Rick Altman

The Technology of the Voice

Recent speculation on the history of cinema technology has quite properly concentrated on broad theoretical questions. Historical hypotheses identified as « idealist », « ideological », or « economic » have provided a series of grids through which technological developments may be defined and evaluated/1. Typically, a well known set of events is explained by reference to one (and only one) of these explanatory principles, often with the aid of a single new fact or unexpected connection. Given the combative tone of recent publications dealing with the history of technology, the overarching goal of most authors has been openly defensive and rhetorical. Written from within a polemic, the average article gains its very reason for being from its ability to demonstrate the worth of a particular point of view, always at the expense of another approach. While this tactic no doubt deserves a place in the realm of cinema studies, especially in the formative period of a new theory, we have perhaps reached the point where it is possible to contemplate the coexistence of multiple explanations for a single phenomenon. When we analyze individual films, we are quick to invoke the notion of overdetermination as a fundamental textual strategy; we will do well, I suggest, to recognize a similar phenomenon at work in the historical arena. Technology develops not according to a single principle, but by a network of related principles. Our task must no longer be to discover a single applicable principle of explanation, but to identify the regulating system by which individual

---

/1. Relevant passages from Bazin and Mitry are discussed in Jean-Louis Comolli, « Technique et idéologie : Caméra, perspective, profondeur de champ », *Cahiers du cinéma* 229, May-June 1971, 4-21 ; 230, July 1971, 51-57 ; 231, Aug.-Sept. 1971, 42-49 ; 233, Nov. 1971, 39-45 ; 234-35, Jan.-Feb. 1972, 94-100 ; 241, Sept.-Oct. 1972, 20-24. The economic approach is perhaps best represented by Douglas Gomery's numerous articles and dissertation, « The Coming of Sound to the American Cinema : A History of the Transformation of an Industry », University of Wisconsin-Madison, 1975. See also *The Cinematic Apparatus*, ed. Teresa de Lauretis and Stephen Heath, New York, St. Martin's Press, 1980. Further bibliography is provided by Charles H. Harpole in « Ideological and Technological Determinism in Deep-Space Cinema Images », *Film Quarterly* 33, Spring 1980, 11-22.

explanatory principles are organized and related. A review of microphone technology during the two decades surrounding the coming of sound will afford an opportunity for illustrating the new type of criticism which I have in mind.

I

While virtually unknown to students of cinema, the history of microphone technology has been the object of extremely careful commentary by technicians, practitioners, and inventors. The general surveys by Frederick/2, Hopper/3, Clark/4, Frayne/5, and Olson/6 may be usefully complemented by more detailed articles in the *Journal of the Society of Motion Picture Engineers,* the *Journal of the Acoustic Society of America,* the *Bell Laboratories Record,* the *Bell System Technical Journal,* the *Bell Telephone Quarterly,* the *Journal of the Audio Engineering Society,* and (for slightly popularized accounts), the *American Cinematographer.* Emerging from these rather technical accounts is a single, surprisingly unified picture of two decades of microphone development which have proven decisive for microphone use ever since. A shortened version of that account might go something like this.

Since the early days of the telephone, the carbon microphone had provided efficient and reasonably faithful sound pick-up service. Based on the principle that the resistance of a mass of carbon granules varies with the pressure applied, the carbon mike derives its signal from a direct current passing through the carbon, varying with pressure changes (i.e. changes in sound), and turned into alternating current by a transformer inserted into the microphone circuit. In order to reduce amplitude distortion (though at the cost of some sensitivity), two such units were commonly connected 180° out-of-phase, producing the familiar double-button push-pull carbon microphone. Developed to a high level of fidelity by Bell Labs for its much publicized

/2. H.A. Frederick, « The Development of the Microphone », *Bell Telephone Quarterly,* July 1931, 164-88.

/3. F.L. Hopper, « Characteristics of Modern Microphones for Sound Recording », JSMPE 33, Sept. 1939, 278 ff.

/4. L.E. Clark, « Microphones », chapter six in *Motion Picture Sound Engineering,* New York, Van Nostrand, 1938, pp. 79-92.

/5. John G. Frayne and Halley Wolfe, *Elements of Sound Recording,* New York, John Wiley, 1949, pp. 34-65.

/6. Harry F. Olson, « A History of High-Quality Studio Microphones », *Journal of the Audio Engineering Society,* Dec. 1976, reprinted in *Microphones, An Anthology of Articles on Microphones from the Pages of the JAES,* New York, AES, 1979, pp. 219-28.

1921 public address events (especially Harding's inaugural address and the coast-to-coast broadcast of the Armistice Day ceremonies at the Arlington Cemetery burial of the Unknown Soldier), the carbon mike ruled the roost throughout the twenties in the related (and heavily Bell-influenced) fields of radio, telephony, and public address systems. Indeed, the completeness of its domination can best be gleaned from the classic article by Green and Maxfield on « Public Address Systems », where the authors carefully explain why the carbon transmitter (as microphones were commonly called in the twenties) was preferred over the condenser transmitter—even though the modern version of the latter was the creation of Bell Labs engineer A.C. Wente (with all patents therefore owned by Bell)/7.

