Kaufmann's Posographe

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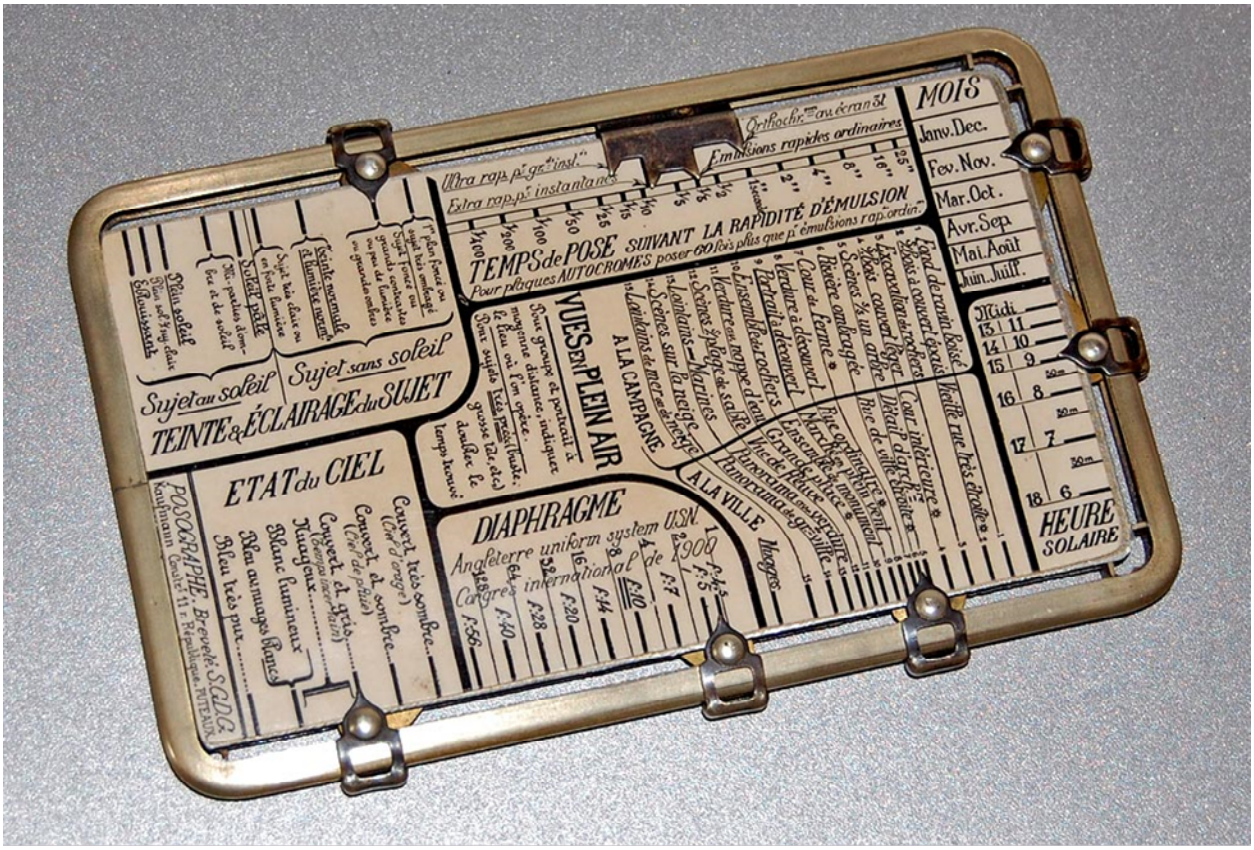

FIGURE 1. The Posographe

The Device

The subject of this article is a mechanical analog computer that calculates two discrete functions of six variables each. Now, to any scholar of computing history, this sentence brings to mind large arrays of axles, gears, cams and so forth; but Kaufmann's Posographe does not contain a single gear. In fact, the Posographe operates with only 11 moving parts – and the computer fits in your pocket.

The Posographe (See Figure 1) is a small rectangular plate, about 13 x 8 cm, covered on both sides with dense writing and drawings, with seven pointers fixed to the frame. The pointers can slide on the frame, and are clearly interconnected internally – moving any of the six small ones will move the larger one.

