Modernist Reconnaissance

Paul K. Saint-Amour

> Then the plane began to move along the ground, bumping like a motorcycle, and then slowly rose into the air. We headed almost straight east of Paris, rising in the air as though we were sitting inside a boat that was being lifted by some giant, and the ground began to flatten out beneath us. It looked cut into brown squares, yellow squares, green squares and big flat blotches of green where there was a forest. I began to understand cubist painting.
>
> —Ernest Hemingway in *The Toronto Daily Star*, September 9, 1922[1]

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The notion that cubist painting is intimately, even causally, connected to aerial perspective has become a fixture in scholarly lore about both.[2] Such a connection has allowed art historians to posit yet another technological base or source for cubism's syntax of rupture, while celebrants of the aerial view and the aerial photograph invoke the same pairing to glamorize the vertical as avant-garde. It is a connection, moreover, whose authority is temptingly underwritten by several prominent contemporaries of cubism. In a 1921 essay introducing a cubist exhibition in Berlin, the critic Waldemar George wrote that "cubism is entirely based on the theory of equivalents: an equivalent for volume, an equivalent for aerial perspective, an equivalent for form. . . . It replaces aerial perspective by an equivalent for the third dimension."[3] Ernest Hemingway claimed to understand cubist painting in a new way when, during his second flight in an airplane, he peered down on the patchwork of fields and forests between Paris and the Vosges mountains. Descriptions of aerial vistas in Evelyn Waugh's novel *Vile Bodies* (1930) draw on his

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accounts of abstract paintings he had seen the previous year at the Parisian *Panorama de l'art contemporain*.[4] Oftenest cited is Gertrude Stein's coupling of aerial perspective and cubism in the conclusion of *Picasso* (1938):

> But the earth seen from an airplane is something different. So the twentieth century is not the same as the nineteenth century and it is very interesting knowing that Picasso has never seen the earth from an airplane, that being of the twentieth century he inevitably knew that the earth is not the same as in the nineteenth century, he knew it, he made it, inevitably he made it different and what he made is a thing that now all the world can see. When I was in America I for the first time travelled pretty much all the time in an airplane and when I looked at the earth I saw all the lines of cubism made at a time when not any painter had ever gone up in an airplane. I saw there on the earth the mingling lines of Picasso, coming and going, developing and destroying themselves, I saw the simple solutions of Braque, I saw the wandering lines of Masson, yes I saw and once more I knew that a creator is contemporary, he understands what is contemporary when the contemporaries do not yet know it, but he is contemporary and as the twentieth century is a century which sees the earth as no one has ever seen it, the earth has a splendor that it never has had, and as everything destroys itself in the twentieth century and nothing continues, so then the twentieth century has a splendor which is its own and Picasso is of this century, he has that strange quality of an earth that one has never seen and of things destroyed as they have never been destroyed. So then Picasso has his splendor. Yes. Thank you.[5]

In the cases of Hemingway and Waugh, if less so with Stein, one might be tempted to dismiss the yoking of cubism to aerial perspective as an instance of writerly agon against painterly innovation, an attempt to domesticate cubism to a sort of proleptic documentarism through the assertion of writerly metaphorical powers. But one finds the same pairing in other quarters as well. By 1918, young British aviators were being trained to see an avant-garde exhibition unfurling beneath their cockpits: a First World War Royal Air Force photo atlas for new pilots used "FUTURIST country" and "CUBIST country" in its taxonomy of aerial landscapes, alongside more everyday mnemonic headings such as "FRUIT GROWING" and "PATCHWORK QUILTING."[6] And the coupling has been repeated enough in more recent scholarship to indicate its durable explanatory, or at least suggestive, power. Martin Jay proposes that the First World War earned Stein's designation of it as "cubist" principally for the views its pilots had of the trench-crossed landscape below them (fig. 1).[7] And Stephen Kern accepts a metaphorical, if not necessarily causal, relation between aerial perspective and cubism, summing up the similarities thus: "The Cubist reduction of depth, elimination of unessential detail, composition with simplified forms, and unification of the entire picture surface are pictorial representations of the view of the earth's surface from an airplane in flight" (*CTS*, 245).

There is something intuitively plausible about an association between cubist painting and views of the earth from an airplane. Expanding on Kern's summation, one might add that aerial views of developed, populous city centers and of cultivated land often replace the redundant, recursive, seemingly random curvilinearity of organic forms with rectilinearity, or at least with a certain geometric regularity and simplicity (fig. 2). One might say that *bios* surrenders to *logos* as the landscape offers itself to be

Fig. 1. Aerial photograph of World War I trench systems at an unidentified front (*AP,* 360).

Fig. 2. World War I-era aerial photograph of French countryside. From photographs and diagrams accompanying U.S. Armed Forces document *Notes on the Interpretation of Aeroplane Photographs, Series A, Issued by the General Staff* [1918?] S.S. 550 A., Ia/12828, not paginated; hereafter abbreviated as *NI*. My thanks to Robin A. White for kindly granting me access to this document.

read, not as a dynamic habitat, but as a deposit of human intentionality, as a planned text. The sharpened lines, clarified structure and geometric shapes of the planned text, in turn, might be said to resonate with cubist mechano-morphism. A machine aesthetic can thrive in the air: from sufficient altitudes, the individual organism dwindles to the vanishing point, bodies recede to exteriorized and genderless dots circulating as particles in the fluid dynamics of the urban mass, made visually contiguous with the material fabric of the city as viewed from above. Alternately, the body diminishes to a data point in the emerging statistical epistemes that were cognate with the aerial perspective in their shared claims to spatially arrayed overviews of an aggregate of such points. The impression that the earth has become a planar grid for abstract data plotting is, in turn, visually enhanced by the flatness of the high-altitude vertical view, with its paradoxical erasure of the vertical dimension; and that leveling might further suggest cubist rejections of perspectival convention in favor of a conspicuously two-dimensional image plane whose depthlessness, like the aerial view's, was no longer hospitable to the conventional pictorial distinction between figure and ground.

Yet in other ways, the coupling of cubist painting and aerial perspective should arouse our skepticism. To begin with, it posits a single visual correlative for an often divergent group of painters, collapsing a range of formal, intentional, and ideological distinctions among them. In addition, it sidelines the movement's infractions of conventional temporal and spatial syntax, its projection onto a single and circumscribed image plane of serial apprehensions of its objects. It reduces an only partially mimetic visual vocabulary to the straightforward mimesis (or, in Kern's words, the "pictorial representation") of a new vista, replacing the novelty of the medium with that of the object, while at the same time substituting a narrative about technologies of representation with one about technologies of flight. Hemingway and Stein observe that the earth from an airplane resembles cubist painting, but in formulating that observation, both really make the reverse assertion: that cubist painting was a cultural harmonic of, was even indebted to, the view of the earth from above. Finally, this filiation or affiliation ignores the fact that airborne viewing was not new to the twentieth century. Though heavier-than-air flight evidently began with the Wrights in 1903, lighter-than-air ascents had been taking place since the Montgolfier balloons went up in 1783. As balloons became safer and more numerous, the vertical view of the earth was no longer the exclusive privilege of an aeronautical elite, but accessible to anyone who could afford the modest price of a commercial ascent. Descriptions of balloon views of cities are a populous subgenre of nineteenth-century ekphrastic writing, as etchings and paintings of balloon vistas are of the period's visual culture. If we are to connect the vocabularies of cubist painting with aeriality at all, we need to ask what had changed about aerial viewing and its cultural contexts between the late eighteenth century and the early twentieth.

One obvious starting point is the invention and fetishization of the airplane shortly after the turn of the century. The airplane undoubtedly altered the context of aerial viewing with its greater velocity and navigability, its louder and more turbulent ride, and its very unballoonlike aesthetic of loud engine, propeller, struts, wheels, flaps,

levers, instrument panels, bombs, and guns. Thus, when Filippo Marinetti described how the vertical aerial view demanded a new poetic syntax in his 1912 "Technical Manifesto of Futurism," he set his epiphany not in the padded interior of a balloon's wicker gondola but astride the gas tank of a Voisin biplane, where he had sat vibrating to its internal combustion engine and listening to the dictations of its propeller.[8] If fast, navigable, motor-driven, heavier-than-air flight didn't exactly deliver an unprecedented view of the earth, it at least provided a different set of procedures by which to achieve and manipulate that view and a novel array of sensations to accompany it. To the extent vision is informed by the body's full sensorium—mechanical vibration, engine noise, strong wind, pressure changes in the ear, nausea induced by changing gravitational forces, the euphoria of high speed—the airplane did alter aerial perception. But it was from the coupling of the airplane with the camera that the most extreme splendors and modes of destruction, to use Stein's words, precipitated. Paul Virilio writes that the ambition of most early balloonists "was not so much *to fly* as *to see from on high*."[9] The formulation applies less fully to early aviators, for whom seeing from on high was less novel than being able to navigate their swifter craft more precisely than aeronauts could steer balloons. Nevertheless, this unprecedented degree of navigability in flight did open up the uses of aerial photography, which previously had been hamstrung by the balloon's captivity to prevailing winds. With its roughly constant speed, direction, and altitude, the airplane provided a steerable, stable platform from which a photographer could take photos in regular series, "covering" an entire area by flying over and photographing it in grid patterns at a consistent scale and orientation. Whereas photos taken from other airborne platforms (balloons, kites, rockets, even pigeons) had never produced much more than haphazard, if tantalizing, results, airplane photography was far more exploitable, quickly burgeoning in its commercial and military uses and gaining a much greater cultural visibility.

This essay, then, is concerned neither with the airplane itself nor with the views its pilots and passengers enjoyed, but rather with the photographic genres, techniques, and discourses that developed in tandem with early aviation, and with their relation to avant-garde representation in the first decades of the twentieth century. Though some of the photo interpretation methods I discuss here were also deployed in interwar civil contexts, the essay is principally devoted to the techniques and technical discourse of aerial reconnaissance photography during World War I. I have chosen the wartime focus partly because it was the germinal site for airplane photography: the techniques and reflexive discourse of aerial photography got exported out of their originary military contexts into their commercial ones, not vice versa, and even in those commercial contexts they retained a residue of their military origins. More importantly, the emphasis here on wartime photography arises from the fact that military reconnaissance was explicitly oriented around equipping, training, and therefore describing human *observers*, which I maintain is also the case with avant-garde representation during the period. Whereas Stein, Hemingway, and others connected cubism and the aerial view through their respective visual characteristics, I will be less concerned here with visual syntax *tout court* than with how wartime reconnaissance photographic techniques con-

structed and conscripted a new kind of observer, and with how that observer might be related to the observer imagined by cubism and other modernist forms of representation. I will also suggest that the nature and objectives of "interpretation" are refashioned by aerial reconnaissance and avant-garde representation in similar enough ways to suggest that both refashionings should be seen as symptomatic of one crisis in the period's dominant scopic regime.[10] My aim in positing the above relationships between aesthetic forms and military techniques is neither to aestheticize the work of wartime reconnaissance nor to recuperate the viewing of military aerial photographs as an avant-garde aesthetic experience. I wish, instead, to understand how the spectator conscripted by cubism might be cognate with the corresponding figure in a military-industrial complex usually taken to be as remote as possible from an autochthonous, self-legislating, self-delighting aesthetic.

