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Symbols of the Elements

by Juris Meija

Four systems of notation have become so universal that they now surpass most linguistic barriers. These are mathematical signs and symbols, the International System of Units, the traditional musical notation, and the symbols for chemical elements.[1] Imagine the world with different symbols for the plus sign in various languages, or different symbols for hydrogen. Although chemists worldwide now enjoy the peace of universally accepted symbols for all elements which are not subject to translation, it took a long time for such convention to root.

The Dawn of Element Symbols

Symbols for various chemical substances are older than the discipline of chemistry. The ancient symbol for water, the upside-down triangle, is among the most recognizable examples of this practice. Even though the modern concept of the chemical element emerged only in the late 18th century with Antoine Lavoisier, substances which we now recognize as proper chemical elements have had standard symbols for a long time. The seven metals upon which modern civilization was founded were traditionally linked to the seven "planets." Consequently, the astrological symbols of the "planets" were used also for these metals. Gold was depicted by alchemists as circumpunct (representing Sun), silver as the crescent moon, iron as a spear and shield (representing Mars), and so on. These symbols, however, were not reserved only to medieval alchemists. Swedish chemist Torbern Bergman (1735-1784), one of the most esteemed chemists of his time, used these symbols in his work, and so did Lavoisier.

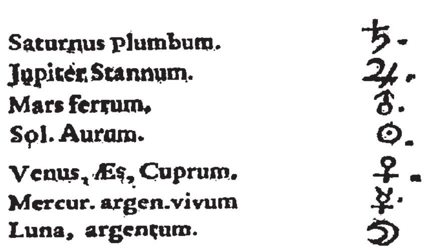

Figure 1. The seven "planets" and their symbols traditionally have been associated with the seven known metals (1652).[2]

Not long after Bergman, English chemist John Dalton (1766-1844) introduced new set of symbols for elements in *A New System of Chemical Philosophy* (1808-1810). As a reference to spherical atoms, Dalton

Figure 2. Bergman's symbols of the chemical elements (1785).[3] Although the symbols are unaltered from the cited source, their layout has been modified.

writes: "the elements [...] are denoted by a small circle, with some distinctive mark."[4]

Phosphorous was represented with a symbol now better known as the Mercedes-Benz hood ornament, and the alchemist's symbol for gold – that circle with a dot in the middle, was to became the symbol for hydrogen. Dalton also combined the element symbols to create composite formulas for chemical substances, something which was almost never done before. Not everyone liked his pictorial symbols and Dalton's system soon entered obscurity. Some forty years later, Michael Faraday noted that these symbols had not the slightest use in chemistry. Nevertheless, they had provided an important stepping stone which soon revolutionized the chemical nomenclature.

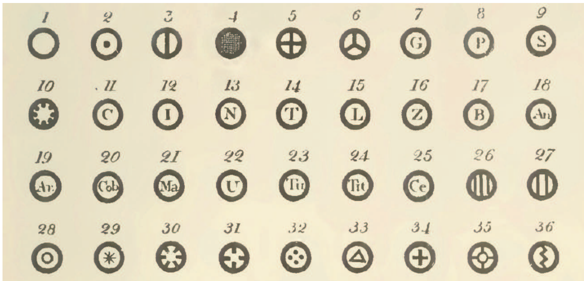

Figure 3. Dalton's symbols of the chemical elements (1810).[5] 1=O, 2=H, 3=N, 4=C, 5=S, 6=P, 7=Au, 8=Pt, 9=Ag, 10=Hg, 11=Cu, 12=Fe, 13=Ni, 14=Sn, 15=Pb, 16=Zn, 17=Bi, 18=Sb, 19=As, 20=Co, 21=Mn, 22=U, 23=W, 24=Ti, 25=Ce, 26=K, 27=Na, 28=Ca, 29=Mg, 30=Ba, 31=Sr, 32=Al, 33=Si, 34=Y, 35=Be, 36=Zr

The Gutenberg of Chemistry

In 1813-1814, the noted Swedish chemist Jacob Berzelius (1779-1848) published a series of articles suggesting that "the chemical signs ought to be letters, for the greater facility of writing, and not to disfigure a printed book."[6] This simple notion is regarded as one of Berzelius' most important contributions to the development of chemistry, at least by his biographer Söderbaum: "I shall take, therefore, for the chemical sign, the initial letter of the Latin name of each elementary substance: but as several have the same initial letter, I shall distinguish them in the following manner: 1. In the class which I call metalloids, I shall employ the initial letter only, even when this letter is common to the metalloid and to some metal. 2. In the class of metals, I shall distinguish those that have the same initials with another metal, or a metalloid, by writing the first two letters of the word. 3. If the first two letters be common to two metals, I shall, in that case, add to the initial letter the first consonant which they have not in common: for example, S= sulphur, Si=silicium, St=stibium (antimony), Sn=stannum (tin), C=carbonicum, Co=cobaltum (cobalt), Cu=cuprum (copper), O=oxygen, Os=osmium, etc."[6]

Berzelius' nomenclature had the advantage that it was founded on a logical set of rules in contrast to Dalton's arbitrary choice of pattern-filled circles. Consequently, Berzelius' system could be codified and then applied for any future element. Like many things of this word, however, Berzelius' system is not without its flaws. For example, how do we decide on the symbols for stibium and stannum? Which element gets "St"? Another problem lies in the chosen language for the symbols. Since Latin is an ancient language, the "Latin names" for newly discovered elements, such as the hydrogen, need to be invented.

O	Oxigène.	B	Bore.
H	Hydrogène.	Si	Silicium.
N	Nitrogène.	Se	Séléuium.
S	Soufre.	As	Arsenic.
P	Phosphore.	Cr	Chrome.
Cl	Chlore.	Mo	Molybdène.
Br	Brome.	W	Tungstène (wolfram).
I	Iode.	Sb	Antimoine (stibium).
F	Fluor.	Te	Tellure.

Figure 4. Berzelius' typographical symbols of the chemical elements (1831).[7]
Although the symbols are unaltered from the cited source, their layout has been modified.

The use of typographic symbols was not new with Berzelius. In fact, half of Dalton's symbols for elements were encircled initials and abbreviations of their English names. In this way, Dalton's nomenclature was positioned exactly in the middle between the pictorial systems of the past and the typographic systems of the future. Concurrently with Berzelius, Thomas Thompson (1773-1852) also attempted to introduce typographic symbols of elements. His series of six articles appeared alongside Berzelius' in the same journal. Thompson wrote:

"I presume the method of denoting the number of atoms combined will be intelligible to every reader. It is denoted by figures prefixed to the initial letters of the substances uniting together."[8]

Thompson used slanted lower-case letters to denote elements, yet it was impossible to deduce the element from his symbols. Thompson used "*m*" for manganese, molybdenum, mercury, and magnesium, "*c*" for carbon, cobalt, and so on. Even his sporadic use of two-letter symbols did not solve the problem: "*si*" was used for both silver and silicon.

Although, as we have seen, Berzelius was not the first to employ typographic symbols, this time a typographical revolution of sorts did have a lasting impact on chemistry. To further simplify his already concise chemical formulas, in 1818 Berzelius introduced special symbol for oxygen: a typographic dot.[9] This refinement was later extended to sulphur (the comma), his discovered selenium (the dash), and also tellurium (the plus sign). In this most-unique notation, "+ + .. = +:" represented the reaction of tellurium with oxygen. This modification clearly did not outlast its time. Nevertheless, despite Dalton's characterization of Berzelius' symbols as "horrifying" and "abominable," they are used in chemistry to this day.[10]

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