Why QWERTY,
And What's Better?

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Introduction

Our Qwerty keyboard layout, named after the top-left six letters, was already known in 1893 as the “universal” layout.

Years ago it was obvious to me that the layout was difficult to learn and inefficient, too. For a long time, we were required in my grade 8 touch-typing classes to type strings of nonsense: asdf, jkl;. Jkjk fdfd dkdk fjfj hdjf. That's because the lessons start on the middle row, “home row”, where one is normally supposed to keep the fingers. A few words and almost-words could be made in these “home row” lessons: a, sad, ass, had, dash, fall, fad, gaff. But sentences were generally impossible without at least introducing E and T from the top row. When using Qwerty, over half of all letters are typed on the top row, but this is not the proper place to keep the fingers because the bottom row would become practically unreachable.

I've investigated the history of typewriters to gain insight into Qwerty's rise to dominance. In this paper I will explain what happened, show what alternatives were created, and which alternatives are better. I intended to cover related issues such as typing on small devices, and keyboard ergonomics, but it turned out that this report was too long even without that material.

Early history of the typewriter

The first commercially successful writing machine was the Sholes & Glidden “Type Writer”, made by E. Remington and Sons, which went on sale in 1873 (1874, according to the VTM)[1]. It only printed capital letters, and it used an “up-stroke” system wherein characters were printed on the underside of the platen (the cylinder against which the paper rests), so that the output could not be seen until four lines after it had been typed. The layout of letters (Fig. 1) was identical to what we use today, but the punctuation was different.

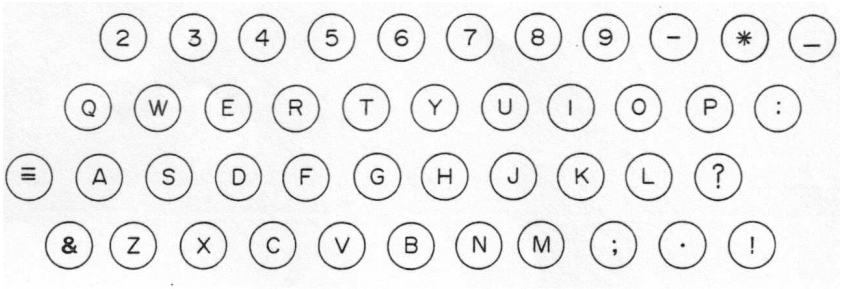

Figure 1: The original Sholes layout (Beeching 74)

There are many conflicting claims about the history of the typewriter, as you could read about in (Adler 73 p.136-137). However, most accounts of the history share similar elements (Campbell 05, Beeching 74, David 85, Liebowitz 96, Diamong 97, Adler 73 p.205). The typewriter began with an alphabetical order, of which a remnant (FGHJKL) can be seen on home row; however, it jammed easily. After the user pressed a key, the corresponding type bar retract relatively slowly by the force of gravity. If a second key was pressed soon enough, and if it was near to the first in the type basket, it

1 It is estimated that there were 51 unsuccessful machines before it (David 85), and it is widely agreed that this machine enjoyed very little sales during its first few years.

would stick to the first and jam. The manufacturer, the inventor (Christopher Latham Sholes), or his brother, solved the problem by rearranging the keys until, empirically, less jamming occurred. Jamming is thought to have occurred when adjacent keys were near one another in the type basket (the circle of type bars underneath the paper), so jamming would be reduced either if common digraphs were far apart in the basket, or if the typist were slowed down by, for instance, a layout that encouraged pressing a pair of keys with the same finger (e.g. ED). There is one source that disputes this story (Yasuoka 06), saying that an 1872 "trial model" had a layout very similar to the final one[2], and also that E and R (a common English digraph) were in the same quadrant of the type basket. It is also widely reported that the letters of the phrase "TYPE WRITER" were placed on the top row to make salesmen's jobs easier.

In any case, the machine could not handle fast typing, and 2- or 4-finger operation was expected, as 8-finger typing was not invented until 8 years later by a Mrs. Elizabeth Longley (Yasuoka 06). In the meantime, the Remington 2 (successor to the 1873 model that was renamed Remington 1) and a competitor called the Caligraph 1 (a 6x8 Qwerty variant, see Fig. 2) became available (VTM). And though an 8-finger method was out there, it did not seem to have much popularity in its day (as a quote from *Cosmopolitan Shorthander* suggests in Campbell-Kelly 2005). That would have to wait until 1888, when Frank E. McGurrin, a Salt Lake City court stenographer, and a Mr. Louis Taub both claimed to be the world's fastest typists. They met in Cincinnati on July 25, 1888 for a famous typing contest in which McGurrin, who apparently invented touch typing on Qwerty, soundly beat Mr. Taub, a four-finger typist using Caligraph 2. This was reported on front pages across the U.S. (TTCS:H) and soon led to a widespread belief that touch typing was the fastest method available—which, of course, is true, but not known before.

