



UMEÅ UNIVERSITY

SOUND OUT OF TIME

Signal Archaeology of Swedish Public Service Radio 1980–1999

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Dissertation for PhD

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Foreword

Though I have a knack for complaining, I have made it a habit to express gratitude for my doctoral studies on granted occasions. Over five years, much can happen, both personally and globally; yet, throughout this half-decade, the opportunities provided by this position have remained a constant beacon of light in my life. Thus, it feels fitting to eternalize this gratefulness in print as well.

The reason ultimately boils down to one simple thing: the inspiring dialogues I've been fortunate to have with friends, colleagues, and family. If there is one essential lesson I've learned during these five years, it is precisely that nothing interests me more deeply than the opportunity to converse – in the most mundane as well as the most abstract ways – about topics that capture my curiosity. The individuals with whom I have had the great joy of speaking to over the past years come from both within and outside academia and are far too numerous to mention comprehensively here. Hopefully, you recognize yourselves.

Nevertheless, a brief list of specific thanks is due – not to establish any hierarchy of gratitude – but because certain contributions have been particularly essential to the realization of this project.

First and foremost, I want to explicitly thank both of my supervisors, Pelle Snickars and Johan Jarlbrink, for putting their faith in me and my strange projects. I could not imagine better guidance and companionship on this journey toward becoming part of the scholarly community. Additionally, my heartfelt thanks go to my stalwart partner in crime, Zakayo Kjellström, without whom my academic journey would have been far bleaker and unhealthier.

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Special thanks are due for the inspiring feedback from intellectual environments at various departments, including The Department of Culture and Media Studies at Umeå University, the Department of Musicology and Media Science at HU Berlin, metaLAB at Harvard, The Digital Theory Lab at New York University, and the Gothenburg Research

Infrastructure in Digital Humanities (GRIDH) at the Department of Literature, History of Ideas, and Religion, University of Gothenburg.

Lastly, and perhaps most importantly, I want to thank my wonderful friends and family, whose voices, laughter, murmurs of concern, grumbles of confusion, and buzz of excitement – among other sounds – have composed the accompaniment to this journey. None of this would have been possible without you.

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Abstract

This dissertation provides a novel analysis of Swedish radio broadcasting by applying digital signal processing techniques to archived audio from 1980 to 1999—a critical era marked by the shift from a monopolistic public service to commercial competition. By directly examining recorded radio sounds, the study reveals the auditory consequences of this transition, offering new insights beyond traditional, text-focused media analyses. Utilizing the extensive Swedish broadcasting archives, the research employs computational methods to dissect radio soundscapes, enriching and challenging prevailing narratives in media and communication studies. The analysis thus expands our understanding of audio as historical data.

Introducing a methodological approach termed 'signal archaeology,' the dissertation merges principles from media archaeology with cultural analytics, treating audio data as historical sources detached from strict temporal constraints. Through detailed analyses of themes such as silence, diversity, programming, and dynamic range, the research demonstrates how radio aesthetics evolved, driven by concepts like entropy from information theory, which informed notions of sonic quality and diversity. However, as demonstrated, while the overall variety of sounds increased significantly, these changes are more readily observable through frequency-based analysis than through examining their distribution over time. This indicates that variation impacted the overall sonic profile of radio more than its temporal flow. By focusing on empirical audio data, the research encourages a reevaluation of the sonic heritage of Swedish radio and inspires further methodological debate in media and cultural studies. Ultimately, the findings indicate that while technical innovations and organizational restructuring have shaped Swedish radio along expected historical lines, its sonic patterns also evolve non-linearly – foreshadowing future media trends in ways that both align with and diverge from conventional trajectories.

List of Articles

Article A1:

"Rhythms of silence: digital audio analysis of Swedish radio broadcasting, 1980-1989." *Journal of Cultural Analytics* 7.1 (2022): 108–138.

Article A2:

"Scale Exercises: Listening to the Sonic Diversity in 5000 hours of Swedish Radio with Computers and Ears." *Zoomland* (2023): 213–234.

Article A3:

"Formatted Sound: Channel Identity and Musical Variation in Swedish Radio, 1988–1999." *M/C Journal* 27.2 (2024).

Article A4:

"Speaking Amplitudes: Dynamical Variation in Swedish Radio Broadcasting, 1980–1998." *Journal of Radio & Audio Media* (2025): 1–17.

Introduction

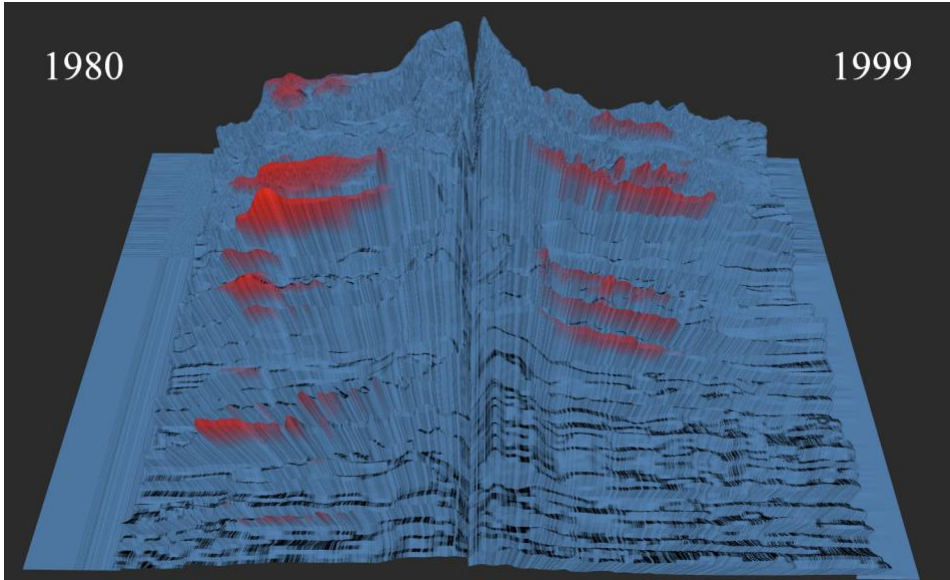


Figure 1: Two days of radio broadcasting, visualized as an experimental 3D object. The cover of this book, in turn, is the same object, printed and photographed. In this scene, frequency values determine depth, while colored peaks indicate intensity. The values from the two data streams are mirrored along the central axis to facilitate visual comparison. The left side of the visualization represents a recording of Swedish public service broadcasting from 1980, while the right side reflects a day in 1999. The depth of the image corresponds to time throughout the day, while the extensions to the left and right represent the frequency spectrum, with higher peaks indicating increased activity. Color grading is based on deviations from the average values. As the image reveals, irregular activity was both more common and more evenly distributed throughout the day in 1980.

If the past truly is a “foreign country”, then let us gaze upon its estranged soundscape.¹ You are looking at the total flow of two days of Swedish public service broadcasting – the left extensions corresponding to a date from the year 1980, and the right one, 1999. It is foreign, not only in the sense of the temporal distance from the moment of broadcasting to the moment of your gaze, but also due to its remediated visual appearance – this is not how we might expect to encounter sound. Yet, this is the nature of the sound archive: It can appear, like on the cover of this book, as a

¹ The idea of the past as a foreign country was made popular by author L. P. Hartley in a novel from 1953 and was adapted to the historical sciences by David Lowenthal in the 1980s (Hartley, 1953; Lowenthal, 1985).

photography of a 3D model of a visualization of statistical metrics of audio signals representing a sound once broadcast on the air.

And still, these jagged shapes suggest a story: they illuminate the structural texture of each broadcast day, and by examining their differences – here presented as mirror-inverted from the center outward – we can gain insight into the history of radio. The left image, representing early 1980s programming, displays a more varied pattern with irregular peaks. The visualization scheme uses shades of red to mark instances where sounds deviate significantly from the overall soundscape – and the left side displays a clear majority. These peaks reflect the music content that filled the airwaves during the morning hours of that era. On the right side, the pattern is more balanced and calmer, suggesting a predominance of similar-sounding speech content. Together, these visual comparisons help us understand how the sonic textures of morning radio differed between the early 1980s and the late 1990s. Yet there are also similarities: further along the daily timeline, deeper into the image, we see spikes aligning on both sides – a time signal and change of pace that has remained intact across the decades.

These continuities and developments in Swedish radio history – and the ways they can be analyzed beyond conventional listening practices – form the focus of this thesis. But these matters of expectations, surprises, and the metrics of qualitative radio are also at the heart of the discourse around broadcasting development during the last two decades of the 20th century. The distant perspective presented above offers only a selective glimpse into this sonic landscape – but it invites us to speculate: what surprises does this foreign country of sound hold? And what was happening to radio over these years that caused such seismic shifts in its tectonic structures?

These are some of the questions addressed in this thesis. The line of inquiry explores the synergy between media historical research and methodological advancement. It is a twofold pursuit that seeks to grant insight into what happened to broadcast content during the last two decades of the 20th-century, whilst also exploring how audio data can be further incorporated within media and communication studies. Due to a rare development in media history, it is today possible to pose such questions directly to the sonic traces of the radiophonic past. Since the inception of radio, there have been different practices for selecting and archiving important or costly segments. In certain cases, larger selections are stored temporarily for legal reasons. Yet, until 1979, radio in its entirety – in its complete flow – was not documented. This was not just

the case in Sweden but all over the world. In fact, according to the records of the International Association of Sound and Audiovisual Archives, Sweden was the very first country to mandate the legal deposit of the complete output. Thus, on a spring night in the late 1970s, machinery was activated that would go on to capture our sonic past in an unprecedented manner.



Figure 2: "Bandcentralen", the center of recording practices at SR.

At the very heart of the radio house, the headquarters of Sveriges Radio (SR henceforth), a nexus of tape emerged – this was the particular solution built for the purpose. This room, known as the central taping unit – or bandcentralen in Swedish – had previously been used for low-quality legal recordings, which were only kept for six months before being discarded.

Now, in its place, stood a wall of TEAC tape recorders lined up, working tirelessly through the night. Instead of being reused, these tapes were now sent to a brand-new archival institution, ALB (Arkivet för ljud och bild). This institution, which essentially delineates the scope of this dissertation, was the unprecedented result of an almost decade-long investigation by the Swedish government into the status of mass media. The conclusion was clear: “radio contains information valuable to the future to the same degree as newspapers” (Cnattingius, 1975).

On the 1st of June, 1978, the machinery was activated, inaugurating the transition from radio as a collection of radiophonic fragments from the past to a medium where every millisecond was preserved as information. This transformation, facilitated by this new machinery, serves as the foundation for the present dissertation. Although the technical means were not available at the time, there are strong indications that this was the archive’s intended destiny. In this new era of audiovisual archiving, sound was enthusiastically subjected to the domain of data and data analysis. This shift occurred against a discursive backdrop where radio increasingly came to be evaluated in numerical terms. Initially, this was in the form of audience statistics and transmission quality data. However, as my research demonstrates, it gradually encompassed more advanced quantitative metrics, such as entropy. Thus, the work that follows can be seen as the predestined cybernetic specter embedded in both the technologies and discourses surrounding radio in the late 20th century. I shall return to the historical radicality of these decisions, but for now, it suffices to note one important transformation – radio is, to an accumulative degree, transforming from an ephemeral transmission into archived data. Radiophonic sound, out of time, and into the timelessness of the archive.

In this state of signal data, what we refer to as radio might as well be represented as number, or as visual shapes, for that matter. For our purposes, radio can be a landscape, a shape in three-dimensional space, like the image of this cover. My contention is that media studies and the historical sciences alike have yet to fully grasp the implications of this form of source material. Audio data, understood as a type of source material based on signal values, remains at the periphery of humanities research, with only a select few innovative examples emerging in recent years.² More specifically, the existence of vast, comprehensive archives opens up a new set of empirical inquiries. We are, in essence, dealing with something akin to an archive of media flow, rather than isolated sounds.

² See, for example, Föllmer, (2016), Clement, McLaughlin (2016), Have, Enevoldsen (2021).

Although Sweden pioneered the construction of this type of archive, it represents an empirical source that is accumulating globally. As modern historiography grapples with the increasing volume of audiovisual sources generated by 24-hour broadcasting and today's continuous media production, it invites us to pursue new lines of historical thinking.

The types of questions that can be posed to audio recordings may differ from those directed at textual materials, just as the questions applicable to archives of media flow may diverge from those for specific documents. Identifying these questions and operationalizing them within the scope of media and communication studies comprises the methodological challenge of this research. In doing so, my hope is to contribute to media studies and the particular scope of radio history, as well as to the development of computational methods within humanities scholarship – what is widely referred to as digital humanities. In both cases, my work positions audio data in a central position. Within the context of media and communication studies, this entails an approach that combines quantitative and qualitative analysis of the broadcast material. In terms of computational humanities, the contribution is rather framed as the proposition and theoretical foundation of new methods for sound analysis.

At the heart of this project lies the media historical inquiry into how, and to what extent, sound media content is influenced by contextual shifts. More specifically, our focus will be on how the sounds of radio are impacted by the transition from a monopolistic, non-commercial framework to a dual system introducing commercial competition. The investigation of how such conditional factors shape media systems is a foundational question within the field of media studies. However, this question has rarely been explored within the content of sound media itself. It is at this juncture that my dissertation aims to make a contribution. Through four articles that utilize data from the former ALB archive, I explore a range of stylistic and radiophonic questions by analyzing the archived signals – the tangible remnants of actual sonic output. By engaging in Sweden's unique historical circumstances through innovative methods, this work contributes both to the methodological advancement of media and communication studies and to our historical comprehension of the transformations within public service broadcasting during the final two decades of the 20th-century.

Bluntly summarized, the period between 1980 and 1999 was marked by significant transformations within Swedish society at large, with media situated at the center of this history. This is an important matter for

current theories of media ecology, as well as for the specific broadcasting history of Sweden (Ahlkvist & Faulkner, 2002). These last decades of the 20th century are usually associated with the decline of the welfare state, as well as the emergence of digital media (Korpi, 2003). As previous research has highlighted, the Nordic countries maintained a long-standing resistance to the marketization of broadcasting, ensuring that public service media retained a central role in society well into the end of the century (Papathanassopoulos, 2023: 44). This history remains a valuable resource for understanding how such approaches shaped media content in contrast to market-driven production.

By listening and processing broadcast audio in light of the historical themes of competition, decentralization, quality, and diversity, this dissertation explores how mediated sound was formed by this historical development. Such an endeavor sits in the middle of media and communication studies and digital history; thus, the dissertation seeks to contribute to both fields alike – and grant new insights into the development of radio aesthetics, as well as the methods by which such matters can be explored.

