

FLYING FILMING

DER REIHENBILDNER AND AERIAL PHOTOMONTAGE

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The First World War represents a fundamental step in the history of aerial warfare due to the first employment of military aeroplanes. These machines were initially designed for aerial observation. During the war, aerial photography aided cartographic investigation, as well as intelligence practices, and it assisted the artillery to aim at targets beyond the line of sight. By the end of the conflict, the institutionalisation of aerial photo-reconnaissance as a military discipline was established. Moreover, aerial photography had become a propagandistic medium used to disseminate persuading and aesthetically innovative content to civilians. Frequently, pictures produced for military and surveying purposes that were not classified as top-secret ended up circulating in the press. From this perspective, World War I aerial photography gained a dual role as an instrument of armies' imagery intelligence on the one hand, and an apparatus of governmental propaganda on the other. Among the variety of aerial photographic material produced and published in WWI, this essay analyses the German system of photomapping territories by means of a military serial aerial camera called *Reihenbildner* (Rb), designed by the film pioneer Oskar Messter in 1915. This device made it possible to create an aerial map of a vast area by recording a series of photographic sections of terrain ("strips") through a technique known as photographic mosaic.

The first two parts of this paper analyse the circumstances that led to the development of this German mapping technique and its importance for aerial warfare, focusing on the infrastructures and manual work necessary to make this type of photographic map. The third part investigates how these 'pasted topographies' were popularised outside the military sphere in the final years of the conflict. Finally, the aesthetic and epistemological

qualities of these maps are clarified in the final section of the essay, which compares the technique of the military aerial photomosaic with more celebrated forms of avant-garde photomontage in the context of an analysis of modernity.

Film camera: recording topographies

Authors from different fields working on military history agree in recognising the *Reihenbildner* camera as a crucial device for aerial reconnaissance and mapping history.¹ In 1961, the WWI aerial photo officer Carl Fink lamented the absence of this device from the Deutsches Museum's aviation exhibition. In a letter to the museum's management, he described Oskar Messter, the inventor of the *Reihenbildner* camera, as a man who deserved to be honoured for having created the first automatic aerial camera for the German Air Force.² According to Fink's description of this device, "[t]he overlapping vertical photographs made it possible to create, as quickly as possible, the best substitute of a map (60 km long, 2.5 km wide, scale 1:10 000), covering theatres of war with very poor or no maps at all. This was a fabulous achievement in 1915. Our opponents were unable to achieve this until 1918!"³

- 1 For an overview of German literature about the *Reihenbildner* camera in different disciplines, cf. Georg Paul Neumann, *Die deutschen Luftstreitkräfte im Weltkrieg*, Berlin 1920, p. 167; Hermann Lüscher, *Kartieren nach Luftbildern*, Berlin 1937, pp. 7–8; Helmut Jäger, *Erkundung mit der Kamera*, München 2007, p. 136; Marco Rasch, *Das Luftbild in Deutschland von den Anfängen bis zu Albert Speer. Geschichte und Rezeption des zivilen "Stiefkindes der Luftfahrt"*, Paderborn 2021, p. 74.
- 2 The German Museum of Masterpieces of Science and Technology in Munich (Deutsches Museum) holds a conspicuous number of Oskar Messter's devices and recordings, see Noemi Quagliati, "Histoire des appareils photographiques aériens. L'exposition Historische

Luftfahrt bis 1918 et les collections insulaires du Deutsches Museum", in *L'image Verticale. Politiques de La Vue Aérienne* (Transbordeur: Photographie, Histoire, Société 6), eds. Marie Sandoz and Anne-Katrin Weber, Paris 2002, pp. 98–111. The rest of Messter's legacy is housed in the German Federal Archives (Bundesarchiv).

- 3 Author's translation; original: "Die senkrechten, übergreifenden Aufnahmen ermöglichten von Kriegsschauplätzen mit sehr schlechten oder gar keinen Karten schnellstens besten Kartenersatz zu schaffen (60 Km Länge, 2,5 Km Breite, Maßstab 1:10 000). Das war 1915 eine fabelhafte Leistung. Die konnten unsere Gegner bis 1918 nicht aufweisen!" Deutsches Museum Archiv, Munich, Korrespondenz zwischen Carl Fink und Deutsches Museum, VA1800/2.

Carl Fink was a central figure in the institutionalisation of aerial photography as a systemic method of imagery intelligence in Germany. He was appointed Photographic Officer in 1915, when Hermann von Lieth-Thomsen became Chief of Field Air Forces. Later, Fink led the Aerial Photography Division of the Commanding General of the Air Forces (*Kogenluft*). Despite initial skepticism by the German High Command, “Luftbild-Fink” (as he became known after the war) promoted the use of photography for supporting aerial monitoring of the enemy positions and advocated the role of recorded images as an essential component of strategic and tactical trench warfare. Having been personally involved in the development of aerial photo-reconnaissance, Fink also knew that correcting perspective distortion in aerial photographs taken with hand-held cameras had been one of the greatest challenges faced by surveying officers in WWI, before Messter’s invention of the *Reihenbildner*. In order to solve this problem – inspired by the experimentation carried out by the pioneers of aerial photogrammetry, i.e., Sebastian Finsterwalder and Theodor Scheimpflug – Fink himself had developed the so-called *Grundrissbildner*: a device that automatically rectified aerial photographs taken from an oblique perspective (not perpendicular to the earth’s surface) transforming them into planimetries of the terrain.⁴ However, straightening and scaling single oblique views with this kind of device, one by one, was a very time-consuming task. Moreover, even if combined, the photos did not offer very extended maps because the pictures were recorded on glass plates at the beginning of the war. These fragile plates allowed only a limited number of snapshots per single flight. Therefore, according to Oskar Messter, the real change in photographic mapping occurred when, for the first time, “the unwieldy, heavy, and splintering glass plate had to give way to the film!”⁵

4 These devices were generally known as *Umbildner* (transformers). Among them, there was the Prussian model *Grundrissbildner*, designed by Fink together with Dresden company Ernemann-Werke, and the Bavarian model *Photokartograph*; see *Die Entwicklung des Militärischen Luftbildwesens in Bayern* (conference proceedings, Deutsches Museum branch Flugwerft Schleißheim 2012), ed. Helmut Jäger, Munich 2012.

5 Author’s translation; original: “Die unhandliche, schwere und splinternde Glasplatte mußte dem Film das Feld räumen!” Oskar Messter, *Mein Weg mit dem Film*, Berlin 1936, p. 85.

6 For a complete overview of Oskar Messter’s career and his role in the German film industry, see *Oskar Messter – Filmpionier der Kaiserzeit* (exhibition catalogue Potsdam/Munich), ed. Martin Loiperdinger, Basel 1994.

Oskar Messter is considered the “father of German film,” or, as the title of the 1994 exhibition at Filmmuseum Potsdam and Deutsches Museum Munich remarks, the “Filmpionier der Kaiserzeit.”⁶ At the turn of the century, he was a well-established projector producer and successful inventor in the field of film technology. Moreover, he pioneered early German cinema, holding the first sound projection in 1903 by means of his patented *Bio-phon*. During WWI, Messter served in the press department of the Deputy General Staff in Berlin, regulating censorship, and producing newsreels and entertainment for the soldiers on the Western Front. At the same time, he designed aerial mapping cameras and other devices for the marine and aviation corps. These activities allowed his companies to survive the war times, and the production of aerial cinematographic film during the warfare had positive consequences on the quality of film stock in the motion picture industry of Weimar Germany. The establishment of the Universum-Film AG (UFA), to which Messter contributed by selling several of his film companies at the end of 1917, demonstrates further the cooperation between the military, the state, and German film industrialists. As a state-controlled film corporation, UFA had originally been founded by the Supreme Command under the name Bild- und Filmamt (Bufa) to function as an instrument of visual propaganda.⁷

In this context, the most effective photo-optical device of German aviation, the *Reihenbildner*, was designed by Messter in 1915 (Fig. 1). As Fink recalled in his letter, during a single flight from a height of 2500 metres, the *Reihenbildner* filmed a land surface that measured 60-by-2.5 kilometres at the scale of conventional topographic maps. The device was equipped with a standard cinema film and, by following the principles of a film camera, made roughly 240 photographs on a single film roll of 60 meters.⁸ The camera was suspended in the aeroplane, behind the

7 For film propaganda in WWI Germany, see Ulrike Oppelt, *Film und Propaganda im Ersten Weltkrieg. Propaganda als Medienrealität im Aktualitäten- und Dokumentarfilm*, Stuttgart 2002; Christoph Makowski, *Deutsche Filmpropaganda im Ersten Weltkrieg. Entwicklung, Hoffnung, Versagen*, Baden-Baden 2002. Wissenschaftsverlag. For the work of Messter after WWI, see Messter 1936

(note 5); Babett Stach, *Nachlaß Oskar Messter, Bestand N 1275. Findbücher zu Beständen des Bundesarchivs*, Koblenz 1994; *Oskar Messter. Erfinder und Geschäftsmann*, eds. Frank Kessler, Sabine Lenk and Martin Loiperdinger, Basel 1994.