World War I has long been regarded as the first modern war in the scale of casualties it produced, in its shift from contained fronts toward "total war," and in its turn from aristocratic pageantry and honor codes to technological, depersonalized, even democratized killing. But a number of recent accounts have characterized the Great War as also witnessing or catalyzing a crisis in perception. According to Virilio, "1914 was not only the physical deportation of millions of men to the fields of battle, it was also, with the apocalypse of the deregulation of perception, a diaspora of another kind, the moment of panic in which the American and European masses no longer believed their eyes."[11] For Martin Jay, this loss of faith in ocular proof marked the final overthrow of the "ancien scopic régime" of ocularcentric Cartesian perspectivalism (*DE,* 212–3). Yet World War I was also the most optical war yet, a war in which observation involved no longer the reconnaissance and reports of lone scouts on foot, but a complex technological matrix: semiautomated aerial cameras obtained photographic coverage of the entire front, and the photomosaic maps compiled from this coverage were reproduced through industrialized techniques and widely disseminated; observers in airplanes and balloons reported by Morse lamp and later by wireless telegraph to command posts, using the coordinates on gridded aerial photos to direct artillery fire; aerial photographic sorties recorded not only the enemy's trench and gun placements but the production and movements of weapons, goods, and armies far behind the front. Contemporary accounts of this aspect of the war bear little obvious witness to a crisis in ocularcentrism, tending rather to celebrate the accuracy of the Allied reconnaissance matrix, and particularly its airborne components, as indispensable to victory. Walter Raleigh's 1922 encomium to the scopic power of aerial reconnaissance is typical, exhibiting if anything a renewed faith in the power of ocular proof: "Reconnaissance, or observation, can never be superseded; knowledge comes before power; and the air is first of all a place to see from."[12] Such rhetoric may well be compensatory for a felt crisis in visual perception, but if so, we need to understand how such a crisis could have been initiated, or at least accelerated, by the very reconnaissance modes that encomiasts celebrated as infallibly precise, revealing, potent.

To this end, we first need to become familiar with the specific terms in which aerial "recco" photography was consecrated, in Alan Sekula's phrase, as the "triumph of ap-

plied realism" during and immediately following the First World War.[13] In essence, aerial photos were seen to surpass all other visual forms in their accuracy, information saturation, and immunity to rhetorical distortion. "Everything revealed in an aerial photograph means something, and in warfare margins of error are neither safe nor officially acknowledged," a British interwar textbook on aerial photography asserts of wartime photographic interpretation; "Accuracy alone was not enough."[14] If interpretation might exceed the standard of mere "accuracy," it was because an image form in which "everything means something" already contained data in excess of that standard, approaching the real in its disregard for informational economy. Having canonized aerial photography as a paradise of pure signification, the same text goes on to speculate that the aerial photograph might eventually succeed more abstract survey genres, replacing the map's imprecise semiosis with its unmediated plenitude:

> It is possible that the time may come when for cadastral and ordinance purposes the aerial photographic survey will be accepted as a map after the customary references already provided by drawn maps have been added. Whereas trees and the like are illustrated on the drawn map by cadastral signs presented in positions that call for the use of imagination or reference to the key in the body of the map, vertical aerial photographs reveal the formation, lay-out and even nature of forestry and other terrestrial marks, thus giving a true topographical impression of the earth's surface. . . . open spaces are recorded in detail, and waterways and coastlines revealed by the aerial photograph do not lie. [*CS*, 13]

Replacing the generalized symbol of a tree with the image of the particular tree, the abstracted red line with the image of the road in question, aerial photos would eliminate the need for "imagination or reference to the key in the body of the map"—that is, the need for decoding the semiotics of the map. Having initially existed in imagination only, the bird's eye view had, in its photographic embodiment, refined both semiosis and "imagination" out of its circuits altogether, arriving at a nearly self-identical relation with the real. Such a relation was seen to resist the tendentious motives of photographer, viewer, or subject, and thus to guarantee the factual status and accuracy of the image. The photographer Edward Steichen, who finished the war as chief of the U.S. Air Service Photographic Section, called aerial photographs "an unequalled historical document of the great war. They represent neither opinions nor prejudice, but indisputable facts."[15] In his memoirs, Steichen claimed that the unrivalled precision of reconnaissance photography roused him from the impressionistic reverie of his early painterly photographs, awakening him to the virtues of a sharper-edged, more accessible image (i.e., the capitalist realism of his postwar work for Madison Avenue).[16] To take accounts like Steichen's, or Winchester and Wills's, at face value is to find in aerial reconnaissance photography the last bastion of naïve realism, and during a period more often celebrated for its extreme departures from the realist matrix of Cartesian perspectivalism.

Looking at wartime aerial photography in its technical and discursive contexts, however, one finds that such realist claims attempted simultaneously to ward off the sup-

posed disfigurements of the contemporary avant-garde and to downplay the equally disfiguring and exaggerative ways in which aerial photographs were actually decoded and deployed. In their more technical chapters on photographic interpretation, the same manuals that prophesied the eventual replacement of maps with aerial photographs acknowledged the absurdity of that prophecy. During the First World War, a whole school of aerial photographic interpretation grew up to extract information from recco photos, which, though they did not necessarily lie, also did not represent the truth in a way that was immediately legible or self-evident to the untrained viewer. Winchester and Wills write:

> The interpretation of aerial photographs was, of course, a real problem and one of vast importance. It meant considerable training of men of high intelligence, and at first much of the training depended upon guess-work as well as deduction, for it was only by an ever-increasing experience that the interpreters could learn the significance of new details and classify their deductions until they had a reliable photographic key or code upon which to work and through which to teach new recruits. The smallest detail had to be accounted for in terms of military importance. Nothing was too slight to escape the attention of those whose difficult task it was to provide rational explanations of the photographs. [*CS*, 8]

If a signal that is exhaustively pure requires an equally exhaustive regime of interpretation, then that signal stands revealed as already coded. Aerial photographs possessed the conceit of laying reality bare by their deadly accuracy, their vertical penetration, their plenitude or even excess of detail, and their ability to reveal facts, objects, and strategic intentions not otherwise accessible. But this realist conceit was mitigated by an accompanying insistence on the defamiliarizing power of the vertical view, on the sense that even the reality beneath the enemy's camouflage was self-camouflaging, and on the need for new codes by which a highly trained interpretive elite could decipher the camouflage of the real. This new interpretive corps also had to learn to rectify the broad range of distortions to which aerial photographs were susceptible—distortions resulting from airplane vibration and tilt, fluctuations in altitude and scale, relief displacement, imperfect lenses and shutters, film warping, paper shrinkage or expansion, aerial haze. And as the following section illustrates, reconnaissance photos not only were subject to distortion but, in their single most strategically crucial use—aerial stereoscopy—actually required distortion to be legible. In exploiting the structural idiosyncrasies of aerial photos and human optical anatomy, aerial stereoscopy required that photo interpreters learn more than a new "photographic key or code"; they had to relearn depth perception, retraining their optical reflexes to see, in effect, through the surrogate eyes of a virtual colossus. Calling forth relief effects in hallucinogenic exaggeration from flat images, the stereoscope enabled its trained users to perform seemingly preternatural acts of perception and interpretation. But the stereoscope and the reconnaissance methods in which it played an essential role did not, strangely, produce observers who believed in the panoptical power attributed to them by propaganda and triumphalist historical accounts. Because the new intelligence techniques exploited rather than denied the limitations and site specificity of perception, they

produced observers who were confronted constantly with the spatial and temporal contingency of human vision and were therefore more willing to extend it by subjecting their bodies, their perceptual habits, even their memories and their emotions, to redisciplining and insertion within a massive optical prosthesis.

Aerial Stereoscapes

Of course, the stereoscope's use in World War I aerial reconnaissance was not the first arena in which it schematized and capitalized on the site-specific elements of vision. Nor should the device be understood deterministically as a technological agent of philosophical or cultural crisis. Jonathan Crary has characterized the much earlier parlor stereoscope, which became a popular domestic curiosity around 1850, as paradigmatic of the dominant status of the observer during the nineteenth century, much as the camera obscura was for the seventeenth and eighteenth centuries. The stereoscope, Crary argues, was neither the cause of theories of vision or crises of visual faith, nor simply a haphazard invention of the 1830s; it was, rather, a crystallization of contemporary demands, anxieties, and developments in physiological optics, epistemology, aesthetics, mechanics, and political economy. It embodied the transition from a geometrical optics to a physiological one, relocating the "events" of vision from an empirically verifiable outside world to the more idiosyncratic domain of the body. At the same time, it symptomatized the decline of classical associations of sight with clear and distinct perception, and the rise of theories of subjective vision, which reimagined the observer as the site as well as the subject of perceptual inscription. Crary writes:

> The stereoscopic viewer sees neither the identity of a copy nor the coherence guaranteed by the frame of a window. Rather, what appears is the technical reconstitution of an already reproduced world fragmented into two nonidentical models, models that precede any experience of their subsequent perception as unified or tangible. The institutionalization of this decentered observer and the stereoscope's dispersed and multiple sign severed from a point of external reference indicate a greater break with a classical observer than that which occurs later in the century in the realm of painting. The stereoscope signals an eradication of "the point of view" around which, for several centuries, meanings had been assigned reciprocally to an observer and the object of his or her vision. There is no longer the possibility of perspective under such a technique of beholding. The relation of observer to image is no longer to an object quantified in relation to a position in space, but rather to two dissimilar images whose position simulates the anatomical structure of the observer's body.[17]

Particularly in its earliest incarnations, the stereoscope foregrounded the process by which the human visual apparatus melds dissimilar images into an illusion of three-dimensional unity and thus schematized human depth perception as a perpetual *effect* of the viewer's physiology, rather than a *fact* about how the world "was." Additionally, it dissociated touch and sight, creating depth effects that looked palpable but were not; having effected this dissociation, it subordinated touch to sight, making tangibility

seem a hallucination or special effect of optics. And it explicitly enlisted its viewer in the work of producing a realistic image, insisting that the viewer was less the user of a tool than a component in a visual apparatus, standing in a relation of contiguity rather than mastery, of metonymy rather than metaphor, with the device. In thus constructing its user as a part of the mechanism, the stereoscope stood in a metonymic relation to industrial modes of production, which transformed the worker from an agent of tool use to one of many components in a mechanized manufacturing process. Though the stereoscope has often been treated as a crucial representational technology of realism in its uncanny power of making objects seem tangibly present within a deep image space, Crary's analysis suggests that, to the contrary, it embodied a complex of increasingly nonveridical theories of vision that a naïve realism would eventually be unable to assimilate.

