Chapter 7
From Computing Girls to Data Processors: Women Assistants in the Rothamsted Statistics Department

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Abstract Over 200 women worked as computing assistants in the Rothamsted statistics department during the twentieth century. They were employed in the analysis of field and laboratory experiments and in the examination of the returns of agricultural surveys. Before World War II they did calculations with pen, paper, slide rules and electromechanical calculating machines, but during the 1950s, when the department underwent an early process of computerisation, their tasks shifted to data processing. Only sparse records exist on the work of these women, and their contribution to the activity of the Rothamsted statistics department has never been assessed, consigning them to invisibility. Combining the literature currently available on laboratory technicians with the one on human computers and data processors, the paper will provide a *longue durée* perspective (1920s–1990) on the work of the female assistants in the Rothamsted statistics department, addressing two distinct aspects. On the one hand it will examine how the tasks of these women evolved with the computing technologies available in the department. On the other hand the paper will reflect on the invisibility of these assistants, who are never explicitly accounted as contributors to the scientific activity of the Rothamsted statistics department, despite being a conspicuous component of its staff.

Since the 1980s women's presence in ICT has drawn the attention of historians, sociologists and professionals engaged in the field. Historical case studies, collections of oral histories, quantitative and qualitative sociological investigations and meetings of professionals associations have addressed the issue.[1]

[1] Lovegrove, Gillian, and Barbara Segal. 1991. *Women into computing: selected papers 1988–1990*. Berlin: Springer. [in collaboration with the British Computer Society]; Light, Jennifer S. 1999. When computers were women. *Technology and Culture* 40(3): 455–483; Grier, David A. 2001. Human computers: the first pioneers of the information age. *Endeavour* 25(1): 28–32, Grier, David A. 2007. *When computers were human*. Princeton: Princeton University Press; Abbate, Janet (ed). 2003. Special Issue on women and gender in the history of computing. *IEEE Annals of the*

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This growing literature has mostly examined educated women, who received training in mathematics, engineering or computer science before entering the field. Yet, this is not fully representative of the female participation in computing during the twentieth century. Routine tasks, such as doing basic arithmetic or punching cards and paper tape, were often entrusted to women without higher education, whose contribution to computing is even more concealed than the one given by their university-trained colleagues.[2]

In the context of scientific research, these blue-collar women,[3] who worked as human computers or data processors, are certainly akin to technical figures. They share the routine nature of their job, the lack of recognition and the scarcity of sources for examining their role in science with the seventeenth-century assistants of Robert Boyle described by Steven Shapin (1989)[4] in his seminal contribution on the "invisible technician".

Combining the current literature on laboratory technicians with the one on human computers and data processors, the paper will address a case study on women, gender and ICT taken from the history of statistics. It will investigate the female assistants who were engaged as human computers and data processors in the statistics department of Rothamsted Experimental Station, a British institution for agricultural research. The Rothamsted statistics department was both a statistical and a computing centre,[5] similarly to the Mathematical and Statistical Service run by George W. Snedecor at Iowa State College and examined by D. A. Grier (2007: 159–169).[6] In both cases statistical methods and computing power were mostly devoted to the solution of problems in agricultural research.

From the 1920s, when the department was founded, until the 1990s, when data processing was outdated by the availability of improved computer technologies, over 200 women worked alongside the scientific staff of the Rothamsted statistics

History of Computing 25(4): 4–8, Abbate, Janet. 2012. *Recoding gender: women's changing participation in computing*. Cambridge, MA: MIT Press; Margolis, Jane, and Allan Fisher. 2003. *Unlocking the clubhouse*. Cambridge, MA: MIT Press; Cohoon, Joanne, and William Aspray. 2006. *Women and information technology: research on underrepresentation*. Cambridge, MA: MIT Press; Misa, Thomas J. (ed.). 2010. *Gender codes: why women are leaving computing?* Hoboken: Wiley/IEEE Computer Society.