While the carbon mike had the benefit of a long and successful history in the communication field, made possible by its high output level, it was not without drawbacks. In particular, its most common version suffered from a very high noise level, especially when used at a distance from the speaker, as well as a tendency for the carbon granules to pack together. In spite of these serious drawbacks, the carbon mike held its own past the turn of the decade. In January, 1931, for example, W.C. Jones, another Bell engineer, concluded in an article published simultaneously in the two most important journals of the period for sound technicians that « the condenser and carbon types of microphone have been developed to a point where there is little to choose between them from the standpoint of quality of transmission »/8.

The very same article, however, explains the difference that opens the way to broad acceptance of the condenser microphone—and with it the beginning of the second important period of cinema microphone technology. For Jones, and for the profession at large, the carbon mike has a noise level simply too high for modern standards. Indeed, though the carbon mike remains vital to telephone, public address, and other voice transmission systems, it has totally disappeared from the Hollywood scene, to the point where its existence is not even mentioned in post-war studio microphone reviews/9.

First developed by A.E. Dolbear in 1881, the condenser transmitter was abandoned because of the low level of signal current produced. With the development of the Audion (vacuum) tube, capable of ampli-

/7. I.W. Green and J.P. Maxfield, « Public Address Systems », *Transactions of the American Institute of Electrical Engineering* 42, April 1923, 347-58.

/8. W.C. Jones, « Condenser and Carbon Microphones—Their Construction and use », JSMPE 16, Jan. 1931, 3-22; same title in *Bell System Technical Journal* 10, 1931, 46-62.

/9. E.g. the Frayne and Olson histories in notes 5 and 6 above.

fying faint signals to usable levels, the condenser transmitter began a second life, as substantially modified and perfected by Wente for Bell Labs during and immediately following World War I /10. Based on the principle of varied capacitance between two plates, the condenser microphone applies a direct current through a high resistance to a fixed plate and a vibrating diaphragm. As the diaphragm vibrates in response to changes in sound waves, the varying distance between the two plates produces a change in capacitance which results in voltage variations across the resistor. Developing an extremely high impedance, the condenser mike needs amplification close to the mike (studio versions from the early thirties on actually included the first-stage amplifier right in the microphone housing). The development of quality condenser transmitters thus remains throughout their history closely tied to advances in amplification technology/11. Not surprisingly, most improvements of the condenser mike were the result of Bell Labs overall impedance, increased damping without increasing overall impedance by cutting grooves in the damping plate, development of a miniature version designed to reduce cavity resonance and directional response/12.

In spite of the importance of the condenser microphone's major attribute—its nearly negligible noise level as compared to the carbon mike—its numerous minor shortcomings eventually led to the development of competitors. Somewhat unwieldy with its incorporated first-stage amplifier, mildly directional above 2000 cps, having a marked response peak at 3000 cps, and particularly sensitive to wind pressure, the condenser microphone nevertheless ruled the Hollywood roost from the end of the twenties to about 1933. It was replaced in part by another product of Bell Labs research, the dynamic or moving coil microphone. First developed by Siemens in 1877, but abandoned like the condenser transmitter until the availability of modern amplification, the moving coil microphone was brought up to commercial specifications by the same Bell team that had developed the condenser

---

/10. See E.C. Wente, « A Condenser Transmitter as a Uniformly Sensitive Instrument for the Absolute Measurement of Sound Intensity », *Physical Review* 10, July 1917, 39-63, and « Electrostatic Transmitter », *Physical Review* 19 (May 1922), 498-503.

/11. See for example the description of Western Electric's new 47-A amplifier in H.C. Curl, « Amplifier for Condenser Transmitter », *Bell Laboratories Record* 6, June 1928, 329-32.

/12. For more detailed descriptions of these improvements, see E.C. Wente, « Contributions of Telephone Research to Sound Pictures », JSMPE 27, Aug. 1936, 188-94 ; as well as the Clark (p. 83) and Frayne (p. 38) references mentioned in notes 4 and 5.

mike : E.C. Wente, A.L. Thuras, and W.C. Jones/13. The moving coil after which the microphone is named is attached to the diaphragm, thus vibrating with the diaphragm in response to sound waves. Located in a strong permanent magnetic field, this coil has an electromagnetic force induced in it, thus producing an electrical current proportional to the velocity of the coil and thereby to the sound pressure of the voice activating the diaphragm. As such, the moving coil microphone reveals a marked response peak at 1000 cps, but the use of acoustic networks developed by Wente and Thuras reduces that peak, producing a nearly flat response from 35 to 10,000 cps.

Since the moving coil mike is less subject to wind noise than the condenser, since it has a significantly lower impedance, since it produces a signal ten decibels stronger than the condenser mike (thus doing away with the need for an incorporated first-stage amplifier, therefore reducing the overall size of the microphone housing), and since it shows a markedly flatter response, it seemed destined to capture immediately and permanently the important sound motion picture market. Its one drawback (in the early thirties Western Electric model 618A version) was a tendency toward directionality over 2000 cps, but even this was corrected by Western Electric's late thirties miniature model, the 630A, which extended the range to 30-15,000 cps and countered the diffraction effects which had produced the earlier mike's directionality/14. By the mid-thirties, however, Western Electric's west-coast marketing outlet, Electric Product Research, Inc. (ERPI), had lost a major share of its business to a still more sensitive microphone with an even flatter response.

