Table manners

There are many different versions of the periodic table, but one among them reigns supreme. **Michelle Francl** ponders on why chemists put elements in boxes.

The postcard to me began '53 90.8.92.g.1.t'. Stifling the urge to throttle my computer scientist sibling the next time we met, I flipped it over on the slim chance that some clue could be found on the other side. No, and worse yet, it was clearly a more complex cipher than simple substitution.

I dug into the decryption: 18 = ar; 53 = i; 6 = c; 90 = th. With that, I had it cracked. 90 is Th all right, element 90 on the periodic table, thorium. Pat had used the periodic table as the basis for his substitution cipher. (Management consultants take note; sometimes thinking inside the box is the key.)

Even so, it was a tough haul. Away on a rustic holiday, the only available periodic table was the slightly incomplete one in my head that I quickly sketched onto paper. The experience prompted me to muse about just why chemists have settled on the iconic, asymmetric, blocked version of the table.

Chemists have created hundreds of variations in search of the perfect periodic table. The periodic table has been mapped onto spirals, circles, triangles and even elephants[1]. The first such 'alternative' periodic table, based on a spiral, was proposed by Gustavus Hinrichs in 1867 (ref. 2), two years before Mendeleev unveiled the forerunner to the current blocked tabular form. Still, open 50 random introductory chemistry texts and it is a fair bet that all 50 of them have IUPAC's standard periodic table, or a close facsimile of it, inside the cover. Chemists are stuck in the box.

Periodic tables are a classic example of 'cognitive art'. Information is communicated, but there can be an enduring aesthetic appeal to the depiction that extends beyond the need for the data set. The map of the London Underground system is an iconic piece of cognitive art; you can use it to find your way from Piccadilly Circus to King's Cross, or you can hang a copy on your living room wall. Periodic tables have a similar iconic and artistic potential.

Is it resistance to change that keeps chemists bound to the square confines of the standard periodic table, even when other tables offer a better representation of the underlying chemical principles? Perhaps it is simply pragmatism. One cynical critic[3] suggested that the compressed version is favoured because it fits well on a standard sheet of paper. Is there a way to distinguish between periodic tables that are masterpieces of cognitive art and those that are the equivalent of Elvis Presleys on velvet?

The periodic table collapses a rich, multivariate chemical universe to a two-dimensional or three-dimensional map. Well-designed tables can quickly be searched for a particular entry, but they should also reveal relationships and patterns in the elements. They are portable. Aesthetics matter, but it always takes a back seat to clarity: any features should be meaningful. How do the alternative periodic tables measure up against these standards?

The Alexander three-dimensional periodic table[4] brings out the helical relationship of the main group elements and offers a rich array of viewing angles. In recent years Hiro Sheridan has created a three-dimensional table on Drexel Island in Second Life[5] that highlights periodic trends in properties such as atomic radii. Alas, neither of these elaborately constructed tables will tuck conveniently into your pocket or slip into your notebook.

Philip Stewart's spiral version[6] of the periodic table is often superimposed on a starry background, having the advantage that sequential atoms are never separated. Despite the arrestingly beautiful galactic background and wide distribution by the Royal Society of Chemistry, it has not displaced the IUPAC standard. From a cognitive art perspective, the starry background has no function. It conveys no additional information about the atoms or their relationships. Like the dragons on medieval maps that signalled the edges, it is only a decorative underscoring of features already displayed.

Tables that are relatively wide or tall complicate matters when trying to abstract patterns and relationships. Making data visible in a single 'eyeful' is ideal; more than that and a reader must refocus both physically and mentally. Perhaps this — and not the constraints of paper