[2] Haigh, Thomas. 2010. Masculinity and the machine man: gender in the history of data processing. In *Gender codes: why women are leaving computing?* ed. Thomas J. Misa, 51–71. Hoboken: Wiley/IEEE Computer Society; Hicks, Mary. 2010a. Meritocracy and feminization in conflict: computerization in the British Government. In *Gender codes: why women are leaving computing?* ed. Thomas J. Misa, 95–114. Hoboken: Wiley/IEEE Computer Society, Hicks, Mary. 2010b. Only the clothes changed: women operators in British computing and advertising, 1950–1970. *IEEE Annals of the History of Computing* 32(4): 5–17.

[3] Misa 2010: 8.

[4] Shapin, Steven. 1989. The invisible technician. *American Scientist* 77(6): 554–563.

[5] Parolini, Giuditta. 2013. *"Making sense of figures": statistics, computing and information technologies in agriculture and biology in Britain, 1920s–1960s*. Doctoral dissertation. University of Bologna, Parolini, Giuditta. 2014. The emergence of modern statistics in agricultural science: analysis of variance, experimental design and the reshaping of research at Rothamsted Experimental Station, 1919–1933. *Journal of the History of Biology*. doi:10.1007/s10739-014-9394-z.

[6] Grier 2007: 159–169.

department contributing to the analysis of agricultural experiments and surveys. At first they did calculations with pen, paper, slide rules and electromechanical calculating machines, but after the World War II, when the department underwent an early process of computerisation, their tasks shifted to data processing jobs, such as punching paper tape and cards, and later in time the use of word processors.

Only sparse records exist on the work of these women and their contribution to the activity of the Rothamsted statistics department has never been assessed, consigning them to invisibility. Writing these women back into the history to which they belong "in action if not in memory"[7] is essential not only to further our knowledge of the female participation in computing but also to gain a deeper understanding of the statistical research performed at Rothamsted.

The paper will provide a *longue durée* perspective on the work of these women assistants covering most part of the twentieth century (1920s–1990). It will address two distinct aspects. On the one hand it will examine how the tasks of these female technicians changed over time and evolved with the computing technologies available in the department. On the other hand the paper will reflect on the invisibility of these women, who are never explicitly accounted as contributors to the scientific activity of the Rothamsted statistics department, despite being a conspicuous component of its staff.

7.1 Technicians in Science

As argued by Steven Shapin, an enriched understanding of laboratory practices in science requires unravelling the role of the technicians who worked alongside scientists. Yet, as Shapin remarks, the persistence of "individualistic and revelatory models of scientific activity" has provided "a cultural basis for the invisibility of technicians and other support personnel, and for our tendency to see science predominantly as thought rather than as work".[8] According to Shapin, thus, historical research has "to document and to clarify the significance of technicians' work", but must also "explain why it was that they were largely transparent to the gaze of those who employed them".[9]

A literature devoted to the role of technicians in science has stemmed from Shapin's contribution.[10] In addressing the social dimension of the scientific enterprise from the technicians' perspective, this literature has emphasised the difficulty to produce even a portrait of the technician. On the one hand, in fact, information on technicians' work and careers is scarce at best and often completely absent, and on the other hand, "there are many sorts of technician, with varying degrees of competence, qualifications and experience".[11] Due to this intrinsic ambiguity, the label of

[7] Light 1999: 483.

[8] Shapin 1989: 561.

[9] Shapin 1989: 556.

[10] E.g. Iliffe, Rob. 2008. Guest editorial: technicians. *Notes and Records of the Royal Society of London* 62(1): 3–16.

[11] Iliffe 2008: 5.

technicians can be applied both to the college-educated women who programmed the ENIAC[12] and to the women without higher education appointed as computers and data processors in the Rothamsted statistics department.

Despite the many differences, a few common elements recur time and again. First of all, technicians perform tasks that are considered mere routine. In so doing they have scarce or absent career perspectives, being often the fate of the senior staff to supervise and train junior technicians. What is most striking of technicians is their social distance from the scientific staff. Even though they work in the same environment as scientists, technicians live in a world apart.

