Herbert Bruderer, *Meilensteine der Rechentechnik*, De Gruyter (Berlin), XXXII+818 pages, 2015 (in German)

Bruderer is a relative newcomer to the history of computer science. His work in the field started in 2009 in preparation for Konrad Zuse's hundredth anniversary in 2010. It led to a number of articles and eventually to a monograph on the relationship between Zuse and Switzerland published in 2012. Prior to this Bruderer had published several books on computer linguistics between 1978 and 1982, and nothing, or very little, for the next thirty years.

Now retired from the ETH (Zurich), Bruderer has become a very prolific author, publishing numerous reports and articles in lay magazines. After the celebration of Zuse's birthday, he was involved in Alan Turing's hundredth anniversary, and little by little, took the task of saving from oblivion the late history of computer science, especially in Switzerland. This is a worthwhile endeavour and Bruderer is to be congratulated for his efforts, persistence and reach to the public.

Bruderer's latest book builds on these efforts and aims at providing a summary of all his research since 2009. At 818 pages, plus 32 pages of introduction, it is an impressive volume. On the cover, Bruderer features one of earliest known key-driven calculating machine, which is kept at the ETH Zurich, and was discovered by Bruderer in early 2014. The book therefore contains many recent discoveries, some of them made as late as December 2014! Bruderer has obviously tried to produce a volume as up-to-date as possible. It does in particular contain a huge bibliography of almost 200 pages and 3000 entries, although we did not check that estimate.

The general content is difficult to describe, as the book contains a lot of diverse material. There is a little bit on everything with a focus on Swiss-related history, including the context of Zuse's development in Switzerland, his early efforts at developing a computer, and similar efforts in other countries. But the book also contains overviews of various computing devices from the Antikythera mechanism to the planimeter, via reduction compasses, typewriters, and musical instruments. An important part of Bruderer's book is the description of several machines or instruments he accidentally "discovered" mainly in the basement of the ETH in Zurich. The book, however, is not a complete history of computing, it is more about bits of history scattered in time and space. Bruderer covers both mechanical and electronic devices, as well as artificial intelligence, in particular the pioneering work of Torres y Quevedo, which is an opportunity for the author to go back to a topic he addressed in 1979.

It will help to give an overview of the contents, as even browsing the book may make it difficult to distinguish its structure. Bruderer starts with a long introductory part (pages 1–211) where he introduces his topic, explains the main concepts of computers and computing, and provides nu-

merous lists and tables, such as of pioneers of computer science, or of items located in museums. These lists are somewhat redundant and the same information is often found scattered in other places, in particular in places not listed in the index (more on that later). This part of the book is probably the most original one and does not seem to have appeared in Bruderer's earlier writings.

In a second part (pages 213–289), Bruderer tries to find out who invented the computer, and naturally borrows from his work on Zuse which had the same aim.

The following parts present some of the author's "discoveries," in Switzerland and elsewhere. First (pages 291–321), there is a description of a key-driven adding machine, as well as of a larger specialized adding machine, both by Schwilgué. Bruderer discovered an example of the first machine in January 2014 in Zurich, and came across the larger machine in Strasbourg in December 2014. Although discoveries for Bruderer, these machines had been known before. The present reviewer examined the Zurich machine in 2007, and analyzed the larger machine in 2009 when it was *really* rediscovered. The reader who is interested in these machines should read the articles published on them in 2015 in the *Bulletin of the Scientific Instrument Society* and the *Annals of the History of Computing*, for he/she will find some striking differences. It should be noted that Bruderer did not want to hear about our prior work on the larger machine, and claimed that we wanted to have some monopoly on Schwilgué, that we refused to work with him, or that we were withholding essential information from mankind… ! In this context, Bruderer had some good words for us on page 25 of his book.

Next come chapters on the discovery of a Thomas arithmometer, two cylindrical LOGA slide rules and a small "Volksrechner" calculating machine (in fact a Resulta 7 type). Except for Schwilgué's large adding machine, and three smaller adding machines similar to the one on the cover, all these computing devices are located in Switzerland, and, with the exception of the "Volksrechner", in the ETH.

