Leonardo Torres Y Quevedo

Born 1852, Santa Cruz, Santander, Spain; died 1936; 1920 Spanish computer inventor

Born in Santa Cruz in the province of Santander in Spain in 1852 and educated as a civil engineer, Torres became director of a major laboratory, president of the Academy of Sciences of Madrid, a member of the French Academy of Sciences, and famous as a prolific and successful inventor. Some of his earliest inventions took the form of mechanical analog calculating devices of impressive originality.[1] He was a pioneer of radio control, and in 1906 successfully demonstrated a radio controlled model boat operating in Bilbao harbor before an admiring crowd that included the king of Spain. He received similar acclaim for his invention of a semi rigid airship that was manufactured in quantity and used by both sets of military forces during World War I. One of his inventions is still thriving as a tourist attraction at Niagara Falls: the Spanish Aero, Car, originally installed in 1916.

In 1911 he made and successfully demonstrated a chess-playing automaton for the endgame of king and rook against king.[2] This chess automaton, believed to have been the world's first, was fully automatic, with electrical sensing of the pieces on the board and what was in effect a mechanical arm to move its own pieces.[3] Some years later Torres made a second chess automaton, which used magnets underneath the board to move the pieces. Like a number of his other inventions, this one still exists and is still operational.

Torres y Quevedo's major motivation in all his work appears to have been to exploit, to the full, the new facilities the electromechanical techniques offered, and to challenge accepted thinking as to the limitations of machines. His attitude was well summarized in the *Scientific American* account (1915) of the first chess automaton:

> There is no claim that [the chess player] will think or accomplish things where thought is necessary, but its inventor claims that the limits within which thought is really necessary need to be better defined, and that an automaton can do many things that are popularly classed with thought. It will do certain things which depend upon certain conditions, and these according to arbitrary rules selected in advance.

Torres' major written work on this subject is the fascinating "Essays on Automatics" (1913), which well repays reading even today. The paper provides us with the main link between Torres and Babbage. Torres gives a brief history of Babbage's efforts at constructing a mechanical Difference Engine and Analytical Engine. He describes the Analytical Engine as exemplifying his theories as to the potential power of machines, and takes the problem of designing such an engine as a challenge to his skills as an inventor of electromechanical devices. The paper in fact contains a complete design (albeit one that Torres regarded as theoretical rather than practical) for a machine capable of calculating completely automatically the value of the formula $a^x (y - z)^2$, for a sequence of sets of values of the variables involved. It demonstrates cunning electromechanical gadgets for

[1] See Eames, Charles, and Ray Eames, *A Computer Perspective,* Harvard Univ. Press, Cambridge, Mass., 1973, pp. 66-68.

[2] Anon., "Torres and His Remarkable Automatic Devices," Scientific American Supplement, Vol. 80, No. 2079, 1915, pp. 296-298.

[3] The one earlier apparent chess automaton, exhibited by von Kempelen, turned out to have a small human operator hidden inside; see Chapuis, A. and E. Droz, 1958. Automata: A Historical and Technological Study, Basford, London.

storing decimal digits, for performing arithmetic operations using built-in function tables, and for comparing the values of two quantities. The whole machine was to be controlled from a read-only program (complete with provisions for conditional branching), represented by a pattern of conducting areas mounted around the surface of a rotating cylinder. Incidentally, the paper also contains, almost casually, what is believed to be the first proposal of the idea of floating-point arithmetic.

The paper ends with a comparison of the advantages of electromechanical devices that were all that were available to Babbage. It establishes that Torres y Quevedo would have been quite capable of building a general-purpose electromechanical computer more than 20 years ahead of its time, had the practical need, motivation, and financing been present.

This opinion need not rest solely on the fact that Torres documented a plausible theoretical design, however, because it turns out that he went ahead to prove his point with a series of working prototypes. Possibly the first was a demonstration machine, capable of evaluating $p \times q - b$. How successful this was in practice we do not know. In 1920 Torres must have removed any uncertainty, because he startled the attendees at a Paris conference, marking the centenary of the invention of the first really practical calculating arithmometer (Torres y Quevedo 1920). This machine consisted of an arithmetic unit connected to a (possibly remote) typewriter, on which commands could be typed and the results printed automatically. Torres apparently had no thought of making such a machine commercially, viewing it instead as a means of demonstrating his ideas and techniques. Thus we can only speculate on what might have happened if he had gone ahead and made a full-scale computer, or even if his writings had become better known to the English-speaking world. As it turned out, his work had little discernible effect on later developments leading to the modern computer. In all other respects, his career must surely be judged as a very successful one, and one that deserves much wider appreciation outside Spain, where a laboratory has been named after him, books have been written about him (Rodriguez Alcalde 1966, 1974; Santesmases 1980), and a number of his machines, some still in working order, are on exhibition at the Colegio di Ingenieros do Carninos, Canales, y Puertos, in Madrid.[1]

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[1] Extracted from Randell 1982.

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UPDATES

Portrait added (MRW, 2013)