All these features apply to the female assistants in the Rothamsted statistics department, but they are not peculiar of these women. Other twentieth-century groups of female technicians employed in scientific laboratories display a similar pattern of low-status recognition. An example widely cited[13] is the one of the "scanning girls" engaged since the late 1930s in the examination of nuclear emulsions in high-energy physics.[14] Despite lacking a background in physics, these women were trained to scrutinise the emulsions using high-power microscopes in order to find significant particle events. Interestingly, while their contribution to the process of discovery was acknowledged at the beginning, in time the names of these female technicians disappeared, leaving them almost invisible by the early 1950s. During the same decade the Cambridge crystallographers engaged in the study of the molecular structure of myoglobin and haemoglobin and hired young women on short-term contracts to do densitometer readings of precession films and perform the related calculations.[15] These women were named *computors*within the laboratory, although doing computations was only one of their tasks. Even though they "were seen as belonging to the 'inner sanctum' of the work and ranked higher than other assistant personnel in the laboratory",[16] these women make only a cursory appearance in the history of the Medical Research Council Laboratory of Molecular Biology in Cambridge.

The examples now mentioned draw attention on the subordinate role that female technicians had during the twentieth century. They raise questions on gender, practical knowledge, professional recognition and participation in the scientific enterprise, the same issues that will be at the core of my analysis of the assistants in the Rothamsted statistics department. The female assistants at Rothamsted had only a basic mathematical and computing knowledge, but without them the statistics department would not have been able to fulfil its scientific mission, as the contribution of the assistant staff was essential in the analysis of the agricultural and biological experiments and surveys that accumulated in the department from year to year. The women assistants, in fact, were engaged in the routine number crunching and data processing that was part and parcel of this statistical analysis.

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[12] Light 1999: 474.

[13] Iliffe 2008: 10.

[14] Galison, Peter. 1997. *Image and logic: a material culture of microphysics*. Chicago: The University of Chicago Press: 33, 198–200.

[15] de Chadarevian, Soraya. 2002. *Designs for life: molecular biology after World War II*. Cambridge: Cambridge University Press.

[16] de Chadarevian 2002: 124 footnote.

Before the computerisation of the department, the assistants were in charge of the arithmetic (e.g. computations of squares and square roots and conversion of measuring units) required by the application of the statistical method known as analysis of variance to the laboratory and field results. They also took part in the analysis of agricultural surveys calculating, averages and errors for the data collected. In both cases the guidelines for the work of these women were set by the local statisticians. When digital computers became available in the department, the involvement of the assistants in number crunching was superseded by activities such as tape/card punching and subsequent verification of the data. Again the assistants worked under the management of the scientific staff that organised the clerical work and distributed the tasks.

7.2 Female Labour in Computing

Computing has been for long time a labour-intensive enterprise.[17] "[M]en and women, young and old, well educated and common" took part in it as human computers.[18] Some computers worked alone and without any financial return, as Emma Gifford who devoted several years of her life to the calculation and publication of an extensive table of natural sines,[19] some instead were members of larger organisations and supported themselves and their families with the income of their labour, like Mary Edwards who worked for the British *Nautical Almanac* in the second half of the eighteenth century.[20]

If in the seventeenth and eighteenth centuries human computers could usually rely only on slide rules, a few collections of mathematical tables, and their personal enterprise, in the nineteenth-century mechanical calculating machines and punched-card equipment entered into accounting and scientific computation easing the burden of number crunching. After World War II, with the availability of electronic computers, the labour of calculation progressively shifted from human beings to machines as suggested by the change in the meaning of the word *computer*.

Yet, computerisation did not coincide with the prompt dismissal of human computers. When electronic computers began to spread in scientific research, military projects and in business, new job opportunities in programming, data processing and key-punching emerged for the former human computers. For instance, the ENIACprogrammers were selected among the women who were previously engaged in the computation of gunnery tables using desk calculators and a differential analyser at the US Army's Ballistic Research Laboratory.[21]

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[17] Grier 2007: 6.

[18] Grier 2001: 28.