8 For the various patents obtained by Messter concerning the *Reihenbildner* device see Paul Karlson, “Oskar Messters

observer's seat, with the lens facing the terrain through a hole in the fuselage. The film was placed 90 degrees transversely to the flight direction (Fig. 2). Driven by a small air propeller, the device took a rapid sequence of vertical aerial pictures (usually one per second), producing a negative size that curiously measured roughly 5×24 cm.⁹ Later, the camera was driven by an electric motor connected to a set of gears, whose shifting imparted speed variation. Rubber rollers moved the film, and a yellow glass pressure plate held it during the exposure and served as a colour filter (Figs. 3a and 3b). By the end of the war, according to the German Army's processing centre (Heeres-Abwicklungsstelle), a total area of 7 202 935 km² had been photographed using 933 000 m film of 241 *Reihenbildner* cameras.¹⁰

Film editing: assembling topographies

The use of film mapping cameras required trained personnel. In Germany, special troops, namely *Reihenbildtrups*, were responsible for operating these devices, which were permanently installed in reconnaissance aeroplanes, such as the Rumpler C-IV. Sitting behind the pilot, the observer

Arbeiten zum Luftbildwesen", *Zeitschrift der Deutschen Gesellschaft für Photogrammetrie e.V., Bildmessung und Luftbildwesen*, 16, 4 (1941), pp. 146–151. See also Philipp Vogler, *Die deutsche militärische Luftbildaufklärung. Von den Anfängen bis 1945*, Karlsruhe 2020, pp. 127–129; Helmut Jäger, *Luftbilder auf der Karte finden: Luftaufnahmen aus dem Ersten Weltkrieg lokalisieren*, München 2014, pp. 32–33; Jäger 2007 (note 1), pp. 292–95. Karlson's text also summarises the technical specifications of all the models of Messter's serial cameras produced from 1915. The technical details described in this article, as most of the figures, refer to the model Rb. I designed in November 1915. This is one of the few still existing 1915 *Reihenbildner* that the author of this article was able to analyse at the Deutsches Museum Munich, thanks to the help of Thomas Rebényi, head of the museum's Restoration Laboratory for Scientific

Instruments and Clocks. The most successful models of *Reihenbildner* were the Rb. II (1916) and the Rb. IV b (1917). Both devices used an image size of 6×24 cm. The Rb. IV b allowed the interchanging of lenses (Zeiss-Tessar or the Zeiss-Triplet) with three different focal lengths ($F = 25, 50, 70$ cm).

- ⁹ This size refers to the Rb I model housed at the Deutsches Museum. The very first prototype of *Reihenbildner* designed in May 1915 exposed a negative size that measured 3.5×24 cm, but the most common Rb. negative size in WWI became 6×24 cm. During the Weimar Republic, the negatives of these kinds of cameras also reached 18×24 cm.
- ¹⁰ See Karlson 1941 (note 8), p. 139.



Fig. 1
Oskar Messter, film mapping camera
Reihenbildner ("Rb I"), 1915, wood and
metal, 890 × 860 × 400 mm. Munich,
Deutsches Museum, Collection Photo-
graphy-Cinematography, Inv. No. 56011
(56011_20220524_001_FotoraumSB_ND_
KRainer)

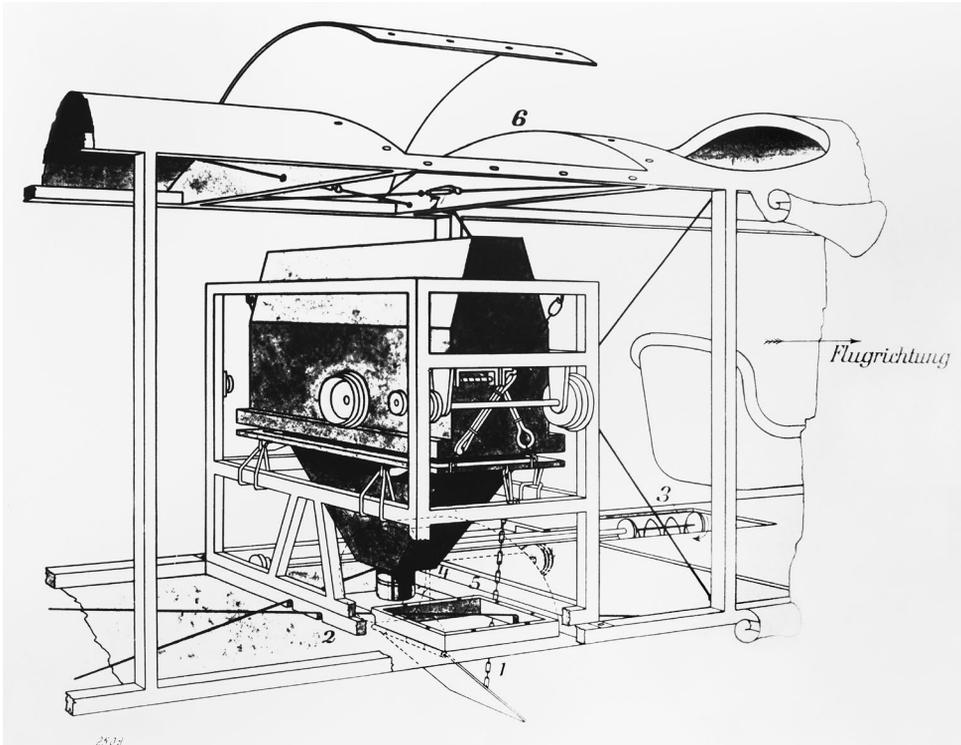


Fig. 2
 Messter-Optikon GmbH, diagram of the camera *Reihenbildner II* installed in an airplane's fuselage, ca. 1915, black and white print, 13 × 18 cm. Munich, Deutsches Museum Archive (BN30896)

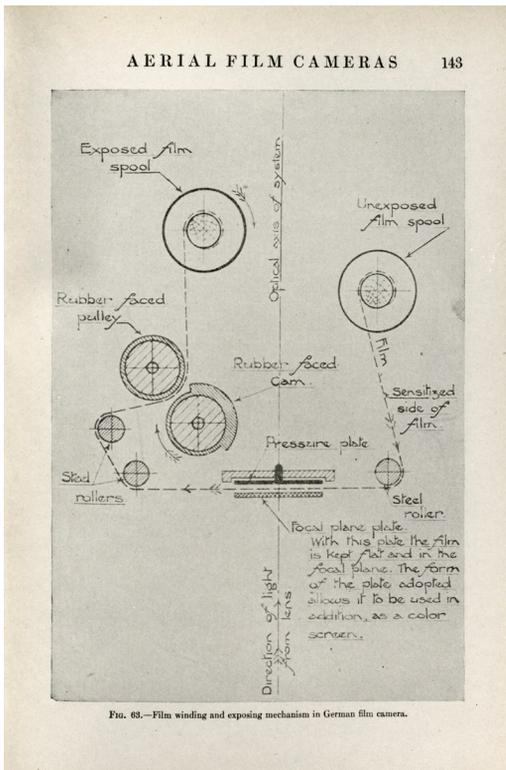
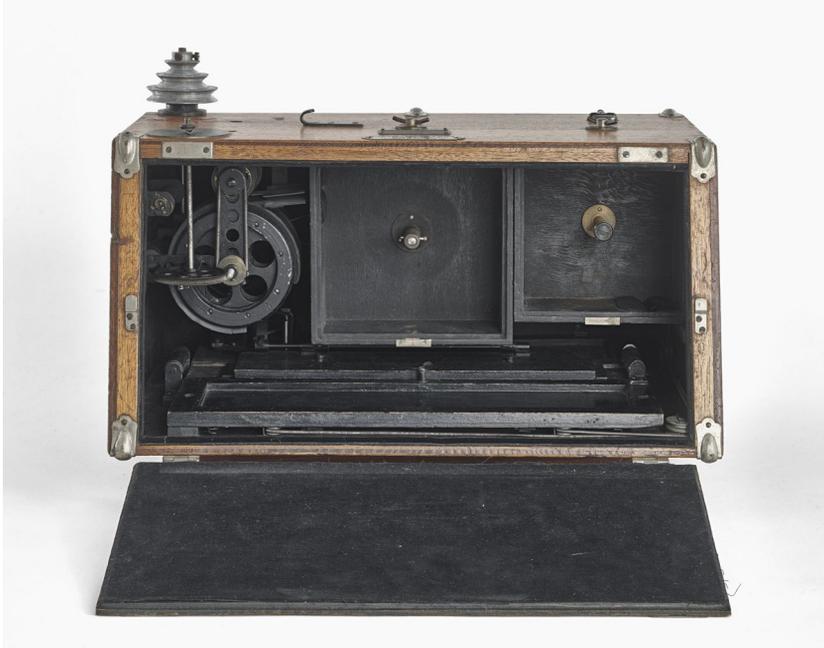


Fig. 3a and Fig. 3b
 Oskar Messter, inner mechanism of the Reihenbildner I, 1915, wood and metal. Munich, Deutsches Museum, Collection Photography-Cinematography, Inv. 56011 [3a: Deutsches Museum, 56011_20220524_005_FotoraumSB_ND_Krainer; 3b: see Ives 1920 (note 12), pl. 63]

switched on the camera manually¹¹ and through an instrument, the *Überdeckungsregler*, regulated the frequency of pictures depending on the aeroplane's speed and flight altitude. Composing the perfect photo map required the precise setting of the time sequence of the film exposure. The aerial photos needed to overlap each other to at least 25% along the longer side to record the terrain without gaps. In 'postproduction,' these overlaps guaranteed that the photo studio operator had enough exposed film negatives to compose the map, even if the plane had curved during the flight. In other words, an excess of exposed film was necessary to find conjunction points for making the map. The film surplus could be cut and removed only when the exact succession of terrain strips was found (Fig. 11). The overlapping pictures obtained through the *Reihenbildner* also served as stereoscopic pairs, a 3D technique that emphasised (unnaturally exaggerating) small details and highlighted volumes to favour the interpretation of aerial photographs and the detection of camouflage.¹²

Even though the automatisisation of the recording allowed the observer to keep his hands free for other activities, such as checking the flight route, taking notes, using the machine gun, etc., mapping with the *Reihenbildner* demanded a controlled movement of the aircraft. Pilot Egon Drogosch described the challenges of manoeuvring the plane while taking mosaic maps: "As a pilot, you had to be careful not to take a curved route during the recording of this film, otherwise the film and the surfaces that were to be filmed deviated."¹³ This was a particular challenge in wartime. Despite

11 In the 1915 model, as soon as an operator released a brake, the small air propeller started to drive the camera mechanism. Indeed, spun by the plane movement, the air propeller activated both the film transport and the opening of the shutter. The speed of the shutter could be controlled by an internal mechanism, but it was also influenced by the plane speed.

