the Revolution That Made Computing Personal*, New York: Viking, 2001; Thierry Bardini, *Bootstrapping: Douglas Engelbart, Coevolution, and the Origins of Personal Computing*, Stanford, CA: Stanford University Press, 2000.

5 Green quoted in Grudin, op. cit. (4), p. 48.

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learn complex office machinery – but the autonomous middle manager or professional. The neutrality of HCI's term 'user' obscured a shifting distribution of tasks across a workplace hierarchy.[6]

To demonstrate the relationship between changes in text-editing work and the shaping of early HCI research, I explore the first decade of Stuart Card, Thomas Moran, and Allen Newell's research group, the Applied Information-Processing Psychology Project (AIP). AIP provided one initial theoretical foundation for the new field of HCI. The research group was based at Xerox's Palo Alto Research Center (PARC), which became famous among computer scientists and business leaders for its developments in personal, interactive computing.[7] I begin by showing how the forerunners of HCI, J.C.R. Licklider and Douglas Engelbart, distinguished clerical and intellectual labour in the 1960s. Then I demonstrate how researchers at AIP went from presenting secretaries as typical computer 'users' in the early 1970s to presenting them as antithetical to who a 'user' was by the mid-1980s. I focus in particular on how AIP researchers navigated the ambiguities of gender and technical skill with regard to the 'user'. Deciding who the user was – and thus how they should be studied – was the key issue by which AIP researchers distinguished themselves from other researchers in AI and industrial engineering – two fields they initially had much in common with. This article contributes to this special issue's goal of situating AI within twentieth-century management by showing how AIP researchers diverged from AI's genealogy by taking a routine labour process as their object of study.

Individualized computers: intellectual or clerical?

Early work in interactive computing took place within military-funded research laboratories during the 1960s. There, engineers designed machines to be used by people like themselves: autonomous, technical workers. Whereas existing computers were typically operated by clerical workers, these engineers reimagined computers as tools for intellectual work. J.C.R. Licklider and Douglas Engelbart, researchers who heavily influenced future generations of HCI professionals, believed that computers should perform routine, clerical work in order to empower intellectual workers.

Historians and HCI practitioners often remember Licklider, a psychologist and research funding agency director, as a progenitor of HCI.[8] According to this narrative, his canonical paper on 'man–computer symbiosis' presented a research programme that was distinct from AI. In the paper, Licklider explained that 'it seems worthwhile to avoid argument with (other) enthusiasts for artificial intelligence by conceding dominance in the distant future of cerebration to machines alone'. In the meantime, he argued, computers should exist in 'symbiotic' relationships with 'men'.[9]

However, scholars have paid less attention to a practical problem that motivated Licklider's paper. He was exhausted with paperwork. Lacking something 'comparable to a time-and-motion-study analysis of the mental work of a person engaged in a scientific

6 On these points, as well as for a more comprehensive history of the personal-computer 'user', see Alice Rzezonka, 'User, der: Begriffsprägung einer privilegierten Position am Personal Computer', doctoral dissertation, Rheinischen Friedrich-Wilhelms-Universität Bonn, 2022.

7 The most comprehensive history of PARC is Michael A. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*, New York: Harper Business, 1999. This account is based mostly on interviews with actors. It focuses on the Computer Science Laboratory, largely eschewing the research taking place in physics, the social sciences and the human sciences.

8 Chapter 1 of Grudin's book begins with an anecdote about Licklider. Grudin, op. cit. (4), p. 1. See other citations from footnote 4 above.

9 J.C.R. Licklider, 'Man–computer symbiosis', *IRE Transactions on Human Factors in Electronics* (1960) HFE-1(1), pp. 4–11, 5.

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or technical enterprise', Licklider performed one on himself. Licklider found that 'my "thinking" time was devoted mainly to activities that were essentially clerical or mechanical … my choices of what to attempt were determined to an embarrassingly great extent by considerations of clerical feasibility, not intellectual capability'. The busy scientist and director complained that 85 per cent of his '"thinking" time' was devoted not to 'thinking' but 'getting into a position to think'.[10] The solution he proposed: 'Computing machines will do the routinizable work' while 'men will set the goals, formulate the hypotheses, determine the criteria, and perform the evaluations'.[11]

Licklider's distinction between clerical and intellectual work resonates with longer patterns in the history of computing. Lorraine Daston has demonstrated how calculation from the nineteenth century onwards went from being seen as an intelligent skill to the mindless activity of 'mechanical' workers after the mathematician Gaspard de Prony applied Adam Smith's division of labour to calculation projects in revolutionary France.[12] Simon Schaffer has shown that debates around the best ways to measure and mechanize mental labour in the late nineteenth century corresponded with the emergence of English intellectuals as a 'specific class formation'. This group distinguished routine mental work from their own 'discretionary' intelligence.[13] A division of labour between mathematicians, engineers, bureaucrats and scientists on the one hand and clerks, (human) computers, and computer operators on the other can be seen in almost all computing work through the mid-twentieth century.[14]

In 1962, Licklider brought his vision of computing to the Information Processing Techniques Office (IPTO), the wing of the US Department of Defense's Advanced Research Projects Agency that would become the major funding agency for computer science research through the 1960s.[15] Under Licklider's inaugural direction, the IPTO also began supporting the research of Stanford Research Institute (SRI) engineer Douglas Engelbart in 1963.