As a popular novelty, the nineteenth-century stereoscope performed verisimilitude as a sort of parlor trick. Through it, viewers watched pairs of adjacent flat images—typically depicting cluttered interiors, exotic landscapes, teeming city scenes—fused and jutting into a compressed three-dimensionality comprised of distal and proximate depth planes (figs. 3 and 4). In its First World War military rehabilitation, the stereoscope was conscripted into a different role: it became "the worst foe of camouflage," a device for decoding the enemy's visual encryptions of the landscape.[18] Owing to the limitations of human optical geometry, neither unaided visual observation from the air nor single aerial photographs proved much good against camouflage or decoys, two optical tactics that bedeviled reconnaissance observers during the first year of the war. By the summer of 1915, however, camera semiautomation enabled pilots to take a series of aerial photographs close enough together that the ground depicted in adjacent photos in the series overlapped.[19] By putting these overlapping pairs of aerial photos under the stereoscope, photo interpreters could use the device's virtual stereopsis to tell bomb craters from mounds and trenches from embankments. They could distinguish flat decoy bridges and aircraft from real ones; they could see through some kinds of camouflage and forest covering to the objects hidden beneath. And if the overlapping photo pairs were taken at wide enough spatial intervals, interpreters could even see part of the ground underneath bridges. By conjuring the impression of elevation from flat images of a remote and miniaturized surface, aerial stereoscopy put the photographic interpreter above, and seemingly inside, a three-dimensional scale model of the landscape. In a sense, the stereoscope also put the landscape inside the viewer: like its domestic predecessor, aerial stereoscopy depended for its effects as much on the viewer's optical anatomy as on the device's placement of overlapping photo pairs, fusing the stereoscope and the photo interpreter into a single viewing apparatus. By the midpoint of World War I, aerial stereoscopy had become a staple in the reconnaissance repertoire of decryptive technologies aimed at exposing the enemy's secrecy to a "pitiless publicity" (*AP,* 18). *Popular Mechanics* would later name the stereoscope "the deadliest weapon in the war."[20]

Given the stereoscope's vaunted power of peering around corners, making the minutest photographic details betray the concealed intentions of the enemy, one is hardly

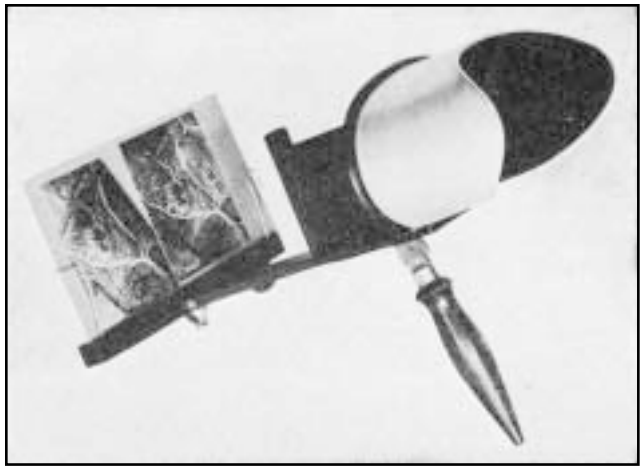

Fig. 3. Holmes parlor stereoscope of the type popular during the nineteenth century, but fitted with aerial stereopairs (*AP*, 331).

Fig. 4. Early-twentieth-century parlor stereogram showing Rock of Gibraltar, with soldier in foreground.

surprised to find the wartime aerial photographic interpreter hailed repeatedly as a detective. In his 1920 textbook on *Airplane Photography*, Herbert Ives describes military photo interpretation as "a task of minute study and deduction worthy of Sherlock Holmes." Harold Porter writes that once an interpreter has scaled a photograph, "there are only two steps—to see what is on the photograph, and to make your conclusions. Sherlock Holmes would have adored it."[21] Arthur Conan Doyle's detective, we should recall, straddles the threshold between a form of realism and a natural supernaturalism. In his self-representations, he is merely a practitioner-advocate of simple veridical technologies (observation, deduction) that allow him to restore dislodged objects and deranged subjects to their proper domains, proportions, and narrative functions. But at the same time, he is one in whom these technologies are so extremely realized—sometimes through his willingness to distort or even reject "normal" scopic and deductive regimes—that they become "powers," giving him a hotline to the real so direct that it appears magical.

Like their fictional patron saint, aerial photographic detectives from World War I on arrived at their documentary narratives about the location, circulation, and strategic significance of military resources by way of a detour through magic, in this case that of an optical trickery that allowed them to decipher the enemy's visual codes by way of a counterdistortion or counterillusion: hyperstereoscopy. For Victorian parlor stereoscopes, photographic stereopairs were taken through two adjacent lenses whose focal points were the same distance apart as the human pupils, i.e., about 2.75 inches. Reproducing the body's interpupillary distance, this *orthostereoscopy* retained the relief proportions of "normal" depth perception by replicating the dimensions of human parallax, the apparent displacement of foreground in relation to background when viewed from two different points. *Hyperstereoscopy* occurs whenever stereopairs are taken from points whose separation exceeds the interpupillary distance. Because unaided human stereopsis drops out at distances over fifteen hundred or two thousand feet, hyperstereoscopy became the rule rather than the exception in aerial reconnaissance. From an aircraft flying at even a modest altitude, the ground is too remote for the naked eyes' sightlines to converge significantly enough to experience stereopsis—hence the apparent flatness of vertical aerial views.[22] However, taking stereopairs with an interaxial separation greater than 2.75 inches could compensate for the increased distance between viewer and object by increasing parallax accordingly. Hyperstereoscopy enabled human observers to see as if through eyes set farther apart than their own, effectively readjusting the scale of the observer's optical geometry in relation to a remote object so that depth perception was once again possible. Separated from the ground by giant distances, the observer swelled back to proportions commensurate with stereoscopic vision by seeing through the eyes of a giant. This virtual gigantism effectively rescaled landscapes—usually so remote as to cancel stereopsis—into interiors with considerable relief effects, domesticating high-altitude views of fronts and cities by giving them the tangibility of a cluttered, tchotchke-strewn drawing room. Yet the actual images read by photo interpreters were minuscule, often in scales of 1:25,000 or smaller. Reconnaissance observers, therefore, grew accustomed to a vertiginous elasticity of scale, oscillating between the scale of their own bodies, the minute scale of the aerial photo, and the colossal scale of hyperstereopsis.

During World War I, aerial stereoscopic pairs used for reconnaissance were not taken simultaneously by a dual-lens camera but diachronically by an automated single-lens device, and were then paired up later under the interpreter's stereoscope. These temporally serial photographs were shot at intervals of 14.5 seconds from a plane flying at around sixty miles per hour, so that stereopairs were taken with an average interaxial distance of 1,250 feet, over 5,400 times the human interpupillary distance (*AC,* 53) (fig. 5). Such large multiples meant that the apparent relief was not just restored up to the "normal" dimensions of more proximate objects, but exaggerated well past it (fig. 6). Initially this exaggeration and the spatiotemporal interval that caused it were technical side effects: the slow reloading speeds of semiautomatic cameras resulted in the plane's covering a substantial distance between shots. But that accidental distortion crucially improved the vertical legibility, and thus the strategic utility, of

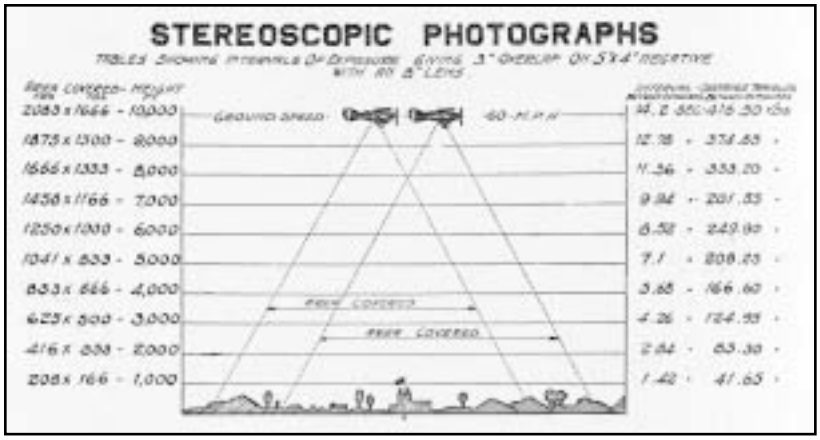

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Fig. 5. Diagram showing method of taking overlapping aerial stereopairs (*AP*, 336).

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Fig. 6. World War I aerial stereopair, exhibiting hyperstereoscopic effects when fused (*NI*).

aerial stereoscopy. Beaumont Newhall, who worked as a U.S. military photo interpreter during World War II, describes the interpretive advantages of hyperstereoscopy as they were discovered during the Great War:

> Unlike those stereoscopic views, once so popular, which give a convincing, "realistic" illusion of depth, pairs of overlapping aerial photographs give an exaggerated, highly distorted sense of height. Hummocks become hills, gulches seem to be deep chasms, and ordinary houses, skyscrapers. This exaggeration helps the interpreter: a machine gun

> emplacement seems to rise up from the ground; he can look under the bridge as well as on it; he can count long trains of freight cars and see the crumbling walls of bombed targets. [*AC,* 53]

Aerial stereoscopy bestowed a seemingly supernatural, Asmodean power of seeing around, under, and through structures from above. It did so not by restoring orthostereoscopic verisimilitude but by departing willfully from it. The truly resourceful photographic interpreter was not held back by a need for lifelike dimensions and elevations, but instead wrung the neck of realism and, in return, gained entry to a virtual landscape at once "highly distorted," in that the apparent proportions of its binocular space had been altered, and more starkly legible. Here we should remember that aerial photography was generally touted by its practitioners as the representational mode most nearly approaching the asymptote of the real. A tension existed between the putative realism of aerial photography on the one hand and, on the other, its resistance to full decryption except through the miraculous distortion of hyperstereoscopy. This tension registers in interpretive manuals and textbooks written during and after World War I, often taking shape in embarrassed equivocations:

> Stereograms made with too large exposure intervals show exaggerated relief. Yet this is often no objection. It is indeed rather an advantage if we wish to bring objects of interest to notice. Consequently, so long as the exaggeration of relief is not offensive, the permissible limits of exposure interval are pretty large. Actually, the eye tolerates such great deviations from strictly normal conditions that satisfactory stereoscopic effects are obtained for pictures viewed at very different distances from the focal length of the taking lens, and with the axes of the eyes parallel or even diverging, although there is some strain whenever focus and convergence points differ. On the whole, therefore, it may be said that the conditions above laid down for correct relief are only a normal, to be approximated as nearly as is practicable. [*AP,* 337–8]

By tentatively allowing exaggerated relief as "no objection" so long as it is "not offensive," Ives relativizes the "normal" dimensions of human vision as "*a* normal," as a baseline from which to depart in favor of distortions that allowed more data to be extracted from the plenum of the aerial photo. Normal dimensions are marginalized here as a question of mere taste (the baseline from which we judge what is and is not "offensive"), while strategic utility is brought forward as the more pressing criterion; the perceptual extremes underwritten by military exigency eclipse the notion of a "true" vision centered in a human optical norm and, in the process, mine more truth from the image than human-centered vision could. Since any appreciable stereoscopic vision at high altitudes is itself the result of a distortion that compensates for the limits of unaided stereopsis, then the former "truth" of biological stereoscopy stands revealed as increasingly *hypostereoscopic* as distances increase, requiring a complex system of prosthetic technologies (airplane, camera, stereoscope) to restore it to a now-destabilized normal.