These articles embark on journeys through the soundscape of Swedish radio, as captured by the institution of ALB. It is a proposition to study the actual content of sound media. I argue that humanities at large, and media and communication studies, in particular, have remained negligent towards signals and audio data. However, throughout the histories of linguistics, acoustics, and media studies, scholars have made scattered advances in the pursuit of grasping the epistemological status of recorded sound. My work will synthesize experiences from vastly different fields, in order to propose a theoretically and methodologically well-founded approach to the digital sound archive.

Radio as sound out of time is the cue for such an endeavor. It is an acknowledgment of the contemporary state of mediated sensory experience. It is a suggestion for a future approach to media and cultural studies. It is also a continuation of the pioneering yet forgotten work of Swedish media scholar Carin Åberg. Her dissertation was the culmination of her decade-long engagement with sound. Yet, in the end, the results were limited to the “ephemeral and fleeting” nature of her object of study (Åberg, 1999, 22). This is because, as developed in her dissertation, she approached “Radio as a phenomenon *in time*” (Åberg, 1999:68. My italics). What Åberg experienced is what media scholars later theorized; as long as radio exists in time, it “imposes its duration” (Chion, 2015:35).

My intention is to pay tribute to her work by returning to the question of late 20th-century radio but with a different perspective on the medium.

To manually code a hundred hours of radio takes at least a hundred hours. With the dawn of digital audio, this condition is subject to change. Åberg worked with radio at a point in history before digital storage was a universal principle. The fact that so much of our sonic past now exists in binary forms on hard drives radically changes the conditions for the history of sound. Wolfgang Ernst's work points the way to an updated understanding of recorded sound: it is: "only with the digital computer", that recorded sound turns into "algorithmic time and operative diagrams" (Ernst, 2012:30). In the age of digital signal processing, time compresses in accordance with power.

In the digital archives of today, this spells out a new type of empirical data for the humanities. Sound studies and media history have listened closely to the documents of the past, but seldom have they explored the actual sonic content beyond human perception. Sonicity is much more than what we hear in the moment of listening. The mediated experience of accessing audio data in all its complexity opens many possible interactions with the sonic beyond close listening. This dissertation treats around 15,000 hours of audio data through various methods of listening, counting, and looking. In doing so, it brings media and culture studies up to date with the development of audio analysis. Thus, my epistemological contestation is that audiovisual media must be understood, at least in part, as being made up of signals. Considering the history of radio this way, rather than solely as communication, shifts our attention to its material and functional dimensions.

My dissertation is an experimental endeavor to reintegrate the signal output into the narrative of history. Technical, ethical, and epistemological factors have long impeded historians' engagement with acoustic signals. By placing digital signal processing at the forefront of humanistic inquiry, we can navigate the interplay between "counted time" and "narrative time" – the calculative rationale behind media data processing and the historical tradition of writing (Ernst, 2016: 37). This rekindles a somewhat neglected aspiration of media and communication studies, eloquently expressed in the published manuscripts of Adorno's radio works, suggesting that we can glean insights into society by examining radio's "specific sound color; its modulations; its clearness" (Adorno, 2009: 46). This approach is critical as it allows us to perceive radio not merely as an auditory counterpart to the newspaper but as a distinctive medium in itself. Radio has a form; it is not just a collection of

sounds but a “soundscape” as conceptualized by Murray Schafer (1977), offering a complex acoustic terrain to explore.

This implies a similar reversal to that of Åberg’s project: It suggests that we need to know something about the content and sound of radio before we even begin to understand its reception. Adorno even goes as far as to suggest that this endeavor can be considered as “radio physiognomics” – the study of the form of radio as an indication of society itself. Throughout the 20th century, there have been a few notable similar attempts to tackle the actual acoustic content of radio as an integrated force within society. This is, for example, evident in Rudolf Arnheim’s early propositions for radio aesthetics. Scattered sections in the works of Schafer and the later work of Henri Lefebvre propose related ideas but without converging. I will attempt to integrate the insights from these authors and infuse them with the method of signal processing. I thus put forward a new methodological approach, combining signal processing, German media theory, and sound studies: *signal archaeology*.³ This move intends to reverse the ontological presentism of sounds in time, to not “hallucinate life” within recorded sound (Ernst, 2012: 183). Instead, by studying the sonic as signals and operative diagrams, it is possible to defamiliarize sound, in turn opening up paths to new knowledge. In this sense, the media archive is a massive repository of signals, and it is the work of the archaeologist to extract significant forms from the soundscape.

But what is the soundscape of radio? In the first half of the 20th century, it would perhaps have been possible to imagine the soundscape of radio as the complete output of the one and later three existing channels. Yet, the organizational process taking place in Swedish broadcasting towards the end of the century can be understood precisely as the rupturing of one homogeneous source of radio. Radio scholar Birgitta Höjjer described the introduction of community radio in 1979 as the “effective end” of the radio monopoly. From this point on, “the audience can choose to listen to a completely different offer than that of classic public service” (Höjjer, 1998:238. *My Translation*).

Though still on a small scale and experimental level, these decisions introduced a new sort of channel multiplicity outside the monopoly. This process allows us to study the differentiations within the media

³ The character and significance of these theoretical strands will be developed throughout this work. The core idea is to fuse the focus on sound culture—developed within sound studies—with the epistemological propositions of authors like Friedrich Kittler and Wolfgang Ernst, who offer alternative models for examining media history. These perspectives are then put into motion through a methodological framework based on audio analysis.

soundscape, the individuation of “radio physiognomics”. The empirical material in this study can thus be aligned with what previous Swedish scholarship defined as the last two epochs of the 20th century: the decentralization phase and the commercialization phase (Djerf-Pierre & Weibull, 2001). These two shifts have been framed as two successive but different steps in a reorganization from a traditional public service media monopoly to a commercialized free-market ether. There are many historical reasons why such a transformation is of interest to study today, and it has already been subject to academic investigation. Recent radio scholarship has directed increasing attention to the formal content of the medium, discussing how digital media has influenced flow (Rolandsson, 2023). Nevertheless, the sound itself has yet to take center stage in radio history. Now, as Swedish public broadcasting celebrates its 100th anniversary, it is finally time to analyze and pay attention to its sonic heritage.

Purpose

This research project springs forth from two rare, coinciding conditions offered by the Swedish context. On the one hand, the endeavor would not be possible were it not for the fact that radio was archived to an extent allowing for large-scale, structural analysis. Sweden was the first European country to apt for “complete” radio documentation (Allerstrand, 2011). From the summer of 1978 and onwards, the media archive provides, perhaps not a complete collection of all radiophonic sounds, but well-representative and extensive documentation of the total daily broadcasting. Such an approach to radio is still to this day rare around the world and offers an empirical source that necessitates new ideas and methods. Furthermore, in the Swedish case, the new archival principle happens to overlap with the onset of the comparatively late demonopolization of broadcasting. The period between 1980 and 1999 is thus also aligned along the life span of ALB. The archive was instigated in 1979 but completed the first year of full documentation in 1980. In the year 1999, the institution was reorganized, effectively putting an end to the ALB-era. SR itself has by that time also transformed thoroughly on an organizational level.

The resulting conditions render the possibility to map the relationship between the institutional organization and sonic content on an unexplored scale. The much-debated question of how, and to what degree, the quality of radio is influenced by economic-political decisions can be partly answered by studying the radiophonic sounds themselves. The following work traces sonic changes – radio physiognomics – within

public service broadcasting throughout the intra-monopoly experiments of the 1980s, and the commercialization of the airwaves in the 1990s. The data is gathered from the three public service channels: P1 (program 1, channel 1); P2 (program 2, channel 2); and P3 (program 3, channel 3) – henceforth P1, P2, and P3. This scope allows for both comparative conclusions, as well as a grasp on the total change within public service broadcasting. The material analyzed was broadcast by the company SR, which held the right to the monopoly up until 1993. P1 was, and is to this day, the flagship of the company. It is considered the “talking channel” and was the very first public service channel in Sweden. P2 started out as a music channel of a more general type but gradually became focused on genres beyond the current popular music, focusing instead on world, and classical music. P3 began airing in 1964, with a more popular orientation and an appeal to the younger audience. The relationship between channels has taken different shapes throughout history, yet all channels remain active today and constitute the bulk of Swedish public service radio.

It is thus a research project that springs from the conditions of a new form of historical archive and therefore requires equal attention to both methodological and historical perspectives. In a sense, what follows is a study of mass media towards the end of the 20th century. In four articles, questions of stylistic development will be explored through specific perspectives of the sonic prism. It’s a matter of broadcasting and its development under changing political, cultural, and organizational circumstances. It is a history of public service media and the expressive content of what we have come to associate with the welfare state. It is in this sense an excursion into the long-time debated question of media competition (Picard, 2002). The dissertation contributes new knowledge of what happens to radio under different forms of competition based on the Swedish case and focuses on questions of quality and diversity.

In a second sense, this dissertation is about the study of sound. To truly understand how radio is shaped by its organizational and economic conditions, it is necessary to turn to the very signals left behind. However, due to the lack of research on sonic data within humanities scholarship, this requires a historical inquiry combined with a consistent methodological and theoretical focus. My work thus integrates and develops various tools and perspectives on audio signal analysis. In putting forward a set of methods for studying recorded sound, the work employs a broad set of signal-processing methods, utilizing, tabular, diagrammatic, and visual means to render new perspectives on the radio archive.

Finally, this thesis is an exploration of what it truly means to regard radio as sound out of time, both from historical and methodological standpoints. It pays homage to these sounds, extracted from their respective temporalities. The concept of ‘sound of time’ is not merely a descriptor of the archival status of this material. It also provides a diagnosis of the content within the radio broadcasts analyzed. Contemporary history often marks digitization as an epochal shift, yet my research reveals that contemporary traits of segmented radio were anticipated much earlier. The fragmented nature of today’s radio, which some might assume began with digital broadcasting, actually has a long and gradual history of evolving formats and scheduling practices. Today’s radio is intrinsically asynchronous. This anticipation of a non-linear radio experience was an untimely foresight, not bound by expectations of linearity. As non-linearity and compartmentalization take hold, and frequency differentiation becomes increasingly important for generating the specific quality of each segment, maintaining overarching coherency becomes a challenge. The proliferation of radio channels and broadcasting actors was already manifest in an ongoing quest for the “right sound – the sound that would capture the ears and the imagination of the consumer” (Föllmer. 2016).

Questions

This dissertation studies the process of creating a radiophonic style, the ‘right sound’, within the context of late 20th-century Swedish broadcasting. It is an attempt to provide a new approach to the analysis of audio data within humanities research, and simultaneously historically map the sonic patterns within the Swedish public service radio during the two last decades of the 20th-century. In this sense, the aim is to contribute an audio-oriented perspective, both to the specific field of media and communication studies, and to digital scholarship at large. The purpose is thus twofold: contributing to the knowledge of radio history and to the methodological toolbox of digital humanities. This is pursued throughout the four separate articles in more specific ways, treating in total about 15,000 hours of audio. The central question of the dissertation boils down to the following simple formulation: how did the sound of SR changed between 1980 and 1999? This question can in turn be more precisely divided into two reciprocal queries: What can signal processing reveal about patterns within the time, and frequency domain respectively? And how do such patterns correspond to notions and ideals of radio from around the same time?

The wager of this dissertation is to pose these questions in a way that is radically centered around the actual sonic. The media historical analysis in each article will of course also treat textual and visual sources, but the aim is to consequently prioritize audio signal data. The primary goal is to write a history of radio that emanates from the recorded sounds, and only secondly uses qualitative text analysis in order to contextualize. Thus, throughout the articles, four subsequent sonically-oriented questions are explored – corresponding to one article each:

1. How was silence interspersed within the temporal flow, and how did this change over time? (A1)
2. What types of timbre characteristics shaped the sound of Swedish broadcasting and to which degree did noise influence frequency distribution? (A2)
3. What music was dominant in the public service content and to what degree did this impact the tonal characteristics of the content? (A3)
4. How did variations in intensity-related characteristics change over time, and to what degree was this impacted by speech content? (A4).

The four articles supplement each other by homing in on the four basic components of recorded sound and squaring this with the four classic elements of radio: Audio data can be studied in many ways, but all these methods spring forth from the rudimentary qualities of timbre characteristics, tonal characteristics, intensity-related characteristics, and temporal characteristics as defined by contemporary audio analysis (Lerch, 2022). The articles square this fourfold against what Rudolf Arnheim already characterized as the essential four aspects of radio: Speech, music, noise, and silence (Arnheim, 1936). Further sections will discuss and develop these pairings. For now, the distinction suffices to frame the relationship between the separate articles in the dissertation. Historically, the individual articles overlap and certain themes, in particular the matter of content diversity, constitute a thematic thread. The analysis will also trace and discuss the nature and cause of these results, considering both aesthetic and technical conditions as well as prior research into the organization and reception of Swedish radio. The ambition is to capture both how competing channels within the monopoly shape each other and to follow the broad spectrum of public service content over time. By focusing on the historical process of

decentralization and commercialization, it is possible to grasp, not only the rapture of broadcasting monopolies but more generally the character of radio in the end stages of the welfare state.

The theme of sonic diversity, in the sense of variation in acoustic content, will be further explicated in the subsequent introduction and articles, but my conviction is that it offers a historically productive point of departure for the analysis of late 20th-century radio. This is partly due to the rather pragmatic reason that the measurements of signal value similarity lend themselves to a computational analysis on a feasible level for a sole media scholar working with a single laptop at his disposal. This question is, however, also interestingly embedded into the media discourse of the time. There is a long tradition lasting well into our days of employing diversity as the distinctive feature separating good radio from bad, commercial radio from public service broadcasting. In the work of both critical scholarship and vocal radio producers such as Andrew Crisell, Wolfgang Hagen, and David Hendy, the matter of audio similarity is a central component for the critical judgment of radio. This became further explicit in the 1990s, with the interest in measuring broadcasting quality in terms of ‘entropy’, which I will highlight further on as an important step in the quantitative understanding of broadcasting style. Thus, both radio theory, as well as the ideas of practitioners and producers, bring us to the matter of variation and diversity in terms of content.

Previous media historical research has offered conflicting interpretations of the relationship between radio content and radio context. By studying the actual sounds of radio on a scale never previously explored, my hope is to contribute to this discussion, both within and beyond Swedish scholarship. The focus of the analysis resides on the three national channels, P1, P2, and P3, together with samples from regional radio. The fashion in which this is done also serves to inspire further methodological debate. At the time of writing, media and culture studies at large still lack serious engagement with the methods of signal processing and the analysis of actual recorded sound. The aim is to change this by suggesting the theoretical and methodological concept of signal archaeology. The concept will be both explained and demonstrated practically throughout the dissertation. It is an approach that has taken shape throughout the past years of work, and which ranges between the precise to the speculative and experimental. The ambition is not to have the final word on the matter but to provoke further inquiry into the realm of sound.