Designed by Harry F. Olson in 1931 for RCA, the ribbon microphone generates its signal from the difference in pressure existing between the two sides of a ribbon vibrating freely in a magnetic field. This difference in pressure produces an electro-magnetic force in the ribbon which, thanks to the low overall impedance associated with this arrangement, compares favorably to that of the condenser and dyna-

---

/13. On the moving coil microphone, see E.C. Wente and A.L. Thuras, « Moving-Coil Telephone Receivers and Microphones », *Bell System Technical Journal* 10, Oct. 1931, 565 ff ; and W.C. Jones and L.W. Giles (also Bell engineers), « A Moving Coil Microphone for High Quality Sound Reproduction », JSMPE 17, Dec. 1931, 977-93 ; as well as B. Leuvelink, « Mountings, Connectors, and Amplifier for Moving-Coil Microphone », *Bell Laboratories Record* 10 (May, 1932), 323-26 ; A. L. Thuras, « A Sensitive Moving-Coil Microphone of High Quality », *Bell Laboratories Record* 10 (May, 1932), 314-18 ; and R.A. Miller, « The 80A Amplifier » (developed by Bell for the moving coil mike), *Bell Laboratories Record* 12 (Oct. 1933), 60-62.

/14. R.N. Marshall and F.F. Romanow, « A Non-Directional Microphone », *Bell System Technical Journal* 16, July 1936, 405-23 ; also Frayne, 1949, p. 42 ; and Olson, 1976, pp. 221-22.

mic microphones. Sometimes incorrectly called a «velocity» microphone (based on the notion that the ribbon responds to the velocity of the sound wave, which is true, but this characteristic is shared by all transducers and is thus not specific to the ribbon mike), RCA's new microphones (model 44A introduced in 1931 and 44B in 1940) are more correctly termed «pressure gradient», because the microphone's response depends on the pressure gradient at the ribbon/15. While the literature of the time vaunts a wide variety of qualities associated with the ribbon mike, more recent commentators dwell on three fundamental characteristics: its extraordinarily flat response characteristic, from 30 to 15,000 cps, its potential for providing extremely high sensitivity (given the low mechanical impedance of the duralumin ribbon), and above all the ribbon mike's bidirectional characteristic. Since the effective surface of the ribbon is dependent on the angle from which the sound arrives at the ribbon (just as any flat surface seems broader, i.e. subtends a larger angle, when viewed straight on than when seen at an angle), the pressure differential varies from a maximum for all sounds arriving at right angle to the ribbon to no differential at all for sounds originating in the plane of the ribbon. The typical response is thus that of the figure eight, with sounds both front and back being picked up, but sounds to the side having no effect.

With the broad adoption of directional microphones by the midthirties, we enter into an entirely new era of sound collection. While the ribbon microphone was discovered to have a characteristic middle-frequency hum, thus largely removing it from the arena of dialogue recording and relegating it to the music studio/16 —where even today as RCA model BK-11A it reigns supreme— the ribbon microphone has enjoyed over half a century of success. From the midthirties on, however, it has shared the limelight with a series of other directional microphones, created or inspired by Olson and his RCA associates. Unidirectional, rather than bidirectional like the original ribbon mike, these microphones combine the principles of the omnidirectional pressure ribbon microphone and the bidirectional pressure-gradient ribbon mike, with the output voltages of the two connected in series, thus reinforcing sounds coming from the front but canceling all sounds coming from the rear since these are out-of-phase by 180° for the two

---

/15. The earliest mention of the ribbon microphone that I have been able to locate is in the Motion Picture Herald 102, Jan. 24, 1931, p. 42. Olson's first article. «The Ribbon Microphone», JSMPE 16, June 1931, 695-708, is followed by «Mass Controlled Electrodynamic Microphones: The Ribbon Microphone», *Journal of the Acoustic Society of America* 3, July 1931, 56-68. See also the relevant portions of Clark, 1938, Frayne, 1949 and Olson 1976.

/16. On this problem see Clark, 1938, p. 86, and Olson, 1976, p. 222.

systems. The resultant area of sensitivity is of cardioid shape/17. First commercialized by RCA as model 77A in 1933, the unidirectional microphone was an immediate success which, since it had been fully developed by Olson and his associates at RCA, could not be copied by Western Electric until their engineers created an alternate (and thus patentable) method of achieving similar results based on their own moving coil principle. This work resulted in the Western Electric model 639-A first commercialized in 1939/18. A single element unidirectional microphone was marketed as the Shure Unidyne in 1941/19. The single element design soon led to polydirectional mikes like RCA's model 77C, which could be readily switched among omnidirectional, bidirectional, and unidirectional settings/20. Post-war research into axial and uniaxial microphones continues the directional impulse which characterizes RCA's activity throughout the thirties, embodied in the storied figure of University of Iowa Ph. D. Harry F. Olson, whose creative activity spans the half-century since the coming of sound/21.