Yet even as it relativized the dimensions and limitations of the body's stereopsis, aerial stereoscopy insisted in other ways on the bodiliness and spatial contingency of

the observer. The pervasive assumption that aerial photos present "totalizing" views of their subjects ignores the fact that the strategic utility of aerial photos lay in their exploitable spatial specificity. Vertical aerial photographs depict perfectly vertical views only of objects directly beneath the center of the lens; elevated objects not along that axis lean radially away from the center, and to a greater degree the farther away they are from that nadir; in a sense, then, vertical photos grow increasingly oblique toward their peripheries (fish-eye lenses merely exaggerate this phenomenon). Though this relief displacement presented a problem for joining overlapping photos into mosaic-maps, it was a sine qua non for aerial stereopsis: the stereoscope fused the distinct relief displacements of its stereopairs into an apparent three-dimensionality. However, in order to perceive that stereoptic effect properly, interpreters had to factor in another defining characteristic of the aerial photo: shadows. Early interpretive manuals insist that in order to preserve the light vectors of the photographic image, aerial stereopairs must be positioned with the shadows falling away from the observer's light source, and thus toward the observer. The observer who failed to reproduce the photograph's light vectors under the stereoscope would find relief inverted in a *pseudoscopic* effect: holes would appear as mounds, and trenches as walls (figs. 7 and 8). Sometimes pseudoscopic effects could arise from hemispheric conditioning as well. Harold Porter's *Aerial Observation* (1921) recounts how, during World War I, a Brazilian pilot and reconnaissance trainee misread shell craters as German gun emplacements on an aerial photo: "The Brazilian aviator was reared of course in the southern hemisphere where the sun is always north and where the shadows fall to the south. He saw in the picture just the reverse of what the Britishers saw, and he had not received enough training to know that he might [*sic*] always adjust his mind to the difference." Porter goes on to express doubts about the accuracy of the story, which he views as "too good to be true, but it demonstrates the point perfectly. First, orient your photograph."[23] In this case, however, "orientation" meant more than aligning the photo coverage with mapped space and compass points, or even recreating original light conditions. It was seen to entail a reprogramming of the individual interpreter's idiosyncratic perceptual circuits in accordance with a hemispherically specific theater of war. In respect to relief displacement, shadow orientation, and hemisphere, aerial stereoscopy insisted not only on a spatially contingent camera, but on an incarnated observer, one who had to be properly oriented toward light, image, and perceptual habits while being lowered, so to speak, into the virtual cockpit of the stereo image. Borrowing a term from linguistics, we might say that aerial stereoscopy was spatially *deictic*, that is, explicitly cognizant of the context-specific "here" that partly constitutes the act of seeing. Far from delivering a disembodied but immediately legible overview of its objects, aerial stereophotography did as much to expose the spatial and biological contingency of its observers as it did to lay bare the terrain it depicted. A scopic regime initially celebrated, and later criticized, as totalizing was useful in proportion as it exploited—and in the process, foregrounded—the radically deictic aspects of depth perception and of seeing generally.

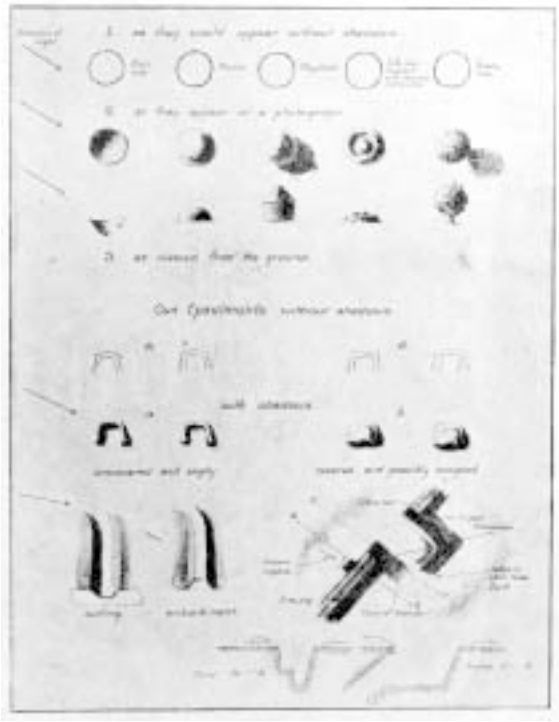

Fig. 7. "Diagram illustrating the reconstruction, from their shadows, of five circular objects seen vertically from above" (*NI*). Note vectors indicating direction of light source.

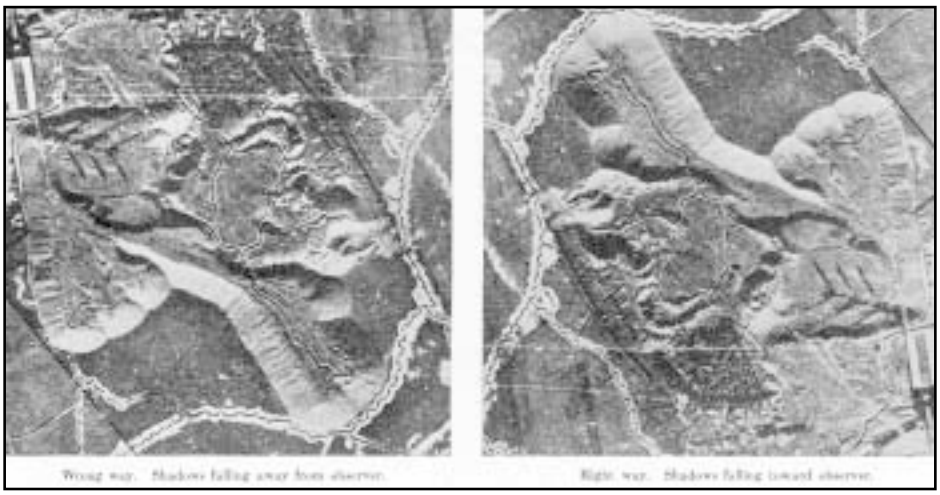

Fig. 8. Proper and improper orientation of shadows on an aerial photograph in relation to observer (*AP*, 353).

But if aerial stereoscopy did not provide the promised totalizing views of the earth's surface, it compensated in the extreme demands it made of its observers. As Porter writes, quoting one of his First World War photo interpretation instructors, "To interpret an aerial photograph is to reverse the habits of a lifetime" (*AO*, 177). As we have seen, this reversal of habits meant much more than learning to recognize trenches,

gun emplacements, and runways in a vertical high-altitude photo. It involved the systematic rediscipliningof observers' perceptual circuits in relation to the narrow requirements of a complex prosthetic optical regime. Before they could realign their bodies with the sightlines and shadowlines of stereopairs, observers first had to learn to use a stereoscope, or at least to use it in the hyperstereoscopic mode demanded by reconnaissance work (fig. 9). This was not as simple as looking through a pair of binoculars, a magnifying glass, or a jeweler's loupe. As one World War II–era manual puts it, observers had to learn to "acquire voluntary control over a previously involuntary reflex," or, in more precise optical terms, to dissociate the visual reflexes of convergence and association, reflexes that usually operate in concert.[24] In essence, observers had to focus their eyes on images just a few inches away; but they had to prevent the sightlines of left and right eye from converging on a single close-up image as they would in unaided stereopsis, instead keeping each eye directed at its corresponding stereopair (fig. 10). Not everyone could achieve artificial stereopsis, and even those who eventually succeeded had to practice, often experiencing eyestrain and headaches along the way. Another 1940s reconnaissance manual counsels patience, noting that "many persons have mastered the trick only after having worked 15 to 20 hours with stereo-prints." But it consoles its readers with the promise that their efforts will reward them with an almost violent 3-D epiphany: "When coincidence of the photographs is secured, as above, the relief should seem to come right up and hit you."[25]

Firsthand accounts of aerial stereoscopy by Great War interpreters are scarce, but their Second World War counterparts—several of them officers in the British Women's Auxiliary Air Force—used very similar methods, and wrote memoirs documenting their first encounters with the stereoscope in the context of reconnaissance work. These accounts vividly describe the epiphanic moment of stereo fusion, but they are equally vivid in recounting what personal associations that moment precipitated or displaced. Former WAAF photo interpreter Constance Babington-Smith describes her first successful stereoscopic session during the early months of World War II:

> I stood [the stereoscope] above a pair of prints as I had seen some of the others doing. I could see two images, not one, and there really did not seem much point. It was much simpler to work with an ordinary magnifying glass. I edged the two prints backward and forward a bit—still two images; and then suddenly the thing happened, the images fused, and the buildings in the photograph shot up toward me so that I almost drew back. It was the same sort of feeling of triumph and wonder that I remember long ago when I first stayed up on a bicycle without someone holding on behind. From then on interpretation was much easier.[26]

Babington-Smith would play a key role in British intelligence efforts against the German aircraft industry and *Vergeltungswaffen*, or "revenge weapons," the V-1 flying bombs and V-2 rockets. But her first artificial stereopsis triggered memories of childhood rather than prophecies about strategic detective work. Her WAAF colleague, Ursula Powys-Lybbe, writes how, in peering down through the scope, she also gazed back in time at her own childhood, except that here it is a childhood in which the

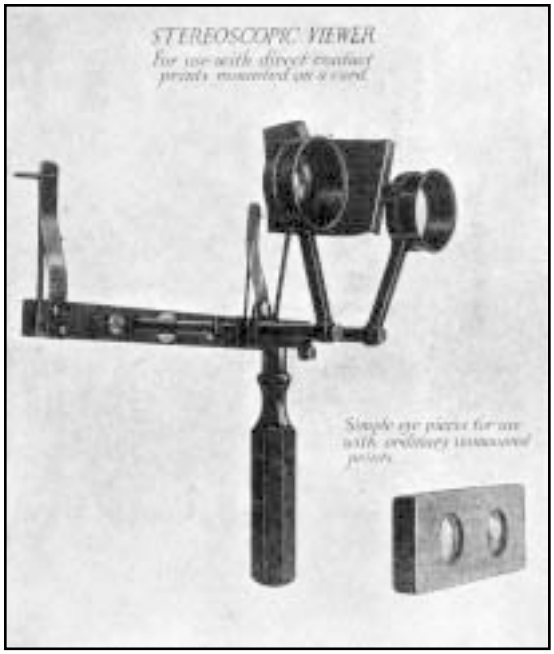

Fig. 9. Stereoscopic viewer and eyepieces, as used in World War I reconnaissance (*NI*).