The main media historical contribution of this dissertation is the supplementation of an unexplored type of empirical source material to the

controversial and important history of late 20th-century Swedish radio, both confirming and nuancing prior research based chiefly on textual sources. By studying the signal content of radio, previous historical narratives can be unsettled, granting insight into the historical stylistics of the broadcast content. The articles also provide empirical insights into the behavior of media ecologies under changing conditions. This is a matter discussed within radio market scholarship, yet with a lack of actual content analysis, and in particular, in the case of public service broadcasting (Greve, 1996, Nygren, 2019).

Finally, the aim is to bring attention to the tricky and still underexplored question of what constitutes a sonic style. My wager is that the scope of broadcasting, in particular during times of market and media ecological changes, offered a historical platform for testing the possibilities of sonic aesthetics. If it is true that we now have entered the sonic turn, it is necessary to start exploring the solidification process of genre and style in sound media beyond classical concepts from musicology (McEananay, 2019). The analysis simultaneously proposes a theoretical and methodological toolbox by which sonic histories can be examined and which serves to inspire further research. Therefore, the dissertation has two parallel aims running throughout – to provide new knowledge concerning the sonic content of radio and suggest ways of dealing with audio source material.

At this point, a brief clarification of terminology will help to navigate the ensuing discussion. Throughout this work, the reader will come across several words relatively associated with sounds. I've tried, however, to make a conceptual distinction in my use of terms that reflect the aforementioned parallel aims of the dissertation. Whereas I use the term 'sonic' to refer to a more theoretical discussion concerning phenomena that sound, have sounded, or existed in a sense that can be conceived acoustically, I employ the word 'audio' when speaking about more pragmatic signal processing conditions. This is thus reflective of two voices that I hope to conflate through this work: one talking on the level of the history of sound media, and one discussing the methodological affordances of a certain storage format. In this way, the dissertation intends to make substantial contributions both to the field of media and communication studies, and to the methodological development within digital history.

Structure of the Dissertation

This dissertation comprises four articles. Before inquiring into the historical narrative, it begins with a disciplinary and thematic introduction that provides a historical and theoretical backdrop for the thesis and summarizes previous research. The first part, Audio Data and the Archive, continues in this vein by contextualizing large audio archives and highlighting the distinctive archival conditions of Swedish radio documentation. Because of the dissertation's dual focus, the following overview of previous research is divided into two sections: one on radio history and another on methods in audio analysis. The first, Previous Research on Swedish Broadcasting History, summarizes relevant studies in Swedish radio historiography, drawing connections to other public service media and offering international comparisons. The separate subsections also highlight historical circumstances of relevancy.

The second, Previous Research on Audio Sources and Computational Methods, explores previous work on audio source material in the digital humanities. The subsection Signal Archaeology concludes the research overview by presenting my own approach to audio data and outlining the broader theoretical and methodological framework developed throughout the dissertation. The subsequent part, Methods: Listening, Counting, Looking, details the key tools and code used in the articles. Finally, The Data Set specifies the structure of the sample sets.

The next section, entitled Four Articles, expands upon each of the included papers, providing a succinct summary of their respective topics and findings. This is designed to offer readers a compressed overview of the substance and outcomes encapsulated within the compilation, effectively preparing them for the concluding segment of the introduction. The final section steps back to reflect on the overarching narratives and insights derived from the entire process of thesis composition. This reflective summary not only encapsulates the conclusions drawn but also opens a window to prospective avenues for continued exploration within the realm of radio history signals. Following this reflective section, the four articles are presented in the sequence of their publication, allowing the reader to traverse the chronological development of the research and its contributions to the field: A1: Rhythms of Silence: Digital audio analysis of Swedish Radio Broadcasting, 1980–1989; A2: Scale Exercises: Listening to the Sonic Diversity in 5000 Hours of Swedish Radio with Computers and Ears; A3: Formatted sound: Programming, Music, and Diversity in Swedish Radio, 1988–1999; A4: Speaking Amplitudes: Dynamical Variation in Swedish Radio Broadcasting, 1980–1998.

Audio Data and the Archive

“In general, post-1960 radio broadcasts are represented more sparsely in archives than is any other contemporary mass medium. Popular public radio broadcast series have long been available for sale on audio cassettes, but few other radio broadcasts are available to libraries or the public.” (Brylawski, 2002)

While the Swedish radio monopoly began to fracture in the early 1960s, another historically significant development was underway—this time within the Swedish library and archival sector. In 1958, Sweden established its first national sound archive, Nationalfonoteket. Despite broad ambitions, its initial focus was primarily on music. SR kept its own recording archive, but cost constraints meant that very little radio material was preserved (SOU, 2004). The resulting gaps in radio archives attracted media attention in the late 1960s, as archivists and researchers took to the newspapers to criticize these practices. Germund Michanek captured their concerns in a statement, remarking that “we are happy to have preserved early films, which images we gladly enjoy, while we in the meantime destroy our sound history one hour at the time” (SOU, 1974:73, my translation).

In 1967, the Dataarkiveringskommittéen (DAK), or Committee for Data Archiving, was formed to address such issues. Its lasting importance lies in its radical interpretation of audiovisual data (SOU, 2004). Whereas most countries preserved only select radio highlights, DAK advocated a more comprehensive approach. At the 1975 International Association of Sound and Audiovisual Archives (IASA) conference, committee member Claes Cnattingius summarized their vision: “The Committee feels that it is very important that information, opinions, cultural productions etc. which are presented to the public via the modern media, such as radio [...] be retained to an extent corresponding somewhat to that applicable in the case of printed material” (Cnattingius, 1975).

The result of this process was the establishment of a new institution in 1979: the Arkivet för Ljud och Bild (ALB) in Stockholm, dedicated to systematically documenting mass media in its entirety. As Cnattingius observed, the aim was that radio “be saved for posterity. The preservation should not only be as comprehensive as possible but also done systematically” (Cnattingius, 1975:3). This was a stark contrast to SR’s previous practice, which had retained barely 10 percent of its total output.

To fully appreciate the historical significance of this Swedish development, it is important to note that the idea of legal deposit for sound materials was not unprecedented. Within the community of sound archives, the concept surfaced regularly throughout the 1970s, particularly in the annual conferences and journal of IASA. In 1976, for instance, Patrick Saul of the British Institute of Recorded Sound addressed the topic, stressing the inherent difficulties. He characterized the introduction of complete legal deposit for printed materials as a “fortunate accident” of history (Saul, 1976, p. 25). For such an extensive deposit system to become standard, he argued, a “generous” cultural and institutional context would be required to sustain ongoing preservation efforts. However, in the second half of the 20th century—marked by an overwhelming proliferation of audio recordings across multiple organizations—archivists faced less-than-favorable conditions for such an undertaking. Nonetheless, Saul and many of his contemporaries continued to acknowledge the value and importance of comprehensive audio documentation.

The tension between the urgency of comprehensive audiovisual archiving, and the material issues of its realization turn up throughout the 20th century. For example, French historians like Jacques le Goff argued for the need to extend analysis beyond classic book sources already back in 1978 (le Goff, 1978). Despite this, it would take until 1992 for France to begin tackling the issue of more extensive radio archiving. Germany testifies to a similar development, showcasing individual appeals to the crucial status of radio documents. Head of archives at Süddeutscher Rundfunk, Ulf Scharlau, argued already back in 1981 for an, as complete as possible, preservation of radio (Scharlau, 1981). However, it would take even longer, until 2002, before an official legal deposit was formulated. In other cases, as in Finland, the complete public service radio documentation was a looming threat. In a personal note from 1993, Lasse Vihonen of the Finnish Broadcasting Company expressed his concern for the economy of the archive considering a new proposal to archive all radio programs. Finland would wait until 2008 for the announcement of a legal deposit act for radio and television. In fact, radio is, as music archivist Sam Brylaswki, has proposed, the “least-well represented medium” in the postwar audiovisual archive (Brylawski, 2002). Indeed, many countries still do not require full documentation of broadcasts.

The reluctance stems in part from structural and economic challenges. Whereas music archives may contain specific recorded works, radio archiving requires capturing a continuous flow of broadcast content across multiple channels. This not only expands storage demands but also

complicates metadata and classification. As Pelle Snickars (2015) shows, ALB struggled early on with categorizing the vast data stream, making the archive difficult to navigate. Some scholars doubt whether radio can be archived at all, arguing that its inherently ephemeral quality resists conventional preservation methods (Hagen, 2017; Eichhorn, 2008). DAK itself referred to their new initiative as a “black sheep” (Cnattingius, 1975:2). In a telling interview on the day of the instigation of the archive, Leif Larsson at ALB got the question from the local press: “But what is the scholarly purpose of saving all music radio being broadcast?” (in Snickars, 2015. *My translation*). Larsson responded somewhat hesitantly that he didn’t know, but that he was sure it would come to use in future mass media research.

The issues with radio archives last well into our days. Not only are many archives haunted by bad metadata and lacking structure. More and more, they have become the battleground for increasingly nested copyright debates. The last decade has witnessed distress concerning access getting more limited every year (Bösch, 2012:98). Nanna Bonde Thylstrup summarized how “new spatio-temporal regimes of bandwidth and copyright frameworks” disable engagement with the true potential of broadcasting archives (Thylstrup, 2018:189).⁴ This is the case with the archive I have worked with as well. To compensate for these constraints, I aim to clarify the epistemological underpinnings of my methods, offering insight into the process, whilst also providing a chance to pick up and reuse the method on other data sets. Because this is, I would argue, what we are responsible for doing. We need to heed the visionary ambition of Cnattingius, Larsson, and the DAK group when they proposed that all this effort and money ought to bear fruit within the media and communications studies of the future. We need to find ways to study sound.

⁴ This is an appropriate moment for a self-reflexive intervention. The reader will come to find that many of the experiments and analyses within my work will be difficult to reproduce. The radio data that I’ve been working with is far from easy to access and requires faith in my integrity as a researcher. The files themselves, as will be specified below, are often in need of manual cleaning. Yet perhaps even more importantly, even as a researcher, you will not get direct access to the source files.

Previous Research on Swedish Broadcasting History

“It used to be the case that books about radio would begin with a rather apologetic justification for writing about the ‘neglected’ medium” (Chignell, 2018:1).

Today we can paraphrase this statement: It used to be the case that books about radio would begin with a rather apologetic discussion about the tendency in prior scholarship to bemoan the status of the ‘neglected’ medium.⁵ I can personally testify that radio is not that particularly neglected within academia. Having spent years trying to grasp the stakes of public service broadcasting history, a certain vastness of the material can be affirmed. This requires certain delimitations. Though this overview will situate the history of Swedish radio within the larger scope of public service broadcasting, the focus will be on radio, specifically as a sound media. While broadcasting history remains contextually relevant, this project hones in on the matter of style and aesthetics. From this perspective, other communication means, like television, are prone to yield very different stories, since the specific aesthetic affordances of a visual medium vary both technologically and historically from those of a sound-based medium. This section will thus focus on previous radio research.

I have also centered the summary around the Swedish context, despite there being many interesting parallels to other national broadcasting contexts. Throughout the last decades, for example, an increasing scholarly focus has been directed toward the similarities and differences in Scandinavian broadcasting (Carlsson, 2013; Syvertsen et al., 2014). These comparisons are valuable, not only for detecting local variations but also because they help us approach the question of whether there is something like a general public service broadcasting style or characteristics. However, both here and in the articles, I only briefly glimpse these parallels. This is because, no matter how interesting they might be, there is virtually no comparative material to study. Thus, a proper comparative analysis of audio content in broadcasting remains a task for the future.

⁵ For example Fourie, “Media studies”, 2001, Kate Lacey, “radio studies: the first ten years”.

Jennifer Wang has argued that radio studies tend to forget the last part of the 20th century, despite, or maybe because of, the omnipresent role of the medium during this time (Wang, 2002:334). This tendency can be observed in Swedish scholarship as well. Michael Forsman (2011:16) observes that broadcasting research has predominantly focused on early radio and television, leaving the deregulation of the 1980s and 1990s largely unexamined. Nonetheless, Forsman’s study of regional radio during competitive periods—covering roughly the same timeframe as this dissertation—offers a valuable exception. Although his primary focus is on regional stations, his work also enriches our understanding of the broader historical development of radio, building on earlier, more concise historiographical accounts.

The Ether Media Project

A comprehensive engagement with Swedish broadcasting history is epitomized by the “Etermedieprojektet” (Ether Media Project). Launched in 1993, this initiative – examined in detail by Snickars (2024) and summarized in the English volume *A History of Swedish Broadcasting: Communicative Ethos, Genres and Institutional Change* (2013) – involved over 60 researchers and has been formative for Swedish media scholarship. Prominent figures such as Dag Nordmark and Stig Hadenius emerged from this project. My dissertation both builds on and critically interrogates this body of work. Although the extensive publications associated with the Etermedieprojektet provide an unparalleled overview of Swedish broadcasting history, they largely overlook the analysis of actual broadcasting content. This omission reflects a longstanding tradition in media studies that privileges textual sources – both written and oral – as the primary means of interpreting radio and television experiences.

While I acknowledge the merits of this traditional approach, it neglects a crucial aspect: the actual audio data remnants of the media. Consequently, the articles in this dissertation strive to complement established narratives by deriving insights from empirical analyses of sonic content. Before outlining this alternative methodology, a brief overview of the current state of Swedish broadcasting scholarship – both within and beyond the framework of the Etermedieprojektet – is warranted.

The *Etermedieprojektet*, as summarized in *A History of Swedish Broadcasting*, traces Swedish radio’s transformation from the 1950s onward as a negotiation between technological change, institutional shifts, and audience engagement. Göran Elgemyr (Elgemyr, 2013: 79)

highlights how portable tape recorders in the 1950s expanded journalistic and creative possibilities, marking the start of a more flexible production culture. Michael Forsman (Forsman, 2013: 132) examines the 1980s rise of audience participation, shifting radio from a top-down medium to one promoting interactivity. Deregulation in the 1990s, as discussed by Forsman and others, brought commercial competition but also reinforced public service strategies rather than dismantling them. Anna Maria Jönsson (Jönsson, 2013: 329) shows how SR adapted, restructuring its channels to maintain relevance amid market pressures. Rather than a decline, the book frames Swedish radio's history as one of adaptation and strategic continuity.

Outside the scope of the book, notable contributions came from media scholars Monika Djerf-Pierre and Lennart Weibull, who in their work *Spegla, granska, tolka* (2001) summarized larger trends in Swedish broadcasting history. The book postulated a periodic distinction that originally pertained specifically to television but has been influential in Swedish media historiography at large. The two phases consist of the “decentralization phase” between 1977 and 1987, and the “commercialization phase” from 1987 onwards (Djerf-Pierre & Weibull, 2001). Interpretations of this shift differ: in Weibull's account, the migration of music is the most noticeable change in content, and together with Ingela Wadbring he argues that “despite the growing strength of commercial radio and television, public service maintained its position in many areas” (Weibull et al., 2018:176). In contrast, Jönsson and Strömbäck (Jönsson & Strömbäck, 2008: 295) downplay the overall effect on mass media, particularly in public service television, while Mikael Forsman and colleagues emphasize that the “market-liberal winds” reconfigured the very process of radio production—a transformation Forsman terms the “modernization of radio” (Forsman, 2001).