From an engineering standpoint, the advent of directional microphones represents a change in basic approach to the problem of securing high-quality recordings. Throughout the « Bell » period, dominated by the creative and rhetorical efforts of Maxfield and Wente, the dominant strategy appears to have been to reduce unwanted signals (noise, directional effects, response peaks, cavity resonance, diffraction effects, and so forth) through advances in engineering. Following the principles outlined by Maxfield in his 1925 essay, « Sound Recording and Reproducing : An Epochal Advance in Theory and Practice »/22, Bell engineers abandoned the cut-and-try approach traditionally associated with Thomas Edison in favor of a

---

/17. Curiously, Olson is not the primary author of the article which first presented unidirectional microphones : Julis Weinberger, Harry F. Olson, and Frank Massa, « A Uni-Directional Ribbon Microphone », JASA 5, oct. 1933, 139-47, though he is of a later, more technical article, « A Unidirectional Microphone », JSMPE 27, Sept. 1936, 284-301. See also J.P. Livadary and M. Rettinger, « Unidirectional Microphone Technic », JSMPE 32, April 1939, 381-89, as well as the relevant portions of Clark, 1938, Frayne, 1949, and Olson, 1976.

/18. Described by R.N. Marshall and W.R. Harry, « A Cardioid Directional Microphone », JSMPE 33, sept. 1939, 260ff.

/19. Olson, 1976, p. 224.

/20. Olson, 1976, p. 224.

/21. On axial and uniaxial microphones, see Olson 1976, pp. 225-26, as well as Olson's other most recent publications : *Modern Sound Reproduction,* New York, Van Nostrand Reinhold, 1972, and « *Microphones for Recording* », JAES, Oct.-Nov. 1977, reprinted in the JAES microphone anthology mentioned in note 6, pp. 229-37.

/22. J.P. Maxfield, « Sound Recording and Reproducing : An Epochal Advance in Theory and Practice », *Bell Laboratories Record* 1, Nov. 1925, 95-101.

theoretical approach to problem solution. While the adoption of this approach at Bell Labs during the twenties no doubt marks the very beginning of modern industrial research, its drawbacks deserve to be noted. From carbon to condenser to moving coil microphone, Bell engineers succeeded extraordinarily well in maximizing the power of desirable signals (e.g. by increasing the signal-to-noise ratio, by reducing the weight and thus the impedance of the condenser mike diaphragm, by designing more powerful and faithful amplifiers and loudspeakers), yet their « scientific » approach appears to have reduced the field of their inquiry artificially, somewhat after the manner of Inspector Dupin in Poe's justly famous « Purloined Letter ».

While Bell engineers were scouring the engineering world for ways of reducing unwanted signals and enhancing the quality of desirable signals, at RCA Olson was looking in the obvious place for a solution to the same problems. Instead of assuring a high-quality signal by reducing distortion in the pick-up system (as Bell continued to do), why not design a method of aiming the microphone right at the desired sound source, thus eliminating numerous unwanted sounds ? As early as 1929, Olson and his RCA colleague Irving Wolff had designed a sound concentrator for microphones which had the effect not so much of increasing the desired signal itself, but of reducing undesirable noises deriving from off-axis sources/23. A year later, a clear example of the usefulness of this device is provided by Carl Dreher (who, as head of RKO's sound department, enjoyed a privileged relation with the parent RCA company). Recording in a noisy railroad roundhouse, only with the help of a parabolic sound concentrator was RKO able to obtain intelligible dialogue for its 1930 feature *Danger Lights*/24. Like the mobile microphone boom developed by MGM and soon generalized/25, the sound concentrator provided a mechanical method of increasing the overall signal-to-noise ratio, a method automatized with the directional microphone. Without losing any of the advantages which engineering had given to Western Electric equipment, RCA's directional microphones added a new method of assuring even higher quality recording.

This rapid survey of two decades of progress in microphone technology does little justice to a complex field which deserves to be treated far more broadly (other countries, other media—especially radio and

---

/23. Harry F. Olson and Irving, Wolff, « Sound Concentrator for Microphones », reported on at the January 1930 meeting and published in JASA 1, April 1930, 410-17.

/24. Carl Dreher, « Microphone Concentrators in Picture Production », JSMPE 16, Jan. 1931, 26.

/25. See Elmer C. Richardson, « A Microphone Boom », JSMPE 15 (July 1930), 41-45.

phonograph). Nevertheless, it perhaps provides an appropriate summary from the engineer's point of view. At every point, the driving forces of technological innovation appear to be fidelity and convenience. One of Olson's numerous books explains this point of view particularly clearly. Indeed, it is particularly appropriate that the principles are enunciated by Olson rather than by Bell personnel, for given his less theoretical approach to certain problems it might be assumed that his goals in some way differed from those which characterize the Bell engineers who provided the sound industry with its major impetus throughout the first third of this century. Yet no such difference appears. In 1934 Olson declares : « The primary object of sound reproduction is the elimination of distortion and the reproduction at the listeners' ears of sound waves identical in structure with those given out at the source »/26. Repeated in nearly every basic text on sound recording, this claim is the sound engineer's basic assumption, his primary article of faith. As the above summary of microphone developments demonstrates, Olson's version of the « primary object of sound reproduction » provides a necessary and perhaps sufficient explanation of two decades of striving for more perfect sound reproduction. One microphone replaces another because it provides a more complete approximation to the ultimate goal of the reproduction of sounds « identical » to their source.