These chapters appear to have been drawn to a large extent from earlier reports that can be downloaded from the ETH library. The chapter on the LOGA slide rules, for instance, contains facsimile of LOGA brochures, which have already been put online by Bruderer.

Neither Schwilgué's machines, nor Thomas "Arithmomètre," nor the "Volksrechner,", nor the LOGA cylinders, are described in detail. This is the more surprising, because there was scope for detailed descriptions. One might have expected to read the working details of Schwilgué's machines, or of Thomas' calculating machine, with diagrams. Even though figures from the lauded *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* are given (pages 325–327), these are poorly reproduced and we are still lacking the technical details. We do not even know if the machine on

the cover page was opened by Bruderer (we opened it in 2007). In fact, speaking of diagrams, there seems to be no original drawing, except rather simplistic ones for Napier's bones (pages 80–82) and for abaci (pages 108–112). With 818 pages of text, one might have expected a more in-depth coverage of the machines "discovered" by the author.

Bruderer in fact focuses not on how the machines work, but on what they do, and he makes a point at providing operating instructions for several of them. It is possible that Bruderer did not intend to go into the details of the machines, but, as a result, he missed a lot of interesting and new things. Even Schwilgué's small adding machines, apparently so primitive, reveal subtle variations which have escaped the author. In any case, even when one focuses on *what* a machine does, it is much easier to explain it if one also knows *how* the machine works. And this, obviously, is not the case for all the machines which were in the author's hands.

After these "discovery" chapters, Bruderer provides an overview of the features of the first computers ABC, Ace, ENIAC, etc. (pages 365–377).

Next comes a long overview of some contributions to early computers, sorted by countries. A first part (pages 379–438) is mostly devoted to the work made in Lichtenstein (Curta) and the UK, and this is unsurprisingly followed by a long section on Switzerland (pages 438–518), and ends with a coverage of Spain and the USA (pages 519–524). An additional chapter (pages 525–576) gives facsimile reproductions of several documents related to the Z4 and Ermeth computers (pages 525–576), but with only one page of introductory comments. The Z4 (1942–1945) is considered as the first commercial digital computer.

By far the largest section of the book is the bibliography (pages 577–801), which is itself divided in a list of published references (pages 585–766) and an annotated list of the holdings of the ETH University (pages 767–801).

There is no question that this book contains a lot of information, and that it gathers material that was otherwise scattered in many places. The title *Meilensteine* (milestones) is certainly appropriate, and one can only regret the lack of a general structure; the book is more like a bag in which every possible item has been stuffed, and which contains many redundancies. Given the wealth of information, the apparatus for accessing it is very weak. The index lacks a huge number of entries, and even for those which are given, only part of the relevant pages are shown, at least for those we have sampled. As a simple example, one can consider the list on page 192, giving the names of inventors of various computing devices. This list starts with Briggs, Bürgi, Napier, etc.; in the index none of the entries leads to this page, indeed Briggs does not appear at all in the index, although he played such an important role in the development of logarithms.

The bibliography is impressive, but it contains also many flaws. Many of its entries do not seem to be referred anywhere. For instance, Bruderer

cites our works on Babbage, Bürgi, Schwilgué and on the reconstruction of mathematical tables, and none (as far as we can see) are cited in the text. One wonders why Bruderer cited these works at all. Moreover, it seems that some of the cited works have not been used, perhaps not even read. This seems to be the case with our work on Babbage, which could have been useful for the author's list of Babbage artifacts kept in museums. Oddly, Bruderer cites his own works incorrectly, for instance on page 70, when he refers to pages 225–237 of his book *Nichtnumerische Informationsverarbeitung*, which according to the bibliography (page 607) only has 202 pages. . . Something is wrong here.