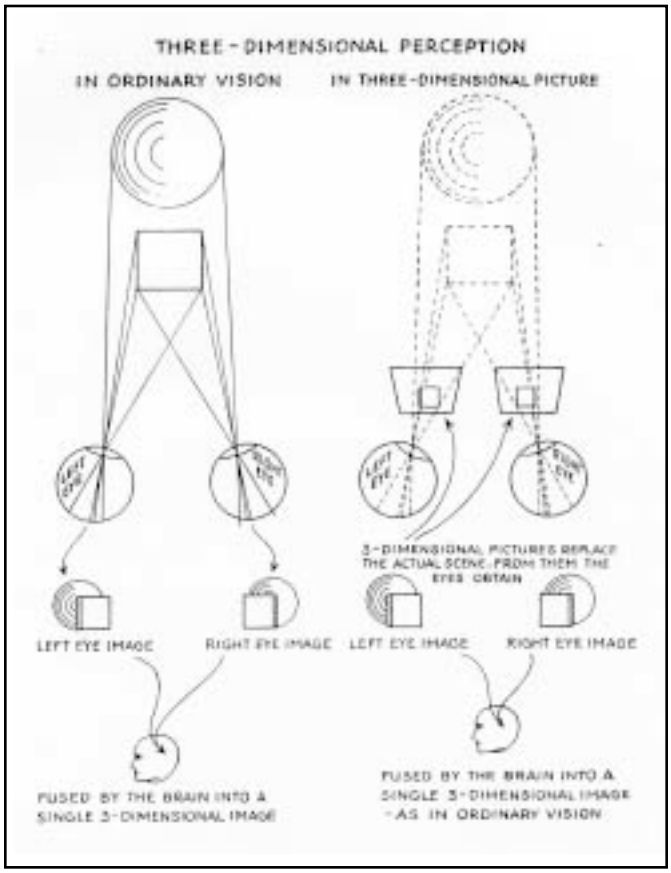

Fig. 10. Unaided and artificial stereopsis, showing different convergence of sightlines (*NI*).

stereoscope itself had played a role. The device acts as both a purveyor and an object of nostalgia:

> Sometimes, when I was a small girl, a treasured box of glass slides would be brought out accompanied by a wooden viewer with two black eyepieces, and I would be allowed to put a slide into the viewer and stare through the eyepieces at a fairy-tale world of sparkling snow, high mountains and dark trees—then suddenly and breath-takingly, my mother and father were standing like real people and looking at me—not flat people as in an ordinary photograph. The slides had been taken during my parents' honeymoon in Switzerland.
>
> That childish thrill was felt by everyone who, for the first time managed to shuffle a stereo pair of aerial photographs into the correct position in the viewer. It might have taken a little time, and you felt convinced that something was wrong with your eyes, and you strained your muscles and tried squinting and then magic! Shapes in plan were transformed into real-life ships or churches or bridges. You begged for more prints, and like the child with its new plaything, you spent a half-hour in a wonderland of discovery.[27]

In its reconnaissance application, the stereoscope's power lay not just in making the enemy's intentions seem legible in the landscape, but in reawakening the observers' personal associations with the medium and channeling them toward the ends of military intelligence. These observers had encountered its technological forerunner, the parlor stereoscope, in another world—in peacetime, in childhood, in domestic spaces where stereograms embodied and catalyzed longing for the past, for possession of a toy-sized world, for escape to exotic locales. By appropriating the same optical technology for reconnaissance, aerial stereoscopy wrote over its observers' first associations; after the war, they would never again regard the stereoscope simply as a portal to personal nostalgia or reverie. But while they squinted through its eyepieces at 3-D images of tiny docklands, factories, airfields, and launch platforms, the device mobilized their affective ties to its former uses, imbuing aerial views of military and industrial sites with the glamour of magic, fantasy, wonder, and play.

The stereoscopic image also camouflaged its own mode of reproduction through the impression of palpable immediacy it conferred on its objects. Amplified by the brief tactical currency of the photos, the image's aura of presence insisted urgently on the here and now of interpretation, collapsing the distance its constituent photos had actually traveled from the site they depicted to the observer's scope. That distance was not only spatial and temporal but technological and industrial as well: once the camera plane had landed safely, the cartridges of exposed film were rushed through a technically cutting-edge process of accelerated mass reproduction. Allan Sekula describes this process of development and dissemination:

> The making of these reconnaissance prints was one of the first instances of virtual assembly-line image production. (Henry Ford's first automobile assembly-line became operative only in 1914.) The establishment of this method of production grew out of demands for resolution, volume, and immediacy. No method of reproduction but direct printing from the original negative would hold the detail necessary for reconnaissance purposes.

> Large numbers of prints from a single negative had to be made for distribution throughout the hierarchy of command. In addition, the information in prints dated very rapidly. Under these circumstances, efficiency depended on a thorough-going division of labor and a virtually continuous speedup of the work process. Printers worked in unventilated, makeshift darkrooms; 20 workers might produce as many as 1,500 prints in an hour, working 16-hour shifts.[28]

As one terminus of this industrialized developing process, reconnaissance interpreters belonged to a kind of consumer vanguard, benefiting from techniques of photographic mass production that had not yet reached consumers in civil society. Installed in comparatively safe and well-organized facilities, they were insulated from the spectrum of violence involved in obtaining and developing the photos, a spectrum that included not only dead pilots and wrecked camera planes, but the exploitive use of conscript labor to ensure the tactical currency and bulk dissemination of the photos. At the same time, the observers' status as professional interpreters of industrially mass-produced images, along with the esoteric nature of their calculations and surveillance, helped conceal the fact that they also belonged to one of several classes of worker within the perception-and-targeting machine of military intelligence. And like most of the workers in the reconnaissance production line, they learned to experience extended shifts, repetitive labor, physical strain, and insulation from the violence their "product" recorded and facilitated, as a rare species of privilege.

If the glamour of the interpreters' work exceeded that of developers and even pilots, it did so because of their singular position within the power/knowledge grid of military intelligence. As we have seen, aerial stereoscopy, like the general work of photo interpretation to which it belonged, was situated within a professional narrative of forgetting, relearning, practice, and eventual mastery—a narrative of election and initiation into a top secret coterie, heavily defended by codes and shibboleths. It was a narrative that consolidated the identity of an elite interpretive school, one whose power lay not in the mere ability to command, but in the more rarefied capacity of producing the knowledge that would inform the commanders—recall Walter Raleigh's boast that "Reconnaissance, or observation, can never be superseded; knowledge comes before power; and the air is first of all a place to see from." Having gazed with childlike fascination into the miniaturized wonderland beneath their stereoscopes, the colleagues of Babington-Smith and Powys-Lybbe, like their Great War predecessors, produced the maps and memos that would, in turn, direct the Allied bombs. After the missions, they would confirm the destruction of the same enchanting objects that had held them in a reverie of detection. In confirming how their detective work had led to the alteration or annihilation of the terrain and structures recorded in reconnaissance photos, observers also confirmed the alteration of their own perceptual systems. To attain stereovision, they had learned to dissociate their optical reflexes of convergence and accommodation, in the process retraining their bodies to become contiguous with an elaborate weapons system that began by recording, identifying, and interpreting its objects, and ended by targeting and finally destroying them. They had become acclimated to a vertigo of scale, learning to be at least three perceptual sizes at once. Most

chillingly, they had retrained themselves affectively so that an optical medium formerly invested in childhood, memory, genealogy, and fantasy could retain the force of that affective tie, but refocus it on the surveillance and obliteration of military, industrial, and eventually civilian targets. In this respect, the observer-interpreters themselves—their bodies, their reflexes, their mnemonic associations, their affective investments—were the secondary targets of their own reconnaissance work.

Observing Cubism

In turning now to consider the relationships between Great War perceptual vocabularies and cubist ones, we are entering a well-cultivated critical terrain, one in which cubism has been seen as anticipating or influencing wartime phenomena as diverse as psychological fragmentation, the rectilinearity of the trench environment, the deprivileging of perspectival centers, and spatial disorientation, along with temporal acceleration, dilation, and rupture. Some of the cubists themselves saw elements of the Great War's perceptual repertoire emanating from their work. Gertrude Stein recalled being with Picasso, on the Boulevard Raspail during the early months of the war, when he first saw camouflage painted on a truck: "It was at night, we had heard of camouflage but we had not yet seen it and Picasso amazed looked at it and then cried out, yes it is we who made it, that is cubism" (*P,* 18). More conventional accounts of the origins of camouflage point to a need to conceal troops, weapons, and supplies from longer-range guns and the extended optical range of the enemy's airborne reconnaissance, but the pragmatism of that need does not rule out the deployment of a cubist visual syntax in meeting it. Stephen Kern cites at least one account of a direct descent from cubism to camouflage: Lucien-Victor Guirand de Scévola, an artilleryman who became the first French *camoufleur*, claimed that "In order to totally deform objects, I employed the means Cubists used to represent them," a decision that resulted in his hiring painters who, "because of their special vision, had an aptitude for denaturing any kind of form whatsoever."[29] Putatively developed to express a manifold but no less "real" or "essential" notion of perception, cubism had been drafted into a military function whose semiotic operations—encryption versus decryption, nature versus denaturing, form versus deformation—were far more binary than its own appeared to be. Stein wrote that "war is only a publicity agent which makes every one know what has happened"—that is, war foregrounds the perceptual sea changes that have already occurred in the culture at large and registered in its artistic vanguards (*P,* 45). If this is so, the Great War either caricatured cubism in publicizing it or exposed the fact that cubism had, from its inception, possessed an encryptive function that suited it to the oppositional perceptual space of the battlefield. In the latter case, the Great War would have been cubist only insofar as cubism was already combat-ready.

But if camouflage was among the war's publicizations of cubist innovation, how could the reconnaissance techniques that helped prompt the invention of camouflage, and that were subsequently dubbed its "worst foe," be said to share a perceptual etiology with cubism? As we have seen, aerial photography was initially celebrated as cap-

turing a plenitude of accurate data, as the photographic genre whose content was least contaminated by rhetoric. By contrast, cubist painting was received as extending the impressionist, postimpressionist, and fauvist disjunctions of object and depiction, pushing representation toward the condition of pure, nonmimetic, code. Though we have also seen that aerial reconnaissance photos were far more coded, contingent, and "produced" than is generally recognized, they still operated within an intelligence context whose legitimizing narrative was one of panoptical realism. That context used technologically enhanced modes of seeing to translate raw visual data into targeting data, progressively narrowing the gap between perception and destruction. Cubist painting might be said to enact, or at least testify to, the violent refraction, attenuation, dismemberment, and flattening of the subjects named by its often conventional, even academic work titles (*Violin*, *Female Nude*, *Still Life with Violin and Pitcher*, *Guitar on Table*). The 1915 critical complaint that Duchamp's *Nude Descending a Staircase* resembled "an explosion in a shingle factory" testified, at least, to this apparent representational violence, one that seems consonant with the violent and changeful period (1907–1914) during which cubism initially flourished. But can one really go so far as to link the harmonic and representational violence of cubism to reconnaissance techniques used to organize physical violence against an enemy army and military-industrial complex?