II

Even within what might be termed the « engineering » approach to microphone development, however, there appear certain anomalies that reveal other forces at work. In the past decade we have learned to read artistic texts symptomatically, recognizing in their gaps, their fissures, their inconsistencies, the mark of another discourse, of another voice. We must learn to read the text of history in precisely the same manner. Instead of perpetuating the time-honored rhetoric whereby exceptions and contradictions are hidden in order to preserve a clear and unified argument, we must learn to concentrate on those very inconsistencies, recognizing in them the potential signs of another signifying system, of another explanatory principle. Why is it, for example, that in 1926 Maxfield nonchalantly reports the choice of the condenser microphone for Bell's new high-quality recording system, when just three years earlier he had painstakingly elaborated all the

---

/26. Harry F. Olson and Frank Massa, *Applied Acoustics*, Philadelphia, P. Blakiston's Son, 1934, p. 418.

reasons for choosing the carbon transmitter over the condenser for Bell's renowned public address system ?/27. Yet in October of that same year a demonstration film of Bell's new Vitaphone sound-on-disc system was shown to the New York Electrical Society, depicting Edward B. Craft speaking into the familiar double-button carbon transmitter/28. By what logic does Carl Dreher, chief sound engineer for RKO insist on placing « the microphones close to the actors, say between two and five feet » in 1929, yet champion the use of distant microphones, accompanied by microphone concentrators barely a year later ?/29 What justifies the repeated attempts to reduce the proportion of reflected sound (by constructing three-walled roofless sets, by reducing studio and theater reverberation time, by devising directional microphones) in light of the industry's stated desire to reproduce the sound as it was originally emitted ? How do these same vows of strict fidelity square with the studios' early acceptance of overt deception : « Since the reproduction of sound is an artificial process », opines Dreher in 1931, « it is necessary to use artificial devices in order to obtain the most desirable effects. For example, it is normal procedure to reproduce dialog at a level higher than the original performance »/30. And why is it that engineers throughout the thirties call for a careful matching of auditory to spatial perspective, yet their practice rarely reflects their stated goals ?/31. These and many other inconsistencies might reasonably lead the revisionist historian to one of three

---

/27. J.P. Maxfield, « Methods of High Quality Recording and Reproducing of Music and Speech Based on Telephone Research », *Bell System Technical Journal* 5, July 1926, 500 ; compare to Green and Maxfield, « Public Address Systems » (see note 7).

/28. « The Vitaphone Tells Tales of Itself », (unsigned article), *Bell Laboratories Record*, Dec. 1926, 126-28.

/29. Dreher, « Stage Technique in the Talkies », *American Cinematographer* 10, Dec. 1929, 2-3, 16, 16 (reprinted from *Radio News*) ; compare to Dreher, « Microphone Concentrators in Picture Production », JSMPE 16, Jan. 1931, 23-30.

/30. Dreher, « Recording, Re-recording, and Editing of Sound », JSMPE 16, June 1931, 756-65.

/31. On the general call for matching of auditory to visual perspective, see especially the numerous comments of J.P. Maxfield, « Acoustic Control of Recording for Talking Motion Pictures », JSMPE 14 (Janv. 1930), 85-95 ; « Technic of Recording Control for Sound Pictures », *American Cinematographer* 11, May, 1930, 11-12, 18, 24, 44 (reprinted in numerous other places) ; « Pick-up for Sound Motion Pictures (Including Stereophonic) », (with A. W. Colledge and R.T. Friebus), JSMPE 30, June, 1938, 666-79 ; as well as later comments on the success of acoustic perspective experiments, e.g. John G. Frayne, *Elements of Sound Recording*, New York, John Wiley, 1949, pp. 52-57. A general study of the problem of acoustic perspective, companion piece to the present article, was presented at the 1984 Semiotic Society of America meeting in Bloomington, Indiana. [NDLR : Comparer aussi avec l'analyse de François Jost, infra].

familiar hypotheses about the true forces underlying the more obvious « engineering » explanation of microphone development.

A Realist Reading

One of the clichés repeated by engineers in the early thirties involves a comparison between binaural and monaural hearing. When we listen to sounds directly, in the real world, our binaural auditory system helps us to choose those sounds that we prefer to hear. By directing our hearing toward a specific sound we cut down on the effective level of reflected sound, thus maximizing the amount of direct sound heard. We can recognize this fact easily, claims this familiar argument, by covering one ear and attempting to concentrate on a specific sound ; when we do so the reverberation level is markedly increased and our understanding of any particular sound clearly diminished/32. More fully explained in 1950 by Colin Cherry and dubbed the « cocktail party effect »/33, the individual's ability to listen selectively is destroyed by a monaural reproduction system, such as the one adopted by early sound cinema. In particular, when any of the early omnidirectional microphones (carbon, condenser, moving coil) are used for sound collection, the reverberation level appears unnaturally high, for the omnidirectional mike picks up all sounds indiscriminately, unlike the binaural human auditory apparatus.

Read from this point of view, the history of microphone technology appears as a conscious attempt to restore to the cinema sound track a quality which the choice of a monaural system had removed. In place of the criterion of « fidelity » proffered by engineers, this explanation recognizes instead a standard of « realism » as driving the history of microphone technology. Rather than strict adherence to reproduction of an original event, this alternate explanation stresses the creation of auditory experiences sufficiently like those which we commonly accept as real. The technology of sound thus contributes to the overall effect of dissimulating its very existence, thereby helping the mediated monaural event to pass for the binaural « real thing ». Looked at in this way, the history of microphone technology takes its place within a broader tradition of research regarding auditorium acoustics and

---

/32. See, for example, George Lewin, « Dubbing and its Relation to Sound Picture Production », JSMPE 16, Jan. 1931, 38-48 ; J. P. Maxfield, « Some Physical Factors Affecting the Illusion in Sound Motion Pictures », JASA 3, July, 1931, 70ff ; Harry F. Olson and F. Massa, « On the Realistic Reproduction of Sound with Particular Reference to Sound Motion Pictures », JSMPE 23, Aug. 1934, 63-81.