12 For stereoscopic aerial photography used for identifying camouflage in WWI, see Herbert E. Ives, *Aerial Photography*. Philadelphia et al. 1920, pp. 329–350; Paul K. Saint-Amour, "Modernist Reconnaissance", *Modernism/Modernity*, 10, 2 (2003), pp. 357–369; Hanna Rose Shell, *Hide and Seek. Camouflage*,

Photography, and the Media of Reconnaissance, New York 2012, pp. 26–77; Noemi Quagliati, "Playing Hide-and-Seek in the German Press: Presence and Absence of Camouflage in WWI Narrations", *Vulcan: The Journal for the History of Military Technology*, 9 (2022), pp. 36–38.

13 Author's translation; original: "Man musste bei diesem Film als Flugzeugführer achten, dass man keine Kurve flog, denn dann verschob sich der Film und die Flächen, die gefilmt werden sollten". Deutsches Museum, Munich, Historische Luftfahrtsammlung, Egon Drogosch Nachlass, *Mein Leben: 1893 Danzig – 1963 Bad Orb*, 1957, p. 48.

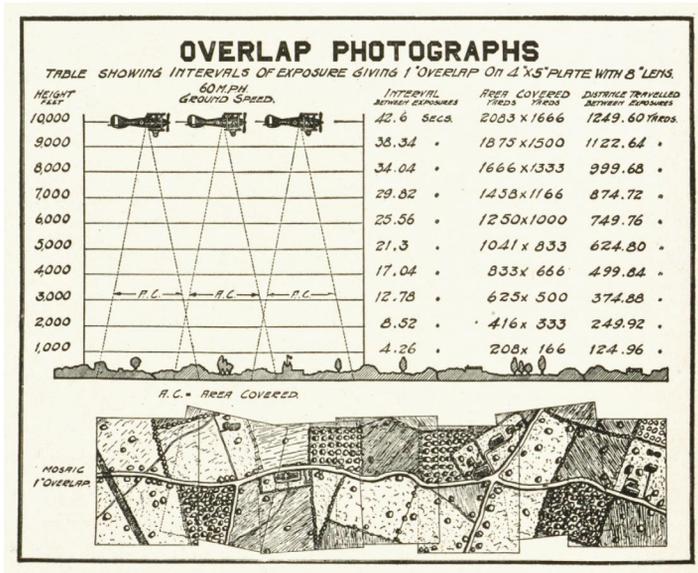


Fig. 4
Allied mapping standard, see Ives 1920
(note 12), pl. 129

the risk of being hit by the anti-aircraft and in all weather conditions, the reconnaissance planes needed to follow a straight route in order to create photo maps. The straight line covered by the planes also showed a peculiar aspect of the German way of mapping. As the U.S. Major Herbert Ives noticed in his 1920 book *Airplane Photography*, the size of the pictures produced by the German film mapping camera was “unusual” compared to the Allied standard (Fig. 4). In German military terminology, the resulting map produced with Messter’s mapping device was called *Reihenbild* or *Bildfolge* (in-line image), and not “mosaic” as in the Allied tradition. The long strips created with the *Reihenbildner* camera (literally “serial imager”) less resembled the classical mosaic tesserae. However, the practice of combining different photos in order to form a photomap was often referred in WWI German aerial surveillance manuals as tessellated (*mosaikartig*).¹⁴ The long and narrow size of the *Reihenbildner*’s snapshots utilised the

14 Cf. Leutnant d. L. Wecker, *Die Erkundung aus Fliegerbildern*, Wahn 1916, p. 18.

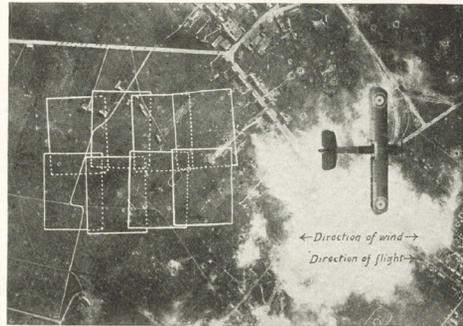


FIG. 137.—Overlaps made when flying with or against the wind.

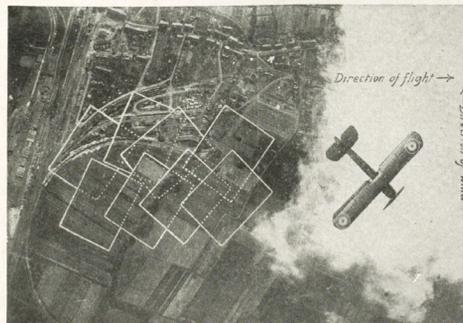


FIG. 138.—Unsatisfactory overlaps made when plane is "crabbing."

Fig. 5
 Making satisfactory overlaps
 depending on wind directions, see
 Ives 1920 (note 12), pl. 137–138

maximum width of field covered by the lens. This system necessitated a larger number of exposures to complete a map but made it easy to find precise junctures between the photographs. Only making overlaps on a turn was more complicated using this method, which is why the pilot Drogosch described the need to fly as straight as possible (**Fig. 5**).

The preceding description shows how the realisation of the photographs during the flight precisely prepared the creation of the photomap. The flight was subordinated to the manual practice of copying, cutting, and pasting, carried out by photographers trained in realising the so-called photo maps, which were a combination of many strips. Messter's company supplied the photographic studios on the war fronts with the specific equipment necessary for the postproduction: wooden drying drums,

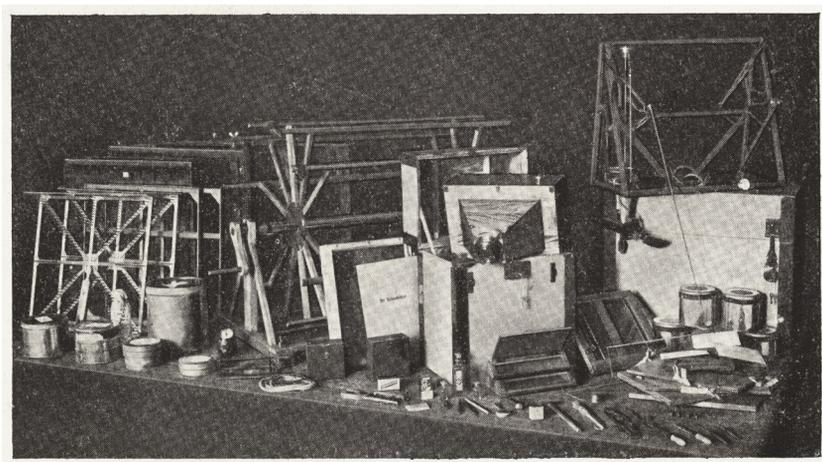


Fig. 6
Messter-Optikon GmbH, equipment for editing the film recorded with the *Reihenbildner* camera, see Karlson 1941 (note 8), pl. 21 (Munich, Deutsches Museum Library, ZB3130/CD89688)

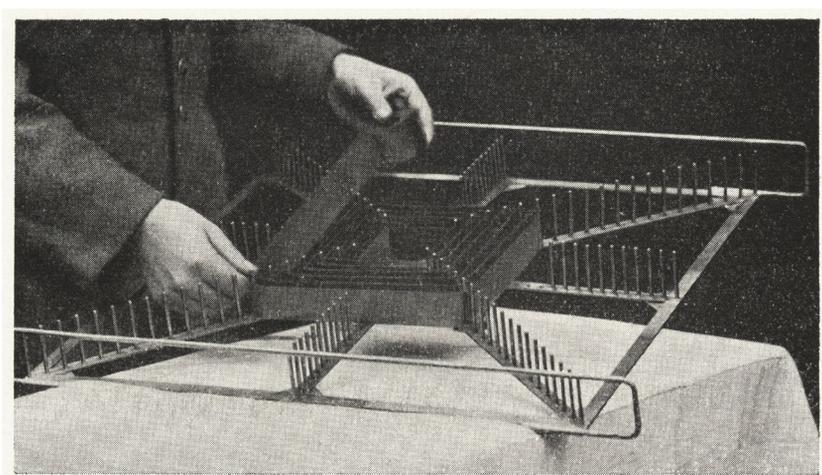


Fig. 7
Messter-Optikon GmbH, developing the Rb film, see Karlson 1941 (note 8), pl. 19 (Munich, Deutsches Museum Library, ZB3130/CD89687)

