SAMPLING COLUMN

Giants of sampling 1: Henry Augustus Vezin

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This column begins a historical track with the present inaugural feature on a true giant, Henry Augustus Vezin. We have asked the prolific compiler and commentator on all matters of early sampling history Alan Rawle for a fascinating opening article. And he is not letting the readership of this column down. Please enjoy his eminent first contribution.

On shoulders and giants

A much-parodied remark relates to scientists, and thus science, moving forward because they are standing on the shoulders of learned giants. The remark is often attributed to Isaac Newton, but from Wikipedia we learn that the quote may go back much further than Newton's time:

John of Salisbury wrote in his *Metalogicon* in 1159: "Bernard of Chartres used to compare us to dwarfs perched on the shoulders of giants. He pointed out that we see more and farther than our predecessors, not because we have keener vision or greater height, but because we are lifted up and borne aloft on their gigantic stature."

Historical background

This quotation (or a parody of it) probably applies very well in the Theory of Sampling (TOS) where the work of early pioneers has had major influence on what is practiced today. Some of these early giants of sampling include David Brunton, Sylvanus Albert Reed, Henry Vezin, Robert Hallowell Richards (possibly his first wife, Ellen Swallow Richards, should be more famous) and Philip Henry Argall ("PHA"). A common theme was association with the gold and silver mines in Colorado where accurate sampling and analysis often meant the difference between success and failure of that mine. These early pioneers, although successful in their respective mining fields, made their fortunes in other ways—David Brunton with a pocket compass, Sylvanus Albert Reed with the metal aircraft propeller, Robert Hallowell Richards through his work at MIT especially with his learned books on mining practice and Phillip Henry Argall supposedly the inventor of the 8-hour shift and cyanidation.

The one exception in terms of (lack of) fortune accumulation was probably Henry (Augustus) Vezin. Henry Vezin was different. He made little money, giving away engineering drawings for his (Vezin) sampling device which then could be built for as little as $200. He patented and published virtually nothing in his lifetime but was extremely well-known and renowned in the mining profession. Even pictures of him are hard to come by. On death it was stated by "P.H.A." (probably Philip Henry Argall) in *The Engineering and Mining Journal*, "We publish a short notice of Mr. Henry A. Vezin, prepared by one of the many young fellows whom he delighted to help. He was characterized by an unfailing courtesy and patience in the giving or procuring of information when consulted by any brother professional and, being a very careful man, he was found to be a good authority on many matters." Let's explore the life of Henry Vezin as it was full of many interesting events, tragedies and insights.

The family Vezin

Henry Vezin was born on 8 March 1836, the 7th child in a family of 14. His father, Charles Henri Vezin, was famed for bringing chess to Philadelphia. His mother, Emilie (née Kalisky), was probably only 18 on marriage (Charles was 39) and died tragically in what was termed "The Burning of the Austria" on passage from Hamburg to New York City on 13 September 1858 together with two of his younger sisters Mary (17 or 18) and Clara (aged 8). This was one of the great maritime tragedies of the nineteenth century with over 500 perishing. A brother, Alfred, survived by swimming for several hours in the sea. Although three of his (male, of course) siblings (Charles, Hermann

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and Oscar) attended the University of Pennsylvania. Henry, apparently, did not attend university. Obviously, he graduated in the school of life… His brother, Hermann, became a famous actor in England. Another brother, Charles, also known as "Fast Charlie", led a more checkered life. He was in business in PA and was German consul (1867–1871) in Philadelphia. Subsequently, he went bankrupt and "escaped" ("took French leave") to South America, then to England and onto South Africa where he died on 11 February 1882 (found dead down a well in Port Elizabeth).

Henry got into mining early. At the age of 15 he travelled to Germany where he apparently studied the topic before returning to Philadelphia in 1858. In 1861 family portraits as CDVs (*carte de visites*) were commissioned from the photographers, F. Gutekunst, 706 Arch Street, Philadelphia. Henry is shown below looking very different to the pictures shown in his obituary (Figure 1).

He and two of his other brothers (Oscar and Alfred) served with distinction in the American Civil War. Henry joined the service as a Captain Company G, Fifth Pennsylvania Cavalry on 27 March 1862, and was mustered out on 8 June 1865. Henry then had the rank of (brevet) Lt Colonel—a rank that gives a commissioned officer a higher rank title as a reward for gallantry or meritorious conduct, but without receiving the authority, precedence or pay of the real rank. On one occasion he and a group of 12 men was said to have put to flight over 100 rebel soldiers. However, it does appear that he was using his mining experience in planning out and constructing trenches and rifle pits as we have correspondence from him with the title "Acting Assistant Engineer".