The purpose of this device is to calculate the *Temps de Pose* in photography – what we call Exposure Time. The French phrase is aptly evocative of the photography of the 19th and early 20th century: at that time you had to *pose* the subject, immobile, before the lens – for a time that could easily stretch into minutes in those days. Absence of electronic light metering meant that figuring this time interval was a major challenge, as the instruction manual[1] eloquently describes:

> Determining the exposure time required to obtain a perfect negative is one of the great difficulties of the photographic technique. When looking at the collection of the amateur photographer, one finds numerous photos that are washed out and without details, hardly usable. Each of these, not to mention those that have been scrapped, represents an unnecessary expense, a loss of time, and especially a very unpleasant disappointment, which usually has no other cause than

> excessive or insufficient exposure time.

After surveying the limitations of existing solutions, notably printed exposure tables, the manual declares:

> The Posographe has been established to completely remedy these disadvantages. It's a truly automatic exposure table, in which the complex influence of the various factors is translated mechanically by the interplay of suitably arranged levers and rods, whose movements are derived from charts similar to those used in industry and laboratories, to solve problems where the influence of various data cannot, as in the present case, be represented by a simple formula and ordinary arithmetic operations.

Each side of the device is a separate calculator, one for indoor photography and the other for the great outdoors. On either side, the six input variables are entered by setting the six small pointers to indicate the desired values on their respective scales; that done, the output indicator will point out the “temps de pose” on the applicable scale. Or, rather, the indicator will indicate four values, because there are four pointers; one then chooses which one to use based on the emulsion type on the photographic plate in the camera.

The input variables are very detailed, yet endearingly colloquial. For outdoors, they include the setting – with 31 values such as “Very narrow old street”, “Dewy foliage”, “Farmyard”, or “Open air market”; the state of the sky – including “Overcast grey sky”, “Blue with white clouds”, or “Deep blue”; The month of the year and hour of the day; the illumination of the subject; and of course the lens aperture (f-number).

For indoor photos, we have the colors of the walls and floor; the location of the subject relative to the windows (depending also on the number of windows, and indicated by the little diagrams); the extent of sky in the windows, as seen from the location of the subject (again illustrated in little pictures); the sunlight level outside, and how much of the sunlight, if any, enters the room; and the aperture.

FIGURE 2. The Two Faces of the Posographe, for Outdoors (top) and Indoors (bottom) Photography

So how does this little marvel work? One looks at the diagram of the inner mechanism (See Figure 3), and the functionality is immediately obvious. For a technically minded person, like myself, seeing that diagram for the first time is a mind-blowing experience, because the mechanism manifests the utmost in ingenuity, and shows that frugality of design that is the hallmark of true engineering elegance. The actual implementation can be seen in Figure 4. The brass plates are wider compared to the diagram, presumably because they are very thin – about 0.5 mm – and their edges might snag against each other as they moved if they did not already overlap. The cover plates holding the scales are made of 0.8 mm aluminum, and I slid them out to take the photo.