The modernization of radio was reflected not only in the technical and production challenges faced by broadcasters but also in the redefinition of the listener. No longer conceived as passive recipients, audiences were increasingly imagined as active participants who influenced programming decisions at SR. This shift is exemplified by the concept of “tap listening”, a term originally used in the English-speaking world to describe listeners who kept the radio on merely as background ambiance—whether while cleaning or during long drives. Although scholars debate the extent of these changes in listening culture, the notion of a new, less attentive yet influential audience loomed large during this period.

Carin Åberg identified a similar phenomenon when she outlined the motivation for her new approach to radio studies. The line of argument suggests that, as radio is being consumed as an ornament, or as sonic interior design, it suffices that we study it as such (Åberg 1999:86). As radio becomes more of an aesthetic object and less a disseminator of messages, it becomes all the more interesting to analyze its form. This was not only a discussion within academia – in 1991, journalist Sune Örnberg suggested in a review that radio is moving toward “sounds instead of meaning” (*GP*, 10-04-1991. *My translation*). Before exploring these aesthetic implications further, it is useful to provide a broader historical context leading up to the destabilization of the radio monopoly in the 1980s.

Swedish Radio Histories

Historical accounts suggest that the very first words broadcast on Swedish radio were the exclamation “jädrar anamma”, allegedly with the Swedish king as the sole listener (Sveriges Radio, 2021). By 1924, experimental transmissions had evolved into organized broadcasts with the establishment of Radiotjänst—the precursor to modern SR, which retained its name until 1957. Over the ensuing decades, Swedish radio experienced various phases of transformation, yet the monopoly persisted as a central guiding principle until the late 1990s. This enduring structure, born from a compromise between commercial interests and state regulation, was maintained in part by SR economic dependence on the government, even as internal debates over its role continued.

Thus, one single private company, SR, assumed the difficult position between political expectations and the desires of the people. This network led Sweden to become one of the leading “information societies”: “During the ‘golden age’ of the welfare state, the early postwar years, people in all Nordic countries watched and listened to much the same content on very few (state-owned) channels, a feature that contributed to the homogeneity of culture and perspectives. [...] Thus, media and communication constitute essential elements in the historical construction of the welfare state” (Syvertsen, 2014:2). Here the idea of radio as a social glue resurfaces. Former Swedish prime minister Per Albin Hansson himself proposed that radio was crucial in linking the vast country together (Höijer 1998:291). This is a view reminiscent of what Adorno described as the physiognomy of radio. It functions as a unifying form. SR accordingly became foundational for the communication network of post-war Sweden, bringing an ether-based substratum to the idea of a welfare state structure.

today consider this to be the deciding moment in the fall of the monopoly. Lars-Åke Engblom appropriately summarizes the historical narrative:

“Technical advancements ruptured the public service monopoly. The process began in 1978 [...] but the larger changes happened in the middle of the 1980s. Simultaneously, the ideological climate was changing in a way that rendered commercial media increasingly more accepted. In a little more than a decade, Swedish radio and television were transformed from a united organization to a mixed system of actors and channels” (Engblom, 1998:178. *My translation*).

A few of these “larger changes” require further unpacking. The narrative above might give the impression of a rather instant and unidirectional process, but that is not quite representative. The change in direction was comprised of several smaller changes, and not without significant back and forth. Perhaps the most significant divergence from the compact three-channel rendition of the monopoly happened in 1978. SR then introduced a set of regional channels. Suddenly, radio production was not only centered in the heart of the largest cities but took place in all regions throughout the country. The following year, a reorganization occurred, which led to SR being split into four compartments, where regional radio and “Riksradio” (national radio) were divided into separate entities.

The original vision was that the regional channels should be a kind of “microphone of the streets” (Forsman, 2011:128. *My translation*). Amongst the many different causes behind the decision, the most influential argument appears to have been that the regional radio would give a “voice to the voiceless” (Forsman, 2011:128. *My translation*). Nevertheless, the sounds preferred by the voiceless quickly turned out to be a more controversial matter. Right from the start, there were concerns that the financial conditions did not fit the ambition. In September 1976, Erwo Karlsson, a reporter at the tabloid newspaper *Göteborgs-Tidningen* with connections to the regional radio station in Trollhättan, predicted that “regional radio will just end up being tap radio” (*GT*. 1976-09-04. *My translation*). Just half a decade later, the statement appeared prophetic. The concern for the quality of regional radio was expressed clearly, both in the press and within the walls of Radiohuset. Instead of providing the audience a direct and in-depth connection to the streets and the regional culture, regional radio had quickly become an outpost for “popular music” and “entertainment” (Gahlin & Wigren, 1980:10). In the press, several readers were disappointed that the regional channels did not even offer

proper music or “entertainment”, just “tap content” (*Expressen*. 1981-04-15, *Aftonbladet*. 1981-10-14, *Expressen*. 1983-07-21. *My translations*).

Regional radio was only available at certain hours, in between the national programs. However, chronologically speaking, this is only the beginning of the “decentralization era”, as prior radio historical scholarship has come to define it (Djerf-Pierre and Weibull, 2012). This tradition of research has stressed that the late ‘70s marked the beginning of a new media environment in Sweden, which gradually disrupted the monolithic status of SR. The pace of change seems to vary by perspective. According to the protocol from the SR audience research department’s first official meeting in the 1980s, an entirely different picture emerges—one even more at odds with the heated press debate. Carina Nilsson spoke first, summarizing a decade of radio listening and forecasting the coming years. She argued that television had not caused the expected decline in radio consumption and stated that “the only trend in radio listening is its unchanging audience numbers” (Nilsson, 1981:5, *my translation*). She and her co-author, Anders Gahlin – who had lost his voice that day – went on to propose an image which stands in contrast to the fiery press debate, concluding that “the ‘70s was a rather uneventful decade with regard to audiences” (Nilsson, 1981:7. *My translation*). Which one of these depictions is the most accurate is, like most cultural history, a matter of perspective. The pace of change might appear faster from the DJ booth than from the desktop of the statistician.

By 1979, licensing was also granted to community broadcasting, resulting in a variety of both small and large-scale alternatives for the audience to tap into. As researchers like Fredrik Stjernstedt have shown, the actual audience numbers for the community radio were rather small; nevertheless, in combination with regional broadcasting, it amounted to significant shifts in the media ecology of the time (Stjernstedt, 2013). One of the results was a more urgent debate around the profiling of the separate channels. This matter returns in many places throughout the articles in this dissertation – what it entails to generate a sonic identity is far from self-evident. However, it is a recurring theme within the internal documents of SR that with changes to the media ecology, channel identity comes into question.

Därför att världen är full av nyheter.

Därför att du är nyfiken och vetgirig.

Därför att utan musik vore livet ett misstag.

Därför att majoriteten inte alltid har rätt.

Därför att underhållning är en del av det goda i livet.

Därför att dygnet har 24 timmar.

Därför att smaken är olika.

Hela Sveriges radio.

Figure 4: Depiction promoted by SR in 1989 of the different channels. Each channel is attributed specific reasons for its appeal (Expressen, 1987-11-11). P1 overlays with sentences “Because the world is full of news”, and “Because you are curious”, where P2 aligns with statements “Because without music, life would be a mistake”, and the slightly more polemical “Because sometimes, the majority is not right”. Between P2 and P3 we find the statement “Because entertainment is a part of the good life”, and further down by P3 there are two sentences, “Because the day has 24 hours”, and “Because taste is different”. The illustration can be read in two ways. In one sense, it presents the totality of public service ideals at the time. However, it also reads a list of how the channels are supposed to correspond to specific values.

We can detect the same tendency not only around the time when the regional channels were introduced in the late 1970s but also in anticipation of commercial licensing around the 1990s (Björnberg, 1998). This type of development shares similarities with other Nordic media history, where, for example, Danish radio saw similar tactics during the demonopolization of the 1980s (Søndergaard & Helles, 2010). A reminiscent chronology has also been described in the Norwegian case (Vagle, 2012). Efforts and strategies for channel profiling have a long history and have been an integrated part of broadcasting environments since the birth of broadcasting. Today, it is perfectly possible to claim that “listeners can easily and in almost no time at all distinguish certain stations or station types from others (usually within a few seconds)” (Föllmer, 2016:301). However, how these self-evident sonic stylistics have developed over time is less studied. This is thus one of the core historical questions which is the subject of my interest. The Swedish radio archive allows for precisely this kind of inquiry – a detailed study of the progressive development towards distinguishable sonic stylistics.

Entropy, Diversity, and Style

This historical tendency is contrasted by another topic within radio history at the time, which, at least initially, may appear to be in opposition to clear sonic identity. In the spring of 1995, the words “relative entropy” were suddenly covering the front pages of the Swedish press. The cryptic expression was framed by triumphant claims – Swedish mass media had the highest relative entropy in the world. The term “relative entropy” was suggested by telecommunication professors Jacob Wakshlag and William Adams in 1985 but received its popularization through the “Quality Assessment of Broadcast Programming” (QABP) report. QABP was a global research project instigated at the University of Tokyo in the early 1990s. Prompted by worries about the increasingly free-market-oriented structure of mass media, researchers set out to determine a definitive measurement of “quality” for broadcasting to navigate by. In a somewhat surprising twist, however, the answer turned out to be related to quantity. Mass media ought to provide the highest variation in content possible. The concept of entropy has a longer history within media and communication, dating back to the post-war information compression and the mathematical theories of Claude Shannon. However, importantly for my line of inquiry, “relative entropy” was in this context reconceived as a comparative metric for estimating diversity – or variation in the content. In Wakshlag’s earlier research, he had suggested that by dividing the entropy of a specific segment by the “maximal entropy”, one would acquire “useful descriptive information in terms of the proportion of

unpredictability remaining in the system” (Wakshlag, 1979:349). This is a departure pertaining to a more abstract and qualitative sense of the content than its mere rate of compression. I take this operationalization of entropy within broadcasting production as a cue to metrically reexamine the overlapping ideas of diversity and variation that the authors sought to address. In the assessments made in the 1990s, entropy was calculated by manual coding of different types of programming content, but the metric invites us to consider a range of quantifiable sonic features.

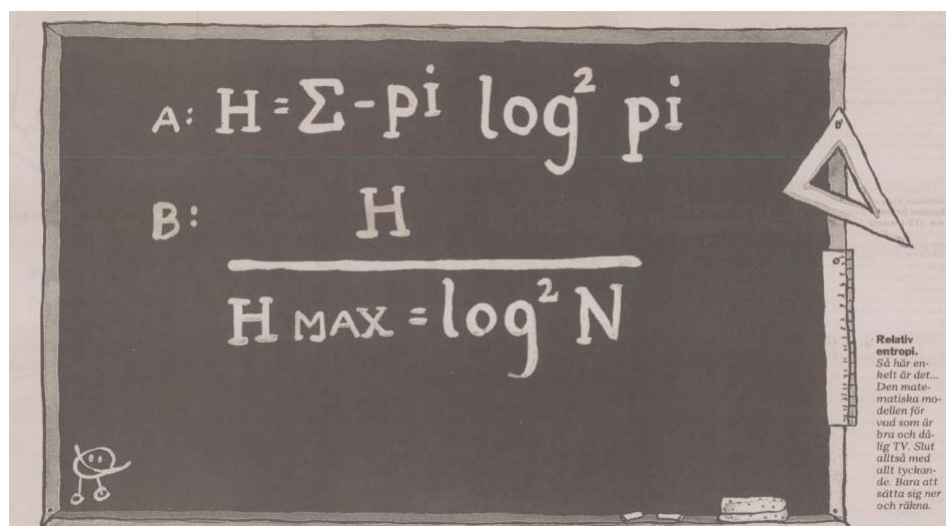


Figure 5.3: Entropy in the headlines. In 1995, the concept of “relative entropy” made the headlines of the Swedish press. As the page declares it was “the mathematical model for good and bad TV” (Göteborgsposten, 1995-11-06). The television medium is here emphasized because, in that regard, Swedish broadcasting had performed very well. Radio, however, was a different story.

This averaged type of entropy became a technical means to estimate much older ideals of public broadcasting. The virtues of “variation and diversity” in content were praised already in the radio debate during the 1940s (SOU: 1946:1:78). During the Cold war era, these stylistic principles grew increasingly sedimented. The Scandinavian countries, with Sweden at the forefront, grew to inhabit a sort of middle position between competing ideologies (Marklund, 2009). The so-called “Swedish model” was a construct of egalitarianism. Despite having primarily political and economic connotations, the idea of a middle way came to influence the identity and style of media as well. Already in 1965, the Swedish minister of communication defined that Swedish media should be defined by “objective questioning” and “open criticism of society” (Ortmark, 1979:5,

144). This minister was no other than Olof Palme himself, who would go on to play a defining role in Swedish history as prime minister. The Swedish Government Official Reports on the role of radio from the same year would go on to echo this sentiment (SOU 1965:21). This commitment was reaffirmed in the official financing proposals for broadcasting, where the directive was unambiguous: radio “shall be diversified in form and content” (Ministry of Education and Cultural Affairs, 1977:9).

These ideals are not unique to Swedish broadcasting. Objectivity and education are central values in journalism worldwide. Despite the proposed uniqueness of the Swedish model, many of the concepts of Swedish radio news are borrowed from international forerunners. Even the title of the largest radio news show in Sweden, Ekot, is a Swedish variation on the German Echo des Tages. Nevertheless, Swedish radio can be argued to have a more specific relationship to a certain type of national education with older roots. German radio, for example, was never a national project in the same sense, but regionally oriented towards specific federal states (‘bundesländer’). The organizational structure, as well as the content of German national broadcasting was decentralized from the start. In contrast, Swedish radio began as a clear national project, with one output to be received by all (Weibull, 2011). It was one singular voice, with a “national project: ‘enlightening of the countryside’” (Weibull, 2011: 38).

Exactly what happens with radio during these decades will be explored further in the articles. However, it should be added that this change also resulted in increasing self-awareness within SR. To tackle these new demands, the company itself began instigating its own research. The internal research department “Avdelningen för publik- och programforskning” (PUB henceforth) had been around since 1959 but expanded significantly after the introduction of regional radio in 1978 (Snickars et al., 2015: 40). During the subsequent decade, the department collected rich and extensive statistical material about the broadcasting audience (Feilitzen, 1997). Forsman quotes journalist Pentti Kemppainen to emphasize how this development came to signify a new era of Swedish radio research, driven by a “new politics”, which was “clearly very concerned with industrial and commercial matters, just as the old politics was primarily cultural and ideological” (Forsman, 2011:23. *My translation*). In the wake of PUB, thus, came a new generation of media and communication scholarship which examined the development of radio and television from the outside. This coincided with the gradual commercial competition and led media scholars like Göran Bolin to return to the question “what is a public service organization?” through new

critical perspectives (Bolin, 2004). This is not only of historical interest. The work at PUB is relevant because it also offers interesting source material for historical research. My analysis will employ repeated references to audience data from the epoch, tracking both listener statistics and providing insight into what kind of information reached the decision-makers at SR at the time. Furthermore, the Swedish press offers a rich insight into how the public debate around radio developed throughout the decades. Thanks to the effective search capabilities provided by the Swedish National Library, it is possible to consult listener opinions as expressed in the press. Importantly, this enables a chronological investigation of the relationship between the sonic content and the debate in the press.