Like Licklider, Engelbart thought that intellectual work could be improved through engineering, and that computer systems were the best means to accomplish this end.[16] Engelbart dedicated much of his research at SRI in the 1960s to improving the interface between users and computers, famously co-inventing the computer mouse with Bill English. Sociologist Thierry Bardini's monograph on Engelbart's career explains how he and his colleagues aimed to build systems for people like themselves, people Engelbart called 'knowledge workers'.[17] Their image of the user was a reflexive and idealized version of themselves. They deemed knowledge workers autonomous and creative – willing and able to sink time into learning complicated input systems. Engelbart shared with Licklider the view that computing machines should be subordinated to knowledge workers, inviting others to imagine the computer as 'a completely attentive, very patient, very fast symbol-manipulating slave'.[18]

10 Licklider, op. cit. (9), p. 6.

11 Licklider, op. cit. (9), p. 4.

12 Lorraine Daston, 'Enlightenment calculations', *Critical Inquiry* (1994) 21(1), pp. 182–202.

13 Simon Schaffer, 'OK computer', in Michael Hagner (ed.) *Ecce Cortex: Beiträge zur Geschichte des modernen Gehirns*, Göttingen: Wallstein, 1999, pp. 254–85.

14 Jennifer S. Light, 'When computers were women', *Technology and Culture* (1999) 40(3), pp 455–83; David Alan Grier, *When Computers Were Human*, Princeton, NJ: Princeton University Press, 2005.

15 On Licklider's role in expanding the IPTO's support for interactive computing see Arthur L. Norberg and Judy O'Neill, *Transforming Computer Technology: Information Processing for the Pentagon, 1962–1986*, Baltimore: Johns Hopkins University Press, 2000.

16 Douglas Engelbart, *Augmenting Human Intellect: A Conceptual Framework*, Stanford Research Institute Summary Report, October 1962.

17 Bardini, op. cit. (4), p. 116.

18 Quoted in Bardini, op. cit. (4), p. 19.

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When the office machinery company Xerox established PARC in 1970, many of the research staff it hired came directly from Engelbart's lab.[19] The team's new research environment, however, brought changes. Xerox aimed to develop a large market for personal computers as generic office machinery, an essential component of the company's 'office of the future'. As a result, their user was no longer a knowledge worker, but a 'naïve user'. As Bill English remembered it,

> When we moved to PARC [in 1971], we were at least thinking about the naïve user. Xerox was a commercial company, and we were thinking we'd better build these systems so as the average person can use the technology ... I think the only model we had, again, were the people around us. Secretaries. We would look at the nontechnical people as the users.[20]

Where the user imagined by Engelbart's lab was a specialized and autonomous knowledge worker, at PARC the user was 'nontechnical', even 'naïve'. No longer an engineer, she was a secretary.[21]

The secretarial user

While at defence-funded laboratories like SRI, computer designers and engineers often centred scientific research and military command and control. In contrast, when these designers moved to the research and development wings of office machinery companies in the 1970s, they placed text-editing at the centre of their research programme. Secretaries – quintessential text editors – became generic 'users' in PARC research in the early 1970s. AIP researchers studied the 'manuscript-editing task' and used data from secretarial subjects to create their first model of the user. They applied Simon and Newell's information-processing psychology to formulate this model. However, tensions emerged between the subjects of AIP's research and the 'user' that these subjects represented.

PARC established AIP with the aim of developing commercial applications for Herbert Simon and Allen Newell's information-processing psychology.[22] Newell, who was then a consultant for PARC, proposed the research group in January 1971, one year after PARC's founding. Newell explained that the emerging 'psychology of cognitive behavior' developed by Simon and himself could be applied to the design of office technology at PARC with 'substantial payoff (in dollars)'.[23] While they are often remembered as progenitors of AI, Simon and Newell initially resisted identifying their work on the Logic Theory

19 See Chapter 6 of Bardini, op. cit. (4).

20 Bill English's personal communication with Bardini and Horvath in December 1992. Thierry Bardini and August T. Horvath, 'The social construction of the personal computer user', *Journal of Communication* (1995) 45 (3), pp. 40–65, 55.

21 In this paper, I use she/her pronouns to refer to secretaries to emphasize the gendered division of labour. This was the pronoun that PARC researchers used to refer to all the secretaries they discussed. In the 1970s, 97 per cent of typists were women. Lane Windham, *Knocking on Labor's Door: Union Organizing in the 1970s and the Roots of a New Economic Divide*, Chapel Hill: The University of North Carolina Press, 2017, p. 154.

22 On Newell, Simon and information-processing psychology see Herbert A. Simon and Allen Newell, 'Information processing in computer and man', *American Scientist* (1964) 52(3) pp. 281–300; Hunter Crowther-Heyck, *Herbert A. Simon: The Bounds of Reason in Modern America*, Baltimore: Johns Hopkins University Press, 2005; Hunter Crowther-Heyck, 'Defining the computer: Herbert Simon and the bureaucratic mind', *IEEE Annals of the History of Computing* (2008) 30(2), pp. 42–63; Stephanie Dick, 'Of models and machines: implementing bounded rationality', *Isis* (2015) 106(3), pp. 623–34.

23 Allen Newell, 'AIP memo 1: notes on a proposal for a psychological research unit', October 1974 reproduction of a memo from January 1971, Carnegie Mellon University Library Allen Newell Collection (subsequently ANC), Box 91, Folder 6326, p. 1.

