OH, WHAT A WEB WE PUNCH

Most mechanical engineers, if they are involved in computer applications, will sooner or later read a statement to the effect that Joseph Jacquard's punched-card controller for textile looms was the "beginning of the computer age." The remark is usually accompanied by a bit of 19th-century history, but no explanation as to how he used a punched card to control a powerful machine like a loom in the absence of electronics.

After spending a couple of months exploring that question, I discovered *Jacquard's Web* by James Essinger. This is such a technically complete and historically significant study that I was disappointed to realize there was nothing I could add.

Essinger shows how control was accomplished by replicating a simple linkage hundreds or even thousands of times. Textile patterns were produced by raising or lowering each of the "warp" threads of a fabric during weaving. The position determined whether a shuttle passed above or below the thread.

In Jacquard's invention, each thread passed through an eyelet called a "mail," which was leashed to the end of a flexible vertical wire having a hook at the upper end. Those hooks engaged teeth of a comb called a "griffe," which moved up and down each cycle of the shuttle. A pattern was sensed by lightly spring-loaded fingers called "needles" passing through holes in the card when it was pressed against what we would now call a sensor head. Each needle connected to a given wire hook and displaced it or not, as the pattern required. Bending the hook had the effect of declutching it from the griffe and determined whether the shuttle passed above or below the thread at its lower end. The relatively light force required to bend a thin wire could thus control the very large force lifting the comb.

In researching this subject, I encountered another asset. A Web site, http://onlinebooks.library.upenn.edu, gives access to technical publications on numerous subjects. These are in the public domain and may be downloaded. I found it after browsing on the word "Jacquard" had produced several publications dating from the 1870s. Those by E.A. Posselt are still influential. They provide complete detail to anyone interested purely in mechanics.

Jacquard's Web describes the mechanism very briefly, but then goes on to explore the colorful subsequent history of Jacquard's invention. Punched cards were adopted in the 1820s by an eccentric genius named Charles Babbage, who hoped to use them to program a steam-driven mechanical computer.

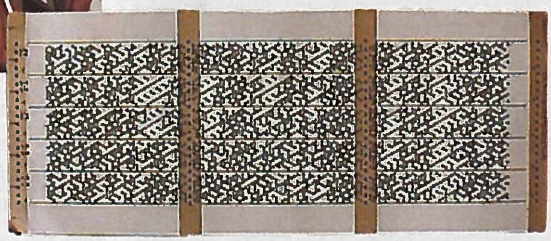
Programming some of the cards was done by a talented amateur mathematician, Ada, Countess of Lovelace, whose name has been given to the present-day programming language. Her half-brother was the poet Lord Byron, who had nothing to do with computers.

Based on Babbage's idea, punched cards were adopted by Herman Hollerith to automate the 1890 U.S. national census. Data for 1880 had been compiled by more than a thousand clerks copying numbers by hand. Hollerith's innovation reduced the number of people required to complete the census, (it had taken 1,495 in 1880) and it reduced the time from seven years to three.

The idea of storing data on punched cards was taken up in the 1930s by Thomas J. Watson and mined as a mother lode by his corporation, International Business Machines.

Anyone involved in computing during its earlier days will remember the immense decks of cards used to program computers. Changing a single line of a program required repunching a card and rerunning the entire deck. Accidentally scrambling the cards was the ultimate disaster. Jacquard's original design did not have that problem. Cards, each on the order of 6 by 25 centimeters, were strung together to form a continuous belt meters long.

Essinger's book was published in 2004 by Oxford University Press. I strongly recommend it to anyone who is interested in seeing how an apparently minor innovation in technology can propagate seismic ripples throughout our society.



The jacquard loom cards transmitted information to a simple linkage replicated hundreds of times.

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