To contextualize the results from the audio data, it is necessary to study these types of sources. The reciprocal relationship between listener and producer is an undeniable historical factor behind the sound of radio. Nevertheless, copious other factors are at stake in the historical interpretation of radio towards the end of the 20th century. From the technological seismic effects of the television medium to specific circumstances in production, like the increasing amount of stand-alone production companies providing materials for broadcasting, the goal is to locate and discuss the most significant of these contextual factors. Both Swedish and international research must be consulted, but summarizing the numerous brief historical sources is not a task for this section. Previous research of less central significance will instead be introduced successively throughout the analysis. Finally, in regard to the results, it will also be interesting to consider research on more contemporary radio. For this purpose, Torbjörn Rolandsson's recent work provides a rich reference. His dissertation maps the specific digitalization effects on the radio medium, pinpointing the playlist element in contemporary digital radio (Rolandsson, 2023). In his study, Rolandsson specifically points to the algorithmic temporality that breaks with the classic flow of radio, the proliferation of formats, and the employment of "real sounds" to mark content in the age of algorithmic playlist radio (Rolandsson, 2023:279). Similar discoveries have also been made recently by international research, in the case of Flemish and Norwegian radio (Van den Bulck, 2018). By comparing such results against the source material from the 20th century, we can historicize the longer developments within broadcasting aesthetics.

Previous Research on Audio Sources and Computational Methods

“It is high time that historians debated the current standards in teaching and researching media history [...] They have to begin to train students to deal with audio-visual [material].” (Bösch, et al., 2012:98)

In a passionate introduction to the 2012 edition of the *Journal of Modern European History*, four renowned historians came together to discuss the challenge of the discipline. Michael Meyen, Jérôme Bourdon, Frank Bösch, and Lynn Spigel all appeared to agree that the central problem was connected to mediation. In an age where “many historians increasingly turn to mass media sources”, it becomes clear that the history of the audiovisual media in large parts remains to be written (Bösch, 2012:98 – 99). Even though much has been written about the mass media of the 20th century, it has mostly been considered from a text-oriented perspective, leaving historians with the task of fully conceiving the audiovisual. This is an issue that has received increasing attention in recent decades. In both the fields of sound studies and media history, the absence of a coherent approach to sound has been addressed repeatedly. As Douglas Kahn formulated it back in 1999, “many issues have not been addressed precisely because they have not been heard” (Kahn, 1999:2). Similar thoughts can be heard echoing twenty years later: “We had understood that in the widely proliferating subject of sound studies there had been no work trying to draw in the issues and problems surrounding how we actually research the sonic – whether that be in the hard sciences, the social sciences, the humanities, or the arts” (Bull & Cobussen, 2021).

My work answers these methodological callings. It was exactly this problem that Åberg anticipated in her work. I thus consider my work as an explicit attempt to redeem the “obvious lack of a theory of sound radio” (Åberg 1999). Åberg might be threading on the hyperbolic when she proposes that, in the entire history of radio, there has only been one prior attempt to analyze the medium aesthetically (Åberg, 1998: 4). The point, however, is not that there haven’t been serious considerations of radio sounds, but rather that these attempts have ended up straying away from the actual sonic content (Åberg, 1998). Her argument is entangled in a longer tradition of debating the proper object of media and communication studies, where production and reception, together with

discursive content analysis, have been the dominant trends. Åberg seems to be trying to direct our attention to something beyond this: to the fact that radio is also sound – the very sonic content of radio.

Nevertheless, my work suggests a further intervention with regard to Åberg's project. Due to her insistence on the direct temporality of the medium, the endeavor runs into both methodological and epistemological difficulties. The assumption that radio only takes "place in time", lends it an ephemeral quality that compromises proper analysis. The problem was anticipated by Marshall McLuhan decades earlier. A sound that occurs in time is experientially immersive, and thus effectively negates the necessary distance associated with analysis (McLuhan, 1964). Thus, there is an inherent contradiction in Åberg's ambition to analyze radio as sound in time. My approach instead affirms the status of recorded sounds, removed from the subjective immersion of direct time.

My wager is that audio data is yet to be properly integrated and theorized in humanities research. This does not mean that sounds, recorded and not, haven't been the object of much excellent scholarship. Research in cultural, media, and sound studies employs listening as a highly developed methodology. Despite – or perhaps because of – frequent complaints about the underprioritized status of sound, there have been several expanding areas of scholarly listening over the past two decades. Within anthropology, authors like Constance Claseens and David Howes directed attention to the absence of aural perspectives already in the 1990s, initiating a long line of sonically attuned scholarship (Classen, 1997; Howes, 2004). These contributions are often conflated with the emergence of sound studies as a scholarly field. However, sonic, and aural interests were brewing in other disciplines at the time. Through authorships like Katja Silverman's *The Acoustic Mirror* (1988) and Douglas Kahn's *Noise, Water, Meat* (1999), sound received an established status in film studies, arts, and beyond. Most relevant for the undertaking of this dissertation is perhaps the groundbreaking work of Emily Thompson. Her book *The Soundscape of Modernity* (2004) contributed to a more systematic approach to the history of modern sounds, whilst inserting digital audio at the heart of research. As part of the publication, Thompson digitized and published the street recordings used as source material in her study, through the means of an interactive website. Thus, in the wake of this "perpetual state of emergence", sound studies has today amounted to a long and rich scholarly heritage (Blaszkievicz, 2021).

Yet, the actual sound object quite seldom graces the pages of the text. And how could it? That is surely the media theoretical enigma at hand. The

critical reader might argue that my dissertation is as mute as any book about sound. Therefore, I want to draw attention to the fact that we are dealing with digital audio. The digital sound archive is not an archive of sound – it is an archive of data (Malmstedt 2022b). For there to be sound, this data must be algorithmically operated. It is no longer possible to consider the sound recording solely as a sonic experience. It is to an equal degree the signal values within the file and visualization in the spectrogram. The latent space of data similarity and the vibration of the computer speaker or just two algorithmic instantiations of audio data. Thus, despite remaining mute, the sound archive emerges throughout the pages.

I propose that this is not only the consequence of considering the conditions of media to their radical ends. In the age of digital storage, sound is always out of time. It is an acoustic signal extracted from the resonance of real-time and abstracted from indexical reference. The result is acoustic data in the domain of time-axis manipulation (Kittler, 1990). To confront this reality means accepting that sound no longer is the phenomenologically familiar, resonant, and ephemeral process that operates in real-time on the eardrum. Sound is mute data, operated on by algorithms, out of time. This removal, however, is not only a loss. It is also an opportunity for the study of sound to be alienated from its beloved object. Recalling the visions of great modernist composers, this can be the impetus for a creative reinvention of the field. By studying sound as signal it is possible to achieve the “originality of new perceptions” (Schaeffer, 1952: 634).

Even within the scope of digital humanities, audio data has remained at the epistemological periphery, strange as it may sound. As Jeffrey Schnapp proposed already back in 2013: “Digital Humanities then melds hands-on work with vastly expanded data sets, across media and through new couplings of the digital and the physical, resulting in definitions of and engagements with knowledge that encompass the entire human sensorium” (Schnapp, 2013: 4). Despite this, sound, together with other nonvisual information have remained in the periphery of computational humanities scholarship. Two exceptional fields of research need to be mentioned as forerunners in this regard. In musicology, for example, signal processing methods were used early on for analytic purposes. This should come as no surprise, since actual sounds are part of the natural empirical material of the discipline. Thus, something akin to digital musicology has been practiced at least since the humanities computing movements of the 1980s (Urberg, 2017). Yet, there are plenty of even earlier cases, such as Benjamin Suchoff’s attempts to translate

ethnomusicological methods into a digital framework in the late 1960s (Suchoff, 1969).

Likewise, linguistics, and phonetics, in particular, have also firmly embraced the possibilities of digital analysis. Both of these disciplines have developed common tools, such as Praat and the MIR package, which have established what can be considered a tradition of scholarship.⁶ This is what is lacking when it comes to audio analysis in general. While this has allowed for comparative and rigorous work, it has been limited to the specific questions of these disciplines – that is, musicological inquiries or questions concerning speech. However, I argue that many other interesting things are happening in sound, even in music, beyond what these disciplines typically explore. For example, radio encompasses both music and speech, but we would be hard-pressed to analyze the spoken content of radio in order to reach any conclusions about the nature of speech outside specific media practices. It must thus be considered partly as a media historical question – yet media historians have not engaged with these methods, and therefore, there is no tradition to relate to. With that being said, there is a small but convincing array of contributions that have paved the way for what we can today recognize as an emerging, yet scattered, toolbox for audio analysis within the human sciences.

One forerunner in this history is the Sonic Research Studio at Simon Fraser University, which was established in the 1960s as part of Schafer's World Soundscape Project. The work of the lab has been perpetually cross-disciplinary, applying their sonic thinking to both nature and music. The lab is still active today and remains an important pillar in audio analysis beyond the strict confines of its original subjects. Nevertheless, the second decade of the 2010s has witnessed several anthology projects with a sonic focus, particularly chapters pertaining to computational methods (See, for example, *The Bloomsbury Handbook of Sonic Methodologies*). Already back in 2016, in the anthology *Sound as Popular Culture*, German media scholar Golo Föllmer explored the possibility of reinventing methods of content analysis, akin to those of Carin Åberg's attempts two decades earlier. His article suggested the potential of signal processing to study the very aesthetics of broadcasting (Föllmer 2016).

Significant progress was also made with the 2018 publication, *Digital Sound Studies*. As the title suggests, the primary concern of this work is to bridge the gap between digital humanities and sound studies. The authors

⁶ Praat is an open-source tool used in phonetics for analyzing speech—extracting features like pitch and formants. Meanwhile, the MIR package supports Music Information Retrieval by analyzing musical signals and quantifying elements such as rhythm and timbre.

address what they describe as the “questionable silence” of computational humanities: “[u]sing sound in one’s work is not only eminently doable for humanities scholars today, it is, as this volume argues, urgently necessary. Digital sound studies has the potential to transform the text-centric and largely silent cultures of communication in the humanities into richer, multisensory experiences that are inclusive of diverse knowledges and abilities” (Trettian et.al, 2018: 4). Among the featured case studies, one contribution specifically focuses on extracting information from sound data. Tanya E. Clement presents the work conducted at the HiPSTAS Institute, which stands for High Performance Sound Technologies for Access and Scholarship, at the University of Texas and the University of Illinois. The research group behind the acronym focuses on large-scale collections of spoken word audio. Their approach to audio data did not merely treat it as pure musical content or speech, but rather tapped into the specifics of the collections and their historical contexts. For example, the project analyzed the amount of applause in poetry recordings to study the specific reception of these performances (Clement, McLaughlin, 2016). Around the HiPSTAS group, researchers like Chris Mustazza have highlighted the benefits of visual support in the humanities analysis of sound. Combining elements of signal processing and data visualization, Mustazza proposed a method for “machine-aided close listening” (Mustazza, 2018).

Further advancements have also been made in the field of radio studies. Danish scholars Iben Have and Kenneth Enevoldsen proposed a shift from close to distant listening through computational means (Have, Enevoldsen 2021). In a 2021 publication in *Digital Humanities Quarterly*, the authors presented work involving quantitative audio analyses of radio content, studying the distribution of speech and music within Danish morning radio. This innovative publication demonstrated the viability of ideas previously outlined by Föllmer, as well as Åberg, suggesting that rather specific distinctions could be operationalized in a type of audio analysis that allows for a new kind of history of radio aesthetics. Thus, we find ourselves in an exciting era of sonically oriented humanities that attempt to integrate the history of sound with machine assistance. This development has proceeded at a slow pace, perhaps because, as Tom McEnaney argued in 2020, “it’s hard to study sound when you’re told it’s just a text” (McEnaney 2020). From an epistemological and methodological standpoint, my dissertation aims to contribute to the establishment of a culture of computational engagement with sound, encompassing close, distant, and all intermediate scales. It is not intended to be the final word in any regard, but a theoretical and practical example of how the humanities can advance these methods comprehensively.

Signal Archaeology

“Discourse analysis cannot be applied to sound archives or towers of film rolls.” (Kittler, 1999/1986: 5)

There is thus an empty space where a method of sound archival analysis ought to be. Kittler pointed this out already back in 1986. My work offers a framework to begin redeeming this lack: signal archaeology. The analysis in the proceeding part will demonstrate this method in action. The ambition is to place signals in the center of media historical scholarship, demonstrating how they can be analyzed and explore what kind of historical narratives may appear with their aid. Signal archaeology is in this sense a method that can be integrated with or supplement qualitative and contextual analyses, in order to produce new histories of media. I choose to speak of signals for two reasons. The first and most obvious cause is empirical. As discussed, the digital sound archive is fundamentally composed of signal values. Referring to the source material as signals thus serves as a reminder that what is being dealt with is always primarily signal values. They are audio signal values in the sense that they refer to and contain information concerning a sonic event (Malmstedt, 2022b). Yet, in the most essential, these are arrays of binary values.

There is a theoretical reason as well. Wolfgang Ernst and his colleagues at the Department of Musicology and Media Studies at Humboldt University have made critical contributions to the theorization of storage and transmission in the 21st century. In works like *Signale aus der Vergangenheit: eine kleine Geschichtskritik* (2013), Ernst traces out a philosophically rigorous distinction between symbolic and signal media, in which the second sort consists, not from symbolic referents and words, but from time-discrete signals. This position resonates within different schools of modern media theory, from the writings of Alexander Galloways to Yuk Hui’s attempts to formulate a theory of the digital (Hui, 2017). Yet it also has a longer history. Already in his *A Theory of Semiotics* (1976), Umberto Eco proposed that “signals” constitute the “lower threshold of semiotics”, which can be “computed quantitatively irrespective of their possible meaning” (Eco, 1976:33). Philosopher Gilles Deleuze considered this in his 1989 book on cinema, where he proposed the term *signaletic material* to describe the content of television and radio: “*signaletic material*”, ‘which: includes all kinds of modulation features, sensory (visual and sound), kinetic, intensive, affective, rhythmic, tonal, and even verbal (oral and written). [...] But, even with its verbal elements, this is neither a language system nor a language. It is a plastic mass, an a-signifying and a-syntactic material, a material not formed linguistically

even though it is not amorphous, and is formed semiotically, aesthetically, and pragmatically” (Deleuze, 1989). Thus, there is good reason to consider that mass media content was essentially signaletic long before the digital archive.