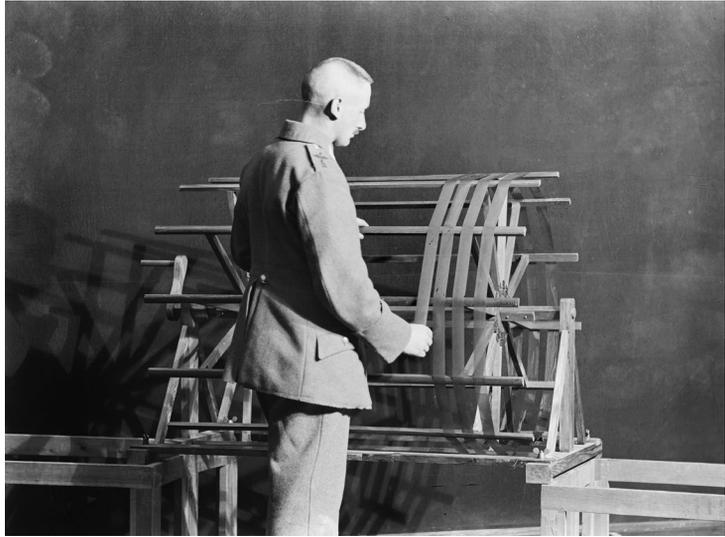


Fig. 8
 Messter-Optikon GmbH, drying the Rb film
 on a wooden drum, ca. 1915, black and
 white print, 18 × 24 cm. Munich, Deutsches
 Museum Archive (BN30906)

contact print frames, cutting desks, etc. (**Fig. 6**). After developing and drying the film (**Figs. 7–8**), the operator combined a sequence of single snapshots by overlapping the strips using a special desk consisting of a glass frame that made it possible to see different layers of film in transparency (**Fig. 9**). Once a congruence of terrain features had been identified on two overlapping negatives, the exact conjunction points were realised by clumping the film stripes with a screw-on ruler to the glass desk and precisely cutting them with a blade. A number of these cut negatives (usually ten pieces) were then positioned next to each other on the gluing desk (**Fig. 10**). Here, they were fixed together with small pieces of sticky tape (**Fig. 11**). The last step consisted of printing a group of taped negatives on photographic paper measuring roughly 30 × 40 cm by using the contact print process (**Figs. 12–13**).¹⁵

¹⁵ For a description of the technical steps for arranging an aerial map in the photographic studio, see Karlson 1941 (note 8), p. 135.

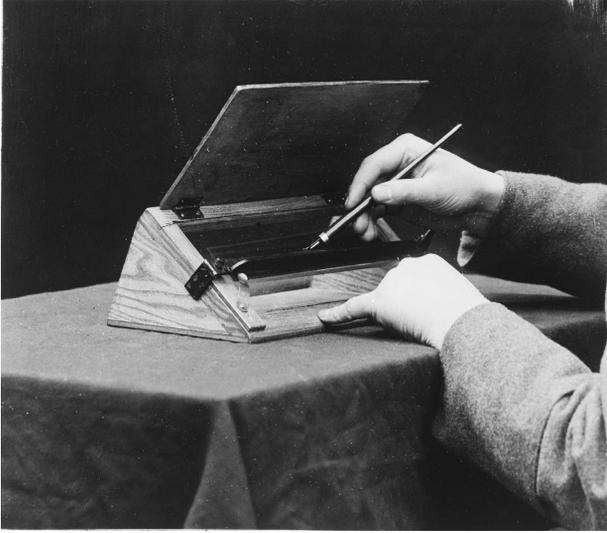


Fig. 9, Fig. 10
Messter-Optikon GmbH, cutting desk (above)
and gluing desk (below), ca. 1915, black and
white print, 18 × 24 cm. Munich, Deutsches
Museum Archive (BN30907)

Small-sized mosaics were included in the aerial reconnaissance weekly report (Fig. 14), but printings of photographic sequences could also be further assembled in larger format wall maps (Fig. 15). Every mosaic, composed of photographic tesserae (called *Reihenbildstreifen*), was classified with all the necessary elements to identify the section of terrain recorded and the context in which the mission took place: the flight number, date, altitude, scale, observer, pilot, aviation department, etc. A political or road map, which always accompanied the photographic mosaic, reported the aeroplane's route and to which sector of this itinerary the photomap corresponded. In the case of Eastern Europe and the Middle East, territories in which the German army lacked cartographic investigation, the photo maps created by *Reihenbildner* constituted the main instrument for designing topographic maps of areas of military interest (Fig. 16).

Film distribution: propagandising topographies

Among the variety of aerial photographic material published in the WWI German press,¹⁶ one could also find mosaic maps taken with the *Reihenbildner*. These particular photographic maps were recognisable by the thin lines that regularly divided the pictures' surface that appeared on the pages of magazines. However, the publication of aerial mosaic maps in the press was only limited to small portions of more extensive mapped areas, and they showed specific cases of target reconnaissance (Fig. 17). The reason for excluding complete maps from the press was that the German General Staff considered cartographic investigation carried out with the *Reihenbildner*, as well as the technology utilised for this innovative kind of mapping, classified information that was censored at the beginning of the war. Only from 1918, when aerial mapping by means of the photomosaic had become a technique amply used by all the countries involved in the conflict, was the German press allowed to propagandise the *Reihenbildner* as an innovative German device that helped the army monitor the enemy and conquest new territories.

16 See Noemi Quagliati, "Training the Eye: Production and Reception of Aerial

Photography during the World Wars", *AUC Geographica*, 55, 1 (2020), pp. 93–111.

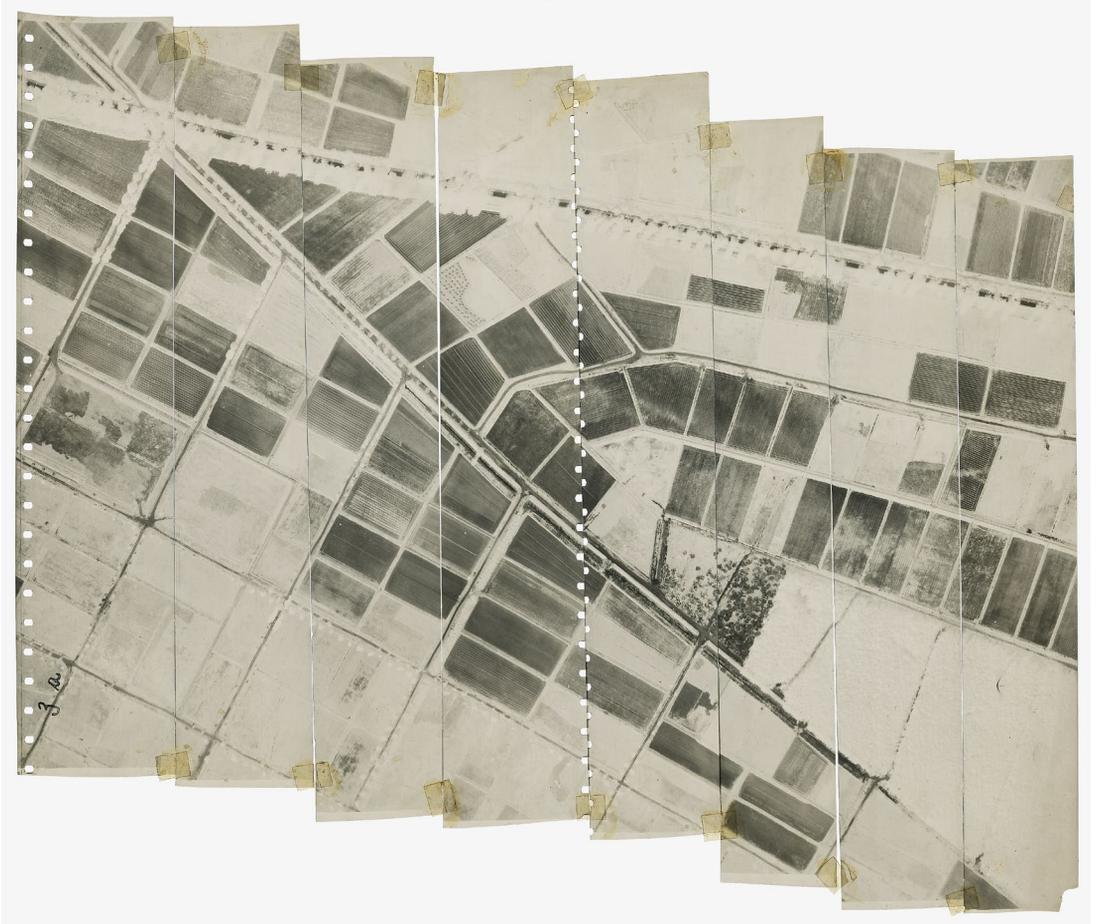


Fig. 11
Messter-Optikon GmbH, Rb film negatives
fixed with pieces of sticky tape, prior to
1918, nitrocellulose film, circa 30 × 40 cm.
Munich, Deutsches Museum, Collection
Photography-Cinematography, Inv. No.
2020-4 (Deutsches Museum Archive
CD84681)

