A History of Precision Engineering and the Making of the Modern World | Simon Winchester

June 28th, 2018

"Is such a wish for perfection truly essential to modern health and happiness, a necessary component of our very being?" – Simon Winchester

Precision, a measure of the detail in which a quantity is expressed.

The word "perfectionist" can conjure up the image of a fussy, slightly anxious person who needs to relax more. The constant pursuit of the flawless can be exhausting. Nothing in our world, after all, is exactly perfect. But what if perfection is not only a goal for its own sake but something on which the lives of others depend? What if the slightest misalignment of a tiny tube in a jet engine could cause a fatal catastrophe? – Simon Winchester

In **"The Perfectionists,"** Simon Winchester celebrates the unsung breed of engineers who through the ages have designed ever more creative and intricate machines. He takes us on a journey through the evolution of "precision," which in his view is the major driver of what we experience as life in the modern world.

1. **Why this Book?** — How did you ever get the idea to write such a book? I don't think that I could have come up with such an idea as "precision" for the subject of a book, but once I saw your title, I knew it was something I wanted to read. How long did it take for you to research and write it? How did you determine that you wanted to write it? ***I love how you organized it thematically by making it a progression of precision from chapter to chapter.

2. **What is Precision?** — Let's start with a definition of precision? What is precision? What is the difference between precision and accuracy? Can we say that precision is detailed understanding such that perfect replication becomes possible?

3. **Approximation of Truth** — Why did you begin Chapter 1 with this quote from Aristotle: "It is the mark of an instructed mind to rest assured with that degree of precision that the nature of the subject admits, and not to seek exactness when only an approximation of the truth is possible."

4. **Precise Origins** — Is it possible or reasonable to claim a start date for precision engineering? You cite John Wilkinson as the person commonly regarded by the engineering fraternity as the father of true precision, but you spend a bit of time exploring alternatives. What is the origin of precision engineering as you see it? You seem to start the clock with the partnership of James Watt and John Wilkinson in solving the problem of air leakage from early steam engines.

5. **Precisely Inaccurate** — Your book is at once both a history of precision and an homage to imprecision, not only by virtue of examples where imperfections have led to disaster or fraud, but where we demand imperfection above the machine-made precision of our modern age. Did you feel, when writing this

A cross section of a late eighteenth-century Boulton and Watt steam engine. The main cylinder, C, would have been bored by John Wilkinson, the piston, P, fitting snugly inside it to the thickness of an English shilling, a tenth of an inch.

book, that ==the further you traveled into the smallest levels of detail that you were moving further and further away from a world that we understand and can comfortably inhabit==? Is there a sort of paradox that emerges, ==as we make better sense of the world that we have a harder time living in it==? In the last chapter of the book you write: Is such a wish for perfection truly essential to modern health and happiness, a necessary component of our very being? ==Could we say that we are beginning to live our lives with less accuracy==? That we are not aligning outcomes with intentions?

6. **Common Exponents & Limits** — There is an interesting corollary that emerges between the exponential rates of change we see (most closely associated with Moore's law and the microchip/transistor) in the world and the amount of precision that we bring to bear in our engineering. ==Precision. Efficiency. Optimization. Order.== There seems to run a common thread through all of these: ==the human mind's desire to bend the world to its will. Is there a limit to what our minds can accomplish in the world==? Is the answer simply that humanity has and will continue to evolve in order to inhabit the world that each new generation is creating?

7. **Anecdotes of Precision** — You have many interesting anecdotes throughout the book as you tell the history of precision. I'd like to ask you about some of my favorite.

    a. **Bramah Lock** – (TOLERANCE: 0.000 000 000 1) Joseph Bramah's "challenge lock" remained unpicked for sixty-one years after first being displayed in a window in London's Piccadilly. An American named Alfred Hobbs eventually beat the challenge, after fifty-one hours of delicate work, allowing the Bramah lock company to declare its invention essentially burglar-proof.
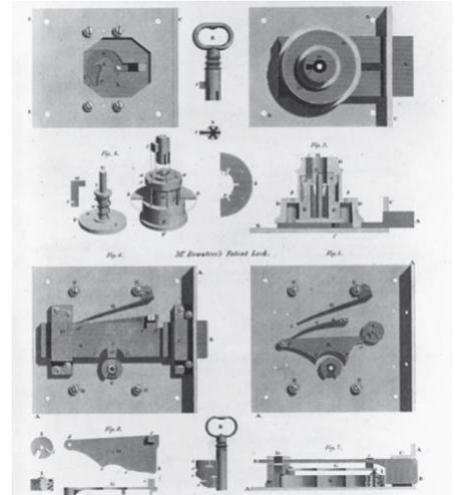
    b. **Henry Royce vs. Henry Ford** – (TOLERANCE: 0.000 000 000 1) The distinction between Ford and Royce. Henry Ford bought the American gauge block business of its inventor, Carl Edvard Johansson, the Swede still known today as the world's "Master of Measurement." With the use of so-called Jo blocks, extreme tolerances could be realized swiftly, further increasing the efficiency and reliability of engineered products. It seems that Rolls Royce was the quintessential craft product. ==Was the Rolls Royce, at its peak the most highly engineering, imprecise, non-machined car?==