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Machine as 'artificial intelligence'. However, by the late 1950s they accepted this description due to its growing rhetorical power.[24] While Simon and Newell's work in AI and AIP's proposed research were based on information-processing psychology, Newell thought that AIP could repair a gap in the information-processing psychology research programme that AI had neglected. Newell regretted that his graduate students who were 'deeply interested in artificial intelligence' obtained no knowledge of cognitive psychology.[25] He hoped that AIP could amend that lack of interest and bring cognitive psychology into computer science.

Newell's idea for an applied-psychology unit came to fruition after he brought his doctoral students Thomas Moran and Stuart Card to PARC in 1974. The two Carnegie Mellon University students would conduct research towards their respective dissertations in computer science and psychology at PARC under Newell's direction. PARC established AIP that year. Newell served the project as a consultant for about three to four days each month.[26] As he had envisioned, the project aimed to create an information-processing model of the personal computer user that designers could refer to without having to conduct user trials. They believed this would save PARC time and money as it prototyped new machinery.

AIP researchers did not initially see their work as explicitly drawing from artificial intelligence. Moran mentioned in 1975 that the name 'AIP' was selected as a 'pun', which may indicate a perceived association with AI.[27] However, as with Simon and Newell's other work, AIP retrospectively applied this terminology. At a January 1986 Association for Computing Machinery conference on the History of Personal Workstations, Card and Moran explained that the idea for AIP 'was to draw concepts from cognitive psychology and artificial intelligence to create an applied cognitive science of the user'.[28]

AIP and PARC agreed that the psychology of the 'editing task' would be the project's first area of study.[29] The 'editing task' encompassed a common relationship between a secretary and her employer. The executive would dictate to the secretary, who would type on a typewriter. She would then pass the copy to the executive, who would mark it up for revisions and return it to the secretary to retype. The process would continue until the pair had produced a finished draft. With Xerox's prototype machines, however, the secretary would not have to completely retype the draft with each revision but only edit the digital file to reflect the executive's corrections. With the time saved, the executive could assign his secretary to other tasks.

AIP researchers' focus on secretaries reflected Xerox's commercial response to US businessmen's concerns in the 1960s and 1970s. Xerox wanted PARC to develop new machinery that would dominate their 'office of the future', just as their copier had for much of the company's history. Secretarial text editing was important in this vision. The labour process of document preparation, and the stenographer or secretary's place in it, had troubled management experts in the United States since the early twentieth century.[30]

24 Jonathan Nigel Ross Penn, 'Inventing intelligence: on the history of complex information processing and artificial intelligence in the United States in the mid-twentieth century', doctoral dissertation, University of Cambridge, 2020, p. 79.

25 Newell, op. cit. (23), pp. 6–7.

26 Tom Moran, 'Outline of operating plan for 1975', 28 August 1974, ANC, Box 72 Folder 5085, p. 4.

27 Tom Moran, 'AIP memo 59: outline of an AIP presentation', 4 June 1975, ANC, Box 72, Folder 5087, p. 1.

28 Stuart Card and Thomas Moran, 'User technology: from pointing to pondering', in Adele Goldberg (ed.), *A History of Personal Workstations*, New York: ACM Press, 1988, pp. 439–526, 494.

29 Allen Newell and Tom Moran, 'Summary of the "AIP covenant review meeting"', 19 May 1975, ANC, Box 72, Folder 5087, p. 1.

30 Margery W. Davies, *Woman's Place Is at the Typewriter: Office Work and Office Workers, 1870–1930*, Philadelphia: Temple University Press, 1982; JoAnne Yates, *Control through Communication: The Rise of System in American*

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Thomas Haigh explains that management experts at this time saw the traditional secretary as 'the enemy of efficiency'.[31] In 1974, the American Management Association reported on secretaries that 'it's very hard to establish procedures and controls over what she does'.[32] Many business leaders in the 1970s briefly believed that 'word processing' was the solution to this problem. While word processing came to refer to a type of computer software by the 1990s, in the 1970s it meant replacing 'the one-man, one-secretary, one-typewriter idea' with a factory-style production of texts.[33] Word-processing centres would supervise a mass of typists using specialized equipment under one roof.

The word-processing vision of the early 1970s was short-lived. Management experts soon came to see personal computers as a more affordable and widely applicable alternative. Along with long-term declines in component costs and an increase in processor power leading into the 1980s, US corporate executives believed that more people could use an individualized computer to produce documents, including secretaries and middle-level managers. They identified this arrangement as 'office automation'.[34] PARC led the wider business community in embracing this office automation vision by about a decade. Haigh points out that while PARC's researchers were not management experts, the centre was funded on Xerox's expectation that individualized computerization would change the office – and sell their products.[35] Within this context, PARC researchers began studying text editing.

Soon after AIP was established in 1974, the project ran experiments recording their colleagues editing a manuscript on the POET text editor, run on PARC's MAXC.[36] They asked subjects to speak aloud to themselves to narrate their thought process and reactions to the machine. AIP adopted this technique from Newell and Simon's research in problem solving at the RAND Corporation in the mid-1950s.[37] AIP transcribed data from the videos into five columns: time, the subject's verbal utterances, where the subject was looking, the subject's keystrokes, and other miscellaneous events and comments.[38] AIP researchers codified these transcripts into sequences of perceptual, motor and mental operations such as 'choose', 'describe', 'look-at' and 'say' at a grain ranging from half a second to five seconds. By analysing computer use into operations using the methods of Simon and Newell's information-processing psychology, Card and Moran promised to predict the time to complete any computer task that could be described in such operations.