Nevertheless, the concept of a signal is as elusive as ever in the age of information processing. There is a variety of senses in which we may speak of the signal. Perhaps the classic illustration by William Powell Frith offers an appropriate historical contrast. The image demonstrates, not so much allegorically, as literally, the composition of the signal in the setting of 18th century England. A lady sits atop a great wall and raises her white handkerchief. Here, the signal is a sparse and carefully organized limited set of visual or auditory impulses. When there was no time for messages, there was the signal – the lowest threshold of communication. It carried little information but could travel far. True to its Latin etymological origin, it was something ‘marked’.

A second sense of the word was popularized in Claude Shannon’s famous formulation of communication. Here, in the midst of the 20th century, the signal is defined in opposition to noise. Instead of being a lesser form of meaning, it represents the significant peaks of communicative action. We can meditate on the difference by comparatively viewing “Signal” by George Earl Ortman with the painting from a century earlier by Frith.



Figure 6: Left – “The signal”, by William Powell Frith 1858. Right – “Signal” by George Earl Ortman, 1966.

In Frith’s conception of a signal, it is constituted by a simple visual cue – a visual mark, perhaps scarce in its informative content, but visible all the way down to the ground where the intended recipient might be waiting. In contrast, Ortman’s signal is everything but simple. It is a nexus of potential symbols appearing against the backdrop of a dense cluster of noise-like scribbblings. In fact, in one of the early, pivotal contributions to sound studies, this shift was already at the center of attention. In her pursuit to map the soundscapes of modernity, Emily Thompson, suggested that “when sounds became signals, a new criterion by which to evaluate them was established, a criterion whose origins, like the sounds themselves, were located in the new electrical technologies” (Thompson, 2004: 3). However, both definitions of signal persist in contemporary discourse. For instance, when Melissa Ragona warns against digital humanities scholarship that “favors the ‘signal’ of consensus over the ‘noise’ of variation”, the distinction emerges once again (Ragona, 2012).

In an era when “everything is marked”, it seems only fitting that we reassess the scope of what we consider a signal (Mowitt, 2002: 1219). As previously argued, true noise in a technical sense is quite rare in computational devices today. Instead, we often use “noise” metaphorically when discussing noisy databases. The methodology I propose here is based on the epistemological assumption that everything in databases

constitutes signals. Thus, like the archaeologist, we must be very mindful of where and how we excavate. This perspective also aids in avoiding the essentialist trap. Radio has always been about signals within signals. The fear of misrepresenting the world through data should be a minor concern within these multilayered caverns of signals. As Sybille Krämer recently suggested, “culture is already flattened” (Krämer, 2023). In modern media systems and digital archives, we are ensconced in signals. But as Krämer reminds us, these heaps of flattened culture might reveal new ways to “light and disclose the culturally unconscious embodied in symbolic forms and practices” (Krämer, 2023). Lev Manovich has recently argued along the same line, claiming that “numerical measurements of cultural artifacts” render a new language, “closer to how the senses represent analog information” (Manovich, 2020).

At its core, my epistemological assumption is that media – and particularly sound media – today must be understood, at least partly, as constituted by signals. By approaching sound as signals rather than as communication, we shift the focus to their material and operational dynamics. This perspective not only offers an alternative entry point for analysis but also illuminates how signals fundamentally underpin communication itself. In an era where sound media are increasingly processed and interpreted through machine learning systems, signals are becoming the underlying constructs of communication. Recognizing this makes it imperative to study them as the foundational elements of media systems, enabling a deeper understanding of both their materiality and their role in shaping the communicative processes they support.

Similarly, there is a theoretical cause for the decision to speak of archaeology. The phrasing is a hint to the tradition of media archaeology. Ernst has been influential in this domain as well, suggesting the necessity to study the deep structure of media technologies. However, Ernst’s media archaeology is importantly nonhistorical, focusing solely on the technological conditions of media. In this sense, signal analysis comes closer to the definition of media archaeology proposed by Andreas Fickers at the C2DH at Luxembourg University. Fickers further focuses more distinctly on experimental media practices combined with historical narrative (Fickers, van den Oever, 2019). This calls for sensitivity and attention to specific qualities of the epistemic object, which in turn allows for a reinvention of hermeneutics (Clavert, Fickers, 2021).

This manner of stressing the experimental nature of media research entails highlighting the scholar as both historian and tinkerer. In my case, this comes down to the attempt to write history which oscillates between

narrative and signal processing. The articles will require the reader to follow along the path between both the structure of digital sounds, and the structures of the radio monopoly, as they intersect. They thus enact a counterpoint between historical knowledge and methodological invention. The result can be understood in the light of what Lincoln Mullen refers to as a “braided narrative” (Mullen, 2019). The concept was proposed back in 1975, as a means to classify the genre-bending work of the Annales school and its integration of graphs and methodological reflection into the core of historiography. Mullen has argued that for digital humanities to come to terms with its methodical obsession, without losing its invasive impetus, it is necessary to learn to write and read braided stories, which move from the historical narrative to the historian’s laboratory, and back (Mullen, 2019). In this manner, the process of generating the historical conclusions, the signal archaeological digging, if you will, becomes integrated into the final product. Thus, there is also a more practical reason for choosing the term archaeology. In a less theoretical sense, the word highlights the “hands-on” nature of the project (Elis, Hall, 2019). I want to leave the reader with the internal image of signal archaeology, as a process of digging within the colossal mound of signals that is the digital sound archive. Engaged and exhausted, unburying “forms and structures” lost in the past (Mullen, 2019).

These considerations are also more fundamentally inherent to the field of digital history. In a certain sense, both my methodological and epistemological suggestions are grappling with questions central to this area of scholarly activity. As Hannu Salmi suggested in the comprehensive *What is Digital History* (2021), the discipline is “an approach to examining and representing the past; it uses new communication technologies and media applications and experiments with computational methods for the analysis, production and dissemination of historical knowledge” (Salmi, 2021: 4). I would be tempted to summarize my contribution, at least in part, within similar words. These articles offer a set of methods for analysis, and ways of disseminating the historical knowledge about the way radio sounded.

Methods: Listening, Counting, Looking

This leaves the question of how signal archaeology works in practice. The signalethic state of these documents harkens back to an initial instance of encoding of acoustic phenomena, often performed by some variation of Fourier transformation. Much has already been said about the curious cultural impact of the mathematical theorem proposed by the 18th-century French physicist (Kittler, 2017). The idea that complex

expressions can be modeled by periodic signals underlies not only sound recording but also much of audiovisual and telematic communication. In effect, signal archaeology thus always starts out from already processed signaletic sources – cultural artefacts whose empirical status is inseparable from numerical values. Taking this into account, the method combines three interrelated processes: listening, counting, and looking. Listening might be the most intuitive to grasp. We are, after all, dealing with recorded sound, and even though most forms of academic publishing today still do not offer practical ways to embed sound for the reader, it is still an essential modality for the researcher. Over the years that I have worked with this archive, I have listened to plenty of the material, to grasp specific archival artifacts or results that have not lent themselves to visual interpretation. This type of manual labor that is common to most digital work (Jarlbrink, 2020). When working with audio data, controlled listening is always valuable, but as I've argued, the acoustic rendering of the data is not the only way to understand it. Sometimes, visualization tells different stories than what the sounds do, and the trick is to let these narratives exist side by side. There is also not just one way of listening. In fact, we could argue that each subject has its own listening practices (Drever & Hugill, 2022). These are further extended by the wide range of technical mediations, such as sound being manipulated on the time axis to be heard in extreme detail or condensed for quick listening.

Counting is another intersecting method that for my part springs from statistical toolkits and digital signal processing. For this purpose, there are several highly developed and maintained python modules. I've mostly used librosa, which has proven stable and is developed with a general application in mind (<https://librosa.org/doc/latest/index.html>). Librosa offers a rich set of low-level and mid-level feature extraction tools. Feature extraction is a term that refers to the different layers of information that can be attained from a raw string of audio data. The core idea is visualized in the figure below.

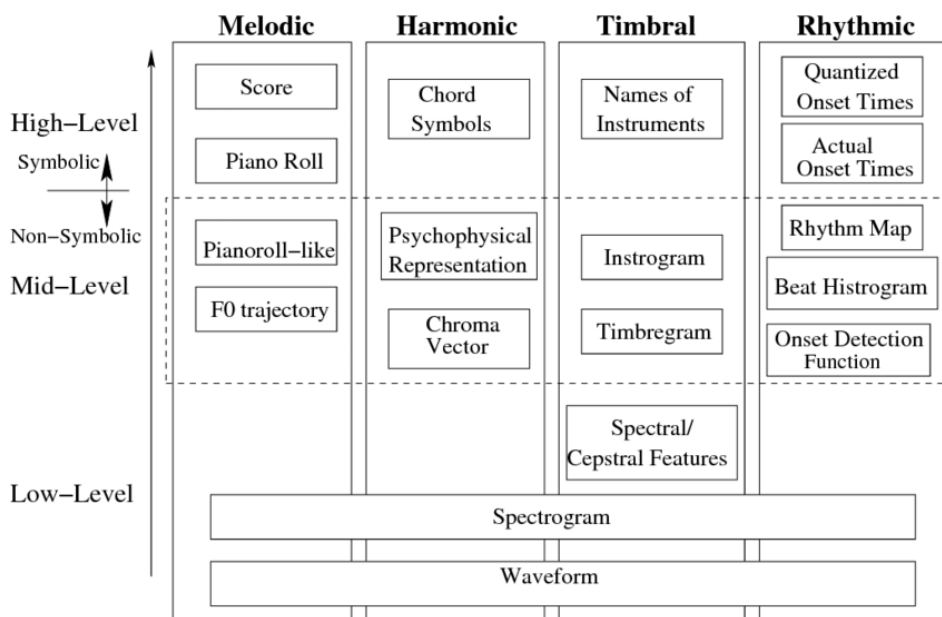


Figure 7: Different levels of audio feature extraction (Ramaseshan, 2013).

Audio analysis often separates features into three separate levels: low, mid, and high levels of processing (Couprie, 2022). Low-level features consist of the most rudimentary aspects of the signal, like zero-crossing rate, spectral flatness, and spectrogram parameters. The meaning of these categories will be explained as they are used subsequently. These values usually become more meaningful when combined or compared. Mid-level features are often examples of such combinations. By combining several of these rudimentary measurements, more nuanced information can be achieved around rhythmic content and harmony. The bulk of the analysis rests on these two levels of feature extraction, yet at certain points, high-level features have also been employed. This level of information extraction pertains to culturally perceptible codes and tends to require supervised machine learning. One manner of high-level feature extraction that I've employed is the distinction between music and speech. There are several available modules for this purpose, but for consistency, I've only utilized the 'inaSpeechSegmenter' toolkit. It was developed as part of the European Union's "Horizon 2020 Research and Innovation" program and is intended to be specifically applied to mass media content (Doukhan et al., 2018). Compared to other available models, it has a rather limited categorization variety but compensates with high accuracy.

Nevertheless, I've tried to center my analysis around the low-level parameters to as high a degree as possible. This is partly because "[o]nly

the first-level descriptors use robust algorithms. The results obtained with mid and high-level descriptors often include errors and are adjusted to specific repertoires, so their generalization is not possible in musicology” (Couprie, 2022). Thus, the lower feature levels allow for more rigor, not only in musicology. However, I would also argue that they are slightly more intuitive, especially for individuals less well-versed in audio. Therefore, with the intent of introducing and presenting the toolbox of signal archaeology through these publications, I have aimed to maintain a level that also allows for a humanistic consideration of the metrics used. Part of the value of remaining close to the signal epistemology is that we are forced to consider what these values and time series mean for contemporary cultural history.

The second leg of the method concerns the processing of this data. The extracted feature information becomes more adaptable to historical narrativity by different means of analysis. For these aims, I’ve employed standard python data processing libraries. Simple data cleaning was performed in pandas and for more advanced analysis, scikit-learn has been employed (Pedregosa et al., 2011).⁷ Since large parts of the analysis are centered around comparative similarity, it is of value to say something specific about the specific methods. Principal component analysis (PCA) is a widely employed method of dimension reduction offered in the scikit-learn library. Dimensionality reduction is a means of accounting for multi-dimensional data comparatively within a shared space. As seen above, audio data is seldom processed in its raw signal but extracted as features like MFCC (Mel-frequency cepstral coefficients) and RMS (Root mean square). Dimensionality reduction thus simplifies a multidimensional dataset by representing it in a lower-dimensional space, enabling comparative mapping. PCA achieves this by identifying the principal component – linear combinations of the original variables that capture the most variance in the data – and projecting the observations onto a two-dimensional plane. The resulting graphs visually depict relationships and similarities between multiple data points, making patterns more interpretable. (Jolliffe, 2002).

There are other statistical methods at play in certain sections of the articles. Variations of dimension reduction have been employed, such as UMAP. Unlike PCA’s linear approach, UMAP uses a non-linear strategy to preserve both local and global structure. Results are also explored through

⁷ Pandas simplifies working with structured data by offering efficient tools for organizing and transforming datasets. In contrast, scikit-learn provides a comprehensive suite of machine learning algorithms that help uncover hidden patterns, such as by reducing data complexity. The manner in which these libraries are utilized is further explicated in each article.

means of Self-Similarity Matrices (SSM), but in these cases, the methods will be further explained in the specific article. The analysis also employs a set of more experimental modules with specific purposes. One example is the human-in-the-loop tool ‘edyson’, developed at the Swedish Royal Institute of Technology (Fallgren, 2014). The tool operates by the same means as described above, combining feature extraction with dimensionality reduction, but offers a built-in possibility to listen back to the results. This comes in handy when exploring larger data sets for specific sonic features. Finally, certain software has been used for visualization and data cleaning. In these cases, I’ve relied on Audacity, which is a free, open-source application that offers simple hands-on treatment of audio files (Audacity®, 2025). In many of the cases, the questions pursued through these methods pertain to some type of analysis of variation, or as we already saw it being defined within the broadcasting policy context: entropy.

The methodological approach of these articles regularly subjects the audio data to the visual register as well – using images and graphs to supplement the information derived from the data. This is not to say that acoustic methods such as data sonification aren’t valuable tools for knowledge. I have explored such approaches in other formats (Malmstedt, 2024). However, for a publication that remains tied to the mute pages of a book, the visual is a productive supplement to textual description. It allows for grasping the audio data for what it is, at least in part: data. I’ve thus chosen a collection of articles that deal with audio data primarily through data visualization. Although rarely applied in sound-related media studies, the methods advanced here are mostly orthodox in the field of data visualization. This, however, opens up toward the complex question of data visualization within humanities research. The fault line of relying extensively on orthodox visualization approaches is that we risk repeating epistemological dogmas. This is Drucker’s point in her call for new methods of visualization (Drucker, 2020). Elsewhere, I have undertaken more advanced experimental visualizations (Malmstedt, 2024). For this work, however, the method of audio analysis is the more central aim, and in order not to lose track of the inherent complexity within that framework, the visualization approach remains rather standardized. This means I have tried to align with statistically acceptable norms.