Important entries are missing. For instance, Bruderer mentions Babbage in several places (although it is hard from the index to find which place is the main one), in particular on pages 252, 268 and 314 (where the author phantasizes about what Babbage would have done with Schwilgué's ideas!). But Bruderer totally forgets to cite Martin Campbell-Kelly's edition of Babbage's writings, as well as Doron Swade's dissertation, to name only these two. Back to the Strasbourg clock, Bruderer cites the translation of Bach's book, but not the original French edition. And the works of Jevons and Marquand are nowhere to be found, although the subject of an article in the *Annals of the history of computing*, which is named by Bruderer as the leading journal in the field (page 210). Some entries of the bibliography also appear to be insignificant and add absolutely nothing to the subject. For instance, Bruderer cites a book by Beillard which has four pages on Schwilgué, and could have been dropped altogether. Other entries are redundant, for instance brochures published in several languages, where one entry, with a note, would have sufficed.

As mentionned earlier, the index is rather incomplete and is not directly referring to the bibliography entries. Bruderer has in fact included a kind of supplementary search help on pages 580–583. This is a mini-index giving for a number of computing topics the names of the authors of the most important works related to this topic. This means that when the reader is looking for some information, he should not only look into the main index which is only going to provide some of the relevant places in the book, but also in the mini-index, which will help him locate some of the bibliographic references. However, there are still many unlinked references. For instance, for "Rechenbrett" (calculating desk), Bruderer forgets to refer to Burnett's book, although the latter is keyed on page 613 as addressing that topic, albeit without telling us exactly where in Burnett's book this is covered. Of course, this mini-index should have been directly included in the main index.

The bibliography contains a number of name inconsistencies. Bruderer has tried to expand all the first and middle names, but he missed many. For instance, he failed to find that Grattan-Guinness's first name is Ivor (page 645). Mary Croarken's middle or maiden name ends up with at least one

typo (page 626). Edmund Berkeley's middle name is given as Calland for one entry, a probable misreading for Callis (page 598). Then, some names are not correctly sorted, for instance d'Ocagne which ends up under "D" (page 627), instead of under "O." Derek de Solla Price is also put under "D" (page 628), but this is no surprise (he should be under "P," this is tricky). And Walther von Dyck (page 632) lacks the "von." In a few cases, Bruderer only has the authors' initials, such as "gsz" or "gu" (page 646), but in most of these cases the identity of the authors could have been obtained from the corresponding publishers.

Among the editions which should have been cited are the original editions of Chapuis and Gélis (page 618), Hopcroft, Motwani, and Ullmann (page 657), Horsburgh (page 658), Ifrah (page 660), Struik (page 730), and probably others. The second edition of Chabert (page 618) is also missing. The author cites three books by Künzel (page 671), but misses the one on Babbage. When Bruderer discusses the invention of the first compilers, he quotes Donald Knuth, but one of the references given in the bibliography is a French translation of a selection of Knuth's articles, and not the original ones. And Jacomy's book on the history of techniques was published in 1990, and not 1960 as written by Bruderer (page 661). It is only in very few cases, such as for Leupold (page 676), that Bruderer mentions the original edition. This is at odds with the book's cover and announcements which put forward the multilingual content of the bibliography.

In the bibliography, Bruderer also insists on calling Lippe a plagiarist (page 677), and, so that the reader doesn't miss that information (which already appeared on pages XVII and 25), it is repeated for each of the three volumes of Lippe's history of computing automata. This accusation may be true, but was it necessary to repeat it three times? Of course, instead of having one entry in the bibliography, we have three...

Within the text, Bruderer makes it very difficult to locate sources. He has decided not to use footnotes and usually does not refer to his sources when he uses them, but only gives a list of references at the end of certain sections (for example on page 170). This, however, is far from systematic. For instance, section 3.13 (page 130) is devoted to the fact that "computers" were initially humans. But there are no references, not even to Grier's book "When computers were human." Moreover, Bruderer's bibliography contains keys such as "Bruderer, Herbert [2011b]," but these keys are not used in the text! This makes it quite inconvenient to check a source especially with Bruderer's own publications which cover four pages and seem to be sorted by year, but then in some random order. As mentioned above, some entries of the bibliography are in fact not referred at all, and one wonders what should be done. Is the reader supposed to browse all of the bibliography entries one by one?