[19] Campbell-Kelly, Martin, Mary Croarken, Raymond Flood, and Eleanor Robson. 2003. *The history of mathematical tables: from Sumer to spreadsheets*. Oxford: Oxford University Press: 9.

[20] Croarken, Mary. 2003. Mary Edwards: computing for a living in 18th century England. *IEEE Annals of the History of Computing* 25(4): 9–15.

[21] Light 1999: 469.

Gender is a crucial category in understanding the contribution of technicians to computing labour. Since the nineteenth-century gender played a part in the selection of human computers because, for a long time, women were a cheaper workforce than men.[22] In punched-card installations female labour was largely employed for data entry, but management and supervision of the machines usually were a male prerogative.[23] In the computer age women engaged as data processors remained low-status clerical workers in the office economy.[24]

In the 1940s a gendered understanding of computing work promoted the association of women with software – at that stage programming was perceived as a technical and routine chore – in contrast to the male-dominated manufacture of hardware. However, only a decade later programming was already a male enterprise,[25] and nowadays computing professionals and educators are left wondering how to remedy the scarce presence of women in computer science.[26]

A process of occupational sex typing[27] maintained the assistants work in the Rothamsted statistics department as a female occupation over the twentieth century. Yet, gender alone cannot explain why the female assistants constantly remained in the periphery of the scientific enterprise. To address this issue it is necessary to take into account the labour organisation in the statistics department and how the tools and practices adopted shaped the role of the female technicians. The information available to pursue this research is scarce, but combining institutional records, archive materials and oral histories, we can follow the female assistants in the Rothamsted statistics department for a large part of the twentieth century.

7.3 Women Assistants in the Rothamsted Statistics Department

From the 1920s to 1990s, over 200 women worked as assistants in the Rothamsted statistics department. A few were secretaries and typists, but the overwhelming majority was employed in the analysis of field and laboratory experiments and in the examination of the returns of agricultural surveys (Table 7.1). These women had no university education and were usually selected among the local population. Up to the 1950s they were full-fledged human computers, but with the computerisation of the department, they began to undertake the more clerical tasks related to data processing. They always worked under the supervision of a statistician, usually a male statistician, and they were (almost) never named in the reports of the scientific

[22] Grier 2007: 83.

[23] Haigh 2010.

[24] Hicks 2010b.

[25] Ensmenger, Nathan. 2010. *The computer boys take over: computers, programmers and the politics of technical expertise*. Cambridge, MA: MIT Press.

[26] Cohoon and Aspray 2006; Misa 2010.

[27] Haigh 2010: 52–55.

Table 7.1 Female assistants engaged in computing/data processing (1920s–1990)

Year	No. of female assistants engaged in computing/data processing	Year	No. of female assistants engaged in computing/data processing	Year	No. of female assistants engaged in computing/data processing
1923/1924	*1* *W. D. Christmas* *A. D. Dunkley*	1952	*18*	1972	*19*
1925/1926	*1* *W. D. Christmas* *A. D. Dunkley*	1953	*20*	1973	*17*
1927/1928	*2* *W. D. Christmas* *A. D. Dunkley*	1954	*20*	1974	*17*
1929	*3*	1955	*19*	1975	*14*
1930	*3*	1956	*20*	1976	*16*
1931	*2*	1957	*19*	1977	*16*
1932	*2*	1958	*21*	1978	*12*
1933	*3* *J. W. West*	1959	*20* *A. G. Davies*	1979	*11*
1934	*3* *J. W. West*	1960	*21*	1980	*10*
1935	*4* *J. M. Wilson*	1961	*25*	1981	*8*
1936	*4* *J. M. Wilson*	1962	*26* *B. M. Cooper*	1982	*10*
1937	*5*	1963	*23*	1983	*10*
1938	*4*	1964	*28*	1984	*6*
1939-1945	*11*	1965	*28*	1985	*7*
1946	*12*	1966	*27*	1986	*6*
1947	*12*	1967	*27* *D. E. T. Thomas*	1987	*5*
1948	*15*	1968	*21*	1988	*5*
1949	*15*	1969	*19*	1989	*5*
1950	*17* *W. J. Walters*	1970	*20*	1990	*4*[a]
1951	*18*	1971	*20*		