The boundaries of AIP's research resembled some prior PARC research on secretaries. In May and August of 1973, before AIP's founding, computer scientist Larry Tesler

Management, Baltimore: Johns Hopkins University Press, 1989; Sharon Hartman Strom, *Beyond the Typewriter: Gender, Class, and the Origins of Modern American Office Work, 1900–1930*, Urbana: University of Illinois Press, 1992.

31 Thomas Haigh, 'Remembering the office of the future: the origins of word processing and office automation', *IEEE Annals of the History of Computing* (2006) 28(4), pp. 6–31, 8. See also Jane Barker and Hazel Downing, 'Word processing and the transformation of the patriarchal relations of control in the office', *Capital & Class* (1980) 4(1), pp. 64–99.

32 W.A. Kleinshrod, *Word Processing: An AMA Management Briefing*, AMACOM, 1974, quoted in Haigh, op. cit. (31), p. 8.

33 This quote is from a December 1970 *Administrative Management* article. Haigh, op. cit. (31), p. 8.

34 Haigh, op. cit. (31), p. 7.

35 Haigh, op. cit. (31), p. 21.

36 Tom Moran, 'AIP memo 8: activity report: January–June, 1974', 13 June 1974, ANC, Box 72, Folder 5085. MAXC was PARC's emulation of the Digital Equipment Corporation's popular time-sharing system the PDP-10 (Personal Data Processor). E.R. Fiala, 'The MAXC systems', *Computer* (1978) 11(5), pp. 57–67.

37 Newell and Simon asked subjects to verbally report their thoughts while doing activities like puzzles; they believed this showed them how human minds dealt with new complex tasks. Allen Newell and Herbert A. Simon, *Human Problem Solving*, Englewood Cliffs: Prentice-Hall, 1972.

38 Tom Moran, 'AIP memo 13: conventions for protocol transcriptions', 8 August 1974, ANC, Box 72, Folder 5085.

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conducted two studies on secretarial text editing at PARC with PARC secretary Sylvia Adams.[39] As Tesler explained, his research was guided by PARC's goal to 'offer a text editor that can be learned quickly and used effectively by users of varying technical backgrounds, including secretaries'.[40] However, secretarial text editing was different from other forms of text editing. It 'involves transcription of another person's writing, as opposed to literary composition or computer program development', and 'usually is guided by copy marked up by another person'.[41] Like AIP, Tesler's experiment included the person editing the text and excluded the person who had dictated it or corrected it. Furthermore, like AIP, Tesler observed Adams working with PARC's prototype system. And finally, both series of experiments reduced secretarial work to its most routine aspect: typing a manuscript produced by someone else.[42] However, Tesler interviewed his subject about her evaluation of the machine. This differed from AIP's quantitative approach, which broke down secretaries' work into discrete steps, resonating more with the methods of time and motion studies.

The affinity of AIP's approach with time and motion studies was a source of disagreement between Moran and Card. By mid-1975, Moran had become frustrated with the group's approach. In May, he wrote to AIP to express his 'vague, but growing, discontent with the current drift of some of AIP's research and stated goals'.[43] The preceding March, Card had proposed establishing a catalog of operators along the lines of a time and motion study.[44] He shared scans of industrial-engineering literature that inspired him. This included some which analysed workers' behaviour into 'Therbligs', eighteen elementary classifications of motion created in the early twentieth century by Lillian Gilbreth and Frank Gilbreth, followers of the founder of scientific management Frederick W. Taylor.[45] Card remarked elsewhere, 'A good all-around measure … is how long it takes to get the job done'.[46] He sought to create models that optimized for performance time – other values like intellectual creativity or ease of use were not captured here.

Moran did not believe that this was the best approach for the project. He contrasted Card's 'industrial engineering' approach, which tried to classify all behaviour into operators to predict performance, with the 'human factors' approach, which tried to develop a psychological theory to inform design choices, rather than exhaustively predict all

39 Larry Tesler, 'Studies related to secretarial text editing', 20 December 1973, ANC, Box 72, Folder 5117, p. 1; Larry Tesler, '1973 user study notes', Larry Tesler Consulting, at www.nomodes.com/Larry_Tesler_Consulting/1973_User_Study_Notes.html (accessed 12 November 2020). Adams also later did data analysis for AIP but it is not clear whether she became a subject again. Stuart Card and Tom Moran, 'AIP memo 61: proposed analyses for the experimental message service (XMS)', 11 June 1975, ANC, Box 72, Folder 5087, p. 8.

40 Tesler, 'Studies related to secretarial text editing', op. cit. (39), p. 1. Tesler would be remembered especially for his innovations in interactive text-editing programs. See Chapter 9 of Haigh and Ceruzzi, op. cit. (1).

41 Tesler, 'Studies related to secretarial text editing', op. cit. (39), p. 1.

42 In fact, as Juliet Webster wrote in 1993, secretaries had considerably more discretion and a wider range of tasks than typists. In these experiments, PARC researchers depicted secretaries as merely typists. Webster, op. cit. (3), p. 116.

43 Tom Moran, 'AIP memo 58: the "industrial engineering" approach versus the "human factors" approach in AIP', 12 May 1975, ANC, Box 72, Folder 5087, p. 1.