Whenever Bruderer makes use of a foreign reference, he cites the original text (for instance on page 224) and then translates it. This heavily bur-

dens the text, and considerably enlarges the book, but perhaps this was the intention.

Many sections of the book start with questions, as if it were some kind of quick-answer book. For instance, (translated) "How many computers were there in 1950 in Europe?" (page 72), "Who had how much influence on the development of computers?" (page 266), "Which were the first commercial computers?" (page 280), "Where did the money come from?" (page 281), "How was the *Prozessrechner* discovered" (page 295), "What was the cost of an arithmometer?" (page 330), "How long is the scale?" (page 337), and many others. These questions are often titles introducing lists.

The book contains other idiosyncrasies. For instance, for some reason, every table, even the smallest one such as the one giving a short list of users of relay and tubes in digital computers (page 51), ends with a copyright by "Bruderer Informatik," although it is unclear what is copyrighted here, and what is not copyrighted elsewhere. Moreover, most of these tables are quite simple, one of the most complex being that on pages 367–372 which happens to be quite inefficiently typeset. The entire table only contains 23 lines and could have been fitted on two facing pages, with much wider columns for the makers and places.

The author also has a penchant for building adjectives out of names, such as "leibnizsche" (meaning "from Leibniz"), "baldwinsche," "braunsche," "dietzscholdsche," "feltsche," and many others (pages 154–161), but these adjectives turn out to be very cumbersome and force the reader to extract the name of the author from the adjective, a burden which could have been avoided, even though the sentences are probably structurally correct.

Given that Bruderer makes passing mentions of tables of logarithms, without showing any, and given that he mentioned our work on Bürgi (but not on Napier!), it is not astonishing that he devoted a section to the invention/discovery of logarithms (pages 102–103). For Bruderer, logarithms have been "discovered" and not "invented" and he makes a point at labelling the Napier 2014 conference as "patriotic." In any case, this section has no reference either to the tables of Bürgi, or those of Napier, moreover, none of them, nor Briggs, made it into the bibliography.

In several occasions (pages 31, 44, 118, 146, 149, and 307), the author distinguishes between digital and analog computers, and he mentions Schwilgué's ecclesiastical calendar on the Strasbourg clock, but incorrectly classifies it as analog, when the calendar part is in fact digital! In that context, it would incidentally have been appropriate to mention Chebyshev's continuous adding machine.

When Bruderer lists the main achievements of his research (pages 24–25), one cannot help smiling at the "discovery" of articles and drawings in the *Bulletin de la société d'encouragement pour l'industrie nationale*, at similar "discoveries" in the catalogue of the 1851 exhibition in London, the visit to several museums, the participation in an international conference

in 2013, and so on, including the exhibition on clockmakers and calculating machines at the Arithmeum museum in Bonn. In the latter case, Bruderer seems to take pride in having originated this exhibition, but first, as far as we know, this exhibition was planned before Bruderer's "discoveries," and second, the main calculating machine from Schwilgué exhibited there came to the attention of the author after the present reviewer asked the museum to move it to the Strasbourg historical museum. Some of the achievements therefore seem dubious.

Although valuable, Bruderer's book is fraught with problems, many of them stemming from the fact that it is not ripe. Historical research takes time, and Bruderer's book reads much more like sensational journalism than genuine research. One can't help thinking that the proofreading process of this book was insufficient and that none of these shortcomings were unavoidable.

The huge bibliography is largely disconnected from the rest of the book, and could have been published separately, without too much inconvenience, keeping only the references actually used.

It is also unfortunate that the machines presented in the book have not been studied in detail, although they could have been. The author has only visited a relatively small number of museums and archives, and has consequently missed numerous items, in particular in the United States and in the UK. Of course, even unripe fruits can be useful, but in this case, we can only advise German-speaking readers to check everything they will find in this book in other sources. Do not use this book as a first-hand source!

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