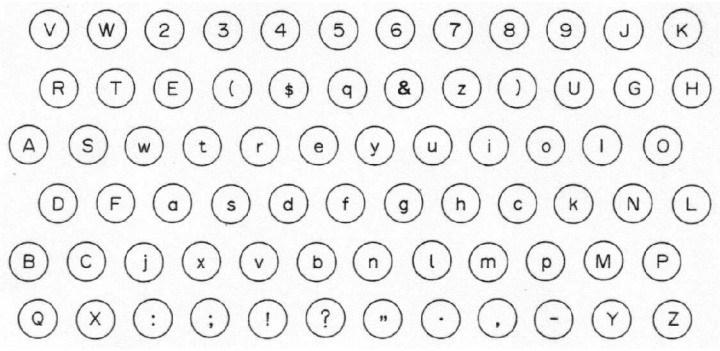

Figure 2: Caligraph 2 (1882) (Beeching 74 p.43)

Before the boom in touch-typing, there were a few other layouts produced. I have found these:

- Caligraph 1 (1880) and 2 (1882, Fig. 2), of which the former could only produce capital letters and appears to be an arbitrarily rearranged Qwerty, while the latter is similar but adds capital letters in a bizarre fashion.

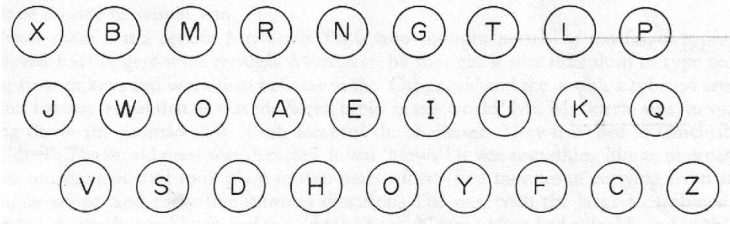

Figure 3: Fitch (1886) (Beeching 74 p.44)

2 Note: the typewriter's development started much earlier than this; the first prototype was made in 1867 (Adler 73 p.140).

- Fitch (1886, Fig. 3), which placed all the vowels in the center as well as most common letters (with the notable exceptions of S and L). This would have been a decent layout for four-finger operation.
- Prouty (1888, Fig. 4) which has no apparent pattern.

Besides these models, and through the rest of the 19th century, a wide variety of writing machines were created without keyboards; these were generally simpler, labor-intensive devices aimed at low-end markets.

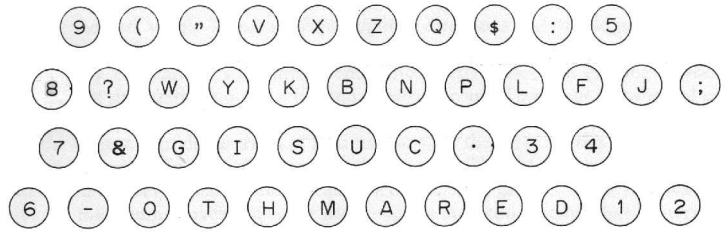

Figure 4: Prouty (1888) (Beeching 74 p.44)

More relevant to this report is what happened after the invention of touch typing. It seems that only one new layout was put on the market between 1888 and 1900: the "Scientific keyboard[3]" on the 1893 Blickensderfer 5 (Fig. 5).

This is the most interesting of the layouts, because its designer almost had the right idea. The 10 most common letters in English text are ETAOINSHRD, in roughly that order[4], and the keyboard puts those letters along the bottom row, with the most common letters in the center.

An 1893 ad shows that Qwerty was already marketed as the "Universal Key Board" (Post 81, p.66), which already points to a difficulty for the new layout. While the Blickensderfer was "the only successful alternative to the Qwerty keyboard, ever", "there was very little demand for [it] as customers opted for the Universal" (Campbell-Kelly 95).

And so it was that before the close of the 19th century, the Universal was already, well, universal. But why? Qwerty is often cited as an example of lock-in—a situation where an inferior standard is *the* standard because switching to something else would be too costly. But there were many factors at work, and to me the most interesting was that

Figure 5: Blickensderfer 5 with "Scientific keyboard" (1893) (Campbell-Kelly 05, Rehr 97)

3 This is called the Ideal keyboard in Campbell-Kelly 05 and Adler 73, but Rehr 97 (p.13) explicitly states that this is an error, for in fact, Ideal is the name of an unrelated 2-row keyboard by the Hammond company.