44 Stuart Card, 'AIP memo 52: some thoughts on organizing behavior into a catalogue of operators', 11 March 1975, ANC, Box 72, Folder 5087.

45 On Taylor and the Gilbreths see Chapter 5 of Daniel Nelson, *Frederick W. Taylor and the Rise of Scientific Management*, Madison: University of Wisconsin Press, 1980; and Chapter 3 of Maarten Derksen, *Histories of Human Engineering: Tact and Technology*, Cambridge: Cambridge University Press, 2017. In 2013, HCI researchers claimed Lillian Gilbreth as an early pioneer of their methods. Jonathan Grudin and Gayna Williams, 'Two women who pioneered user-centered design', *Interactions* (2013) 20(6), pp. 15–20.

46 Stuart Card, 'AIP memo 54: a benchmark comparison of on-line text editors with respect to the time required to produce an office document', 7 April 1975, ANC, Box 72, Folder 5087, p. 1.

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behaviour. 'A basic tension in this Applied Psychology game', Moran explained, was the problem of 'being psychologists or being time-study hacks'.[47] Moran called for Card's industrial-engineering approach to be 'abandoned'. Furthermore, 'AIP should temper its "*megalomodelomania*": the compulsion to build a complete (in some sense) model of the user in some task domain'.[48] Despite Moran's criticism, the construction of generic user models would remain a central goal for AIP through the early 1980s.

AIP's first two years of research culminated in the circulation of their first PARC report, 'The manuscript editing task: a routine cognitive skill', in December 1976. Where Newell and Simon's earlier work had focused on humans encountering novel problems, Card and Moran extended their information-processing psychology to encompass routine clerical work. This paper evaluated ten models of a manuscript-editing task, 'differing with respect to generality and descriptive detail'.[49] All the models described the manuscript-editing task in terms of goals, operators, methods and selection rules (GOMS), a technique that would continue to be widely used in HCI through the late 1990s. The trio recognized the 'kinship' of their work 'with the time-and-motion studies done by industrial engineers' but they claimed that it was different. Rather than setting performance standards, their research sought to predict performance based on a theory of 'skilled behavior'.[50]

The experiment described in this report blurred the distinction between the woman clerical worker and the masculine user that would come to dominate Xerox's vision for its machines. AIP collected the data used to create and evaluate the models from an experiment whose only subject was a 'highly skilled female secretary–typist' referred to as Subject 13 (see Figure 1).[51] Subject 13 was given a manuscript to edit which took about twenty minutes. As with their previous experiments, AIP video-recorded Subject 13 and the terminal display and analysed her work into operations. AIP spoke of Subject 13, the basis for their models and the only subject of the main experiment, using she/her pronouns. However, they spoke of the generic subject in the outline of experimental procedure and the 'user' it represented exclusively using he/him pronouns.[52]

More tensions between their research subject and the 'user' surfaced when Card, Moran and Newell submitted the 'Manuscript editing task' article to *Cognitive Psychology* in 1978. Referee B praised the article for extending Simon and Newell's 'theory of problem-solving to real-world tasks' but was hesitant to accept it. Referee B questioned the group's description of manuscript editing as routine since 'much editing, even on computers, involves deciphering the author's handwriting which in itself is a (routine?) problem-solving task for secretaries'. Furthermore, Subject 13's typing speed was unrepresentative: she 'typed at 103 words per minute ... which has limited generalization to most mortals, even secretaries'.[53] The journal's editor, Earl Hunt, said that their work was important and accepted the article with significant revisions. Nonetheless, the

47 Moran, op. cit. (43), p. 1.

48 Moran, op. cit. (43), p. 3, emphasis in original.

49 Stuart K. Card, Thomas P. Moran and Allen Newell, 'The manuscript editing task: a routine cognitive skill', December 1976, ANC, Box 72, Folder 5095.

50 Card, Moran and Newell, op. cit. (49). p. 76.

51 Card, Moran and Newell, op. cit. (49). p. 24.

52 In her 1979 doctoral thesis based on AIP research, the Stanford computer scientist Teresa Roberts, Moran's advisee, used the 'feminine' pronoun when speaking of the generic user as 'a small reminder to a society for whom the default gender has long been masculine'. 'Note to the reader' in Teresa Roberts, 'Evaluation of computer text editors', November 1979, Xerox Archives via Xerox Archives manager Ray Brewer, personal communication, 10 October 2019.