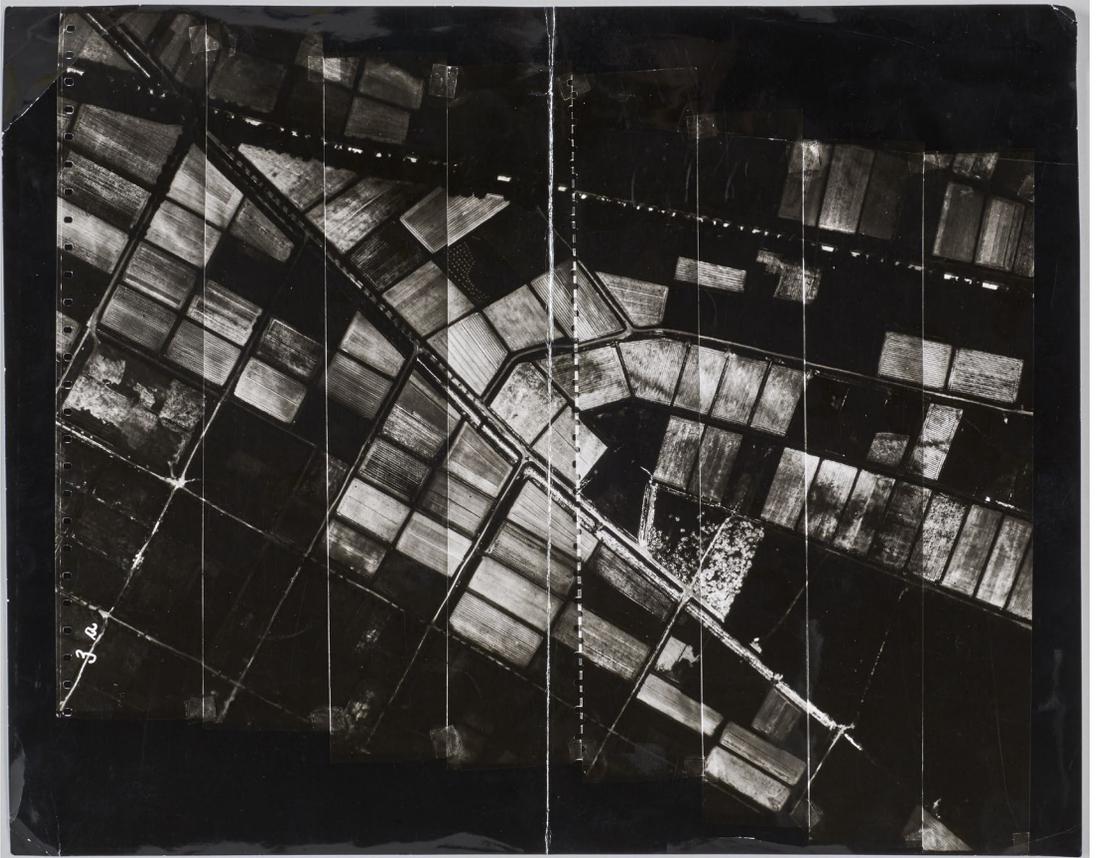


Fig. 12
Messter-Optikon GmbH, Rb film strips
printed with contact print process, prior to
1918, black and white print, circa 30 × 40 cm.
Munich, Deutsches Museum, Collection
Photography-Cinematography, Inv. No.
2020-4Z1 (OI_851077_20190710_001_D10_
ND_AGöttert)

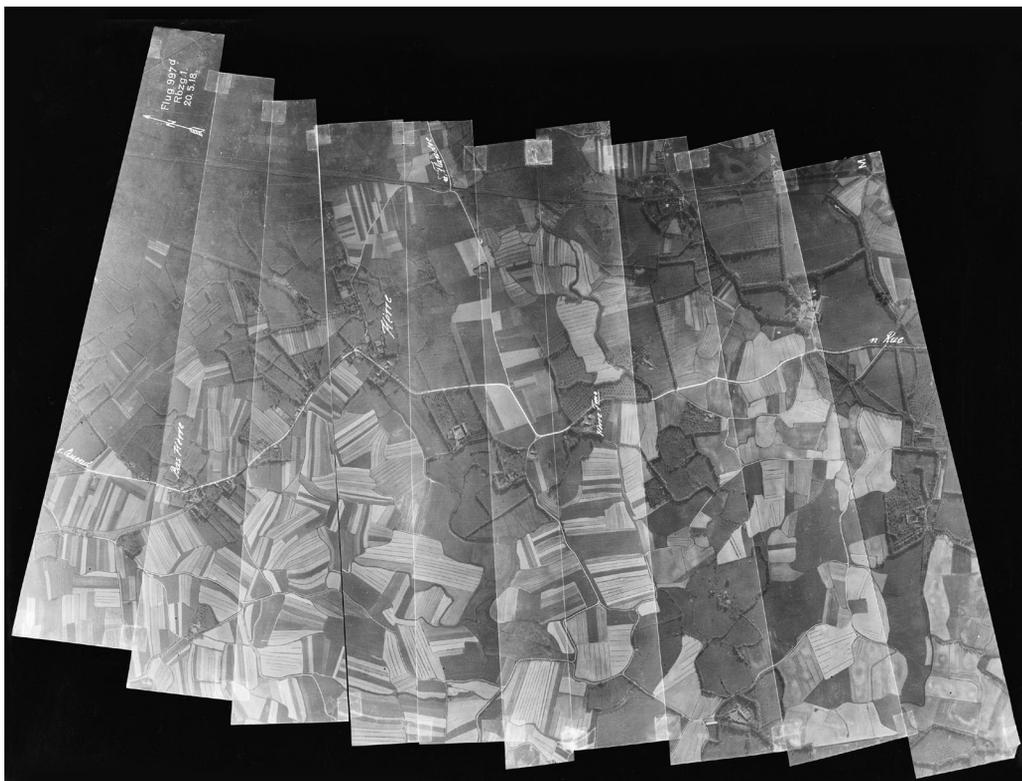


Fig. 13
Messter-Optikon GmbH, aerial map of
Hère (Hauts-de-France) taken with the
Reihenbildner, 1918, black and white print,
40,5 x 30 cm. Munich, Deutsches Museum,
Collection Photography-Cinematography,
Inv. No. 64401T2 (Deutsches Museum
Archive, BN44571)

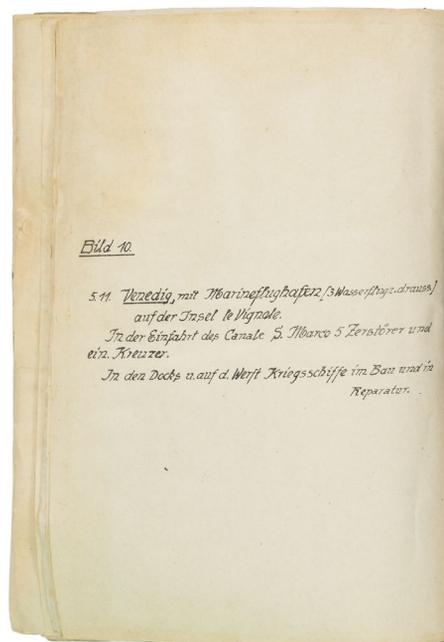




Fig. 15
Feldflieger Abteilung 31, large-format wall map made with Rb recordings that show four parallel flights following the course of the Berezina river (Belarus) until its confluence with the Neman, 1915, black and white print, 13 × 18 cm (original lost). Munich, Deutsches Museum Archive (BN30897)

Fig. 16

Messter-Optikon GmbH, section of a map, scale 1:25 000, which was produced in Palestine in 1917 on the basis of a series of photographs taken with the *Reihenbildner*, see Karlson 1941 (note 8), pl. 25

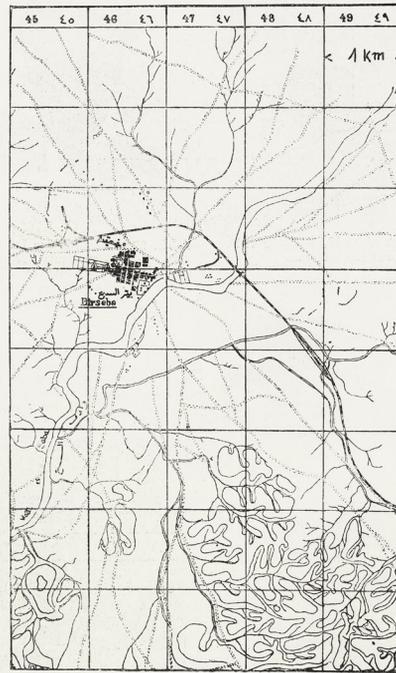


Abb. 25. Ausschnitt einer Karte, Maßstab 1 : 25 000, die im Jahre 1917 in Palästina auf Grund von Reihenbildaufnahmen angefertigt wurde. Die aufgenommene Fläche maß 1500 qkm; der fertige Plan konnte bereits 14 Tage nach dem Bildflug abgeliefert werden.

In November 1918, on the pages of the popular illustrated magazine *Die Woche*, Lieutenant Gehrts announced: “We own this automatic imaging device in our ‘Reihenbildner,’ the flying cinematograph, with which in a single flight countless square kilometres can be captured in one photo.”¹⁷ The expression “der fliegende Kino” (the flying cinematograph),¹⁸ which was also the title of Gehrts’ article, emphasised that the military serial camera *Reihenbildner* took recordings from the most modern flying machine, namely the aeroplane, by using the same principle as a film camera (Fig. 18).