4 This order was known at least as early as 1886; ETAOIN SHRDLU formed two columns on the first linotype machine, a typesetting machine sold starting in 1886—that machine's layout is not shown here because it was not used in typewriters. My own frequency analysis at http://millikeys.sf.net/freqanalysis.html basically confirms this order of letter frequencies.

Qwerty was *not* inferior for touch typing.

Standards of efficiency

In 1932[5] August Dvorak finished his keyboard, which was designed according to the following oft-cited criteria (Parkinson 72), which are intended to make touch typing both efficient and comfortable:

1. Hand alternation: each successive character is best typed by a different hand.
2. Hand load: Dvorak believed that the left hand was weaker. Qwerty places 55% of typed characters on the left hand[6]; Dvorak's design gives slightly more work to the right hand instead[7].
3. Finger load: the ring finger and especially the pinkie have less strength and dexterity than the other two fingers, so they should be given less work to do.
4. Finger movement/home row: typing is slower, and increased fatigue may result, if the typist must frequently move his hands from home row. The most common letters should be placed on this row. On Qwerty, 32% of typing is on home row, but 52% on the upper row (compared with 70% and 22% for Dvorak). In my opinion, this upper-row bias is Qwerty's single biggest problem.
5. Lower row: this row is the hardest to reach and should require the least amount of typing. Qwerty unfortunately places N on the bottom row (the 6th most common letter). On Qwerty, 16% of typing is on the bottom row (versus 8% for Dvorak).
6. Same-finger digraphs: one wishes not to type two consecutive characters with the same finger. ED/DE is the biggest such problem in Qwerty; others include MY and LO/OL.
7. Stroke awkwardness: pressing two nearby keys on different rows is awkward and slow compared to pressing two adjacent keys on the same row. Problem digraphs on Qwerty include CE, MY, OL/LO, and WA (as in WAS).

The following additional principles are also espoused often by layout designers today (Capewell, Coleman, Hallingstad, Piepgrass 06):

- The pinky, being much shorter and weaker than other fingers, should rarely be required to reach anywhere.
- A layout similar to Qwerty is easier to learn for those familiar with Qwerty.
- Hand-rolling movements or “combos” have similar value to hand alternation; so on Qwerty, such sequences AS, DF, JK, and perhaps JL and RE/ER are acceptable. Opinions vary as to which sequences are acceptable and whether they are better or worse than hand alternation, but it seems agreed that combos and alternation are both worthwhile. It should be noted that combos are probably more acceptable on modern keyboards, where keys are easy to press.

5 Though completed in 1932, Dvorak was granted a patent in 1936 (DSK).

6 This figure is based on my own analysis; I recall seeing a figure of 56% somewhere else.

7 In my opinion, equal loading is best, but there is actually an argument for higher left-hand loading on modern keyboards: computer users must frequently reach for the mouse, and if they wish to type must use the left hand only. Also, consider that the cursor/editing keys (arrows, home/end, delete) are also assigned to the right hand.

Why Qwerty won: 1890s

1890s folk had no access to 1930s research, but it is reasonable to suppose that some of those considering a typewriter purchase may have had an intuitive understanding of these factors. They might therefore have realized that Qwerty's main competitor, the Blick 5, was actually not that great for touch typing. Notice the following in Fig. 5:

- The home row (with the most common letters) is the bottom row, so that ZXKGBVQJ are hard to reach. One practically needs to move the hands off home row, which is certainly detrimental to touch typing.
- There is no clear choice of home fingers. If one rests the fingers on DHIA NSOR, then the two most common letters E and T require the index finger to reach. If one chooses HIAT ENSO, on the other hand, it's even worse, as the weak pinky finger must hit the very common letters D and R.
- Assuming the DHIA NSOR rest position, there are some major same-finger conflicts, the worst of which are EN/NE, AT/TA, LE/EL, and UT/TU (PFL 06).

For the four-finger typing market, whose size in relation to the touch-typing market I could not ascertain, the Blick was also not better than Qwerty, for such users might prefer the most common letters to be spread over two rows, in order to reduce horizontal hand movement.

Similar analysis would show that other, earlier layouts were even worse. Thus, while Qwerty is clearly suboptimal, it was the best layout available at the time. According to Stan Liebowitz & Stephen E. Margolis, there were other typing contests in 1888 and 1889 and “The other keyboards did compete. They just couldn't surpass QWERTY” (Liebowitz 96).