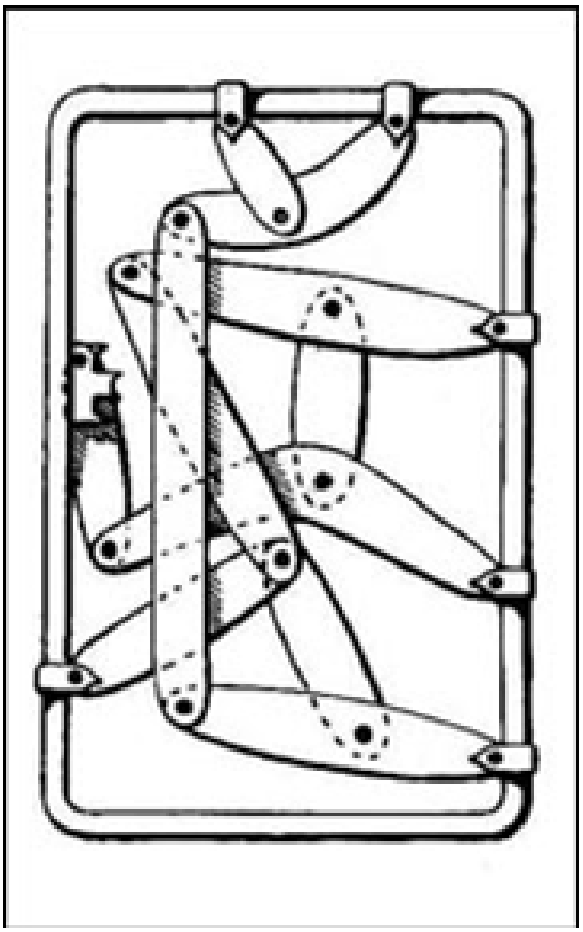

FIGURE 3. Schematic of Mechanism

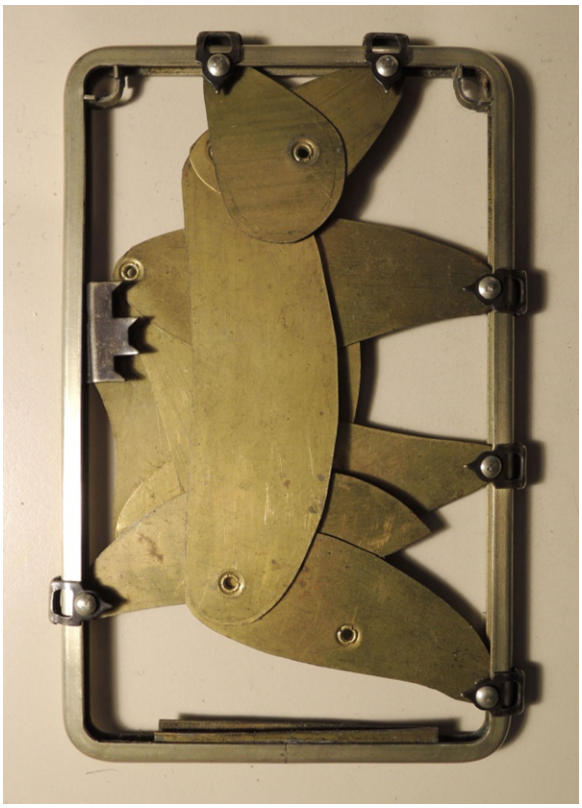

FIGURE 4. The Actual Mechanism

The Inventor

I now know much more about the man behind the device than I did when I bought it, because Jean-Louis Aubert, the inventor's great-grandson, has recently put up a Facebook page dedicated to his ancestor's life and work[2]. I am indebted to Mr. Aubert for permission to use photos from his page; and to Mr. Jean-Yves Moulinier, whose detailed article in Issue 74 of Declic[3], a French journal devoted to the history of photography, provided me with invaluable information.

Auguste Robert Kaufmann was born in Paris on October 2nd, 1885. His father, a broker, died young, and his mother remarried; the family left Paris during the First World War to the more tranquil town of Boullay-les-Troux, where Auguste Robert and his wife Henriette settled after the war. Kaufmann himself had served in a logistics transport unit of the French army during that war.

FIGURE 5. Auguste Robert Kaufmann

FIGURE 6. Kaufmann with his Pathé-Baby Movie Camera

Kaufmann was an enterprising man; when he was 25 he already had a successful workshop in Puteaux (a suburb of Paris) that produced award-winning motorized ride-in cars for children. He subsequently developed and sold a tuner for violin strings. By 1922 he was advertising himself as a general mechanical constructor, owner of a small firm for technical studies, design, and construction. He was also an avid amateur photographer (See Figure 6), which gave him the incentive to develop the device presented here.

The Development Process

As soon as I saw how the Posographe works, the foremost question in my mind was how did Kaufmann design this device – empirically, by trial and error, or analytically, by understanding the math and designing his system of levers to execute the math? We can get a good answer from a letter Kaufmann had sent to Maurice d'Ocagne, a noted engineer and mathematician, and the inventor of Nomography, in September 1922. Kaufmann writes to him:

> The mechanisms shown diagrammatically in figs. 2, 3, 4, 5 and 6 of page 14 of the manual have been established by trial and error in referring to graphs representing results of practical experiments.

Some further references shed light on what this means. The manual states:

> The Posographe's indications are based on the best books dealing with exposure time. During the four years required for its development, these have been verified and corrected by a great many practical experiments, made in all possible conditions and with different commercial emulsions, autochromes included.

(*Autochrome Lumière* was the first commercially successful color photography process).

To sum up, Kaufmann had used a systematic approach combining his training in mechanics with his knowledge of photography. Initially he did an exhaustive literature search for the state of the art in exposure time calculation; then he modified and improved the findings using extensive tests. The result was the "graphs" he mentions, nomograms like Figure 7, which represented the solution to the problem in graphic form.

I would love to know – but cannot – at which point exactly he had the "Aha!" moment when his inventive

mind realized that a nomogram can be converted to a set of mechanical linkages that do the same calculation but are easier and faster to use. With this insight, he proceeded to convert the graphs empirically to a mechanical movement, using the step by step approach seen in Figure 8. In the process he considered the mathematical equations behind the solution – the patent[4] explains how the original (but unspecified) function of the logarithms of six variables can be reduced stepwise to fewer variables, by successive combination of each intermediate result – the motion seen as an arrow in each diagram of fig. 8 – with one added variable at a time. He started (left diagram) by combining the month and hour, then added at each step an additional variable until he had a movement proportional to the exposure time (right).