53 Referee B, review of 'The manuscript editing task: a routine cognitive skill', ANC, Box 72, Folder 5083.

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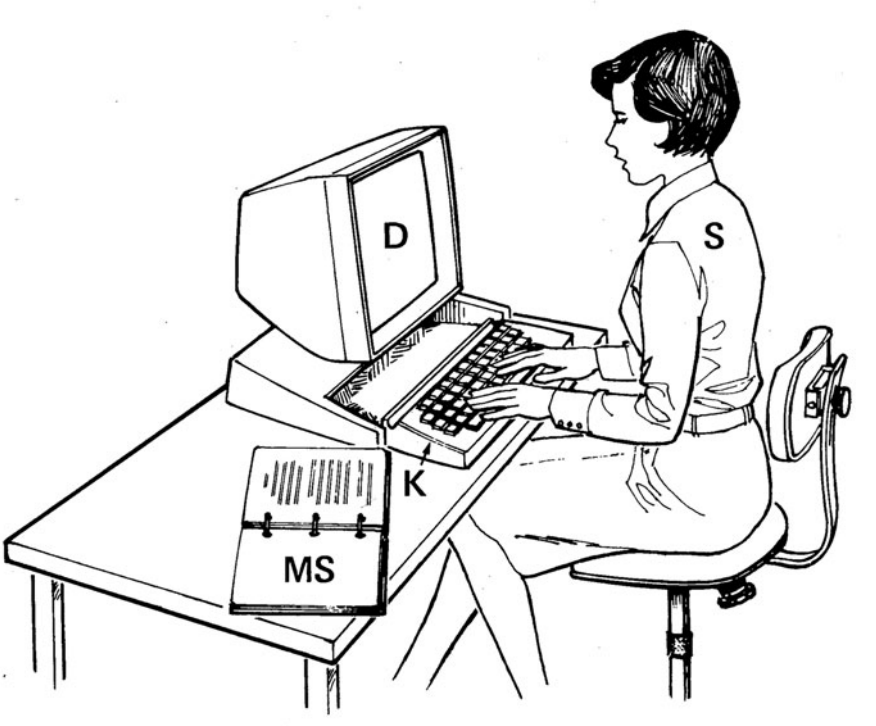

Figure 1. 'Physical Layout of the MS-Editing Task'. Stuart K. Card, Thomas P. Moran and Allen Newell, 'The manuscript editing task: a routine cognitive skill', December 1976, Carnegie Mellon University Archives, Allen Newell Collection, Box 72, Folder 5095, p. 3. Republished with permission of Carnegie Mellon University Archives and the author.

referees were challenging some of AIP's base assumptions. Like Licklider, AIP researchers assumed that clerical work was 'routine'. Furthermore, their attempt to depict secretaries as generic users failed to consider their special affinity with text-editing technology, notably the QWERTY keyboard. The researchers who moved from Engelbart's laboratory assumed that secretaries were 'naïve' while AIP saw them as generic. But as the referees here emphasized, secretaries were too technologically adept to count among 'naïve' or generic users.

The paper was eventually published in 1980 after Card and Moran included computer scientists as subjects in addition to secretaries.[54] They retitled the paper from 'manuscript editing' to 'computer text editing'. This reframing presented computer text editing not as feminine clerical labour but as a generic and gender-neutral activity. This was significant. Although they were far less common in US offices, programmers – typically male – were the other key users of text-editing software. As Haigh points out, text-editing software for programmers was 'the direct technological ancestor' for typists' word-processing software.[55] However, the difference between these two applications was 'more cultural than technical'.[56] In this case, it had more to do with the perceived difference in gender

54 Stuart K. Card, Thomas P. Moran and Allen Newell, 'Computer text-editing: an information-processing analysis of a routine cognitive skill', *Cognitive Psychology* (1980) 12(1), pp. 32–74.

55 Haigh, op. cit. (31), p. 13.

56 Haigh, op. cit. (31), p. 14.

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and technical skills between programmers and secretaries than with technical differences in the software. AIP's new model of the text-editing user collapsed this difference and de-emphasized its secretarial origins. Although AIP researchers had used the secretarial user image in two other internal reports, they left it out of their publication.[57] In the following years, a new user image took shape.

The user reconstructed

AIP's first decade of research resulted in the 1983 publication of *The Psychology of Human–Computer Interaction*, the first book to use the emerging field's name in its title.[58] The book also announced the launch of the journal *Human–Computer Interaction*, which included Moran as editor with Licklider, Newell, Card and other researchers on the editorial board. As PARC developed the Alto and then the Star – a notoriously commercially unsuccessful personal computer – Xerox realized that the kind of computers PARC wanted to build remained priced well beyond what an executive could justify purchasing for his secretary. At the same time, many male executives were wary of using keyboards, instruments that they regarded as feminine.[59] As political scientist Jeanette Hofmann reflected in the following decade, the Xerox Star possessed 'the only word processing program ... ever to have been developed for men'.[60] Hofmann's provocative observation drew attention to the changing gender of manuscript production work in the office that followed the introduction of personal computers.

While the user began at PARC as a secretary in the early 1970s, its gender and position in the office hierarchy had changed by the 1980s. Card, Moran and Newell's book depicted the user as a bald person sitting in front of an Alto (see Figure 2).[61] Even disregarding the white, cartoonishly 'neutral' human figure, the masculinity of this image compared to the diagram of Subject 13 is apparent. The then-ubiquitous QWERTY keyboard was missing from this image, which is striking given the importance of keystrokes to AIP's models.[62] This absence is also conspicuous given that the keyboard typically fit snugly between the legs of the display's stand (compare to Figure 1). The secretary reappeared in the book's 'keystroke-level model' in a negative sense: Card, Moran and Newell disaggregated the 'average non-secretary typist' in the crucial parameter of typing speed.[63]

In this short period of time, the group of researchers who would help create the field of HCI realigned their focus to fit a new arrangement of office work. During the 1960s, Licklider and Engelbart imagined users to be intellectual and technically skilled workers like themselves. When the researchers from Engelbart's lab arrived at PARC in the early 1970s committed to building (and selling) machines usable by non-engineers, they saw the secretary as a typical user. Secretarial subjects became the focus of Card and Moran's early research on text editing, sources of data about computer use that AIP used to construct models. However, as the personal computer came to be seen less as a clerical

57 The image appears in Marilyn Mantei, 'AIP memo 109: an investigation of individual differences in computer based text editing', August 1977, ANC, Box 72, Folder 5089, p. 1; and Stuart Card, 'AIP memo 97: an exploratory attempt to simulate a user of Bravo', 7 November 1977, ANC, Box 72, Folder 5089, p. 2.