On sampling in particular

We now come to the important (and interesting!) part and the involvement of Henry Vezin with sample theory and sampling practice. There is some confusion in this matter as we will see. Figure 2 is from Robert Richards' classic texts on *Ore Dressing*, in Volume 2, p. 850.

We note that in 1866 Vezin was still living in Philadelphia (the tax records for the city below indicate this) prior to a move to Nevada in 1870 or 1872 or so.

The simplest rule, adopted by Vezin[14] in 1866, is: first, to decide what weight (w) should be taken for assay or analysis after the ore has been ground to 100-mesh (approximately 0.125 mm. diameter); second, to compute the number (n) of maximum sized grains passing through a 100-mesh screen that would weigh (w); and third, to cut down to a weight after each crushing which will be equal to n of the maximum sized particles.

This rule may be said to use a constant number of particles whatever their size. The following figures show the weights of different sizes required by this rule on the basis of 0.1 assay ton (2.917 grams) of ore through a 100-mesh screen (0.125 mm.):

128	mm.	3,131	metric tons.
64	"	391	" "
32	"	48.9	" "
16	"	6.12	" "
8	"	764.6	kilos.
4	"	95.57	"
2	"	11.95	"
1	"	1.493	"
0.5	"	186.7	grams.
0.25	"	23.33	"
0.125	"	2.917	"

The above rule demands finer crushing than practice indicates to be necessary, and it is, therefore, more expensive than is wise.

Figure 2. Extract from Robert Richards' Ore Dressing (1909) Volume 2 page 850 indicating minimum masses required for sampling materials of different (top screened) sizes.

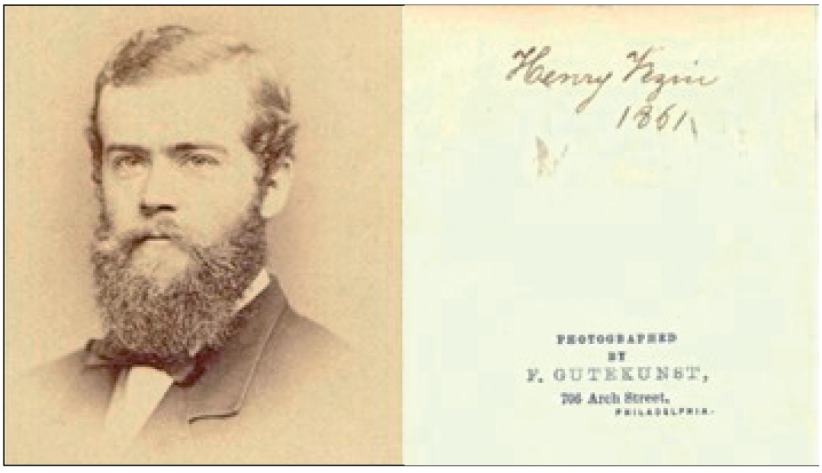

Figure 1. Henry Vezin's *carte de visite* from 1861.

When we examine Reference 14 in Roberts' tome, we find it refers to Heinrich Hofman (a compatriot professor to Roberts at MIT) and Hofman's book on the *Metallurgy of Lead* in 1892[1] (later editions in Google Books omitted the sampling section) gives a Vezin 1866 attribution with the following unreferenced statement "Vezin, in 1866, finding that with pyritic ores of Gilpin County, Colo., running from 1 to 4 oz of gold per ton, it was safe to cut down to 1 oz, a sample that had passed a 20-mesh screen, the diameter of the largest

particle being 1 mm (1/25 in.)." Hofman actually refers back to Sylvanus (Albert) Reed and David Brunton (with much later dates) for more rigorous calculations. The date of "1866" is puzzling for other reasons—it's at least 20 years before others such as Brunton and Reed would be discussing sampling in the AIME journals and there is no mention or writings elsewhere (in particular, A.W. Warwick's *Notes on Sampling* ghosted by Vezin)[2] of theoretical or practical sampling around the mid-1860s. There is no similar table anywhere in the literature dating from this time or even after. However, the indication that numbers of particles are key and that it's the top end of the distribution that dictates the minimum sample mass is obvious from this text. Numbers and standard errors are, of course, synonymous in statistical analysis. Simple analysis of the masses shown above indicate that these are calculated using a standard error of 1 % on the x_{99} point of the particle size distribution for a material with density 2.6 g cm^{-3} (Table 1).

A slight change of density to that approaching dolomite (a common gangue material in Colorado) would account for this constant 10 % discrepancy between Robert's tabulated figures and those calculated via the x_{99}/1 % SE route. We also note that Richards considered these calculated masses as too excessive and later uses a mass proportional to (diameter^2) to reduce these to values he considered more practical. This set back sampling theory by about 50 years until Pierre Gy would retrieve the statistical situation.