The specific measures used are further explicated in each respective article. But on a more general point, I would like to bring attention to how the methodological experiments in the collection of articles provide a sort of historical exposé on the development and trends within digital humanities over the past half-decade. The reader will be exposed to the

journey of one scholar's engagement with methods and techniques in a field arguably undergoing rapid change. This is a subjective journey, but it also reflects something about the state of the research. These articles have all been subject to peer review, testifying to the changing criteria of digital humanities scholarship. One example is the gradual integration of comparative dimension reduction techniques. In the earlier papers, PCA (Principal Component Analysis) alone was deemed a valuable demonstration of time series similarity. Over time, the familiarity within digital scholarship with these methods has grown and has enabled a more critical stance.

The same can be said for visualization itself. Reviewers' expectations of the aesthetics of data modeling have been a persistent experience in my past five years of publishing. This is, of course, partly subjective in nature and reflects personal development and an enriched understanding of data processing. However, I would argue that the collection of articles also tells us something about the field of digital humanities, particularly in regard to audiovisual data analysis. Without overemphasizing the point, I want to connect this to the previous discussion around the archaeological nature of my approach. It is an old but accurate insight within archaeological scholarship that tools of all sorts influence and shape the kind of research being conducted, and that these tools are subject to historical development. To understand the state of computational humanities research, I therefore hope that this collection of articles can be approached as a sample of the history of tools and their different affordances and outcomes.

The Data Set

Each one of the articles works on a specific data set, which is explained in each respective article. However, they share the same principles and could be considered as part of the same larger sample set of Swedish radio broadcasting. As mentioned above, the total data spans from 1980 to 1999. Swedish radio documentation began full-day recordings in 1978; however, only the material from mid-1979 onward is fully preserved, making year before the turn of the century unsuitable for random sampling. 1999 not only marks the transference to a new database system but also encapsulates the historical change relevant to the research project. All files have been streamed from the Swedish Media Database (Svensk mediadatabas) and accessed in MP3 format. Readers familiar with audio data might react to this, since it is common practice to use a non-compressed format in the study of acoustic phenomena. MP3 format runs the risk of generating small acoustic smears of sounds. However, my

estimation is that the analytic work undertaken in these articles rarely engages with the data on such granular levels where the smearing would have a significant impact (Kunchur, 2007). The most significant effect of MP3 compression concerns the lowest register of the sound spectrum. These values may be vital in certain environmental analyses, yet radiophonic sounds, digitized from tape sources, produce no substantial loss. Partly because the recorded sound already has more significant issues of noise and recording artifacts. Partly because the targeted frequencies below 20 Hz would play a rather inconsequential role in any listening experiences of the time.

Departing from the conditions above, the articles of the dissertation work roughly with a data set of 15,000 hours. Samples are collected from all channels and throughout the decades, but the bulk of the data set is composed of 15 sample days from P1, P2, and P3, from every year between 1980 and 1999. The sample set is composed of 10 randomly sampled weekdays from every year, together with 5 days from the same week every year. The 10 random samples are in turn made up of two days from each weekday between Monday and Friday and the sample week is week 9, in every data set. Each day is composed of several separate files, which I've edited together in post-production. On average, one such day contains around 18 hours of broadcasting. This part of the sample set only includes weekdays. The reason is two-fold. In the analysis, I've been interested in focusing on weekdays, because the statistics from the time indicate that this is a domain where radio still had an impact. Weekend listening, which in the age before television was a common free-time activity, was by the eighties an uncommon practice. Moreover, the archived data contains more gaps and missing segments in weekend content, and therefore there have also been practical reasons in the process of constructing a consequent data set which, has brought about the focus on weekdays. Nevertheless, a total of 30 weekend days have been used in specific segments for comparative purposes.

The data is archived in varying levels of consistency and has required partial cleaning and ordering. Total daily broadcasting is commonly stored in several files, not seldom containing documentation noise, such as tape rewinding during the beginning and end. In preparation for analysis, an initial survey was made, together with people responsible for the archiving process at SR, locating the main issues and biases in the data. The two central issues have been reduced to non-broadcasting noises, indicated by backward sounds and therefore easily detectable, and overlapping segments in the separate files from each day, which can be adjusted with time-stamp correction. Departing from this knowledge, it

has been possible to reconstruct the data with the aim to remain faithful to the actual broadcasting flow. The sample days have been generated by statistical random sampling (Cochran, 1977). In cases where this hasn't been possible due to limitations in the source material, this is indicated in the text.⁸

⁸ Besides the audio data, the articles employ a variety of textual sources. Excerpts from the press and newspapers are assembled from the collection at the Swedish National Library. The reports and other documents produced by the SR research department PUB are available at the SR archive, as well as at several university libraries across Sweden

Four Articles

Writing a dissertation is, much like listening to the radio, a journey through time. Thus, as argued above, this collection of articles traces the path of my own development as a scholar. Beyond the foundational impact of the Umeå environment and Humlab, my work has been enriched by inspiring international networks, both in digital humanities and radio studies. As a first step in developing my approach, I immersed myself in the fundamentals of signal processing, devoting considerable effort to learning Python, computational methods, and to more fully grasp the capacities of digital audio. Throughout the writing of these articles, both the media archaeological scholarship at Humboldt University, as well as the nuanced understanding of knowledge design at Harvard metaLAB have impacted my thinking. Over time, I have gradually come to realize that what I do in fact appropriately deserves its specific methodological conceptualization – I would come to refer to it as signal archaeology. Thus, the name itself came into being after the publication of the first two of these articles. Only implicitly present, as a stage of development in the two first articles, I would still opt for the reader to consider all the articles in the collection as stepping-stones in the framing of signal archaeology.

These methodological experiments are one side of the articles, but equally important is the historical matter at hand. As previously discussed, all four articles are related in that they tackle a specific period in Swedish radio broadcasting. The common question spanning the collection comes down to a matter of how a sonic media system transitions from a non-commercial monopoly arrangement to a dual system. This entails that a set of more general questions will overlap. Roughly put, the two poles of stylistic analysis at stake are the foundation of channel identity and the maintenance of sonic diversity. Whether studied through large-scale patterns of how silence is dispersed throughout the content, or in subtle amplitude differences in spoken words, it all happens against the backdrop, as it was called at the time “relative entropy” (Åberg, 1996). Although identity and diversity could be considered two sides of the coin, they constitute opposite tangents – both conceptually and in the audio data. The demand for clearer product identity required certain stylistic homogeneity. Simultaneously, the concept of diversity and variation received an increasingly central status as a public service virtue. At the level of signal values, the question translates into measures of similarity and entropy. Thus, all articles return to the matters of total amount of variation, as well as pattern continuity in data.

Whilst treating similar questions on a larger scale, each article hones in on a specific topic and method. The intention is to present the reader with a wide span of the possible interactions between signal archaeology and radio studies. To achieve this breadth, each article centers around a different aspect of audio data. Audio analysis tends to categorize four essential types of audio information. In Alexander Lerch's recent rendition of *An Introduction to Audio Content Classification*, the general distinction is presented in the following:

- timbre characteristics: information related to sound quality such as spectral shape,
- tonal characteristics: pitch-related information such as melody, harmony, key, intonation,
- intensity-related characteristics: dynamics-related information such as envelope-, level-, and loudness, and
- temporal characteristics: information comprising the tempo, timing, meter, of the signal. (Lerch, 2022: 13).

Although subject to variation, this general distinction is common. For example, we can note its reoccurrence in pedagogical works, like that of Douglas Cohen; “frequency, amplitude, waveform, duration” (Cohen, 2006: 97). It also maps onto John Cage's suggested elements of sound: “frequency, amplitude, timbre, and duration” (Cage 1961: 4). This is in essence a reflection of a much older practice, related to the very nature of signals discussed in previous parts. The additional aspect when dealing with audio data specifically is the more elusive aspect of timbre or waveform, the status of which is much debated (Chion, 2015).⁹ Adding timbre to the aspects of amplitude, frequency, and duration allows for a focus on the more complex aspects of multilayered signals.

Thus, the four articles each respectively focus more specifically on one of these features. This fourfold is further aligned with the four core components of radio, proposed already back in 1936 by Rudolf Arnheim. As he stated, and many of the cited scholars in the dissertation echo, radio

⁹ Whilst the discussion is in itself interesting, my interpretation of the debate is that the autonomous existence of waveform qualities is a matter of context for application. The list of audio features can also be made extensively much longer, with aspects like tempo. That means that the selection is not meant to be seen as a comment on the state of audio data, but as an application of a well-established distinction. If the source material was merely composed of sine waves, the three core components might have been enough, but since we are dealing with audio data with intermixed frequencies, separate attention to their interactions is arguably appropriate.

is essentially made of four components: music, speech, noise, and silence (Arnheim, 1936). The four articles thus pair up concepts from both these four-folds: A1 (“Rhythms of Silence”) explores the topic of silence through the methodological focus on duration. A2 (“Scale Exercises”) locates the roles of noises in the sonic profile by frequency analysis. A3 (“Formatted Sounds”) compares music content by classifying it based on waveform shapes. A4 (“Speaking Amplitudes”), explores the very subtle dynamics of speech communications. As already implied, the articles span the scale levels from the very most distant statistics to close listening and analysis. There is no inherent order in which to read them – they are all in dialogue with each other. A2, for example, answers certain questions concerning frequency variation left unaddressed in A3, whilst only briefly touching upon aspects of the time domain patterns more thoroughly discussed in A1. This article, however, ends on an open note, which is answered in A4. In this sense, the aim is to grant some value to the combined reading experiences of these scattered publications.

A1: Rhythms of Silence

This article was published in 2022 in the *Journal of Cultural Analytics*, and seeks to shed light on the understudied aspect of silence within radio broadcasting, particularly through the lens of an era marked by the pursuit of modernization. It presents an innovative approach by using computational analysis to examine the archives of the public service program 1 (P1), allowing for a large-scale exploration of the radio’s content – or lack thereof. The study is focused on the periods of silence, investigating how these intervals, in their various durations, are interspersed throughout the day’s broadcasts and what this distribution tells us about the content’s rhythm and density.

As Sweden was among the final western democracies to transition from a broadcasting monopoly to a more competitive dual system, this period, leading up to the introduction of commercial competition in 1993, provides a fertile ground for examining how public radio contended with and reflected changes in society. It was a time when the structure of the industry remained intact, yet the content broadcast was in flux, caught between traditional values and new influences. The shifts in the duration and patterns of silence encapsulated these broader changes, offering insights into the radio medium’s response to organizational and ideological shifts.

Variation in content affects the amount of silence, and P1 is progressing towards diminishing amounts, as hypothesized by previous scholarship.

However, scaling up reveals more surprising continuities in the manner in which the content is interpunctuated. Even despite program and schedule changes throughout the decade, the data indicates that the same patterns not only persist but are more distinctly emerging at the end of the decade. This aligns with the idea that P1 perpetually refined its channel identity, at least in terms of the pulsation between content and pauses. One interpretation is that the daily patterns become more increasingly predictable, and in this establishing a certain rhythm of the radio. However, this might also be a sign of a clearer compartmentalization, where silence is distributed distinctly differently in different time slots. The conclusions open up further questions, partly regarding what happens to non-silence during the same time frame. It also begs the comparative question of how channel identity is practiced within the monopoly at large. These questions will be further explained in the following sections.

A2: Scale Exercises

“Scale Exercises” was published in 2023 as part of an anthology on scaling data, produced following workshops at the C2DH, University of Luxembourg (Armaselu & Fickers, 2023). This article examines the challenges of analyzing audio data at multiple scales to track shifts in Swedish radio broadcasts during the 1980s. Using computational tools to quantify sonic diversity, the research reveals nuanced changes in the audio landscape, with an increase in diverse sounds over the decade. The inspiration partly springs from the questions left unanswered in the previously mentioned article. Thus, the article takes a general grasp on the non-silent features in both P1, and its comparative P3. Tools from bioacoustics and musicology, like the Acoustic Diversity Index (ADI) and the Acoustic Complexity Index (ACI), are applied to measure diversity and complexity, leading to insights that challenge traditional notions of radio sound variety. The study reveals that while the diversity of sonic events increased, the rhythmic predictability of content in terms of speech and music distribution became more homogenous, indicating a complex picture of sonic diversity.

The article homes in on the significance of noise as a factor in the profile of radio content. This granular analysis uncovers a significant part of the soundscape previously unaccounted for, demonstrating the intricacies of noise and its contribution to the overall diversity of the broadcasts. The results display clear tendencies that the frequency spectrum is expanded through the two decades encapsulating the introduction of the dual system. Finally, however, considering the order of these elements on the

time-axis suggests, in contrast, an increase in the predictability of program structures. These findings point to an interesting dynamic where internal channel content becomes more predictable, while the differentiation between channels increases, leading to a more heterogeneous broadcasting selection overall.

The methodological approach underscores the importance of scale in sound studies, suggesting that audio data analysis requires navigating multiple scales to capture the full spectrum of sonic diversity. The article calls for a nuanced approach that combines visual representation, algorithmic analysis, and auditory perception, highlighting the need for scale exercises in audio research. By shifting perspectives and employing different scales, the study exemplifies the complexity of recorded sound and the evolving nature of radio broadcasting, encouraging further exploration into the scalable nature of audio data to better understand historical media landscapes.

A3: Formatted Sound

“Formatted Sound” was published in the 2024 special “audio” edition of the *Media/Culture* journal. It investigates how formatting influenced Swedish radio between 1988 and 1999, drawing on internal documents and sound recordings to examine how the programs’ content and delivery were changing during the time of the dissolution of the monopoly. Whereas the previous article analyzed the general distribution of sound types and dwelled upon noises, this article focuses on the much more common category of music. The prospect of mapping the history of radio formatting through auditory materials still poses questions, but this study suggests possibilities for extended research. The insights from data analysis have both affirmed and added subtlety to the available written records. Focusing on music choices and formatting strategies in Channels P2 and P3 has revealed a trend toward homogenization that corresponds with previously presumed patterns and dynamics in the broadcast stream.

The research thus involves juxtaposing multiple historical perspectives. Radio formatting appears to be a process whose effects may not be immediately evident to individual listeners or producers, nor can it be determined beforehand whether it’s a manifestation of technological, stylistic, or economic factors. This presents a methodological challenge for the historian but also offers an empirically rich entry point into fundamental issues in media and cultural research. At the same time, formatting processes have a potentially crucial impact on the matter of stylistic entropy.