However, there is more that could and should be said. While I could not find sales figures, it seems clear from the way historical books are written that Qwerty-based typewriters had always been the market leaders, for the entire duration from 1874 until now. “The standard QWERTYUIOP order imposed itself on the others gradually and they succumbed to it one at a time” (Adler 73 p.207).

Even if Qwerty hadn't been superior, there are other factors that could have had an effect. Let us consider relevant social groups: buyers, typists, and manufacturers.

Buyers: A keyboard-based typewriter was a very expensive device, and businesses were the largest market. (Campbell-Kelly 05) explains that they replaced “writers”, who “were employed in large numbers” to “make fair copies of documents as needed”:

> [...] Where legibility was paramount, the services of a printer were used and it was common to typeset important communications. However, typesetting was very expensive and was no threat to the copyist’s occupation. The need for typewriters arose as much from the desire to save manager’s reading time as to reduce the labour cost of longhand copying.

How would a business choose a machine? There were a bewildering array of features a buyer had to consider in the 1890s (for a colorful account, see Adler 73, p.34-36). Typewriters became more

similar over time, but in Fig. 6 you'll see a 1909 ad whose left side indicates that customers still had many features to look out for. Layout was just one factor among many, and perhaps not the main factor in a buying decision. It is reasonable to suggest that businesses would feel safer choosing Qwerty because it was the most generic—for while Qwerty was available from many manufacturers in the 1890s, alternatives came only from single companies.

Figure 6: 1909 ad for a typewriter with separate upper and lower cases (Post 81 p.101)

Manufacturers: these apparently were the sellers too, and would have been wise to "simplify" the choices made by buyers, with the same sort of techniques you might expect from car, vacuum and computer salesmen today. An important strategy was not just to sell machines, but train typists, too:

> As the typewriter became more widely used in offices, the manufacturers began to set up typewriter schools in the major cities as a way of easing the supply of labour and thereby stimulating sales. Both existing staff of potential purchasers and learners without jobs were trained in typewriter operation and four-finger keyboarding. The typewriter schools also acted as employment agencies, eventually placing hundreds of thousands of newly trained workers with employers. Because typewriters were so similar, training was easily transferable to other vendor's machines. (Campbell-Kelly 05)

With such systems in place, the layouts learned by typists might have been decided by the manufacturers who trained them. Perhaps, in this way, Qwerty's initial popularity led to its use by more and more typists.

Users: Typists, who intended to type for a living, were likely to train on the Qwerty layout because that is what businesses had. And so there is a complete self-reinforcing system, aptly described in (Campbell-Kelly 05):

> Purchasers (primarily businesses) were unwilling to invest in novel keyboards because there were no trained operators to use them; and manufacturers would not supply novel

keyboards because no one would buy them.

An excellent question is why manufacturers never managed to surpass Qwerty—why something like Dvorak didn't come along until 60 years after Qwerty. I cannot read their minds, but would propose that Qwerty's “safeness” was key. There were many other typewriter features on which manufacturers could compete, so that competing on layout was one of the more risky approaches.

The Failure of Dvorak

The Dvorak Simplified Keyboard (DSK), shown in Fig. 7, was developed after “several years of intensive research” (Parkinson 72). It offered the following features, which you can match with the efficiency criteria above:

1. Hand alternation: All vowels (and Y) are assigned to one hand, so hand alternation is guaranteed for all words with more than one letter.
2. Hand load: Dvorak's design gives slightly more work to the stronger right hand.
3. Finger load: each finger is given a workload appropriate to its strength and dexterity.
4. Finger movement/home row: 70% of typing is done on home row (more than twice as much as Qwerty)
5. Lower row: 8% of characters are typed here, compared with 16% on Qwerty.
6. Same-finger digraphs: the number of these are substantially reduced compared to Qwerty.
7. Stroke awkwardness: Dvorak beats Qwerty in this area “ten to one”.