17 Author’s translation; original: “Dieses selbsttätige Bildgerät besitzen wir in unserem ‚Reihenbildner‘, dem fliegenden Kino, mit dem auf einem Fluge unzählige Quadratkilometer in einem Lichtbild aufgenommen werden können.” Lt. Gehrts, “Der fliegende Kino”, *Die Woche*, 44 (1918), pp. 1092–1095.

18 In the WWI press, the term “der Kino” was the abbreviation of “der Kinematograph,” namely the motion-picture camera. Instead, “das Kino” was the short form of “das Kinotheater,” which referred to the room used for screening films to the public.

Installing a camera that employed an innovative motion picture film mechanism on the fastest aircraft must have been an exciting fact to report in the press.¹⁹ The promise of national technological progress embedded in the “flying cinematograph” perfectly matched with a broad fascination with technology – particularly the thrill of speed – that existed among the German public in the Wilhelmine Period.²⁰

Cinematography, just introduced to the general public at the end of the nineteenth century, was considered the most “modern” audio-visual medium available at that time and the perfect tool for boosting the troop’s morale in WWI by promoting the heroic achievements of the German army.²¹ Combining this medium with the aircraft constituted a further impressive innovation that *Die Woche*’s article introduced in these terms:

The filmmaker has even ventured into the realm of the air. Before the viewer’s eyes, magnificent landscape representations pass by and are presented to cinemagoers. The most important scenes of the war [...] are shown in living pictures.²²

Recording the war landscape from a vantage point in the sky did not only serve to document historical events through a new perspective but, the article explained, it also assisted military exploration. Thus, photography

19 For a technological history of motion pictures comprising a section on Oskar Messter, see Raymond Fielding, *A Technological History of Motion Pictures and Television. An Anthology from the Pages of the Journal of the Society of Motion Picture and Television Engineers*, Berkeley 1967.

20 For an overview of technological fascination in Wilhelminism, see the DFG project *Technikfaszination in Deutschland 1890–1914* led by Alexander Gall, URL: <https://www.deutsches-museum.de/forschung/forschungsinstitut/projekte/detailseite/technikfaszination-in-deutschland-1890-1914#>. See also Alexander Gall, “Überwältigt vom Anblick des Kolosses. Kollektive Emotionen und die Landung des Zeppelins in München 1909”, in *Technikemotionen*, ed. Martina Heßler, Paderborn 2020, pp. 154–177.

21 As already mentioned, the *Oberste Heeresleitung* (OHL, Supreme Army Command) established the *Bild- und Filmamt* (BUFA), a centralised system of visual propaganda. In order to cover the various theatres of war, BUFA organised twenty troops, each of them composed of an army official, a photographer, a cameraman, and two assistants. Military film productions, feature films, and newsreels were distributed to civilians and troops from 1917.

22 Author’s translation; original: “Selbst ins Reich der Lüfte hat sich der Filmer gewagt. Vor den Augen des Beschauers ziehen herrliche Landschaftsbilder vorüber und werden dem Besucher des Kinotheaters übermittelt. Die wichtigsten Schauplätze des Krieges [...] werden in lebenden Bildern vorgeführt.” Gehrts 1918 (note 17), p. 1092.

and cinema were not only forms of art and entertainment, but they could produce photo-topography that responded to utilitarian aims, such as measurement of space, calculation of distances, comparison of areas, and monitoring of territories.²³

By showing some mosaic maps, the magazine described the different phases and skills necessary to produce aerial photo mapping: from the preparation of the device before an aerial mission to the composition and interpretation of the maps. In the first phase,

The observer lets the serial aerial camera run one more time on a trial basis, sets it to a certain speed, and once again keeps an eye on all directions to see whether “the sky is clear”. If there are no enemy aircraft in the vicinity, the work begins. The pilot carefully guides his observer and checks and occasionally corrects the direction of flight.²⁴

The article stressed the risks that the crew faced in accomplishing aerial mapping caused by both the anti-aircraft and the dogfighting. Highlighting the heroism of the aviators was a common practice in WWI German propaganda. However, the article also showed technical details concerning the practical phases for assembling and interpreting aerial photographic maps in WWI.

This public and rich explanation of the postproduction work for map making is quite singular and is introduced in the 1918 article in these terms: “If the flight completely succeeds despite all the obstacles and dangers, the crew can be proud of the job carried out. But with the completion of the flight, the task is not yet over.”²⁵ No less important than the recordings from the aeroplane was the manual work involved in assembling mosaic

23 Cf. “Doch nicht nur zur Aufnahme solcher interessanten und geschichtlich wichtigen Ereignisse, sondern auch für wichtige militärische Erkundungszwecke wird der Kino verwandt.” Gehrts 1918 (note 17), p. 1093.

24 Author’s translation; original: “Der Beobachter läßt den Reihenbildner noch einmal probeweise laufen, stellt ihn auf eine bestimmte Geschwindigkeit ein und hält noch einmal Umschau nach allen Seiten, ob ‘die Luft auch rein ist’. Ist kein feindlicher Flieger in der Nähe, so geht’s

an die Arbeit. Sorgfältig winkt der Führer seinen Beobachter ein und überprüft und berichtigt ab und zu die Flugrichtung.” Gehrts 1918 (note 17), p. 1094.

25 Author’s translation; original: “Gelingt trotz aller Hindernisse und Gefahren der Flug restlos, so kann die Besatzung stolz auf den ausgeführten Auftrag sein. Aber mit der Erledigung des Fluges hat der Auftrag noch nicht seinen Abschluß gefunden.” Gehrts 1918 (note 17), pp. 1094–95.

maps. During the postproduction, “[t]he recordings have to be carefully developed, and the individual pieces of film cropped and put together. [...] A special method makes it possible to combine the individual prints of uncut film strips in such a way that the whole gives the impression of a single shot.”²⁶

As the previous section of this paper has clarified, the correct arrangement of the filmstrips was the necessary prerequisite for interpreting the visual material, which consisted of searching “with the magnifying glass in order to explore all the details of the enemy facilities. It is extraordinarily arduous work that keeps many workers busy until late at night. Only those who spend hours interpreting such images with a magnifying glass can really appreciate them.”²⁷ Here, the roles of the specialised military photographer who worked in the studios and the photo interpreter able to “read” aerial maps were recognised as the essential workforce who, together with the technological infrastructure, made aerial photo-reconnaissance an established discipline by the end of the war. In the last part of the *Die Woche* article, the author foresaw the successful employment of this photographic technology in times of peace. In fact, photo-topography realised through the *Reihenbildner* continued to be used after the conflict to represent planimetries of cities and other non-military sites.²⁸

26 Author’s translation; original: “Die Aufnahmen müssen sorgfältig entwickelt und die einzelnen Filmstücke beschnitten und zusammengesetzt werden. [...] Ein besonderes Verfahren gestattet, die Einzelabzüge unbeschnittener Filmstreifen so zusammenzusetzen, daß das Ganze den Eindruck einer Einzelaufnahme macht.” Gehrts 1918 (note 17), p. 1095.

27 Author’s translation; original: “Die fertigen Abzüge werden dann mit dem Vergrößerungsglas abgesehen, um alle Einzelheiten der feindlichen Anlagen genau zu erkunden. Das ist eine außerordentlich mühevoll Arbeit, die bis spät in die Nacht viele Arbeitskräfte beschäftigt. Sie recht zu würdigen weiß nur der, der selbst mit der Lupe stundenlang über solche Bildern saß.” Gehrts 1918 (note 17), p. 1095.

28 See Paul K. Saint-Amour, “Applied Modernism. Military and Civilian Uses of the Aerial Photomosaic”, *Theory, Culture & Society*, 28, 7–8 (2011), pp. 241–69; Rasch 2021 (note 1).

Aerial photomontage and modernity

The military context, the technical details, and the wartime propaganda described so far allow us to reflect deeply on the aesthetic and material qualities of photo mosaic maps, as well as their practical applications. Nowadays, the use of cameras for military purposes is not surprising. The relationship between image-making and military targeting technology has been amply analysed in recent decades, and it can be summarised with the statement by the media theorist Friedrich Kittler: “the history of the movie camera coincides with the history of automatic weapons.”²⁹ During WWI, however, the reliability of the kinematic ‘artificial eye’ was presented as an absolute novelty to both the German high command and the general public.

The technique used for mapping territories showed many differences from previous experimentations in motion picture sequences and chronophotography. The famous works of Eadweard Muybridge, Etienne-Jules Marey, and Ottomar Anschütz had demonstrated the capacity of recording locomotion through various techniques. Muybridge used batteries of sequential still cameras to study the motion of humans and animals, presenting the results as separate freeze-frames or displaying moving images through the zoopraxiscope.³⁰ Similarly, Anschütz studied and recreated movement using a device called an electrotachyscope, also working for the Ministry of War.³¹ In France, the scientist Etienne-Jules Marey,

29 Friedrich A. Kittler, *Gramophone, Film, Typewriter*, trans. Geoffrey Winthrop-Young and Michael Wutz, Redwood City, Stanford 1999 (1986), p. 124. For an analysis of the use of photo-cinematic techniques and war, see also Paul Virilio, *War and Cinema: The Logistics of Perception*, London et al. 1989; Thilo Koenig, “Das Kriegerische Vokabular der Fotografie”, *Fotogeschichte. Beiträge zur Geschichte und Ästhetik der Fotografie*, 43, 12 (1992), pp. 39–48; Bodo von Dewitz, “Schießen oder Fotografieren? Über Fotografierende Soldaten im Ersten Weltkrieg”, *Fotogeschichte. Beiträge zur Geschichte und Ästhetik der Fotografie*, 43, 12 (1992), pp. 49–60;

Susan Sontag, *Regarding the Pain of Others*, New York 2003; Roger Stahl, *Through the Crosshairs. War, Visual Culture, and the Weaponized Gaze*, New Brunswick 2018; Antoine Bousquet, *The Eye of War. Military Perception from the Telescope to the Drone*, Minneapolis 2018.