/33. See Claude Bailblé, « Le Son : Programmation de l'écoute », 3, *Cahiers du cinéma* 297, Feb. 1979, 55ff.

reverberation time/34, as well as Bell Laboratories' ongoing program of research regarding the difference between various quantities as measured and perceived/35, not to mention the repeated attempts throughout the thirties to reproduce sound in auditory perspective by binaural or stereophonic methods/36. In terms of microphone technology, the culmination of this movement toward real-seeming perception is clearly constituted by the introduction of directional microphones. Olson is quite clear about his motivation in developing directional microphones : « The discrimination against undesired sounds that can be realized with a binaural reproducing system may be attained with a single-channel system by employing a directional pick-up »/37. By cutting out camera, light, and crew noises, and by reducing random reverberation, directional mikes finally permit the selective hearing to which real binaural listening has accustomed all spectators. Fundamentally realist in nature, Hollywood cinema could not possibly achieve its illusionist goal without developing microphones capable of the selection and focus characteristic of its cameras. Microphone technology is thus at the service of and is explained by a need for realism growing out of the shortcomings of the basic apparatus.

/34. The research on auditorium acoustic and reverberation time was well known to and often quoted by cinema sound engineers during the twenties and thirties. The most important figures in this tradition are Wallace Clement Sabine, *Collected Papers on Acoustics,* Cambridge, Harvard Univ. Press, 1922 ; Floyd Rowe Watson, *Acoustics of Buildings,* New York, Wiley, 1923 ; and Vern O. Knudsen, *Architectural Acoustics,* New York, Wiley, 1932, whose teaching position at UCLA made him a regular consultant to Hollywood Studios.

/35. The condenser transmitter, perfected by Wente during World War I, was one of many new measurement devices developed in support of Bell research—see Wente, « Contributions of Telephone Research to Sound Pictures », JSMPE 27, Aug. 1936, 188-94. Perhaps the most important and influential of the Bell studies was Harvey Fletcher's *Speech and Hearing,* New York, Van Nostrand, 1929, which distinguishes, among many other things, between those properties of speech sounds which contribute to intelligibility and those which contribute to a sense of naturalness (p. 281).

/36. Not surprisingly, Bell took the lead here as well, in stereo transmission (the April 27, 1933, Philadelphia Philharmonic stereo transmission to Washington's Constitution Hall is reported in nearly identical series of articles in *Electrical Engineering* 53, Jan. 1934, and the *Bell Laboratories Record* 12, March 1934), in true binaural reproduction (for example the New York World's Fair demonstrations with the binaural dummy dubbed « Oscar » —see Harvey Fletcher, « An Acoustic Illusion Telephonically Achieved », *Bell Laboratories Record* 11, June 1933), and in stereo cinema sound track reproduction (see, for example, J.P. Maxfield, « Demonstration of Stereophonic Recording with Motion Pictures », JSMPE 30, Feb. 1938, 131-35). These experiments, as well as many others, are chronicled in a forthcoming book on stereo technology by Rick Altman, Phil Beck, Greg Easley, and Pieter Pereboom.

/37. Olson and Massa, « On the Realistic Reproduction... » 1934, p. 67.

An Ideological Reading.

One might well begin to sketch out one possible ideological reading of the development of microphone technology by noting the frequent appeal made in the technical literature to that which is natural, normal, or original. Used as justification for practices which have nothing of the natural about them, these terms betray the presence of the fundamental rhetoric on which all ideology is based : presenting the cultural as natural. The summary of the binaural/monaural argument provided by Olson and Massa in their important 1934 article affords a particularly clear view of the stakes of such a strategy/38. In a short section entitled « Use of a Directional-Sound-Collecting System for Discriminating against Sounds Incidental to the Action », the authors note that « When one listens normally with both ears he is able to focus his attention on the main source of action and subconsciously attenuate incidental noises that may be present. In single-channel sound reproduction, it is important that the same emphasis be placed on the main action and a corresponding discrimination be made against the incidental sounds. In those respects the directional collecting system possesses distinct advantages » (pp. 70-71). There follows an example demonstrating the use of directional miking to concentrate attention on one table out of three in a restaurant, the one that « the action centers about ». The section concludes with the following confident pronouncement : « This example illustrates how 'a center of gravity' of the recorded sound can be established comparable with the 'center of gravity' of the action » (p. 71).