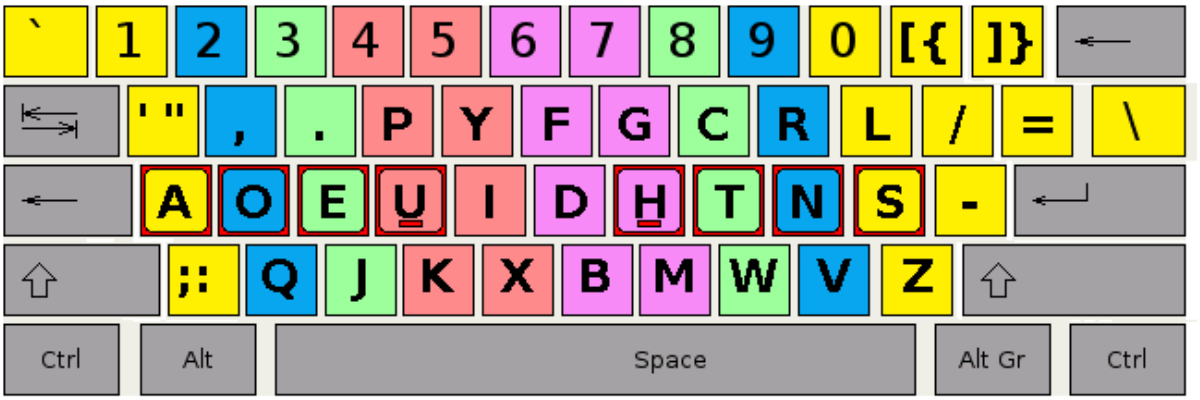

Figure 7: The Dvorak layout (modern version)

In this section I will explore why DSK never obtained a significant market share. I will consider economic conditions, marketing, perceived and actual superiority of the layout, and other factors.

While you're looking at Fig. 7, note that the numbers were originally arranged in an odd pattern: “7 5 3 1 9 0 2 4 6 8”. I'll let you draw your own conclusions about that.

There is a lot of controversy over DSK that centers on the idea of “path dependence”. On one side are economists such as Paul A. David and Brian Arthur, as well as various DSK users, and on the

other side are Stan Liebowitz and Stephen E. Margolis.

In (Liebowitz 96), Liebowitz & Margolis claim that Dvorak failed because it was not demonstrably superior to Qwerty. They are perhaps the world's foremost critics of "path dependence", which, they say, includes a claim that "the past so strongly influences the future that we become 'locked in' to choices that are no longer appropriate." (David 97) refutes this definition, but let us continue. They claim that path dependence is "the centerpiece of a theory that argues that market winners will only by the sheerest of coincidences be the best of the available alternatives." They seem concerned above all about "the effectiveness of free markets and individual choice", and wish to oppose "interventionist technology policy". It is my feeling that they are not so much concerned with the accuracy of economic theory, as with defending the idea that markets naturally make the best choices.

There is some truth to their argument, but they are placing too much emphasis on "demonstrability". Over the years there have been a small number of studies of Dvorak's claimed superiority, and the first one, conducted by the U.S. Navy, showed very strong benefits in DSK. However, Liebowitz & Margolis give indications that the study was biased, and turned out to have been conducted by Dr. Dvorak himself. They then proceed to talk of a "carefully controlled experiment" in the "mid 1950s" that did not indicate that DSK offered a speed improvement. However, this assertion of objectivity is countered by (Brooks 99):

> The "Fable" article uses a different slant, but here's what it tells us: The GSA study put 10 QWERTY typists through a blistering 25-day regimen, training four hours a day in Dvorak to reach their pre-conversion speed. Four hours a day! A well-worn rule of thumb (Dvorak cites studies from the 1920's) is that it's a waste of effort to speed drill for more than two hours daily. After this torture, Strong found that the **overtrained** Dvorak typists didn't gain from additional training as fast as 10 **fresh** QWERTY typists did.

But the focus on studies misses something very important: there is a lot more to market success than scientific studies. For example, in my opinion, marketing is crucial, but none of the papers I have reviewed have made any comments about Dvorak's marketing strategy, nor the amount of money that was spent on marketing. Perhaps Dvorak and his connections in industry could not afford a marketing blitz, or perhaps the marketing was less persuasive than competitors, but without data, I can only pose the question. Liebowitz & Margolis criticize "a book published by Dvorak and several co-authors in 1936" because it "has the feel of a late-night television infomercial rather than scientific work." Well, perhaps that was precisely the intention.

All entrepreneurs know that marketing matters, because it is perception, not absolute truth, that governs buying decisions. Did consumers—if they knew about DSK at all—perceive it to be superior? Let us suppose, for a moment, that they did. Would they therefore buy a DSK typewriter? I believe that there was a similar dynamic in the 1930s and 1940s as there was in the 1890s. Businesses bought Qwerty because that is what the workforce of typists knew; and the workforce of typists learned Qwerty for two reasons:

1. Schools taught Qwerty.

2. Businesses expected skill in Qwerty.

At the risk of offending Liebowitz & Margolis, I would argue that this is obviously a large barrier to entry for a new layout—it's common sense in business, and one doesn't need to believe in "interventionist technology policy" to see it.