30 See Hollis Frampton, “Eadweard Muybridge. Fragments of a Tesseract”, in *On the Camera Arts and Consecutive Matters. The Writings of Hollis Frampton*, ed. Bruce Jenkins, Cambridge 2009, pp. 69–80.

31 See Friedrich Tietjen, “Loop and Life. A False Start into Protocinematic Photographic Representations of Movement”, *History of Photography*, 35, 1 (2011), pp. 15–22.

who coined the word *chronophotographie*, showed overlapping phases of movement superimposed into one single photograph using a chronographic rifle that shot twelve images per second. Based on this last device, Oskar Messter designed the machine gun camera employed to train pilots during dogfights.³²

Even though the *Reihenbildner* was advertised as a “flying cinematograph,” implying the idea of moving images and locomotion, it differed from previous cinematic techniques for two main reasons. First, the recording of snapshot sequences did not create the illusion of movement. From a certain altitude, “the aeroplane eye” flying over the landscape recorded the terrain as a steady object.³³ In the absence of a kinetic object, the moving subject (the flying aircraft with the camera) created an aerial photo mosaic map that was the exact trace of the plane’s routes. The flight paths usually followed switchback lanes and could also be recorded in distant moments. This last aspect has led the literary scholar Paul K. Saint-Amour to describe the photo map as a mosaic of temporalities: “[...] the photomosaic offers the distinct vertigo of temporal parallax, one arising from the experience of counterfeiting a spatially self-identical landscape from a constellation of segregated moments”.³⁴ Furthermore, Saint-Amour defined the aerial photomosaic as a form of “applied modernism,” namely a tendency, in common with Western modernists’ experimentations, to interpret totality as a fragmentary space of partial viewpoints.³⁵

Reflecting on this idea of “applied modernism,” the last part of this essay investigates another quality that allows associating aerial photomosaic to modernist techniques; this feature is the montage that served to paste the cut strips of photographed land onto a unified picture-space.

32 See Marta Braun, *Picturing Time. The Work of Etienne-Jules Marey (1830–1904)*, Chicago 1992. For Messter’s chronophotography, see the slow-motion recordings of a falling cat at Deutsches Museum Archive, Munich, BN12093 (Inv. No. 50238). Messter’s machine gun cameras are permanently exhibited in the Deutsches Museum’s *Foto und Film* exhibition as well as in the section *Kamerastadt Dresden* of the Technischen Sammlungen Dresden.

33 Cf. Christoph Asendorf, *Super Constellation – Flugzeug und Raumrevolution. Die Wirkung der Luftfahrt auf Kunst und Kultur der Moderne*, Vienna 1997, p. 34.

34 See Saint-Amour 2011 (note 28), p. 246; cf. Laszlo Moholy-Nagy, *Vision in Motion*, Chicago 1947, p. 12.

35 For Applied Modernism see Saint-Amour 2011 (note 28).

Indeed, the second aspect around which *Reihenbildner's* recordings differed from previous chronophotography is that the printed snapshots (*Reihenbildstreifen*) were not presented as singular entities that could be individually compared, like Muybridge's photographs. By rearranging in line the long strips through the process of cutting and pasting, the military aviation departments created maps that could also be defined as aerial photomontages. According to Robert Sobieszek, the American curator of photography who extensively wrote on both commercial and artistic photomontage, at the heart of this technique there was always "the use of multiple pictures to make up another single picture. Photomontage is the creation of pictures from other pictures".³⁶ Considering the period between the origin of photomontage in the 1850s until its so-called golden age, with the invention of the Dadaist montage at the end of WWI, Sobieszek described various methods for realising photomontage: combination printing, cutting and pasting and rephotographing, sequentially exposing negatives, etc.³⁷ By considering these practices, it is possible to classify the creation of the military aerial photomap as a form of photomontage, in which the individual recordings of land became a new unitary object once the map was completed.

Sobieszek has described the history of both modernist photomontage by the avant-garde movements and its precursors by commercial photographers (e.g. André Adolphe-Eugène Disdéri's *carte-de-visite mosaïque*). This essay adds new insights into this history of photomontage by showing its military use in wartime as an instrument of German aviation. In other words, photomontage may be interpreted not only as a political, satirical, artistic, and commercial tool but also as a scientific and military technique for copying and pasting topographies. Sobieszek distinguishes two forms of photomontage, which he describes as the naturalistic strain and the formalist strain.³⁸ In the early tradition of photomontage, professional photographers (e.g. Oscar Gustave Rejlander and Henry Peach Robinson) created true-to-nature scenes. On the contrary, modernist photomontage

36 Robert A. Sobieszek, "Composite Imagery and the Origins of Photomontage, Part II: The Formalist Strain", *Art Forum*, 17, 2 (1978), pp. 40–45, here p. 40.

37 Cf. Sobieszek 1978 (note 36), p. 44.

38 See Robert A. Sobieszek, "Composite Imagery and the Origins of Photomontage, Part I: The Naturalistic Strain", *Art Forum*, 17, 2 (1978), pp. 58–65; Sobieszek 1978 (note 36).

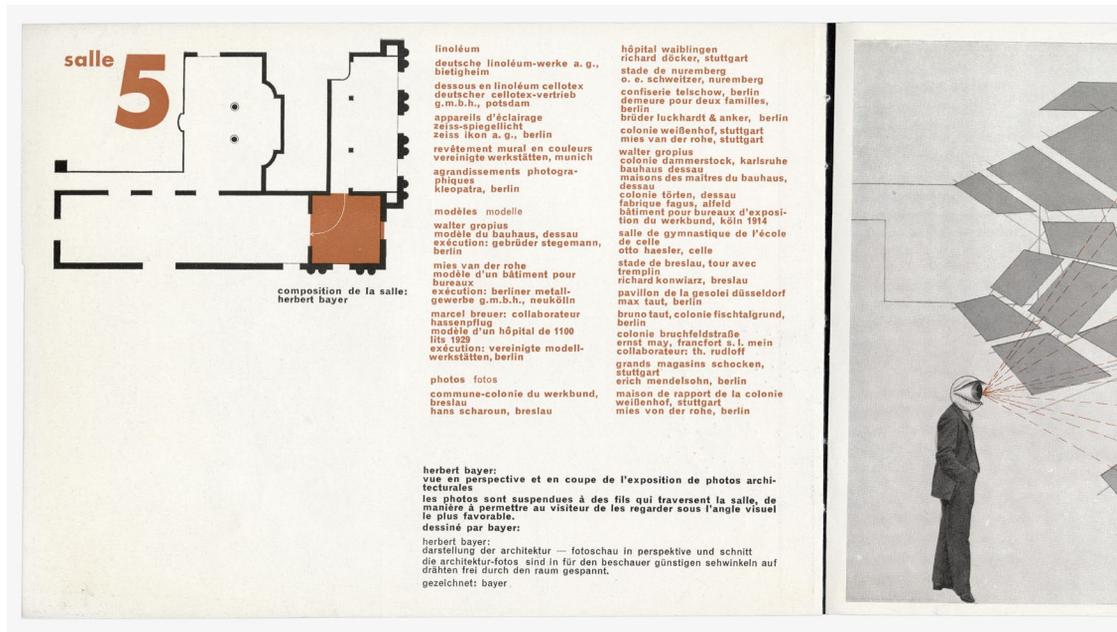
(a practice developed within the fine arts and used by Dada and Surrealism, among others) followed a formalistic imperative by assembling figures in unnaturalistic compositions.

It is challenging to include the aerial mosaic either in the naturalistic tendency or in the formalist tendency of photomontage. At the beginning of the twentieth century, the vertical perspective, from which the earth's surface was photographed perfectly perpendicularly from a great distance, seemed completely unnatural to untrained observers. However, the structure of the aerial mosaic was always dependent on the precise overlapping of the different pieces, in a process of reordering space that prevented any formalist constructions. Moreover, the military technique of photomontage lacked the incorporation of ready-made images, which was a feature of the high culture's modernist photomontage. In the military context, monitoring enemy movements and defences required the constant analysis of territories, and therefore the permanent production of new pictures.

Certainly, the military photomontage followed the idea of "static film" described by Raoul Hausmann, one of the founding members of the Berlin Dada Movement.³⁹ By mapping with the *Reihenbildner*, the kinetic qualities of both flying machine and flying cinematograph (the controlled and straight movements of aeroplane, camera propeller, film, and shutter) were not recreated through a film projection onto a screen; rather they served to record the terrain as a static and uniform photo paper map. Differently from the modernist photomontage, however, the internal composition of the aerial photomontage did not integrate "heterogeneous, often contradictory structures, [...] the most violent oppositions."⁴⁰ It did not even present the simultaneity of different points of view and

39 Cf. Raoul Hausmann, "Fotomontage" (1931), in *Film und Foto der zwanziger Jahre. Eine Betrachtung der Internationalen Werkbundaussstellung "Film und Foto" 1929*, eds. Ute Eskildsen and Jan-Christopher Horak, Stuttgart 1979, pp. 132–133, here p. 132. All English translations in the following are taken from the translation of "Fotomontage" in *The Weimar Republic Sourcebook*, eds. and trans. Anton Kaes, Martin Jay and Edward Dimendberg, Berkeley 1994, pp. 651–653.