The rhetoric of this passage is exemplary. Beginning with the well known (but not necessarily relevant) physical fact termed above the « cocktail party effect », Olson and Massa start down the path which led to our previous « realist » reading : in order to reproduce the sensation of « normal » hearing we must have recourse to directional sound collection. However normal this type of hearing may be (one wonders whether the cocktail party effect is not a function of what might well be termed a « cocktail party society »), Olson and Massa use its supposed normality to great effect, introducing through the notion of « normal » listening the (supposedly) equally normal notions of « the main source of action » and « incidental noises ». These phrases are carefully kept impersonal in the first sentence —even though they clearly apply to the listener's choice of focus— in order to permit a clever transfer in the second sentence, where they are again used impersonally, but this time can refer only to the decisions made by the filmmakers and not to any choices made by the audience. The circle is

---

/38. Olson and Massa, « On the Realistic Reproduction... » 1934, pp. 70-71.

closed (the trap snaps shut) when we return in the final summary sentence to the well known physical notion of «center of gravity». Though Olson and Massa carefully disguise the notion of narrative interest behind an apparently incontrovertible fact of nature (after all, doesn't everything have a center of gravity ?), the center in question is quite clearly the one which is identified by the camera (as the accompanying diagram makes abundantly clear). From «normal» hearing to the «facts of nature», every device is used to make directional miking appear ineluctable — and with it a notion of sound perception assuming that sound sources can be split into important and incidental components.

Behind the increase in realism due to the introduction of directional microphones, an ideological reading might properly claim, lies a covert privileging of a certain kind of narrative (and of narrative in general). Between so-called normal hearing, with its selectivity, and the selectivity represented by directional miking, there lies a narrative function introduced by the need to *choose* the direction in which the mike will be aimed. While this mode of directional listening perhaps resembles normal binaural listening, it differs in that it does the listening *for* the spectator. Introducing a hidden narrative function, directional miking thus destroys the auditor's individual relation to events, reducing all auditions of a particular scene to a common version chosen by the sound crew in conjunction with the director and scenarist. It is precisely this narrative function of directional miking, substituting the sound man's selectivity for the spectator's, that Godard so effectively foregrounds in his films of the sixties and early seventies. Using omnidirectional microphones in café scenes where carefully placed directional mikes had become the rule, or aiming directional mikes in the «wrong» (i.e. unexpected, unconventional, self-revealing) direction, films like *Masculin féminin* implicitly make a similar ideological critique of directional microphones.

While space does not permit full discussion of the topic here, it would undoubtedly be fruitful to follow this ideological reading in two complementary directions. In particular, attention should be focused on the various devices created throughout the thirties to assure comprehensibility of dialogue when other tracks were also present (music, effects, etc.). From ERPI's «up-and-downer» in the early thirties (a device automatically controlling the dialogue/music balance, used by Warner as early as late 32 or early 33 but not generally distributed until late 33 or early 34)/39, to the automatic dialogue compression of the

/39. See «Progress in the Motion Picture Industry : Report of the Progress Committee», JSMPE 22, June 1934, 360 ; and W.A. Mueller, «A Device for Automatically Controlling Balance Between Recorded Sounds», JSMPE 25, July 1935, 79-86.

late thirties/40, the decade is flooded by devices which complement the directional microphone in an attempt to recognize and support a narrative «center of gravity». A second area which deserves attention is the industrial substructure which concentrates narrative choice in the hands of a few powerful studios, producers, and production personnel. The selectivity and concentration provided by directional miking does not arise or succeed in a vacuum. A more thoroughgoing ideological reading would certainly have to deal with this problem more fully.

An Economic Reading.

However illuminating they may be in regard to reality perception or subject positioning, the «realist» and «ideological» readings remain entirely oblivious to the corporate context of microphone development. While the dossier on industrial dealings in the twenties and thirties is too incomplete to permit any conclusions at this point, understanding of the history of microphone technology nevertheless requires at least a schematic placing of technological developments within the broad background of corporate concerns. Indeed, the championing by RCA of Olson's directional mike against the wide range of omnidirectional mikes developed by Bell affords a unique opportunity to witness on a small scale the clash of two corporate giants of the communications world. Though this is not the place to detail the rise of AT&T, its research facilities (especially the world-renowned Bell Laboratories), and its marketing subsidiaries (including Electrical Research Products, Inc., the Western Electric cinema sound system outlet), or the Rockefeller support behind the competing General Electric/Radio Corporation of America complex, it is worth recalling here some of the circumstances surrounding the major economic shift associated with the widespread adoption of RCA's directional microphones. Two domains in particular seem worthy of further investigation.

1 - When RCA was formed in 1919, AT&T was already a corporate giant, growing at a dizzying pace along with the spread of modern communications. Within the following decade, AT&T subsidiaries had made extraordinary advances in numerous areas, in particular those that depended on AT&T technology developed for the tele-

/40. See J.O. Aalberg and J.G. Stewart, «Application of Non-Linear Volume Characteristics to Dialog Recording», JSMPE 31, Sept. 1938, 248-55; and W.A. Mueller, «Audience Noise as a Limitation to the Permissible Volume Range of Dialog in Sound Motion Pictures», JSMPE 35, July 1940, 48-58.