[a]This number has been obtained considering the compensation between retirements during the year and new appointments. Counting the women assistants from the staff lists gives a reliable estimation of the magnitude of their number, but the total is subject to shifts of some units because: (a) clerical roles (secretary, typists, etc.) were not always explicitly indicated; (b) women who did not leave the job upon marriage were listed at first under their maiden's name and afterwards with their married name, and it is not always possible to trace them; and (c) the women who worked only for a few months were not mentioned in the staff lists. The names of the few men who worked in the statistics department as assistants are explicitly reported. The table has been compiled using the Rothamsted Experimental Station reports (1923/1924–1987) and AFRC Institute of Arable Crops Research reports (1988–1990)

activity of the department, except the staff lists. Until 1990 in the staff lists women were mentioned with their full name, while men were only listed with initials of their first name, offering therefore a straightforward criterion for discrimination between male and female staff. Although providing only essential information, the lists allow to reconstruct how the number of the female assistants changed during the period examined, for how long these women remained in the department on average and how the role of the female assistants was identified.

The first female assistant in the Rothamsted statistics department, Kathleen Abbott, is listed in the station report for the years 1923/1924. She is classified as an assistant computer, and during the 1920s and 1930s a few more women were hired in the department with the same qualification. Before World War II, however, only 11 female assistants in total are mentioned in the station reports. This is not surprising as the exponential growth of the Rothamsted statistics department began only during the 1940s and strengthened in the decades after World War II.[28] By 1948 there were already 15 women assistants; in 1953, 20; and in 1964, 28. After the war these women were just accounted as assistant or clerical staff, without further specifications.

During the 1950s and 1960s, the number of the female assistants constantly increased despite the computerisation of the department. But the female assistants at Rothamsted were never involved in programming the first mainframe available for the local statisticians, a prototype computer named Elliott 401.[29] Programming was always performed by the scientific staff – during the 1950s and 1960s the programming staff was all male – but even when the computations were entrusted to the computer, several tasks, such as punching the paper tape with the input data or converting the units of the experimental results, were still done by hand by the female assistants. This clerical labour decreased over time with the availability of more sophisticated mainframes, but in the 1950s, 1960s, 1970s and even 1980s, the women assistants had a role to play in the statistics department. Only in 1968 the assistant staff suddenly diminished because an autonomous computer department was created at Rothamsted, and some of the female assistants previously working in the statistics department were transferred there.

In 1978 the staff list of the statistics department began to offer a more articulate description of the female assistants. The women engaged as secretaries, typists or in other administrative roles were listed aside from the women engaged in the computing work, for the first time classified as data processors. There were 12 data processors in that year and there was a hierarchy among them, with senior and junior staff listed apart. The number of data processors in the department oscillated around ten until 1984, when it began to diminish again, and in 1987 the women assistants were deprived of their status as data processors and merely listed as administrative officers or administrative assistants. In the late 1980s and early 1990s, there were still

[28] Parolini 2013: Chap. 4.

[29] Parolini 2013: 226–244.

four to five women assistants in the statistics department and their role was merely labelled as "data preparation".

The different denominations reflect the change in the tasks assigned to the female assistants who shifted from being human computers, solely engaged in calculations, to data processors who devoted their time to key-punching, data entry and filing. Sometimes the assistants also contributed to run the computer, when the statistics department was in charge of its own mainframe. Vera Wiltsher, a former data processor, used to do "overtime" on the Elliott 401. "You put the program tape in and then you run the tape and you got an output tape, which you had to print out", recalls Wiltsher,[30] who began to work at Rothamsted in 1961, when she was 17. Wiltsher remained in the statistics department until February 1967, when she left for a few years to raise her children. She came back to the department in 1979 to work on the analysis of surveys. For this work she had to use punched cards instead of the already-familiar paper tape and she recalls: "It was so different from anything I had ever touched before!".[31]

In the early 1980s the female assistants had to deal with the new systems for data entry and word processing that progressively replaced punched cards with key-to-disc systems. According to the station reports, the operators liked the new equipment, which improved their working conditions[32] and reduced the time for preparing the yield book of the field experiments,[33] but on the other hand the assistants had to learn new keyboard operations.