40 Hausmann 1994 (note 39), p. 652. Cf. Raoul Hausmann's original text: "Sie [die Dadaisten] waren die ersten, die das Material der Fotografie benutzten, um aus Strukturteilen besonderer, einander oftmals entgegengesetzter dinglicher und räumlicher Art, eine neue Einheit zu schaffen, die dem Chaos der Kriegs- und Revolutionszeit ein optisch und gedanklich neues Spiegelbild entriß," Hausmann 1979 (note 39), p. 132.



the constant alternation of close and distant surfaces that, according to the designer and artist Herbert Bayer (an influential Bauhaus student and teacher), should make the viewer perceive the volume of space (Fig. 19).⁴¹ The Dadaist photomontage aesthetic, in particular, included a cacophony of fragments initially devoid of any essential tie. Only when composed together did these fragments acquire meaning in a new image that, without any single-point perspective, led the observer's eye to roam the space. On the contrary, the aerial photomosaic was based on a logical concatenation of the sections which were combined in order to reach a homogeneous rendering of space – this method aimed at creating parallel-projection maps that eliminated the linear perspective effect of photography. Finally, it is interesting to notice that, in describing aerial photomontage, *dynamic*

41 Cf. Herbert Bayer, "Aspects of Design of Exhibitions and Museums", *Curator. The Museum Journal*, 4 (1961), pp. 257–288, here p. 267; *Welt im Umbruch. Kunst der 20er Jahre* (exhibition catalogue Munich), eds. Kathrin Baumstark et al.,

2019, p. 235. See also Herbert Bayer, *Design for Room 5, Exposition de la Société des Artistes Décorateurs, Section Allemande* (exhibition catalogue Paris), [Berlin] 1930, n.p.

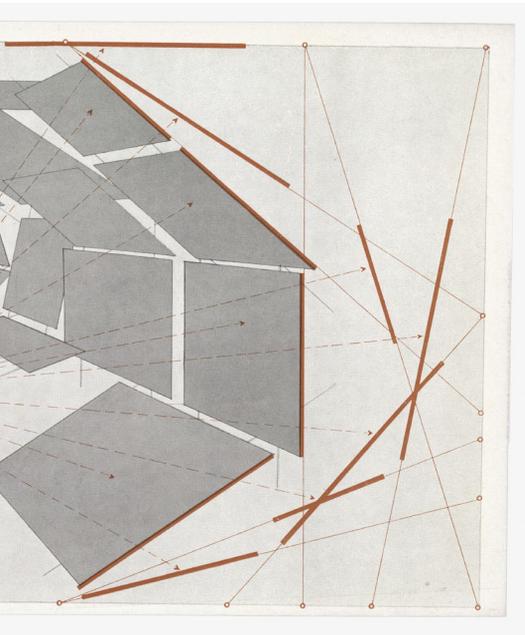


Fig. 19

Herbert Bayer, pages of the catalogue of the *Section allemande* (German section) at the annual exhibition of the *Société des Artistes décorateurs* (Association of French Interior Designers), held at the Grand Palais in Paris, see Bayer 1930 (note 41), room 5

and *static* are not opposite features. Rather they can be considered complementary qualities of the mosaic map.

In the analysis of modernity, montage symbolises the redefinition of time and space that started in the late nineteenth century.⁴² Dadaists (re)invented the artistic technique of photomontage after WWI, composing an “explosive image, a provocative dismembering of reality”.⁴³ By the 1930s, the photomontage was considered “the means of expression of our time”

42 A reflection on the concepts of modernism, modernisation, and modernity can be found in Thomas Elsaesser, “Modernity. The Troubled Trope”, in *The Visual Culture of Modernism*, eds. Deborah L. Madsen and Mario Klarer, Tübingen 2011, pp. 21–40. For an analysis of the terms “collage”, “photomontage”, and “montage” as peculiar representations of modernity, see also Francis Frascina, “Collage. Conceptual and Historical Overview”, in *Encyclopedia of Aesthetics*, New York 1998, pp. 382–384.

43 Dawn Adès, *Photomontage*, London 1976, p. 7; cf. Bernd Stiegler, “Politische Montage”, in *Welt im Umbruch: Kunst der 20er Jahre*, eds. Kathrin Baumstark et al., 2019, p. 212–21. Cf. also Raoul Hausmann’s original text: “[d]ie Fotomontage in ihrer frühen Form [war] eine Explosion von Blickpunkten und durcheinandergewirbelten Bildebenen”, Hausmann 1979 (note 39), p. 132.

in Germany, omnipresent in political propaganda and commercial advertisement.⁴⁴ It is enough to say that the advertising campaign of the famous typeface *Futura*, designed by Paul Renner and released in 1927, waged on the fact that only the geometric sans-serif type could cope with the nature – exact and impersonal – of photomontage, for a perfect unity of word and image. The motto could be summarised: since photomontage is “the means of expression of our time,” *Futura* is “the typeface of our time” (Fig. 20 a, b). The montage strategy incorporated the fragmentation and multiperspectivism of the human experience, which resulted from mobility and mass production in the metropolis that created new dynamic imaginaries.⁴⁵

This interpretation of modernity often forgets another use of photographic montage, as shown in the military photo maps. Nevertheless, the form of aerial photomontage that the present essay has analysed is not necessarily an expression of metropolitan modernity.⁴⁶ Photo maps composed with the *Reihenbildner* mostly portrayed remote places lacking German mapping coverage or countryside with military instalments and trenches. Moreover, the public that had access to this material was not only the metropolitan audience; war reports in illustrated magazines widely circulated all around Germany due to the general request for information from the various theatres of war.

However, there is another fundamental aspect that differentiates the aerial photo map from other kinds of photomontage. Within the military process, the multi-directional deformations of the images recorded on the

44 At the opening of César Domela-Nieuwenhuis's exhibition *Fotomontage* at the Staatliche Kunstbibliothek Berlin in 1931, Raoul Hausmann's public lecture declared the photomontage a Dadaist invention. However, the artist of the Berlin Dada Movement also recognised the importance this technique acquired in the Weimar Republic as a commercial and political tool. Responding to this most recent scope, Hausmann envisioned a future in which the photomontage loses playfulness and radicalism, gaining simplification, clarity, and constructivism. Hausmann 1979 (note 39), pp. 132–133.

45 For an analysis of the cultural effects of new modes of transport between the 1870s and the 1920s, see Christoph Asendorf, *Ströme und Strahlen*, Gießen 1989, particularly the section “Das nervöse Zeitalter.” Here, the role of Futurism in theorising experiences of speed and dislocation is clarified. See also Umbro Apollonio, *Der Futurismus: Manifeste und Dokumente einer künstlerischen Revolution 1909–1918*, Köln 1972.

46 Cf. Frascina 1998 (note 42), p. 383; Elsaesser 2011 (note 42), p. 24.

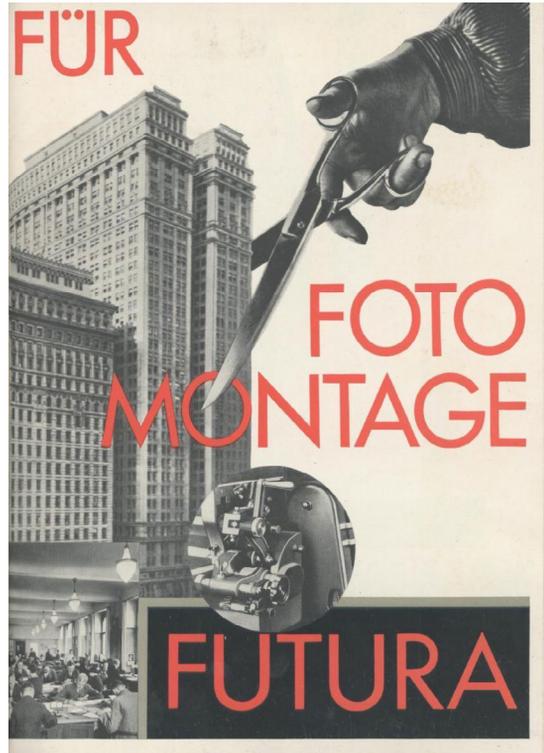


Fig. 20 a, b
 Heinrich Jost (Design), Futura. Für Fotomontage, *Gebrauchsgraphik*, 6 (1929)



photographic film – deformations determined by a change of altitude of the plane, movement of the camera axis, etc. – were all calibrated in post-production in order to obtain the most uniform map possible. In this case, the fragments (a synonym for a sense of loss)⁴⁷ were replaced by sections (regulated cuttings). Within what we call modernity, the chaotic, nostalgic, and traumatic coexisted with a static and sequential order produced by sectioning rather than by fragmentation.

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47 For shock, trauma, and loss as a Benjaminian version of modernity, see *Walter Benjamin: Critical Evaluations in Cultural Theory*, ed. Peter Osborne, 3 vols., London et al. 2004, vol. 2: *Modernity*.