Positive publicity also matters, and DSK had at least some. According to (Parkinson 72):

> Beginning in 1933, Dr. Dvorak started entering his DSK-trained typists in the I.C.S.C. His students began "sweeping the field." Ten times in 1934-41 DSK typists not only placed first in their class event, but also placed first in events for contestants with much more training.

The article suggests that for nefarious reasons, the typing contest holders would not report that the winners used Dvorak. Today, the world typing record is held by Barbara Blackburn on DSK.

What about economic conditions? DSK became available during the great depression, at which time most businesses persisted in using typewriters purchased before the stock market crash[8]. Soon after, World War II started, and the world's industrial production shifted from consumer/business goods to war goods. Obviously, Dvorak did not enjoy the best timing.

It is conceivable that if some major buyer had chosen to try DSK, it could have carved out a niche that could have grown over time. However, Dr. Dvorak only met dead ends. (Parkinson 72) offers the following two examples:

> *1.* During the Depression of the 1930s, an experimental program in personal typing was instituted by the school district in Tacoma, Washington. Great care was taken to choose students who wanted to use the typewriter for personal use, rather than in a business environment. Parents understood that they would have to purchase DSK typewriters for their children to use after finishing these experimental classes.
>
> 2700 students were put through the various courses in DSK typing. These classes showed that senior high school kids could learn the DSK in one-third the time it took to learn the standard keyboard. The program was an outstanding success, and was reported in various educational publications.
>
> But, then came a school board election. [...] The man who was against the new keyboard won the election. [...] He asked businesses in the area how many DSK machines they had in their offices. Answer: *None*. Then, he asked how many standard keyboard typewriters the had. Answer: *Why, all of them, of course*. On these grounds, he closed down the personal typing classes (regardless of the fact that these students were not planning to go into office typing[...]).
>
> *2.* [...] the Navy Department issued a request for bids for 2,000 DSK-equipped typewriters. [...] But the request was turned down by the Procurement Division of the U.S. Treasury Department (which was responsible for all government purchases of typewriters at the time). No satisfactory reason was given (at least from the viewpoint of the Dvorak proponents). The

8 Source forgotten, sorry.

request was simply denied!

According to (Parkinson 72), ANSI had recently proposed a standard for computer keyboards. They chose Qwerty, apparently because "Research consistently revealed that the overriding criterion for continued use (of the Standard Keyboard arrangement) was the millions of people already familiar (and those trained annually in schools) with this arrangement." This was simply considered more important than typing efficiency or comfort.

In summary, reasons for Dvorak's failure might be found in economics, path dependence (or network effects, or "increasing returns"), marketing, or politics.

I will discuss the following additional factors in the "Qwerty's superiors" section: whether Dvorak is truly optimal, whether Qwerty is truly dismal, and the difficulty of learning Dvorak.

Learning and comfort

Discussions of keyboard layouts always seem to center around typing speed. DSK has proven a superior layout for setting speed records, but what about everyday use? What about ergonomics? From my own experience, Qwerty is a fairly uncomfortable layout that has taken many years to master, and I don't think you'd ever find such a critical anecdote for Dvorak.

What about learning? Isn't there some societal benefit to a keyboard that one can learn faster? There's no question that a class in Qwerty touch-typing is boring and tedious, as I said at the beginning. As a result, I suspect most young people would prefer not to take a typing class and to hazard their way through the hunt-and-peck approach. Dvorak and other alternatives allow many words and some sentences to be typed with the home row alone, relieving some tedium and conceivably increasing learning speed.

But Dvorak is not easy for existing Qwerty users to learn. In modern times, almost all students use computers, and the majority don't take typing classes. Instead they learn hunting-and-pecking, often starting very young. They also use multiple computers: school and library and home computers, and occasionally, keyboards on pocket computers or game systems such as the Nintendo DS.

Also, consider computer editing functions, especially Cut/Copy/Paste. These have long been assigned to Ctrl+X/C/V, doubtlessly because those keys are adjacent on Qwerty and nearby the Ctrl key, so that they can be invoked with a single hand motion. Other common shortcuts include Ctrl+Z/A/S/W (Undo/Select All/Save/Close Window). Muscle memory for shortcuts is learned separately, so that if those keys move, a user requires a lot of re-learning for editing as well as text entry. Dvorak not only scatters these keys, it also moves all the punctuation marks.

If an alternative is similar to Qwerty, it would be more practical to learn and would fit in better with the network of existing Qwerty machines.

Modern layouts

The meaning of a key can be decided by software, so as long as an operating system supports it, keyboards can be reprogrammed to any desired layout at no cost. Operating System support is a prerequisite, and tools to create and distribute layouts are also helpful. On June 4, 2003, Microsoft released a free program, the Microsoft Keyboard Layout Creator, which in part has allowed hobbyist users to develop new layouts.