58 Stuart K. Card, Thomas P. Moran and Allen Newell, *The Psychology of Human–Computer Interaction*, Hillsdale, NJ: L. Erlbaum Associates, 1983.

59 Paul Atkinson, 'The best laid plans of mice and men: the computer mouse in the history of computing', *Design Issues* (2007) 23(3), pp. 46–61; Resnikoff, op. cit. (2).

60 Hofmann, op. cit. (3), p. 233.

61 Card, Moran and Newell, op. cit. (58), p. 5.

62 Furthermore, Card had published a nearly identical image in 1981, except that version included a QWERTY keyboard. S.K. Card, 'The model human processor: a model for making engineering calculations of human performance' *Proceedings of the Human Factors Society Annual Meeting* (1981) 25(1), pp. 301–5.

63 Card, Moran and Newell, op. cit. (58), p. 264.

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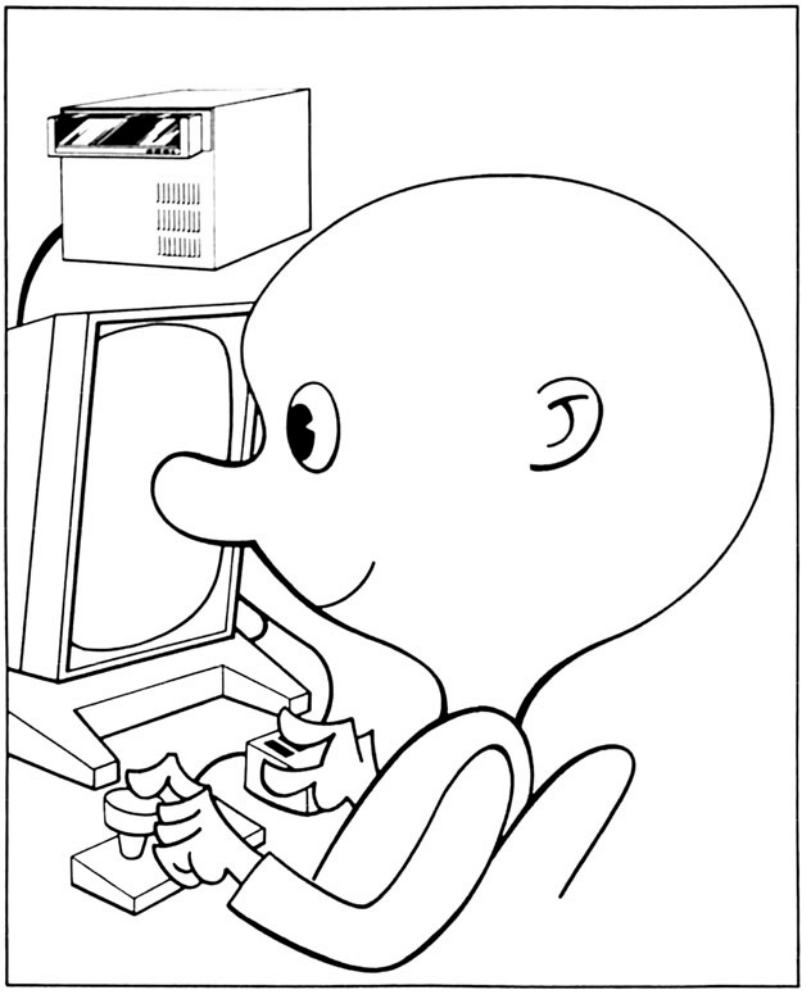

Figure 2. 'The human–computer interface'. Stuart K. Card, Thomas P. Moran and Allen Newell, *The Psychology of Human–Computer Interaction*, Hillsdale, NJ: L. Erlbaum Associates, 1983, p. 5. Republished with permission of the author.

machine and more as a managerial tool, secretaries appeared less typical.[64] They were also too technical to be considered 'naïve users'. Card, Moran and Newell's book simultaneously finalized and obscured the transition they had undergone. As they explained, the user was explicitly not a secretary:

> Prior styles of interaction between people and machines such as driver and automobile, secretary and typewriter, or operator and control room are all extremely lean:

64 This is a common theme in the history of computer work: the gendered meaning of the technology followed from the gendering of the labour it was associated with. See Abbate on 'occupational metaphors' in Janet Abbate, *Recoding Gender: Women's Changing Participation in Computing*, Cambridge, MA: MIT Press, 2012. See also Nathan Ensmenger, *The Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise*, Cambridge, MA: MIT Press, 2010; Mar Hicks, *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing*, Cambridge, MA: MIT Press, 2017.

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> there is a limited range of tasks to be accomplished and a narrow range of means (wheels, levers, and knobs) for accomplishing them. The notion of the *operator* of a machine arose out of this context. But the user is not an operator. He does not operate the computer, he communicates with it to accomplish a task. Thus we are creating a new arena of human action: communication *with* machines rather than operation *of* machines.[65]

The replacement of 'operation' with 'communication' here mimicked the language used by Licklider and Engelbart. 'Communication' also evoked a relationship that was familiar to managers: dictation to a secretary.