phone, disc, and public address domains/41. In a world where the broadcast media were soon to rule the roost, however, it is perhaps significant that AT&T companies at least three times during the twenties took a conservative approach to new technologies. Faced with the challenge of radio, AT&T continually spoke of the new invention as if it were but an extension of the telephone. « Radio telephony » and « toll broad-casting » are the terms used to tame, as it were, the threat of radio/42. With a different approach, RCA had within a decade created the NBC networks and taken hold of a new field, recognized as new and treated accordingly. In the area of phonograph technology, a similar difference in approch reigned. Though much is new in the Orthophonic Victrola which Bell perfected in the mid-twenties, there is a surprising fidelity to the already outmoded replaceable stell stylus/43. Nor were AT&T subsidiaries particularly good in capitalizing on the new victrola. Yet, by 1930 RCA was merging with Victor and cornering the market not only on traditional distribution but on record clubs, long-playing records, and juke boxes as well. In the cinema world, Bell is of course the home of sound-on-disc, a system characteristic of a company which seems to have made a career —albeit a distinguished one— of pushing every old technology just as far as it can be pushed, and thus always reacting to every new problem by looking around the lab to find some old solution. For a company controlling AT&T's portfolio of patents, such an approach is perhaps neither unexpected nor unwise, but it does open the way to a younger, smaller company willing to take a chance on a new approach. It is no great surprise, then, that RCA's variable-area sound-on-film system eventually takes over the Hollywood field. While Olson's directional microphones were replacing Western Electric's omnidirectional models, studio after studio was converting to the RCA system : Disney in January, 1933, Republic in October, 1935, Warner in June, 1936, Columbia in May, 1936/44. Looked at from this standpoint, Bell's efforts in microphone development clearly appear as a concerted

---

/41. For a résumé of these developments (though from a particularly in-house point of view), see Frank H. Lovette and Stanley Watkins, « Twenty Years of 'Talking Movies'; An Anniversary, « *Bell Telephone Magazine,* Summer 1946, 82-100.

/42. Erik Barnouw, *Tube of Plenty : The Evolution of American Television,* New York, Oxford Univ. Press, 1975, p. 43.

/43. Oliver Read and Walter Welch, *From Tin Foil to Stereo : Evolution of the Phonograph,* Indianapolis and New York, Howard W. Sams and Bobbs-Merrill, 1976, second edition, pp. 237-54.

/44. Edward W. Kellogg, « History of Sound Motion Pictures », 2, JSMPTE 64 (July 1955), reprinted in Raymond Fielding, ed. *A Technological History of Motion Pictures and Television,* Berkeley, Univ. of California Press, 1967, p. 187.

attempt to milk the last bit of usefulness from devices earlier developed for telephone and measurement purposes/45.

2 - The model of communication proper to the AT&T/Bell enterprise is of course a discursive one : party A has a message to communicate to party B; AT&T provides the technology permitting A to speak directly to B. At its most obvious in the traditional telephone/telegraph complex dominated by Bell, this arrangement is visible as well in the public address market which Western Electric cornered with its showy national events of the postwar period. While phonography dispenses with one half of the sender-receiver pair, it nevertheless provides little challenge to the company's discourse orientation. Though RCA was conceived in a period still characterized by a discourse approach to radio (ship-to-shore, military, amateur), it soon abandoned the direct discourse of the communications complex for the representational stress of the broadcast field. For radio, the twenties are a period of intense growth in dramatic programming, culminating with the spread of dramatic serials in the late twenties and early thirties. A decade later, a second version of this progression begins under the leadership of the RCA-controlled NBC television network. The difference in orientation between the two corporate complexes is particularly clear in the application of microphone technology to theater sound reinforcement systems. Typically, Bell's approach to the problem of theater sound reinforcement (a requirement which the crystal-clear dialogue of the talkies seems to have forced on the legitimate theater) involved the application to the theater of mikes developed for public address. As Olson shows repeatedly, however, it takes a directional microphone to avoid the problem of feedback in a proscenium stage situation/46. Because directional mikes are designed for a representational rather than a communicational situation (the Hollywood sound stage), they are readily adaptable to other representational situations, while Western Electric's telephone technology never quite succeeds.

As sketchy as these remarks must remain at this point, both for lack of space and my own limited knowledge of the full AT&T/RCA situation, it appears to me evident that the two giants—at least in the realm of sound technology—approach problems in a radically different manner. The directional microphone introduces a hidden narra-

/45. Indeed, they are presented as just that by Wente in his review of « Contributions of Telephone Research to Sound Pictures », JSMPE 27, Aug. 1936, 188-94.

/46. See, for example, Weinberger, Olson, and Massa, « A Uni-Directional Microphone », JASA 5, Oct. 1933, 139 ; and Olson and Massa, *Applied Acoustics*, Philadelphia, P. Blakiston's Son, 1934, pp. 363-65.

tive function ideally suited to support the voyeuristic tendencies characteristic of Hollywood in general/47. As such it provides the perfect correlate to RCA's overall preference for mass media narrative events over AT&T's traditional involvement with minimally mediated person-to-person discourse.

End of part. I.

L'histoire de la prise de son au cinéma —et tout particulièrement des diverses sortes de microphones introduits pendant les années trente— est racontée ici selon plusieurs hypothèses différentes. La parole est d'abord aux techniciens, selon lesquels les micros directionnels auraient été introduits uniquement pour assurer une meilleure fidélité de la reproduction sonore. Trois autres points de vue possibles sont ensuite considérés : réaliste, idéologique et économique.

Une dernière partie (à paraître dans le prochain numéro) proposera une nouvelle approche de ces dossiers à partir de l'analyse du système de la représentation sociale hollywoodienne.

/47. On this point see especially Christian Metz, « Histoire / Discours (Note sur deux voyeurismes) », in *Le Signifiant imaginaire*, Paris ; 10/18, 1977.