By the above characterizations, the realist tenets of reconnaissance will seem, at most, to be a curative response to the perceptual disorder of cubism. The two would be etiologically related, then, only in the sense that a disorder and its treatment can be said to share an etiology. But we have also seen that the hyperrealist claims made on behalf of reconnaissance were accompanied by an internal recognition that camouflage—a distortion or concealment of an object's visual signature—was the general rather than the exceptional case of vision, and that countering it involved not so much undoing distortion as offering a counterdistortion, one that manifestly did not restore or recuperate the real. In this respect, we might say that reconnaissance administered not a medicinal dose of truth, but rather "a lie that makes us realize truth, at least the truth that is given us to understand."[30] Picasso said this of art, and of cubism in particular; his recognition of the provisional nature of realizable "truth" has the syntax of an afterthought, but insofar as it acknowledges the contingency of perception, it articulates a generative condition of both cubism and Great War reconnaissance. I have described this condition above as the culmination of a nineteenth-century antiocularcentrism in physiological optics, epistemology, and aesthetic production, a current of thought crystallized in the parlor stereoscope. By 1907 this deconsecration of vision and visual metaphors had been more recently emphasized by Nietzsche and Bergson, who helped bring about what Martin Jay has schematized as a threefold revision of vision: the detranscendentalization of perspective, the recorporealization of the cognitive subject, and the revalorization of time over space (*DE,* 187). Though aerial reconnaissance might be assumed to reject any such deconsecration of ocular proof, we have seen that instead it capitalized on decentered optics and temporal parallax. And though cubism certainly responded to antiocular epistemology, it often

did so in surprisingly eye-minded ways, preserving at least the metaphor of stereopsis in attempting to tell the story of depth, if never quite to reproduce its effects. In fact, by projecting onto a single picture plane many facets of an object not simultaneously visible to the eye (tops next to bottoms, backs adjacent to fronts), cubism made its own bid to see beneath bridges, to provide a total reconnaissance cover of its objects. To regard cubism as exclusively encryptive, and reconnaissance as exclusively decryptive, then, would be to install both within the very positivist, cryptological syntax whose rejection they embodied.

Early accounts of cubism described the movement as reckoning in new ways with an old problem: the impossibility of inducing natural stereopsis from within a two-dimensional pictorial space.[31] The parlor stereoscope had provided one solution to this problem; but even it could not induce the viewer's eyes to converge and accommodate differently at separate depth planes within the fused image, with the unlifelike result that foreground, middleground, and background depth planes in a stereogram are all simultaneously in focus. In taking up this problem, cubism might be described as a second-generation stereoscopy, trading optical illusionism in for other techniques of suggesting, narrating, or inflicting depth. In 1912, two prominent cubist painters, Albert Gleizes and Jean Metzinger, undertook in their essay *Cubism* to defend and publicize the movement, and above all to begin a process of reeducation, one that would address "the difficulty which even a sensible and cultivated public experiences in reading modern works." Heretofore, they argued, the public had only been looking at cubist paintings through the retina. But cubism had from the start been cognizant of the flatness of the picture plane, utterly dispensing with the notion that a painting acted as a window looking out onto Cartesian space. Such a recognition confronted the limitations of retinal perception for painting, not the least of which being that in the single depth plane of pictorial space, the reflex of focal accommodation to different depth planes was mooted, and thus "the convergence which perspective teaches us to represent cannot evoke the idea of depth." Since even a painstaking reproduction of perspectival dimensions and proportions failed to convey depth, painters had to resort to more distortive means of conveying "the fictitious depths in which the coordinative light resides":[32]

> Let us imagine a landscape. The width of the river, the thickness of the foliage, and the height of the banks, the dimensions of each object and the relations of these dimensions—these are secure guarantees. Well, if we find these intact upon the canvas, we shall have learned nothing as to the talent or the genius of the painter. River, foliage, and banks, despite a conscientious representation to scale, no longer "tell" by virtue of their width, thickness, and height, or the relations between these dimensions. Torn from natural space, they have entered a different kind of space, which does not assimilate the proportion observed. This remains an external matter. It has just so much importance as a catalogue number, or a title at the bottom of a picture frame. . . . The painter has the power of rendering as enormous things that we regard as infinitesimal, and as infinitesimal things that we know to be considerable; he changes quantity into quality. [*C,* 25–6]

With the stereoptic reflexes annulled by pictorial space, the painter could compensate by distorting the dimensions of natural space in such a way that they would once again "tell" as depth—i.e., by a variation on hyperstereopsis. Painters also had recourse to "tactile and motor sensations, indeed to all our faculties. It is our whole personality which, contracting or dilating, transforms the plane of the picture. As in reacting this plane reflects the personality upon the understanding of the spectator, pictorial space may be defined as a sensible passage between two subjective spaces" (*C,* 29–30).[33] It is no longer the iris alone, but the whole personality that contracts or dilates. Reimagined here as a synesthetic perceptual organ, the new spectator would open his or her whole sensorium to the painting even as the painter had done; painter and spectator would collaborate in the creation of a pictorial space through the fusion, not of two sightlines, but of two subjectivities. Despite its antiocularcentrism and its insistence that painters are not geometers, *Cubism* retains stereopsis, or rather hyperstereopsis, as its master trope, widening its parallactic baseline from an interocular to an intersubjective distance. Gleizes and Metzinger even conferred a variant of stereoptic fusion on cubist painting. Confident that even "the least intelligent" painters and spectators would eventually recalibrate their perceptual habits in accordance with cubist hyperstereoperception, they forecast a day when "the fact of moving around an object to seize several successive appearances, which, fused in a single image, reconstitute it in time, will no longer make thoughtful people indignant." Meanwhile, they declared, cubist forms must remain "sufficiently remote from the imagination of the vulgar to prevent the truth which they convey from assuming a general character," and cubism must continue to "employ its own language, in order to move, dominate, and direct the crowd, not in order to be understood" (*C,* 54–5, 24, 62).

The notion that the serial glances constituting a cubist painting could "fuse in a single image," as if with a sudden stereoscopic clarity, seems questionable given the sense of irretrievable dispersal conveyed by much cubist work. Besides, Gleizes and Metzinger seem here to describe the painter's, rather than the spectator's, fusion of a series of "appearances" onto a single image plane. But in other accounts of cubism, an experience very like stereoscopic fusion is clearly attributed to the spectator. In his *Rise of Cubism* (1920), Daniel-Henry Kahnweiler, one of the movement's key exhibitors and dealers, likened cubism to "stereometric drawing on the plane," adding that it can present "an analytical study of [an] object which the spectator then fuses into one again in his mind." Though Kahnweiler conceded that the fusion may lack the "closed manner of the stereometric drawing," he nonetheless bestowed on that more "open" fusion the same ontological status as the stereoscopic image: "there exists, as well, but only in the mind of the spectator, the finished product of the assimilation, the human head, for instance."[34] This "assimilation," he added, could be assisted through a painting's titular reference to familiar objects, mention of which would summon catalytic memory images in the spectator:

> Naturally, with this, as with any new mode of expression in painting, the assimilation which leads to seeing the represented things objectively does not immediately take place

> when the spectator is unfamiliar with the new language. But for lyric painting to fulfill its purpose completely, it must be more than just a pleasure to the eye of the spectator. To be sure, assimilation always takes place finally, but in order to facilitate it, and impress its urgency upon the spectator, Cubist pictures should always be provided with descriptive titles, such as *Bottle and Glass*, *Playing Cards and Dice* and so on. In this way, the condition will arise which H. G. Lewes [*sic*] referred to as "preperception" and memory images connected with the title will then focus much more easily on the stimuli in the painting. [*RC,* 12–3]

The painting could further facilitate the spectator's "assimilation" by including recognizable details—clues, such as domestic objects or personal effects, that could help establish the scale, location, and orientation of its subject. Picasso's 1910 portrait *Daniel-Henry Kahnweiler* (fig. 11), a celebrated example of analytical cubism, offsets its defamiliarizing gestures with details such as the subject's watch-chain, a bottle and glass, a table, and a piece of New Caledonian sculpture. Like the materiality and familiarity of its work titles, the cubist detail suggests the movement's residual engagement with more conventionally realist forms of representation, and its odd proximity to the detail-obsessed, decryptive, and denominative operations of reconnaissance. And as with reconnaissance, Kahnweiler insisted that despite cubism's concessions to the familiar, its spectators must, in the name of "urgency," relearn perception, becoming familiar with the movement's "new language" and enlisting their memories of more conventional perceptual acts in order to "assimilate" the cubist image. Viewers who misconstrued cubism as "Geometric Art" did so, he said, because geometry was the only memory image they could connect with the paintings. That misperception would end "as soon as the spectator familiarizes himself with the new method of expression and gains in perception" (*RC,* 13).

As they did in reconnaissance discourse, such prescriptions for a reeducated spectator served social as well as perceptual ends in the reception of cubism. Like Kahnweiler, Picasso likened cubism to a language that only some people understood: "The fact that for a long time Cubism has not been understood and that even today there are people who cannot see anything in it, means nothing. I do not read English, an English book is a blank book to me. This does not mean that the English language does not exist, and why should I blame anybody else but myself if I cannot understand what I know nothing about?"[35] By equating the viewing of a painting with various forms of translation—from one language to another, from optical dispersal to assimilation, from lies to "the truth that is given us to understand"—such directives made a two-way toggle switch of the spectator's understanding. As a result, they conferred an elite identity on those spectators who could answer one question in the affirmative: "Do you *get it*?" Thus, however much Great War *camoufleurs* like de Scévola may seem to have misappropriated cubism as a straightforwardly encryptive resource, one finds that the dichotomous logic of camouflage was immanent within cubist self-representation from the start, and furthermore that cubism partly contracted that logic from the stereoscope, only a subset of whose users could gain access to the "fictitious depths" latent in its flat images. Along with the gatekeeping question as to its specta-