The women who remained in the Rothamsted statistics department for several years therefore experienced a constant transformation of their tasks in relation to the new technologies available. Moving from one technology to the other forced the female assistants to learn from scratch new skills and follow different work practices. This is a reminder that the know-how of the laboratory technician is first and foremost a know-how related to machines. For instance, both Vera Wiltsher, already mentioned, and Brenda Watler, another data processor who worked in the statistics department in the period 1972–1989, suggested that a decisive change for them was related to the type of computer input adopted, that is paper tape or punched cards. Unlike Vera Wiltsher who began to work at Rothamsted when she was in her teens, Brenda Watler arrived in the statistics department while she was in her early 40s and had already acquired an experience with punched cards working for the insurance company Friends Provident. At Rothamsted Watler had to learn all about paper tape and oral histories collected with Wiltsher, and Watler suggests that for both women the change of medium, from tape to cards for Wiltsher and vice versa for Watler, was a challenge.

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[30] Parolini 2013: 257.

[31] Parolini 2013: 256.

[32] Rothamsted Experimental Station. 1981. *Report for 1980 Part 1*. Harpenden: Rothamsted Experimental Station: 269.

[33] Rothamsted Experimental Station. 1982. *Report for 1981 Part 1*. Harpenden: Rothamsted Experimental Station: 276.

7.4 A Job for Women

During the 70-year period examined, less than ten men – an extremely small percentage when compared with the over 200 female assistants – are listed among the computing/data processing staff of the Rothamsted statistics department (Table 7.1). Evidently men considered the role of assistant in the statistics department an unsuitable occupation.

The economic conditions were certainly not appealing. The pay of the assistant staff in the statistics department was not high. Before World War II, when the finances of the department were rather scarce, mostly young and inexperienced women were appointed as human computers. The weekly entry pay for these young assistants, just mentioned as "girls" in some correspondence of the 1930s, was 7s 6d, less than the weekly income for the Rothamsted female cleaners in the same period.[34]

The young women who entered in the department before World War II were expected to quit the job in a few years for marrying. But even after the war, when female employment became more socially acceptable and married women worked for several years as assistants in the statistics department, the situation remained unchanged. The female assistants never had a career progression. Such is the case of a married woman called Verona Roberts who entered in the department in the 1940s and remained there until the 1970s. During this time Roberts was engaged in the computing work related to the survey of fertiliser practice, an annual investigation into the use of fertilisers in farming that the Rothamsted statistics department began during World War II and carried on for decades. At her retirement in 1975, the station report could just commend Roberts' "devoted work" for the survey, as a summary of her 32-year service in the department.[35]

Only in the late 1970s, the staff lists adopted an explicit distinction between junior and senior roles in data processing, giving to the female assistants a semblance of a progression. But it was only a meagre improvement, as the tasks of the senior members were not different from the ones of the junior staff. Brenda Watler, who is listed among the senior data processors since 1978, remembers in fact that she used to share the work of all the other assistants.

The low salary and the absence of perspectives here described were certainly the main elements that made the job of assistant in the statistics department unappealing for a male workforce. On the other hand the assistant role was considered suitable for women because, for a large part of the twentieth century, they were not expected to have proper careers. This situation is not peculiar of the research institution here examined, but representative of a general trend in Britain, as argued by Mary Hicks in her examination of gender patterns in the computerisation of the

[34] For the definition of the human computers in the department as girls, see below the correspondence of the computers Pennells and Rolt with the local statisticians. For the weekly wages of the assistant staff, see the archive of Rothamsted Research (RRes), LAT 45.2.

[35] Rothamsted Experimental Station. 1976. *Report for 1975 Part 1*. Harpenden: Rothamsted Experimental Station: 332.