Of course, after all that work there did remain an element of heuristic knowledge, which had always been a key part of photography. This is seen in the little notes inscribed on the faces of the Posographe, indicating modifications to the straightforward calculation. For example, on the Indoor side we see:

> With a subject in sunlight [inside a room] use the OUTDOOR table, and [Use] next darker zone for bays hung with network or lace curtains;

and on both sides:

> For very near subjects (bust, large heads, small objects, etc.) double the exposure shown.

The manual adds corrective directives, for example:

> In the vicinity of the equator, indicate July during the entire dry season and September during the rainy season.

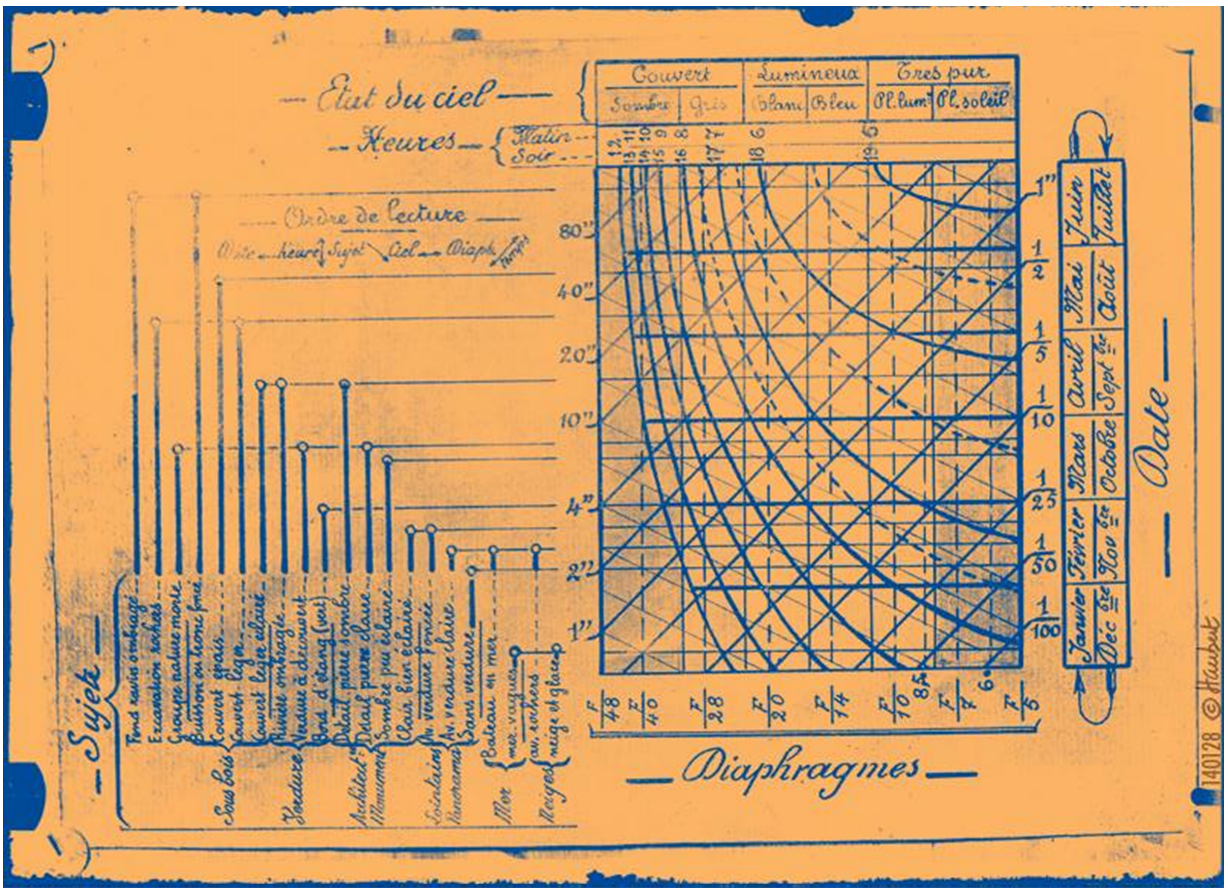

FIGURE 7. A Nomogram Representing the Relationship of Exposure Time to the Variables