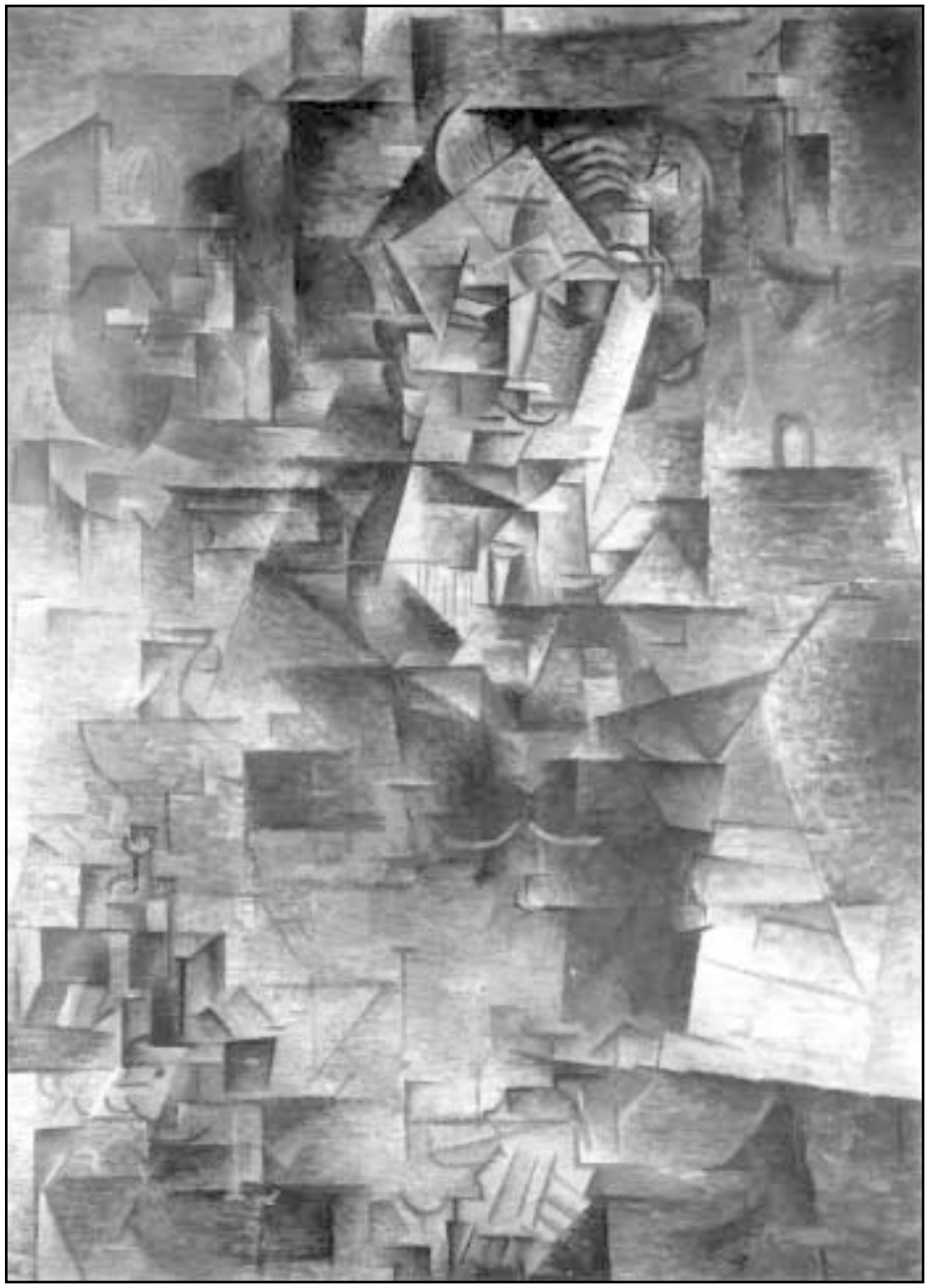

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Fig. 11. Pablo Picasso, Spanish, 1881–1973, *Daniel-Henry Kahnweiler*, 1910, oil on canvas, 101.1 x 73.3 cm. The Art Institute of Chicago. Gift of Mrs. Gilbert W. Chapman in memory of Charles B. Goodspeed, 1948.561.

tors' understanding, cubism also issued them a series of implicit dares, all of which point up both its adversarial tendencies and its homologies with Great War reconnaissance: can you either recover the subject named by the image from its defamiliarized form, or find the irrecuperable estrangement of that subject pleasurable, legitimate, interesting, or important? Will you assimilate work titles like *Still Life* and *Woman with Pears*, commonly found in more conventional contexts, in their reapplication to a seemingly violent dismemberment of the old optical order the titles ask you to remember? Will you be able to achieve a fusion of such paintings and their titles, perceptually unifying those two disparate informational fields? How far will you go in retraining yourself either to see anew, or to assent to not-seeing as a nobler, worthier, harder, or more contemporary act of perception?

Open Fusion

From two spectacularly different vantages, the conscripted gazes of the reconnaissance observer and the cubist spectator converged in a single scopic regime. Both were asked to gaze on conspicuously flat image spaces and endeavor, through retraining their perceptual coordinates and reflexes, to produce a "fusion" or "assimilation" in the mind that would reveal objects in "fictitious depths" that were both deeper and more overtly fictitious than the conventions of Cartesian perspectivalism. This fictitious depth was constituted not only of spatial parallax, but of temporal as well: the cubist painting projected a series of glimpses onto a single canvas, while aerial hyperstereoscopy allowed a simultaneous fusion of stereopairs shot in sequence; both constructed a mobile rather than a fixed observer in relation to the observed. Like the parlor stereoscope of which they were rival offspring, cubism and aerial stereoscopy depicted an object in such a way as to make it seem the more present for being the result of a differential effect that took place, if it took place at all, nowhere but in the mind of the observer. They required their observers to earn that impression of presence, along with its conceit of providing a three-dimensional cover (seeing under bridges from above, say, or behind forward-facing *demoiselles*), through an arduous perceptual reeducation, one that forced them to confront the contingency of scalar stability, depth perception, normal dimension, and ultimately the coexistence and interpenetration of different spatial orders. But as a reward for that reeducation, they promised to admit the observer into an elite made up of those who "understood." Obviously cubism and Great War reconnaissance bore very different relations to physical violence, the latter being explicitly involved in planning, facilitating, and confirming destruction. But the chief site of that destruction proved the most hospitable climate for cubist painting during the war years: although its reputation suffered amid the formal conservatism of patriotic Paris, cubism thrived at the front. There, soldier-painters such as Fernand Léger, André Fraye, Albert Gleizes, and André Maré used cubist analytical syntax to represent the real destruction they were now helping to fend off and to wreak.[36]

Although this essay has juxtaposed the observer constructed by Great War reconnaissance with the corresponding figure in cubist painting, other pairings suggest themselves. To begin with, stereopsis has long been understood as integral to the figurative and philosophical vocabularies of much modernist literature. The differential optics of parallax undergird meditations on both epistemology and ethics in Joyce's *Ulysses*, a text that also asks to be read stereoptically, challenging its readers to fuse Homeric and contemporary narratives without conflating them, remaining mindful of how each narrative consecrates or desecrates, distorts, rectifies, or relativizes the other. Woolf's *Mrs. Dalloway* is structured around a stereopsis of class and gender, pairing the upper-class Clarissa with the petit-bourgeois Great War veteran Septimus—characters who, like stereopairs, are kept adjacent but separate, throwing one another into relief. Roger Shattuck has described the chronotope of Proust's *À la recherche du temps perdu* as binocular in its abandonment of motion for the relief effects achieved by juxtaposing arrested, temporally disjunct moments.[37] In all three cases, however, one notes that the conspicuously broad separations between various conceptual stereopairs—separations in class, gender, genre, time, and space—suggest not the subtle interocular distance and simultaneity of parlor stereograms, but the more considerable spatial and temporal intervals, the self-conscious distortion, and the equivocal interpretive mandates of reconnaissance hyperstereoscopy. The stereoptic preoccupations of such texts might be revisited in the context of a second-generation stereoptic regime, one distinct from nineteenth-century stereoscopy in its use of scalar manipulation and industrialized image production, in its role as the perceptual component of an integrated weapons system, and in its conflicted claims about its own simultaneously realist and illusionist powers.

In other registers, too, reconnaissance optics and rhetoric were homologous with a whole series of gestures that have come to seem characteristic of many interwar modernisms. As Great War reconnaissance did with aerial photography and the stereoscope, modernist texts tended to recombine nineteenth-century representational technologies, but within hyperbolized contexts that insisted on the interdependence of representation and destruction. They foregrounded the extent to which conventions of documenting the real are constructed by strategic and compensatory exaggerations that become naturalized, even normativized, over time. While indulging frequently in fantasies of comprehensive and totalizing representation, they also illustrated the dependence of such fantasies upon site-specific, partial, relativistic acts of perception. They further shifted the function of reading and viewing away from the veridical category of "vision" to "*a* vision," the expression of a lone artist whose worldview was so radically eccentric as to invalidate former ways of reading and seeing. Having nullified the usefulness of precedent, they asked their viewers or readers to engage in extravagant acts of rediscipline and reeducation, to devote a lifetime not just to studying, but to "studying under" a singular text or artifact (e.g., *Remembrance of Things Past*, *Ulysses* and *Finnegans Wake*, the *Cantos*, Duchamp's *Large Glass* with its unique physics).[38] They thereby created, and in several cases plainly set out to create, elite corps of interpreters devoted to exceeding the standards of mere accuracy in extracting meaning

from every detail in a semiotic field. In doing so, they activated the oppositional dynamics of encryption/decryption, presenting themselves as puzzles for their interpreters to solve through perseverance, resourcefulness, collaboration, and the development of new interpretive protocols and technologies. This oppositional relationship recast the artist in a manner largely peculiar to the twentieth century: as an adversary whose occulted intentions the observer set out to fathom by decoding, identifying, and interrelating objects in a textual or perceptual domain, using exaggerative theoretical optics and interpretive trigonometry to take the measure of those objects by the light of social forces external to the artist's control. And by calling for interpretive schools whose work was inseparably devotional *and* adversarial, they helped catalyze the relation of ambivalence that is characteristic of much twentieth-century critical discourse toward its objects, a stance in which affection and aggression seem inextricably knotted, even mutually constitutive.

This last series of claims will seem to make a totalizing gesture of its own, one in which the technical, rhetorical, and social dynamics of Great War reconnaissance are put forward as the key to all modernist mythologies. This is certainly not the aim of this essay, which seeks rather to juxtapose two disjunct images of a culture wrestling with the predication of totality on locality, partiality, contingency. If these two images appear to fuse into an integrated concept, that concept is none other than the recognition of any totalizing system as illusionist, as possessed of decryptive or explanatory powers only in proportion as it exaggeratively dubs "real," "natural," "infallible," or "total" observations that it knows to be vulnerably site-specific. To bring a remote object out of flatness, the critic, like the observer, overcompensates: seeing it in any legible depth is the result of distortion—a falsified conflation or a distended separation of moments, spaces, gazes, discourses, epistemes. Yet this counterdistortion neither restores nor presupposes the dimensions of the real with any certainty, because the process of mapping the pathways of critical stereopsis reveals what formerly were "normal" dimensions to be "a normal," a highly contingent baseline rather than a fixed cardinal point. If the veridical notion of "vision" has, in the process, been forsaken for the more eccentric criterion of "a vision," the critic-observer hopes to recuperate in tactical advantage what has been lost in the waning—or sacrifice—of ocular proof, stable notions of the natural, and the fantastic certainty of a God's-eye view. A critical overview of modernist reconnaissance, if it is sufficiently attentive to its subject, will have schooled its observer to be circumspect about its own final, panoramic observation: that aerial hyperstereoscopy was paradigmatic of the dominant status of the observer in the early twentieth century.

Writing during the late 1930s of cubism and the airplane view of America, Gertrude Stein was performing her own act of modernist cultural reconnaissance. Two radically separate high-altitude stereopairs lay beneath her lenses: on one side, a long-expired avant-garde movement; on the other, a technologically sponsored view of the earth that cubism's key exponents had never, to her knowledge, seen firsthand. The respective images—after all, rather flattened versions of cubism and early aerial perspective—were both spatially and temporally disjunct, occupying different discursive spaces

and historical moments. Stein's prose juggles the stereopairs about, uncertain whether they line up in a relation of causality, and if so, which way that causality flows. If the two images can be said to fuse, they do so in the elusive but suggestive notion that creators are supercontemporary: that they are people who simply and instantly intuit the epoch-making changes their contemporaries must register in the fullness of time. The rhetorical majesty with which the idea is expressed belies the spatial and temporal contingency of which it is the special effect. Yet the illusory nature of Stein's synthesis is nothing against its persuasive force among students of modernism, whom it has repeatedly "come right up and hit" as a crucial formulation. That quality of being at once theatrically distortive and revealingly (or revoltingly) accurate is characteristic of many modernisms, and many interpretive theories about modernism. So are the stakes concealed by this hallucinatory realism: namely, an observer of "splendors" whose aesthetic power is indissolubly bound not only to the potential destruction of the object but also to the violent perceptual and ethical redisciplining of the observer. Such an observer could experience both the annihilation of the represented object and the trials and spectacle of her own retraining—as Stein does in her conclusion to *Picasso*, and as Powys-Lybbe did in her wartime reunion with the stereoscope—as unalloyed aspects of "splendor."