British civil service.[36] There is certainly a third cultural component that acted after World War II and that Hicks points out. In British advertising, the image of the computer operator was stereotypically female and perceived as a "low-cost, high-turnover, relatively unskilled worker".[37] This enduring stereotype certainly contributed to identifying the role of assistant in the Rothamsted statistics department as a female job.

7.5 From Human Computers to Data Processors

As observed by David Grier, the stories of human computers "are often difficult to tell, as the vast majority of computers left no record of their lives beyond a single footnote to a scholarly article or an acknowledgment in the bottom margin of a mathematical table".[38] The Rothamsted computers did not even have these brief mentions. The only insight into the working life of the Rothamsted human computers is offered by the unsuccessful request of wage increase filed in December 1931 by two women, Florence Pennells and Kitty Rolt.[39]

Pennells and Rolt appealed to the then head of the department, Ronald Aylmer Fisher, for a better salary. They were earning, respectively, 22s 6d and 12s per week, while a (male) assistant statistician earned in the same period about £7 per week. Asking for more money, they complained that their work as assistant computers was a much harder chore than the one of the other girls employed as assistants in the station.[40]

Yet, the role of assistant computers was not perceived as a real professional qualification at Rothamsted. For instance, a colleague of Florence Pennells and Kitty Rolt moved from the assistant staff in the department of statistics right to the task of laboratory attendant in the department of chemistry, when the grant that supported her computing work expired. Her departure prompted the request of pay rise by Pennells and Rolt.

Fisher's answer suggests a sympathetic attitude towards his computing girls. "I shall certainly feel responsible for seeing that you are not driven to work harder than is good for your health, or indeed beyond what is necessary to attain full competence in computing practice", he wrote them and committed himself to support their request if they could prove a "real increase" in their computing capacity.[41] He invited

[36] Hicks 2010a.

[37] Hicks 2010b: 3.

[38] Grier 2007: 8.

[39] The correspondence between the women computers, the statisticians in the department and the station director is held in the Fisher Papers at the Barr Smith Library, the University of Adelaide (hereafter BSL), and in the archive of Rothamsted Research [ref. STATS 7.11] (hereafter RRes).

[40] Letters from F. Pennells and K. Rolt to R. A. Fisher, 3rd and 12th December 1931, BSL.

[41] Letter from R. A. Fisher to F. Pennells and K. Rolt, 5th December 1931, RRes. For the qualification of the computers as 'girls' see Letter from R. A. Fisher to F. Yates, 5th December 1931, RRes.

them to show to Frank Yates, the assistant statistician in charge of the computing staff, which calculating machines they could use "skilfully and quickly for the different routine processes required" and, "what is very valuable when there is a shortage of machines", he invited the human computers to show the tasks for which they were "able to use the slide rule or logarithm tables".[42]

The Rothamsted computers of the 1930s were taught not only how to manage desk calculators, slide rules and mathematical tables but also basic notions of statistics, because, from time to time, they were called to handle a bit of statistics on their own. For instance, in the absence of Fisher's assistant statisticians, Pennells and Rolt had to examine a set of data related to a sheep experiment. The Rothamsted farm manager wanted the human computers "to work out some correlations" for him, and Pennells and Rolt resorted to Frank Yates for advice, still unsure about their statistical competences.[43]

The work undertaken by the woman computers in the 1930s was not very different from the tasks of their female colleagues in the 1940s and 1950s. Tabulators were introduced at Rothamsted in the 1940s, but until the second half of the 1950s, experiments and surveys were mainly analysed by hand and using desk calculators. Only in the late 1950s and during the 1960s, when the Rothamsted statistics department developed effective computer programmes for the analysis of agricultural and biological experiments and surveys, the tasks of the women assistants shifted from computing to data processing.