In 1870, Vezin (aged 34) is shown on the Summit, CO portion of the US census as a white (W) male born in Pennsylvania with father and mother shown as foreign birth, and "not deaf, dumb, blind, insane or idiotic". The value of his "personal estate" appears to be $20,000 with profession given as engineer. So, it appears Vezin was pretty successful in the 1866–1870 period increasing his income by more than sevenfold in that five-year period. Vezin was the mechanical engineer for the Boston Silver Co., with a mine located near Saint John's, Summit County, Colorado and it was stated that the plant was a failure until Vezin took charge of it in 1872. It must have been around this time when Vezin produced what was probably his best gift (literally) to the mining industry—the so-called Vezin sampler or simply "The Vezin". This conforms to the golden rules of sampling—all of the production stream is taken for a period of time and that the sample is moving (not static) when taken. He did appear to return to Philadelphia in the 1874–1880 period apart from an 18-month stint in the Russian coalmines and iron ore fields where we learn that he spoke three "modern languages" excluding Russian (probably English, French and German).

Apparently, his "most important foreign work" was on the first Nicaraguan Canal survey under a French company, but further research is needed here to quantify his contribution.

Focus on technology

There are a number of videos indicating how the Vezin sampler operates, and these can be seen on YouTube. Likewise, the entry "Vezin samplers" on Google will supply an overwhelming abundance of illustrations and descriptions (see Fact box below).

The construction of the sampler is relatively simple (Figures 3 and 4).

Other (earlier) references quote an installed price at around $100.

Vezin was very meticulous and kept detailed notes. These notes (called "tapeworms" by Vezin) became the basis for a set of 18 articles in the *Denver Mining Reporter* which subsequently were compiled into a classic volume called *Notes on Sampling* by A.W. Warwick with a publication date of 1903. Vezin had requested that the articles be published anonymously. This historical gem can be downloaded for free (showing the apparent value of practical scientific information!) as a 44-page Google book.[2]

Vezin never married and thus had no heirs. He died at a relatively young age (66) on 27 December 1902 of a heart complaint ("angina pectoris") and was interred at the family plot in Laurel Hill, Philadelphia, PA. We learn from his obituary in *The Engineering and Mining Journal* (Saturday 10 January 1903; what journal is published on a Saturday these days?!) that "Mr. Vezin was distinguished by his

Table 1. x_{99} 1 % SE (99 % confidence limits) density = 2.6 g cm^{-3}. Needs 10,000 particles and this represents 1 % of the total mass of the system.

	x_{99} 1% SE (99% confidence limits) density = 2.6 g/cm^3						
	Needs 10000 particles and this represents 1% of the total mass of the system						
x (μm)	x/10000	x^3	Density (g/cm^3)	10000*100*(π/6)	Minimum Mass (g)	Vezin (1865/1866)	Vezin/Rawle
1	0.0001	1E-12	2.6	523598.7756	0.000001		
10	0.001	1E-09	2.6	523598.7756	0.001361		
100	0.01	0.000001	2.6	523598.7756	1.36		
125	0.0125	1.9531E-06	2.6	523598.7756	2.66	2.92	1.10
200	0.02	0.000008	2.6	523598.7756	10.89		
250	0.025	1.5625E-05	2.6	523598.7756	21.27	23.3	1.10
500	0.05	0.000125	2.6	523598.7756	170.2	186.7	1.10
1000	0.1	0.001	2.6	523598.7756	1361.4	1493	1.10
1500	0.15	0.003375	2.6	523598.7756	4595		
2000	0.2	0.008	2.6	523598.7756	10891	11950	1.10
4000	0.4	0.064	2.6	523598.7756	87127	95570	1.10
5000	0.5	0.125	2.6	523598.7756	170170		
8000	0.8	0.512	2.6	523598.7756	697015	764600	1.10
10000	1	1	2.6	523598.7756	1361357		
					Vezin referenced in Richards' Ore Dressing		
					Volume II Page 850		

