► played at a certain time, may generate sadness, which is meaning. It's part of the musical grammar that European culture invented, which allows composers to convey moods or emotions. It wouldn't mean the same to someone raised in a different culture. I once heard a well-known opera with a computer scientist from India. He told me that all arias sounded the same to him. For him, meaning came through rhythms and harmonics associated with Indian classical music. In fact, the formal mechanisms that we use in computing to generate and recognize syntactic structures are the same for music and language — both involve the hierarchical organization of the constitutive elements.

Tell me about your new opera, *Fausto*.

We wanted to explore the impact of information technology on humanity, so we transported Faust to the modern world. The original Faust sells his soul to the demon Mephistopheles in exchange for eternal youth and knowledge. Our Faust is a hipster who is addicted to social media and virtual reality. Devastated by the suicide of Marguerita, who loved him, he makes a pact with Mephistopheles: in exchange for virtual communion with her, he will upload his mind and leave his body to Mephistopheles. It's a cautionary tale. Humans are being drawn into virtual worlds, and the question of how we might upload our minds to enjoy eternal life is being discussed. I see this as a dangerous trajectory. Our minds are embodied both physically and socially, as Mephistopheles knows. It is the reason he wants bodies — so that, by inhabiting them, virtual agents like him can feel fully human. Faust only realizes it as his mind is uploading: he'll never have real love in a virtual world.

Will there be a role for new technologies in the opera?

The actors will wear virtual-reality glasses, and the audience will be able to see what they are seeing, which will be projected onto a screen. This will heighten the sense of blurred boundaries. Is Marguerita real or virtual? Dead or alive? Could Mephistopheles be an app? We want to create an atmosphere of uncertainty similar to the one in which artificial-intelligence researchers find themselves today, with respect to one important question. That is, are humans just information processors, or are there extra elements, such as consciousness, that we might never be able to capture? ■

INTERVIEW BY LAURA SPINNEY.

This interview has been edited for length and clarity.

Early Chinese typewriters had thousands of keys to search through.

HISTORY OF TECHNOLOGY

How China sidestepped QWERTY

Raja Adal investigates the 150-year history of a typewriter able to reproduce thousands of characters.

When the A key is pressed on a QWERTY keyboard, the letter 'a' appears on the screen. When that key is pressed in a standard Chinese word-processing program, however, it triggers a dozen or so Chinese characters that are pronounced 'a'. Thomas Mullaney's *The Chinese Typewriter* tells the story of the technolinguistic innovations behind the Chinese typewriter, and how they led to input methods used in Chinese computers today.

Improving typing speed was a priority. At stake was not only the recognition of Chinese as a modern language but also, for the millions of Chinese people employed in producing government and business documents, potentially enormous gains in productivity. The economic, cultural and geopolitical stakes were so high that, for 150 years, engineers and linguists from within China and beyond — including the Soviet Union, Japan and the United States

The Chinese Typewriter: A History

THOMAS S. MULLANEY
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— wrestled with the challenge of typing Chinese characters. The problem was sheer number: anything from 2,000 to 8,000 Chinese characters (called kanji in Japanese and hanja in Korean) are considered a basic requirement for a viable Chinese typewriter.

Early designs, Mullaney shows, accommodated this sea of characters by putting them on individual slugs in a rectangular tray bed. The typist had to hunt and peck for the desired character, which a mechanical arm would then project onto the page. That challenge led to fascinating taxonomic innovations aimed at efficiency. Instead

The MingKwai machine narrowed the selection to just 72 keys.

the advent of the word processor; jotting characters on a piece of paper was much more efficient. What will the future of input look like? Voice recognition may let us entirely sidestep the keyboard; with stylus-equipped tablets, handwriting could make a comeback. From this perspective, the history of the Chinese typewriter is part, not only of the history of the keyboard, but also of the much larger history of inscription.

Within that broader scope, this book joins recent works such as Lisa Gitelman's *Paper Knowledge* (Duke University Press, 2014) in exploring the intersection between technology and language. The Chinese typewriter was the outcome of a process that required both a technological rethinking of the alphabetic typewriter and a taxonomic reordering of the Chinese language.

If we think of recent transformations in how we read, write, search and communicate — from e-books to smartphone keyboards, searchable databases and Twitter feeds — and of the ways in which these changes affect everything from our political environment to scientific research, technolinguistic transformation is more relevant than ever. *The Chinese Typewriter* provides a captivating exploration of one of the most consequential technolinguistic feats in modern history. ■

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(1895–1976) in the mid-1940s, the MingKwai typewriter had even more character slugs than the average Chinese typewriters of the day — 8,352. Instead of using the hunt-and-peck method on thousands of keys, however, the typist (primarily Lin's daughter, Lin Taiyi) had to contend with only 72. Two sets, upper and lower, held constituent parts of Chinese characters; another set held eight number keys. The rest of the mechanism, including character slugs, was hidden inside the machine. Pressing a key from the first set narrowed the choices by a factor of 36; pressing one from the second narrowed them down to 8 characters or fewer. These appeared in a window and were selected using the number keys.

This “sleep-deprived, torment-ridden history”, during which inventors and entrepreneurs “were never permitted to drift off into the comfortable dream of immediacy like their counterparts in the alphabetic world”, had an immense, but delayed, impact. Attempts to improve the Chinese typewriter, such as the MingKwai, paid off only after the 1970s, in the computer age. Then, the IME transformed the Chinese keyboard into a ‘smart’ peripheral, much more sophisticated at taking instructions from the user than its static, rather stupid alphabetic cousin. Mullaney's history is thus a prehistory of computer input, and will be followed by his *The Chinese Computer* (forthcoming from MIT Press).

Some may ask how relevant the keyboard is to the future of input. Japanese engineers, after all, developed the fax machine to escape the constraints of the keyboard. Typing on a Chinese, Japanese or Korean typewriter remained difficult, slow and tiring until

of organizing the characters by counting their graphical components, or radicals and strokes — as is common in Chinese orthography — new methods arranged them according to factors such as their usage frequency.

During a period of experimentation starting in the early twentieth century, each character still had its own key; but for Mullaney, the main lesson of this history is that inventors soon began to pioneer completely new methods for text input. It was they who started to dispel the “myth of immediacy” represented by the nineteenth-century direct-input keyboard, and who opened up the possibility of typing Chinese in a way that accepts a lack of direct correlation between what you type and what you see. Ultimately, their work led to today's sophisticated predictive-text engines, which benefit from increasing processing power and cloud integration. The Chinese computer IME (input method editor) now enables access to characters, entire words and even commonly used sentences at the press of a key.

Among several early designs that did away with the thousands of key slugs was the 1915 ‘divisible type’ machine devised by Qi Xuan, a student at New York University. This broke individual characters into their constituent parts, which were then pieced together by the typist.

The most interesting invention, however, is also the one Mullaney sees as the most direct ancestor of the Chinese IME. Invented by towering literary figure Lin Yutang

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