Asset

Back in 2004 I decided to learn Dvorak touch typing, but encountered a learning difficulty that persisted through many lessons. I would often press a key with the correct finger, but the wrong hand—the Qwerty hand. I concluded that the hand and finger motion were things that had to be learned separately. I abandoned my attempt to learn Dvorak and instead designed a layout somewhat like Qwerty, that kept most keys on the same hand. R was switched to the right hand in order to improve hand balance (to 50.5% vs 49.5%) and to allow the most common ten letters to be on home row; and 9 letters stayed in their Qwerty positions. It was called "Asset" because the first four letters on home row were "ASET". However, although I put up a web page about it, I never actually used it! I was later contacted by someone who, suprisingly, had been using a layout with a nearly identical home row since 1992. This November I updated the layout with improvements suggested to me by that person. I then discovered a layout called Colemak and a keyboard competition at CapsOff.org, posted my layout there, and responded to criticism by Shai Coleman with further improvements to my layout. The current version is shown in Fig. 8.

Figure 8: Asset Layout (completed Nov. 13, 2006)

Colemak

Colemak's designer, Shai Coleman, put more work into his layout than I did into mine. The layout in Fig. 9, released Jan. 2006, is not the first version, but Coleman has promised his users that it will not change in the future. It allows highly efficient typing, keeps WAZXCV in place for the sake of

Figure 9: Colemak layout (2006)

"QWERF"	"Capewell"	"Evolved"	"Arensito"
QWERF JYKL; ASDTG HUIOP' ZXCVB NM,./	.YMDF JPLUQ AERSG BTNIO XZCV; KWH,'	K,UYP WLMFC OAEID RNTHS Q.';Z XVGBJ	QL,P' ;FUDK ARENB GSITO ZW.HJ VCYMX

Figure 10: Other recent designs

shortcuts, and like Asset, puts the ten most common English letters on home row. Caps Lock, which Coleman (and the community at CapsOff.org) argues is a waste of real estate, is replaced with backspace, although the original backspace is retained to accommodate existing habits. This innovation is justified only in the computer age; now that mistakes are trivially corrected, they are also frequent, so the pinky finger shouldn't be burdened with such a long reach to the backspace key.

Capewell

This is a family of layouts designed by Micheal Capewell. One called QWERF (Fig. 10) maximizes Qwerty similarity, making only a few changes to Qwerty to fix a few glaring problems (with the notable exception of the ED digraph problem). He designed Capewell-Dvorak, a modification of Dvorak which moves ZXCV into Qwerty positions for the sake of the Undo/Cut/Copy/Paste shortcuts, and which reduces finger movement compared to Dvorak. The one called Capewell in Fig. 10 was "evolved" using a genetic algorithm that tested millions of layouts to find the best one according to criteria chosen by Capewell. Capewell was inspired by Evolved (also in Fig. 10) but keeps ZXCV in place and uses a different fitness function.

Arensito

This novel layout is intended for those that use a lot of punctuation: the same keys used for letters can also be used for numbers and punctuation by holding down the right Alt key. (Hallingstad)

Personally, I find the layout terribly random.

Qwerty's Superiors

During my research I saw a claim in a couple of places that Qwerty is no better than a “random” layout. This is not a fair claim.

The most uncommon letters in English are PBKVXJQZ. In Qwerty's defense, note that of those 8 letters, BVXZ are on the bottom row, PQ are in the corners of the keyboard, which is not bad, and only J and K waste important real estate. Only one very common letter, N, is on the bottom row. Qwerty is better than an alphabetic layout which is effectively random (the order of the alphabet itself is random, and even if it weren't, there's no reason to presume efficiency when you put it on a keyboard.) Consider the ABC layout in Fig. 11. It places T, the 2nd most common letter of English, on the bottom-left corner: a huge no-no. It also places E and A in uncomfortable positions, and places the uncommon letters PKQ on home row. This would be a horrible touch-typing board and also poor for two-finger use because common keys are far apart.

Figure 11: "ABC" layout (http://abckeyboard.co.uk/)

Dvorak, meanwhile, has relatively minor deficiencies:

- Most significantly, L (the 11th most common letter) is pushed by the pinkie on the top row.
- R (9th) is not on home row.
- I (5th) is not on a home finger.
- M, W, and F are in sub-optimal positions, which may be explained as the opportunity cost of the fact that period and comma are more prominently placed.
- Some modern layouts offer decreased finger movement and/or fewer same-finger digraphs.