At the same time, however, the computing tools that proliferated office work in the 1980s diverged strongly from the visions of these earlier engineers. Licklider wanted to free intellectual workers like himself from clerical labour. But with personal computers, managers found themselves doing more text-editing work, rather than less.[66] Personal computers became something that was remarkably rare in the history of industrial capitalism: they became machinery for managers.[67] HCI explained and accommodated this new arrangement by affirming the vision of computers as 'augmenting the intellect' while – in contrast to Engelbart – designing computers to be usable by non-technical managers.

Card, Moran and Newell's work was not uncontroversial. In December of 1981, before the book's publication, three computer scientists wrote with concern to *Association for Computing Machinery Computing Surveys*, questioning whether AIP's goal of 'augmentation' would result in 'dehumanization'. They accused Moran, who had edited a previous *Surveys* special issue on psychology, of 'controlling human behavior in order to subordinate it to the purpose of computer system performance irrespective of the goals that people wish to achieve with the help of the system'.[68] While sidestepping the criticism, Moran acknowledged some ambivalence about the political ramifications of his research: 'Scientific power does not guarantee good taste. A scientifically powerful user psychology could be used against, as well as for, the user'.[69] Despite their attempt at a reorientation, the residue of industrial engineering was difficult to remove.

Conclusion

A 'second wave' of HCI research would emerge in the late 1980s and grow through the 1990s.[70] Many of these researchers also criticized AIP's cognitive-psychology approach and its perceived association with human factors, the legatee of scientific management. However, as I have shown in this paper, the tensions between HCI's ideal autonomous user and the work-disciplining goals of industrial engineering were already present within AIP itself. Later HCI practitioners came to displace much of AIP's psychological approach

65 Card, Moran and Newell, op. cit. (58), p. 7, emphasis in original.

66 Resnikoff, op. cit. (2).

67 On the conversion of the management function into mechanized clerical labour in the twentieth century see Chapters 12, 15, 18 of Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century*, New York: Monthly Review Press, 1974.

68 Christiane Floyd, Reinhard Keil and Erhard Nullmeier, 'Surveyor's forum: augmentation or dehumanization?', *ACM Computing Surveys* (1981) 13(4), pp. 491–2, 491.

69 Thomas P. Moran, 'Surveyor's forum: augmentation or dehumanization?', *ACM Computing Surveys* (1981) 13 (4), pp. 492–3, 493.

70 Victor Kaptelinin, Bonnie Nardi, Susanne Bødker, John Carroll, Jim Hollan, Edwin Hutchins and Terry Winograd, 'Post-cognitivist HCI: second-wave theories', in *CHI '03 Extended Abstracts on Human Factors in Computing Systems*, Fort Lauderdale: ACM Press, 2003, pp. 692–3, 692.

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with research methods based in design, anthropology and sociology. Lucy Suchman's work, beginning with her doctoral dissertation research conducted at PARC during the mid-1980s, was highly influential in this reorientation.[71] As HCI practitioner Jonathan Grudin reflected in his 2016 history of the field, 'Although highly respected by CHI cognitive psychologists, [AIP's] models did not address discretionary, novice use. They modeled the repetitive expert use studied in human factors.'[72] By distinguishing between 'discretionary' and 'mandatory' users, Grudin positioned HCI as accommodating the 'discretionary' computer workers who already possessed relative autonomy in determining their work procedures. Furthermore, as HCI's focus became empowering technically unskilled professionals and managers, some practitioners would position themselves against AI, despite sharing roots in cognitive psychology and computer science.[73]

By analysing the work of one research group, this paper has shown that the changing conditions of office work with computers shaped HCI research. Researchers at AIP altered their understanding of their subject, the user, in response to the changing gendered division of labour in text-editing work with computers. This paper tracked these changes through a decade of research and demonstrated that this affected the group's resulting theoretical model. As HCI took shape as a field, practitioners came to believe that modelling people as cognitive machines would not appropriately describe the discretionary, autonomous work that managers and other professionals were supposed to do with computers. From this new perspective, secretaries – due to the perceived mandatory and routine nature of their work – became imperfect representatives of the 'human' portion of HCI's human–computer dyad. This history suggests that early HCI researchers' seemingly neutral orientation toward 'users' was in fact directed toward managerial and professional positions in the gendered hierarchy of office work.

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71 This research was eventually published as Lucy A. Suchman, *Plans and Situated Actions: The Problem of Human–Machine Communication*, Cambridge: Cambridge University Press, 1987.

72 Grudin, op. cit. (4), p. 49. CHI refers to the groups of HCI researchers that frequented the ACM special-interest group on computer–human interaction (SIGCHI), the leading HCI conference. For another practitioner perspective on the relationship between HCI, AI and human factors see Mark Chignell, Lu Wang, Atefeh Zare and Jamy Li, 'The evolution of HCI and human factors: integrating human and artificial intelligence', *ACM Transactions on Computer–Human Interaction* (2023) 30(2) pp. 17:1–17:30.

73 For practitioners' perspectives on the division of AI and HCI see Jonathan Grudin, 'AI and HCI: two fields divided by a common focus', *AI Magazine* (2009) 30(4), pp. 48–57. Terry Winograd, 'Shifting viewpoints: artificial intelligence and human–computer interaction', *Artificial Intelligence* (2006) 170(18), pp. 1256–58.

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