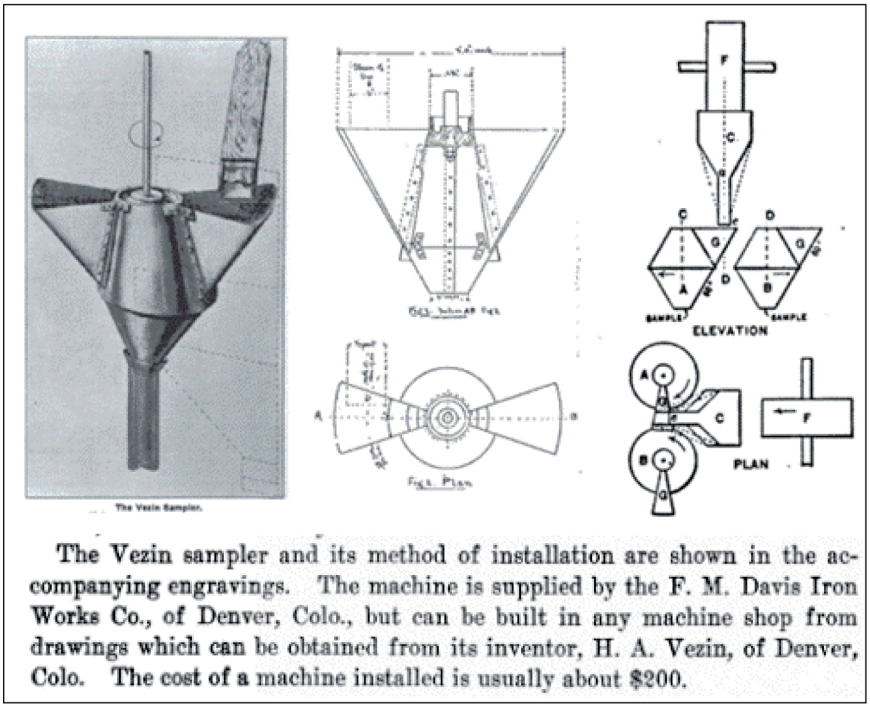

Figure 3. Construction of the Vezin sampler.

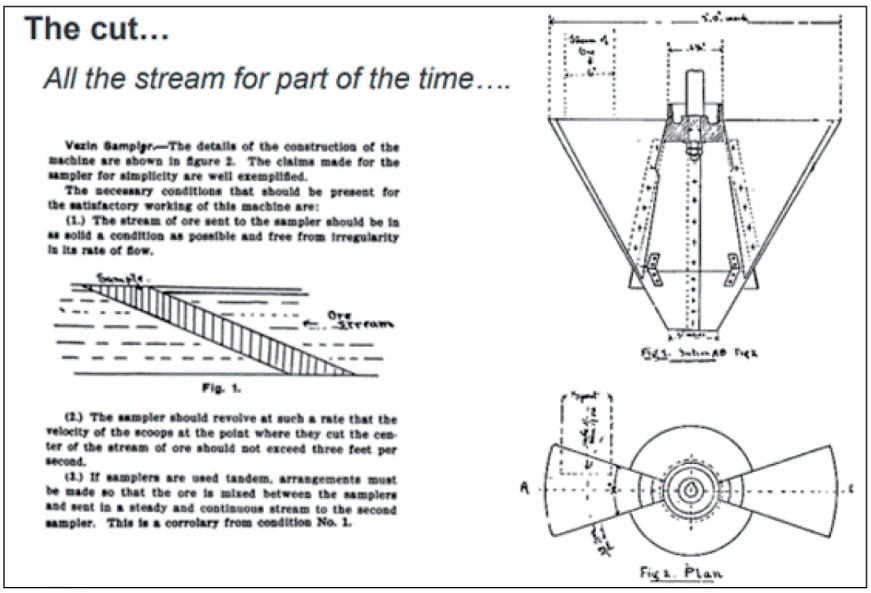

Figure 4. Extract from Reference 1 indicating the type of cross-cut sample taken and the construction of a Vezin Sampler.

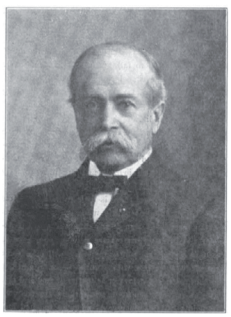

Figure 5. Obituary photo of Henry Vezin.

unusual knowledge of his profession down to the minutest detail, as well as by his tenacity of purpose in following out a subject to its finality".

His legacy is here to see for everybody, and his contribution to both the theory and practice of sampling is not difficult to measure—it is immense!

Fact box: The Vezin sampler: a success story *sine qua non*

Part 1: YouTube video from CSIRO

Part 2: Internet search on "Vezin samplers"

Choose your favoured search engine!

Part 3: Webinar on Henry Vezin

Henry Vezin and Early Sampling Practice (1850s–1900) (requires free registration). https://www.malvernpanalytical.com/en/learn/events-and-training/webinars/W140904SamplingPractice.html

References

1. H.O. Hofman, *The Metallurgy of Lead and the Desilverization of Base Bullion*, 5th Edn. The Scientific Publishing Company (1899). https://tinyurl.com/mrx3xak7 N.B. The 1892 edition is not available, so I go with the 1899 edition). Note that the sampling section was omitted from later editions of the book (not as seemingly indicated as later editions of the Google Book).
2. A.W. Warwick, *Notes on Sampling*. Industrial Printing and Publishing Company (1903). https://tinyurl.com/5fmmtw5u