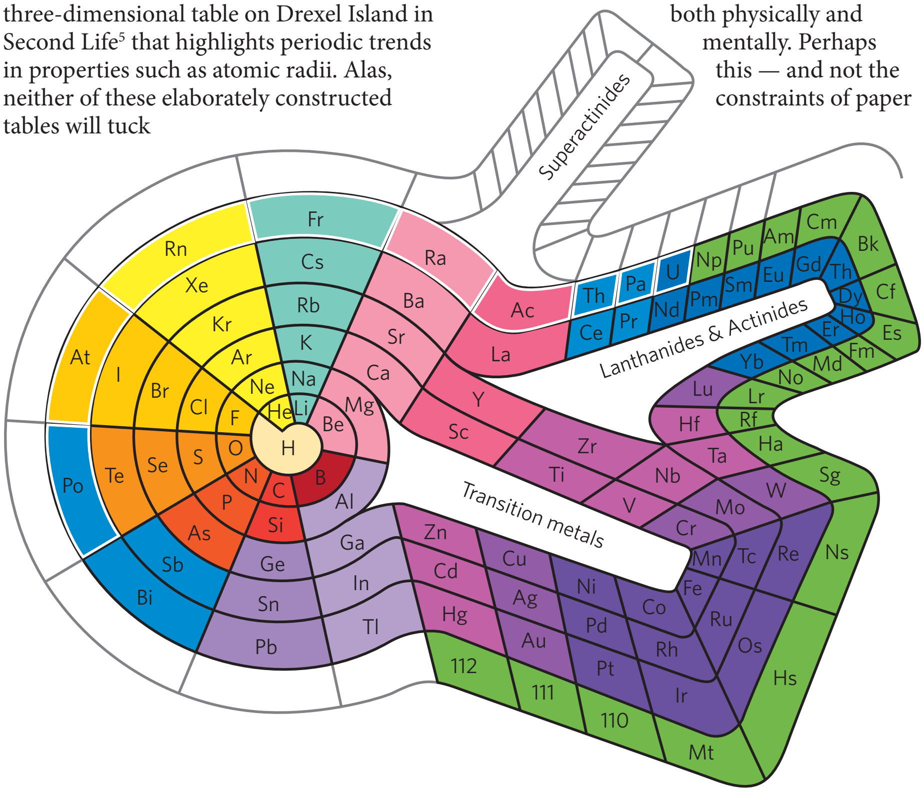

Figure 1 | Benfey's spiral periodic table. Theodor Benfey developed this table in 1960 while editor of the chemical education magazine *Chemistry* to illustrate more dramatically the different periods: 8, 18 and 32. Figure reproduced with permission from Theodor Benfey.

H	He	Li	Be											B	C	N	O
F	Ne	Na	Mg											Al	Si	P	S
Cl	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se
Br	Kr	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te
I	Xe	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po
At	Rn	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	Uut	Uuq	Uup	Uuh
Uus	Uuo																

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

Figure 2 | Scerri's periodic table. Eric Scerri proposes a symmetrical version of the periodic table in which hydrogen is grouped with the halogens, and there are no longer any exceptional periods. Figure adapted with permission from Eric Scerri.

size — is why extended tables in which the *f*-block elements are inserted in their proper sequence have failed to displace the compressed versions.

The regularity of grid forms, particularly square grids, makes them easier to reproduce from memory — try reconstructing Benfey's periodic table (Fig. 1) or the serpentine presentation of Gooch and Walker without the original[7] in front of you. You need to know significantly more about the relationship between the elements to visualize these tables in your mind. Jeff Moran's spiral table[8] uses a hexagonal skeleton to hang the more complex form on, but still is harder to sketch than the standard squares.

Font and colour choice seem inconsequential, but serifed fonts, which play up the differences between letters, make a table faster to scan. Bright colours do not always clarify; instead they can confuse matters by inadvertently drawing your eye to large blocks of saturated colour. Note how the actinides, coded lime green on Benfey's table, jump out as if they were the most important elements on the table. (Of course so do large white spaces; look at the standard periodic table and note where your eye falls first — most probably on the white space above the transition elements!) Good tables make sparse annotations with thin red lines, imitating the red lettered instructions or rubrics in medieval liturgical books.

Scerri has proposed a new variant of the periodic table (Fig. 2) that, he argues, well captures the triads of elements[9]. I would suggest that as cognitive art Scerri's version has potential that the other alternative periodic tables do not, and so ought to compete well in chemists' eyes with the IUPAC standard. It is compact. There is less white space to pull the eye away, as hydrogen and helium move to the first row. It is symmetrical on a rectangular grid, easy to hold in the mind. Reactive elements, the halogens and the chalcogens occupy the privileged positions on the edges, instead of the noble gases. It is, I believe, a keeper.

What will the periodic tables of the future look like? Thin haptic 'smart sheets', perhaps, flat and flexible enough to slip into pocket or notebook, that switch with a touch between various tables. Spirals, the left-hand stack, the extended version and even rotatable three-dimensional tables literally at your fingertips.

And the default version on the front of that high-tech periodic table? I'm betting it will be a near cousin to Scerri's proposed table, in black and white with red annotations and a serifed font for the elements — all in all, not so different from the antique Sargent–Welch wall chart that hangs over my desk. ❐

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