Vera Wiltsher remembers: "We were employed as data processors, which means we assisted in running the computer. […] You had to punch the tape, and then you put it through the verification program. Another person would find out any mistakes you had made. Also you had to do a lot of hand-work because the output we were getting was not very sophisticated, so you had to do a lot of calculations, standard errors etc. To do all these computations we used calculating machines. […] You had to work with a colleague because everything was double checked".[44]

Frank Yates, who promoted the computerisation of the Rothamsted statistics department, claimed that computerisation made it unnecessary to train "computers in the complexities of routine computation, such as the analysis of variance".[45] Although the human computers interacted with more advanced technologies, in fact, they progressively lost control on the calculations performed in the department and they became just scientific clerks, with a deskilling of the computing tasks for which the female assistants had been employed at Rothamsted since the 1920s.

However, if number crunching began to be computerised in the 1950s, all the operations concerned with the preparation of the data for the analysis of experiments and surveys and the distribution of the computer output to the experimental

[42] Letter from R. A. Fisher to F. Pennells and K. Rolt, 5th December 1931, RRes.

[43] Letter from F. Pennells and K. Rolt to F. Yates, 29th December 1931, RRes.

[44] Parolini 2013: 256.

[45] Yates, Frank. 1960. The use of electronic computers in the analysis of replicated experiments, and groups of experiments of the same design. *Bulletin de l'Institut Agronomique et des Stations de Recherches de Gembloux* 1: 201–210: 210.

scientists were automated only very slowly. Therefore, the women assistants did not vanish from the statistics department, but remained there and progressively acquired the role of data processors, a function that was still crucial in the analysis of experiments and surveys.

The transformation of the computers into data processors was a long and continuous process that lasted more than two decades and co-evolved with the computing technologies available in the department. For instance, the memories of Vera Wiltsher refer to the work with the Elliott 401, the first mainframe available at Rothamsted. When a second more advanced computer, a Ferranti Orion, arrived in the statistics department in the 1960s, she remembers that "you had not to do hand calculations because the computer did all by itself and also the output was much more sophisticated".[46] But the improved technologies emphasised the clerical features of the assistants over their technical skills, contributing to isolate them in a world apart within the statistics department.

7.6 Conclusion: On the Invisibility of the Women Assistants at Rothamsted

Gender was not the main element that contributed to the invisibility of the female assistants in the Rothamsted statistics department. It was the lack of authority[47] to preside over scientific work that relegated these women to invisibility. They "did not have anything to do with the scientific side", they "just did the punching of the tape and verified it, and the tape was sent off to be run".[48]

The female technicians were not perceived by the statisticians as equals and their practical labour was not acknowledged as akin to research, although it was essential for the department. The analysis of agricultural and biological experiments and surveys, in fact, did not require only sound statistical knowledge, but more prosaically hands able to interact with the computing technologies available and to transform experimental results and survey returns in figures that the statisticians could then evaluate and convey through publications in journals and books and in the yearly reports of the institution that were for decades one of the principal commitments for the statistics department.

It is likely that the computers themselves felt unimportant in the scientific enterprise, as a clear division in terms of competences, financial rewards and career perspectives between scientific and assistant staff was traditionally enforced at Rothamsted, and the female assistants in the statistics department were local people who had realistic expectations over an employment in the agricultural institution.

[46] Parolini 2013: 258.

[47] Shapin 1989: 560.

[48] Vera Wiltsher in Parolini 2013: 257.

On the other hand, as "[t]echnicians' work is fixed to a particular location in a way that scientific work is not",[49] the stories of these women give an immediate outlook on how computerisation and data management changed statistical work at Rothamsted. The fluctuations of the number of the female assistants from year to year and the shift of their role from human computers to data processors allow us to evaluate the impact that technologies had on the organisation of the department.

These women offer also a perspective on scientific research that is complementary to the scientists' own claims. For instance, Frank Yates, the statistician who promoted the computerisation of the department, argued that already with the Rothamsted first mainframe, the Elliott 401, the clerical work involved in the preparation of the computer input and output was reduced to a minimum, but the memories of Vera Wiltsher tell a different story.[50]

To the historian's gaze the female assistants in the Rothamsted statistics department cannot and should not remain invisible, unless we accept to perpetuate partial histories of the scientific enterprise that neglect the development of scientific practices in favour of theoretical achievements.

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[49] Iliffe 2008: 6.

[50] Parolini 2013: 240.

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