In a Qwerty world, Dvorak also suffers because

- Most keys switch between hands.
- Punctuation marks are moved around extensively, which gives little advantage to the typist.
- Computer hotkeys Ctrl+Z/X/C/V/A/S/W must be re-learned and are not grouped together.

All things considered, I believe Colemak is better than Dvorak and the best alternative to Qwerty. Here's why:

- It is much easier than to learn than Dvorak (for Qwerty users).
- Compared to Dvorak, by my own measurements, Colemak has roughly 15% fewer same-finger digraphs, 4% more use of the home row, and 1% less finger travelling, although I found more use of the bottom row (11.3% vs 8.4%).[9]

9 These figures came from pasting several novellas by different authors, which I have in electronic form, into the box at http://colemak.com/Compare. The Java layout comparison applet there was originally written by Jon A. Maxwell. I used

- Unlike the other new layouts mentioned here, Colemak's web site (colemak.com) offers a Windows installer for the layout[10].
- Colemak typing lessons can be taken in a free program (though installation is unfriendly so far).
- Colemak has a (small) community of users that meet in the Colemak forum on the web site.

Conclusion

Though suboptimal, Qwerty is used throughout the world. A simple "path dependence" explanation suffices for many, but a wholistic perspective, considering society in relation to the technology, reveals other factors that may have combined to produce our situation today. It is also worth noting that Qwerty is not necessarily as bad as a random layout, so that the keyboard's inadequacy is not sufficient to cause consumers to want better.

A major factor preventing people from switching away from Qwerty is that Qwerty is what they know, and at the present time it is unlikely that many people are aware of superior alternatives. But who says Qwerty users *have* to switch? Instead, what if a simple software or hardware switch for Colemak were available as a standard, easy-to-use, universal feature of Windows, or of keyboards? And what if keyboard manufacturers included, as a standard feature, a set of stickers that allowed people to add new key labels? These two changes would be cheap from the point of view of Microsoft and keyboard manufacturers, and would allow individual users to switch to the new layout. An easy switching mechanism is also crucial, because it would allow individuals to switch temporarily to a new layout when using a machine that does not belong to them.

These measures are not enough. Schools would have to begin using and teaching the new layout; otherwise the rising generation will use Qwerty. Governments control schools, so in a sense, it is the government that enforces the status quo.

If done right, the change would be inexpensive, but the trouble is that there is little altruism in business and little innovation in government. Unfortunately, I do not know of a business model that could realistically convert the world to a new layout.

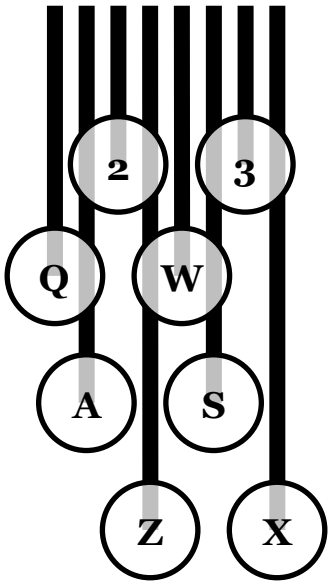

Figure 12: Keys are staggered to separate the type bars

One final thought. Old habits die hard; some things continue to be done illogically even when change is easy. This can be seen in the way keys are staggered (Fig. 12). Decades ago, keys were staggered so that the type bars would be evenly separated. But ergonomically, the design makes no sense. Firstly, consider that human beings are symmetrical; it is illogical that the keyboard is not. Secondly, a touch typist is expected to move fingers from the middle to the lower row, but when one does so in the most natural manner (particularly for the left hand), the fingers end up *between the keys*. Thus, the user must do extra work to move the finger laterally. I myself strike the wrong key sometimes

about 1.6 MB of data; please note that these measurements vary a lot between texts, and need a lot of data to stabilize.

10 Update (Dec. 25, 2006): there is now a Windows installer for Asset also.

as a result of this oddity.

To align the keys vertically would be a trivial change for manufacturers, but do they even consider it? For the most part, even "ergonomic" designs do not! Now, some would worry that it would be difficult to get used to. That is conceivable. But what about a compromise: rather than achieving complete alignment, by shifting the bottom row *half* a key to the left, why not shift it a *quarter* key? I hypothesize that it would be more comfortable even for a longtime typist. And then, in twenty years when we are all used to the change, the row could be shifted by another quarter key. The adjustment would be painless and free, but I bet you have never even thought about it: witness the power of habit.

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11 The page itself requests not to be quoted, but I got permission from Paul A. David (I couldn't find a later version of it anyway.)

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