Notes

1. Ernest Hemingway, "A Paris-to-Strasbourg Flight," *The Toronto Daily Star*, September 9, 1922; reprinted in *By-Line: Ernest Hemingway: Selected Articles and Dispatches of Four Decades,* ed. William White (New York: Charles Scribner's Sons, 1967), 42–3. I would like to thank Marlene Briggs, Joel Dinerstein, Frederic Gleach, Neil Hertz, Arden Reed, Ned Schantz, and Hilary Schor for their valuable comments on earlier versions of this essay.

2. See, for example, Beaumont Newhall, *Airborne Camera: The World from the Air and Outer Space* (New York: Hastings House, 1969), 105; hereafter abbreviated as *AC;* Stephen Kern, *The Culture of Time and Space 1880–1918* (Cambridge, Mass.: Harvard University Press, 1983), 245; hereafter abbreviated as *CTS;* Julie H. Wosk, "The Aeroplane in Art," *Art & Artists* no. 219 (December 1984): 24; Margret Dreikausen, *Aerial Perception: The Earth as Seen from Aircraft and Spacecraft and Its Influence on Comtemporary Art* (Philadelphia: Art Alliance Press, 1985), 15; John Welchman, "Here there & otherwise," *Artforum* 27 (September 1988): 18. The association between cubism and aerial perspective has even begun to appear in broad cultural history surveys. Jacques Barzun writes: "Rather than science it was techne that affected the Cubist eye: motor-car speed and aviation, which respectively force images into each other and flatten what is rounded. There is no record of Cubist fliers, but photographs showed the earth in the geometric way now familiar to the air traveler." *From Dawn to Decadence: 500 Years of Western Cultural Life, 1500 to the Present* (New York: Harper Collins, 2000), 649.

3. Waldemar George, "Vorwort zur 93. Sturm-Ausstellung," *Der Sturm* (Berlin), January 1921; translated and reprinted as "Foreword to an Exhibition held by *Der Sturm*, Berlin" in *Cubism*, ed. Edward F. Fry (New York: McGraw-Hill, 1966), 161.

4. George McCartney, *Confused Roaring: Evelyn Waugh and the Modernist Tradition* (Bloomington: Indiana University Press, 1987), 56–62.

5. Gertrude Stein, *Picasso* (London: B. T. Batsford, 1938); reprinted in *Gertrude Stein on Picasso*, ed. Edward Burns (New York: Liveright, 1970), 76; hereafter abbreviated as *P*.

6. Quoted in Welchman, "Here there & otherwise," 18. The photo atlas Welchman describes is *Characteristics of the Ground and Landmarks in the Enemy Lines opposite the BRITISH FRONT from the Sea to St. Quentin*, Branch Intelligence Section of the G.H.Q. Wing, RAF [1918?].

7. Martin Jay, *Downcast Eyes: The Denigration of Vision in Twentieth-Century French Thought* (Berkeley: University of California Press, 1993), 213–4; hereafter abbreviated as *DE*.

8. See Filippo Tommaso Marinetti, "Technical Manifesto of Futurism" (1912); reprinted in *Marinetti: Selected Writings*, ed. R. W. Flint, trans. R. W. Flint and Arthur A. Coppotelli (New York: Farrar, Straus and Giroux, 1972). Marinetti writes that "Deep intuitions of life joined to one another, word for word according to their illogical birth, will give us the general lines of an *intuitive psychology of matter*. This was revealed to me when I was flying in an airplane. As I looked at objects from a new point of view, no longer head on or from behind, but straight down, foreshortened, that is, I was able to break apart the old shackles of logic and the plumb lines of the ancient way of thinking" (88–9). Jeffrey Schnapp describes how the structural peculiarities of the Voisin biplane—e.g, its deafening engine, the unobstructed forward view resulting from its rearward-facing propeller—informed the reveries and mandates of Marinetti's "Technical Manifesto." See Jeffrey Schnapp, "Propeller Talk," *MODERNISM/modernity* 1, no. 3 (1994): 153–78.

9. Paul Virilio, *The Art of the Motor* (Minneapolis: University of Minnesota Press, 1995), 40; italics in original.

10. The phrase "scopic regime" was apparently coined by Christian Metz in *The Imaginary Signifier: Psychoanalysis and the Cinema*, trans. Celia Britton et al. (Bloomington: Indiana University Press, 1982), 61. See also Martin Jay, "Scopic Regimes of Modernity," in *Vision and Visuality*, ed. Hal Foster (Seattle: Bay Press, 1988).

11. Paul Virilio, *La Machine de Vision* (Paris: Galilée, 1988), 38, quoted in *DE,* 211.

12. Walter Raleigh, *The War in the Air,* vol. 1 (Oxford: Clarendon Press, 1922), 446.

13. Allan Sekula, "The Instrumental Image: Steichen at War," *Artforum* 14 (December 1975): 28.

14. Clarence Winchester and F. L. Wills, F.R.P.S., *Aerial Photography: A Comprehensive Survey of its Practice & Development* (London: Chapman and Hall, 1928), 8; hereafter abbreviated as *CS*.

15. Maj. Edward J. Steichen, "American Aerial Photography at the Front," *U.S. Air Service* 1 (June 1919): 39.

16. See Edward Steichen, *A Life in Photography* (Garden City, N.Y.: Doubleday, 1963), n.p.

17. Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century* (Cambridge, Mass.: MIT Press, 1990), 128.

18. Herbert E. Ives, *Airplane Photography* (Philadelphia: J. B. Lippincott Company, 1920), 358; hereafter abbreviated as *AP.*

19. Roy Conyers Nesbit notes that the Watson Air Camera, designed in 1913 for the British Royal Flying Corps, took the Corps's first vertical photos, from the rigid airship *Beta*. By the summer of 1915, the C-type camera permitted a sequence of overlapping shots (eighteen per magazine) to be taken semiautomatically from airplanes. See Nesbit, *Eyes of the RAF: A History of Photo-Reconnaissance* (Phoenix Mill; [Washington, D.C.]: Alan Sutton Publishing, 1996), 11, 35; and Andrew J. Brookes, *Photo Reconnaissance* (London: Ian Allan, 1975), 20.

20. Quoted in Harold E. Porter, *Aerial Observation: The Airplane Observer, the Balloon Observer, and the Army Air Corps Pilot* (New York: Harper and Brothers, 1921), 163; hereafter abbreviated as *AO*.

21. *AP,* 352; *AO,* 179. Winchester and Wills write that the observer's duty was "to act as an aerial detective, making notes of the movements of troops and recording on maps the position of trenches, ammunition dumps and the like. He had to rely chiefly upon his visual observations and an intelligence which would grow keener only by continued experience as an observer"; see *CS,* 5.

22. World War I aerial reconnaissance photos were typically taken from altitudes of ten thousand feet, as the aircraft had to fly above the ranges of ground-based artillery, and hopefully high enough to elude detection.

23. *AO,* 179–81. Porter reproduces the anecdote from a recent but unnamed "highly technical magazine published in Chicago."

24. H. T. U. Smith, *Aerial Photographs and their Applications* (New York: D. Appleton-Century Company, 1943), 74.

25. Talbert Abrams, *Essentials of Aerial Surveying and Photo Interpretation* (New York: McGraw Hill, 1944), 130.

26. Constance Babington-Smith, *Air Spy: The Story of Photo Intelligence in World War II* (New York, 1957), 78–9.

27. Ursula Powys-Lybbe, *The Eye of Intelligence* (London: William Kimber and Company, 1983), 47–8.

28. Sekula, "The Instrumental Image," 28.

29. Lucien-Victor Guirand de Scévola, "Souvenirs du camouflage (1914–1918)," *La revue,* December 1950, 719–20, quoted in Stephen Kern, "Cubism, Camouflage, Silence, and Democracy: A Phenomenological Approach," in *NowHere: Space, Time, and Modernity*, ed. Roger Friedland and Deirdre Boden (Berkeley: University of California Press, 1994), 166. See also André Ducasse, Jacques Meyer, and Gabriel Perreux, *Vie et mort des Français, 1914–1918* (Paris, 1962), 510–1, quoted in *CTS*, 303; and Elizabeth Kahn Baldewicz, "Les Camoufleurs: The Mobilization of Art and the Artist in Wartime France, 1914–1918," Ph.D. dissertation, University of California, Los Angeles, 1980. De Scévola's proposal led to the establishment of the French *service de camouflage* on February 12, 1915.

30. Pablo Picasso, interview with Marius de Zayas, 1923; translation (approved by Picasso) published as "Picasso Speaks," *The Arts* (New York), May 1923, quoted in Herschel B. Chipp, *Theories of Modern Art: A Source Book by Artists and Critics* (Berkeley: University of California Press, 1968), 264.

31. The Englishman Charles Wheatstone, one of the inventors of the stereoscope, had been among the first to posit a physiological reason for this impossibility: "When the painting and the object are seen with both eyes, in the case of the painting two similar objects are projected on the retinas, in the case of the solid object the pictures are dissimilar; there is therefore an essential difference between the impressions on the organs of sensation in the two cases, and consequently between the perceptions formed in the mind; the painting therefore cannot be confounded with the solid object." Charles Wheatstone, "Contributions to the Physiology of Vision," in *Brewster and Wheatstone on Vision*, ed. Nicholas J. Wade (London: Academic Press, 1983), 66.

32. Albert Gleizes and Jean Metzinger, *Du Cubisme* (Paris, 1912); translated as *Cubism* (London: T. Fisher Unwin, 1913), 21, 29, 19; hereafter abbreviated as *C*.

33. Robert L. Herbert's translation of the passage's final sentence is clearer: "Since in reaction this plane reflects the viewer's personality back upon his understanding, pictorial space may be defined as a sensible passage between two subjective spaces." *Modern Artists on Art: Ten Unabridged Essays*, ed. Robert L. Herbert (Englewood Cliffs, N.J.: Prentice-Hall, 1965), 18.

34. Daniel-Henry Kahnweiler, *Der Weg zum Kubismus* (Munich: Delphin-Verlag, 1920); translated as *The Rise of Cubism* by Henry Aronson (New York: Wittenborn, Schultz, 1949), 12; hereafter abbreviated as *RC*.

35. Picasso, "Picasso Speaks," quoted in Chipp, *Theories of Modern Art*, 264.

36. See Kenneth E. Silver, *Esprit de Corps: The Art of the Parisian Avant-Garde and the First World War, 1914–1925* (Princeton, N.J.: Princeton University Press, 1989), 78–85.

37. Roger Shattuck, *Proust's Binoculars: A Study of Memory, Time and Recognition in À la recherche du temps perdu* (Princeton, N.J.: Princeton University Press, 1983).

38. Jean Clair has discussed Duchamp's fascination and experiments with stereoscopic photographic vision and anaglyphs in "Opticeries," *October* 5 (summer 1978): 101–12.