    c. **Airline Jet Engines** – (TOLERANCE: 0.000 000 000 001) The story of the Qantas airliner with its Royce jet engine blowing up, all because a small part of the fractured oil feed stub pipe that failed due to metal fatigue caused by slightly misaligned machining that left the pipe a little thinner on one side. Fatigue cracking probably began upon takeoff in Los Angeles, and worsened after takeoff from London. A minute after takeoff from Singapore, the pipe broke open and spewed hot oil over the rapidly spinning rotor.

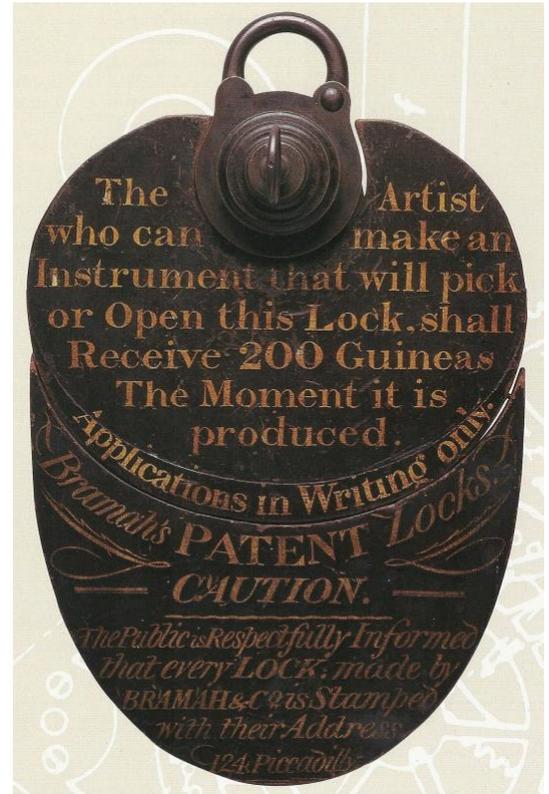**(TOLERANCE: 0.1)** "This was the tolerance to which John Wilkinson had ground out his first cylinder."

(TOLERANCE: 0.0001) Henry Maudslay's bench micrometer could measure down to one one-thousandth of an inch and, according to some, maybe even one ten-thousandth of an inch: to a tolerance of 0.0001.

(TOLERANCE: 0.000 01) Honoré Blanc and fire-arms parts made combinatorially.

(TOLERANCE: 0.000 000 1) "John Wilkinson had given birth to the concept of precision with a machine that could bore a hole to a tolerance of one-tenth of an inch. Now metal pieces could be made and measured to a tolerance of one-millionth of an inch."

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(TOLERANCE: 0.000 000 000 000 1) "The Hubble telescope's eight-foot-diameter primary mirror being polished at the Perkin-Elmer Corporation's top-secret facility in Danbury, Connecticut. An overlooked measurement error on the mirror amounting to one-fiftieth the thickness of a human hair managed to render most of the images beamed down from Hubble fuzzy and almost wholly useless." Got me thinking about the NASA lost its $125-million Mars Climate Orbiter because spacecraft engineers failed to convert from English to metric measurements when exchanging vital data before the craft was launched, space agency officials said Thursday.
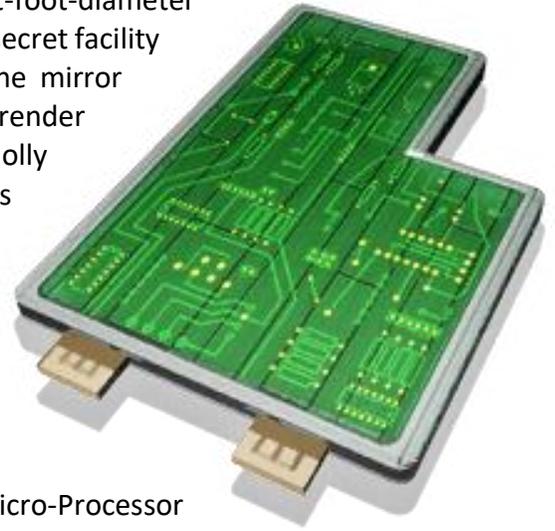
(TOLERANCE: 0.000 000 000 000 000 01) Satellite

(TOLERANCE: 0.000 000 000 000 000 000 000 000 000 000 000 01) Micro-Processor