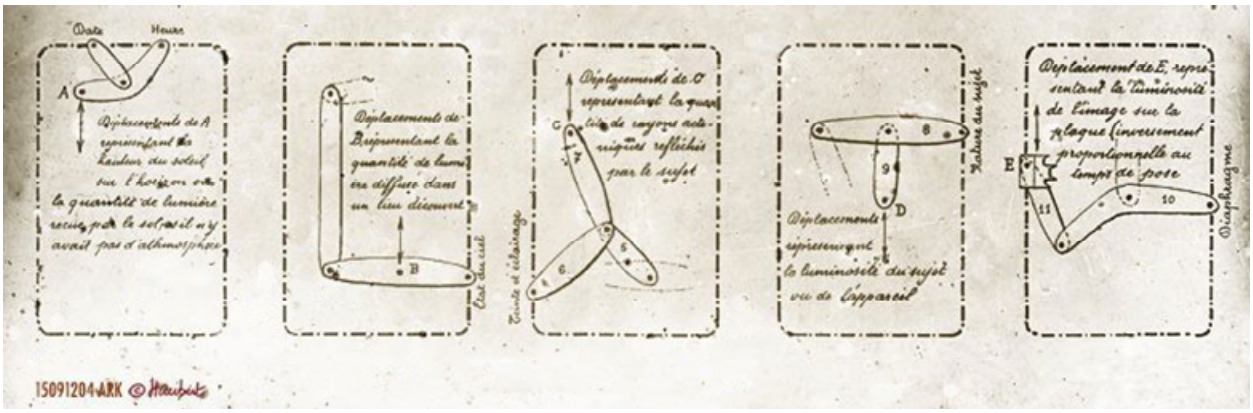

FIGURE 8. Stepwise Development of the Mechanical System (study for patent filing)

FIGURE 9. The English Version for use with the Pathé-Baby Amateur Movie Camera
(Photos courtesy of Gonzalo Martin[5])

FIGURE 10. The Uréographe Hamel

Variations on a Theme

The Posographe was made in multiple variants over the production life. The basic model for still camera exposure time had versions differing in the range of apertures covered. There was a model for cinematography, specifically for the popular Pathé-Baby amateur movie camera (See Figure 9), that computed the lens aperture to use. There was a rare model calibrated for tropical lands. And the Posographe came in different languages – French (See Figure 2), English (See Figure 9), Spanish, German, and Italian.

Kaufmann was well aware that he had invented a general method for automating the calculation of multi-variable functions. In his correspondence with d'Ocagne during 1922 he proposes to discuss applications to firing tables for artillery and aviation (d'Ocagne's invention of Nomography had originally been used for that purpose during WW1). He also notes that by adding to the mechanism cams and curved slides one could achieve greater precision than that obtainable by the simple levers of the Posographe (which he estimates at 10% worse than that of other more laborious methods, but good enough for photography). However, in reality we know of only one actual application he addressed beyond photography: the Uréographe Hamel, from 1925. This device calculated Ambard's constant, a now obsolete parameter, which was used at the time to assess kidney function based on the amount of urea in blood and

urine. As can be seen in Figure 10, this device had five input parameters and applied the same principle as the Posographe but in a different internal configuration. However, unlike the Posographe, there is no indication that the Uréographe had achieved any commercial success.

Commercial Production

Kaufmann's Posographe was patented in 1922 and was produced in a small but evidently well-run workshop, at the same address where Kaufmann had produced his children's cars 12 years earlier. The Posographe had sold (according to one late version of the manual) over 100,000 units by 1933, and had won multiple awards, from the first prize in the Lépine innovation contest in 1922 to two silver and two gold medals in various international and French expositions over the next decade. Production continued after Kaufmann's death in a car accident on 11/11/1927, first under the management of his widow Henriette and then, from 1934, by Ateliers Cercelier, a company in Bezons.

When Cercelier ceased production is unknown, but note that modern exposure meters using Selenium photoelectric cells started appearing commercially in the early 1930's. With devices that could indicate exposure time directly at a glance, the Posographe was destined to disappear from the market. The Posographe does remain a lovely collectible and a reminder of an ingenious, resourceful, determined innovator from times gone by.

Notes

1. A transcription of the French instruction manual is available at http://www.brocantina.com/posogr.pdf.
2. Facebook page dedicated to Kaufmann: https://www.facebook.com/posographe.kaufmann
3. Declic web site: http://declic87.free.fr/publi.php
4. Posographe patent: https://bases-brevets.inpi.fr/en/document-en/FR542107/publications.html
5. Gonzalo Martin's site: https://photocalcul.com/