A4: Speaking Amplitudes

This article was published in 2025 in the long-running *Journal of Radio and Audio Media* and tackles the matter of volume and amplitude within Swedish broadcasting. The time span is focused on a period marked by the loudness wars, yet punctuated by voices calling for nuance. In 1980, following the increase in volume of the CD format, Swedish radio production educators championed the unique and enigmatic sound qualities of radio. This period also saw the rise of a niche collective of radio producers advocating for the medium's subtlety. This approach stood in stark contrast to the dominant soundscape of the era, which was saturated with insistent pop music. These producers leaned towards experimental means to engage listeners, distinguishing themselves from the norm.

Focusing on the contrasting sound dynamics in Swedish public service radio at the end of the 20th century, the research first examines samples from an extensive set of radio broadcasts between 1980 and 1999. The loudest and softest parts of these broadcasts are analyzed to discern patterns, particularly noting the versatile use of the human voice. Unlike music that tends to maintain a consistent level, or other sounds that typically exhibit high amplitude, speech is distinctively harnessed across the entire amplitude spectrum.

The subsequent part of the study shifts attention to how radio has utilized these dynamic ranges, specifically within the domain of artistic radio drama, to provide a broader understanding of the dynamic use of speech in everyday broadcasting. It reveals that amplitude not only affects the experience of surprise but serves as a tool for stylistic analysis. Through this lens, the research uncovers specific trends in how loudness is deliberately crafted and embedded within radio programming, illustrating the crystallization of these tendencies in the broadcast content. In this sense, the article's conclusions also tie back to the unanswered matters of large-scale patterns discussed in "Rhythms of Silence".

Concluding remarks

These radio recordings defy conventional temporality. The signal archive only contains “implicit sonicity”, to use Wolfgang Ernst’s expression – in its dormant state it lacks a temporal flow in which it can be actualized (Ernst, 2017). Yet, as this research has shown, these archives are “out of time” in more ways than one. While each article in this collection provides its specific contribution, together they highlight two overarching forms of untimeliness: one rooted in content and another in context.

We shall demonstrate this by reiterating some common themes in this research. I want to remind the reader that one of the core stakes of radio during the time of analysis was the aim of entropy. The project was to mold the sonic flow into a state of variety. This process takes place against the backdrop of a negotiation between identity and diversity. A juxtaposition which found further amplification in the fact that SR gradually seemed to settle on the idea of branding their own public service style of broadcasting precisely through variation, introducing an interesting sonic paradox where nonidentity becomes the marker of identity. This negotiation between a distinct style and varied content, accelerated by the expanding ecology of channel options, I propose to be of fundamental importance in this periodicity. As argued in the introduction above, and further elaborated in each article, the matter of “relative entropy” can be considered as a conceptual tool that is introduced to overcome this tension. It offers a specific definition of variation which allows only certain elements of variation to be called into consideration. This, in turn, renders possible a historical development where radio content becomes both less and more varied at the same time. Yet, as I’ve repeatedly discovered in my analyses, this sought-after experience of entropy is achieved only by considering the signal values non-temporally.

Untimely Content

We can see this most clearly in the comparative entropy analysis in A2; the pattern repetitions discovered in A1 testify to the same process. Time-axis predictability increases over the decades. This perspective on SR’s history becomes apparent from the standpoint of signal processing as a method of aesthetic evaluation. By considering radio content as an accumulation of signals that includes characteristics across both the frequency spectrum as well as specific sequences on the time axis, I have been able to draw conclusions about two distinct trajectories. Within my

samples of the output of SR s broadcasting, one could perhaps speak of a trend where the general diversity increases but with each channel becoming more identical with itself. This is a less surprising result in the light of previous research – it can be considered as a consequence of a longer tradition of channel distinctiveness. The idea of each channel within the company to fill different functions is integral to the multichannel idea itself. However, to which degree the channel content is allowed to overlap is subject to change and I would argue that my results demonstrate an increasingly more rigid approach to this distinction. Throughout the second half of the 1990s, there was another tendency appearing which pertained to the identity of separate segments. Both speech and music are sorted more consequently into genres or styles, which allows for a compartmentalized soundscape, as demonstrated in both A3 and A4. With the increase in formats, however, there also appears to be an increase in sonic variation as new programming segments give space for other types of frequency patterns.

In fact, besides certain exceptions, the results generally suggest an increasingly entropic distribution of frequencies over the two decades. There are indications of more varied sounds and broader soundscapes over time. Even if P1's general sonic distribution is primarily driven by a relatively small set of distinct noises and vignettes, as demonstrated in A2, it nonetheless contributes to an increasingly diverse sonic landscape. On the music channels, new instruments are introduced, and a wider range of noises and environmental sounds are integrated. Regarded from a perspective of distribution within one specific channel there are signs of increasing musical self-similarity. Nevertheless, considered in its totality, the trend is a development towards more variation within the frequency spectrum.

However, as I've tried to demonstrate in the articles, these results become nuanced when we consider variation and entropy from the perspective of the time axis. Entropy can be measured as the total distribution of frequency phenomena during a certain time span, but it can just as well be calculated as a set of pattern possibilities. We can consider this as a question of how the distribution of actual orders of events in the time domain pairs with the potential amount of variation. We are thus considering the distribution of sequences of sonic phenomena. This is an equally important question in designing the radio experience. As argued in A4, the order of content, at its location on specific time slots is a valuable feature for the audience. As Jørgen Rahm-Skågeby has argued, interruptions maintain a kind of parasitic relationship to the flow of broadcasting (Rahm-Skågeby, 2021). As we have seen in the historical

material, the predictability of radio had a contested status. From this perspective, another narrative emerges within the sampled data. In the articles that explore this aspect of time series patterns, the outcome is almost unambiguously a decline over the two decades. It becomes clear that pauses, sound effects, and even the way of speaking are more systematically arranged into specific parts of the day. There may be an increase in different types of sounds, voices, and noises intermixing, but their pattern of appearance becomes increasingly homogeneous when compared from day to day. In effect, this means that the sense in which the explicit aim of the radio content overlaps with the actual content is only conceivable on the nontemporal plane of the frequency axis. We achieve a relatively entropic radio in terms of overall distribution, perceived in the totality of events, and not their temporal order. Thus, the radiophonic aim of SR is achieved, but only out of time.

Before delving deeper into its historical and contextual effects, it is an opportune moment to reflect on the broader challenge of applying such metrics to broadcasting content. This observation, in turn, highlights a long-standing debate within the field of thermodynamics, still relevant today. Entropic principles are notoriously difficult to reconcile with temporal experiences, having been the causes of several famous paradoxes.¹⁰ Now, we should be mindful that when media content is discussed as entropic, it is primarily in a metaphorical sense. Even if there have been recurring cultural interpretations of the concept, it is safe to assume that thermodynamic systems and media systems are separate things (Letzler, 2015). Upon applying this concept of order to sound, there are at least two fundamental perspectives to keep in mind, these are the aforementioned frequency-, and time-domains (Kittler, 2017: 15). These are two established dimensions of audio processing, with their origin in a more general time series analysis. The problem that enforces this bifurcation comes from issues of estimating both the event's position in time, and the total complexity of that event itself.¹¹ The risk is thus that entropic metrics only grant attention to one of these dimensions.

This has, nevertheless, not stopped researchers from applying entropic metrics to all sorts of cultural occurrences. Today, digital humanists use related approaches to estimate everything from the history of painting to cultural heritage characteristics (Sigaki et al., 2018, Xu, X et al., 2023). These contemporary computational approaches are however just the latest in a long tradition of cultural applications (Köpping, 2007).

¹⁰ See for example, the Poincaré recurrence theorem.

¹¹ Though today, technology of processing is available which makes this more affordable.

Although now is not the time to explore the extensive history of entropic metrics, historical research by scholars such as Friedrich Kittler and N. Katherine Hayles assures us that communication studies have long benefited from entropic analysis (Hayles, 2000). This was evident from the very beginning, with the Shannon/Weaver reinterpretation of the concept, which explicitly quantified message complexity. More pertinent to my inquiry is how these metrics were applied to broadcasting media and its characteristic flow. In the 2003 UNESCO Public Services Broadcasting: A Best Practices Sourcebook, diversity in content is identified as a main virtue of the medium. As mentioned however, the Quality Assessment Research Group contributed to launching the equation between variety and quality already a decade earlier. There is still interesting research to be done into the implementation of these ideas on a local level, however, it certainly seems to be a tendency of the times. My response is to take this cybernetic approach to cultural production seriously and push it one step further.

This was also a concern for Åberg: that we risk generating a meaningless measurement when we compress variation into overly simplistic measures. In her article titled "Diversity = Quality?", she explores the potential implications of "relative entropy" for the future of broadcasting. By reducing the value of public service broadcasting to diversity, and further codifying this criterion as a matter of total variation within the day, we not only lose certain previously cherished qualities of broadcasting, such as the element of surprise discussed in A4, but we also create an operational metric that hardly reveals anything about the very topic it purports to measure. Following my interpretation of Åberg's work, I suggest there are two ways to resolve this predicament. On the one hand, there is a necessary call for the conceptual autonomy of quality, distinct from quantity. This should be supplemented with a serious qualitative engagement that takes the multifarious nature of entropy and variation into consideration. This is what I intend to address here: revisiting material originally conceived under limited quantitative incentives, but now examined with multidimensional metrics. Equipped with a nuanced, multidimensional conception of entropy and signal processing tools that enable such explorations, we can finally begin answering the questions inherently posed by sound recordings. This approach, in turn, has in my case revealed how the coveted aspects of surprise, variation, and entropy are only realized in the non-temporal domain. This yields a history of public service radio that only corresponds to its producers' conception outside of temporality.

Contextual Untimeliness

I hope to convince the reader that there is another aspect to consider regarding the untimeliness of these sounds. Media studies, and particularly convergence theory, have emphasized the impact of radio's transition to the internet and its adaptation to a broader digital framework. This narrative typically suggests that some form of "digital media" has "changed the face of radio", where radio, as a medium with distinct expressions, is reshaped by the process of integration into digital infrastructures. Without necessarily undermining these suggestions, I want to offer a different perspective on the historical development of radio. As we have observed, even in the 1990s there was already a clear compartmentalization, with certain shows and styles appearing at specific times. I have demonstrated this through content analysis within several of the articles.

There is also an increasingly rich plethora of soundscapes, creating increasingly divergent shows. We see a content flow where shows become more clearly distinct entities, even though producers seemed set on the identity of channels. Although the channels do become more distinct, the key point is that each show features specific speech and music genres set for particular time slots. The identity of each show becomes clearer, belonging to its specific genre, characterized by specific sound effects and sonic tropes. I have discovered clearer channel and programme distinction in the musical data studied in A3. A4 even gestures towards the development of speech genres. This all aligns with what authors like John Nathan Anderson and, more recently, Mihalis Kyucu have described as convergence effects (Kyucu, 2019). They argue that digitization will lead to the proliferation of more specific types of shows, which can, in turn, be understood as specific formats (Anderson, 2013: 280).

Thus, the convergence narrative of radio represents an intensification of specific formats that dictate content flow rather than the other way around. This, in turn, undermines the very flow of broadcasting by creating compartmentalized sections of genre choices. This argument has previously been concerning television, where "streaming services have frequently been defined against what Raymond Williams has called the 'programmed flow'" (Tryon 2015: 107). From another perspective, this is perhaps not so shocking. As I argued in A3, there is already an inherent reason to question the aesthetic divergence of public service music broadcasting. As P3 exemplifies, popular music curation is in the end not so much a matter of the broadcaster, as of the music industry. If the imperative is to play the most popular music of the day, the financial or

organizational structure of a radio station is unlikely to make much difference. Popular rotation is governed by other laws – a condition that was as true in the 1980s as it is today.

We are also reminded of Rolandsson’s scholarship on the digital impact on Swedish radio (Rolandsson, 2023). In his conclusion, the effects intensified by digital broadcasting platforms, were, in fact, part of a much longer development. As I hope to have shown, trends in radio that anticipated this development were already detectable by the end of the 1990s. The increased use of varied real sounds – generating a larger plethora of sounds – can be traced back much earlier than the late 2010s. Instead, the strategy of marking content with specific sounds runs through both the 1980s and 1990s, a tradition that is traced in the noises detected in A2. Similarly, we have seen in A3 that formatting was an explicit method already by the early 1990s at SR. Likewise, the content analysis has displayed how the actual arrangement of genres, both musical and in terms of speech, crystallized throughout the era.

Finally, we see that the compartmentalization of similar daily structures challenges the natural order of the flow. As Rolandsson argues, digital radio struggles to assemble the separated components into a flow that appears as narratively intertwined (Rolandsson, 2023: 22). But precisely as we saw in the article A4, it is possible to identify a development towards more distinctly detached stylistic segments within the overall flow decades before the introduction of web-based streaming. In the case of 21st-century radio, this operation is accomplished through a collaboration between “algorithms and human” (Rolandsson, 2023: 146). As my research points out, however, such collaborative efforts of automation algorithms and people in the production of radio content were not unfamiliar to SR during the 1990s. Though on a different scale, and with less advanced technology, time-independent segments have been curated on the air long before the introduction of playlist radio. In fact, by tracing the silences in radio broadcasting on P1 from the early 1980s, as in A1, there are indications of a more general time-dependency.

Thus, much of what has been attributed to digital convergence seems to have been embedded already in radio stylistics much earlier. Such a realization might help nuance the sometimes overly distinct narratives of digital transformation and convergence. Instead, elements within the restructured media ecology of the last two decades of the last century reinforce a logic of radio production that already includes the content style typically associated with digital radio. This is not to imply that technological differences between digital and analog frameworks are

indistinguishable in radio, but that these symptoms need to be historically scrutinized before being attributed as expressions of a change in production technology.

This is also a key point that my contributions seek to highlight. In media studies, there is sometimes a tendency to view content as being directly determined by mediating technology – a proposition that warrants further scrutiny.¹² It would be a mistake to interpret even the classical notions of “determination” by theorists like Kittler or McLuhan as implying a straightforward back-end to front-end relationship. If hardware determines content, it rarely does so in such predictable ways. This is a point I have sought to emphasize. While we can identify historical discursive ideals and technical changes that influence content, there are certain aspects of the very radiophonic conditions that regulate aesthetic expression. This is apparent, for example, in the gradual establishment of talking genres, which seem unaffected by specific microphones or technological advancements.

My conclusions have highlighted that ideals and technical advancements have varying degrees of evident effect, such as the increase in loudness in CD music or channel profiling attempts. Nevertheless, I would argue, that there is always a certain surplus of tendencies that are not completely reducible to clear contextual factors; the specific aspects of the audio signal itself. This statement should not be interpreted as more or less speculative than what has already been suggested by media scholars from various perspectives. A similar idea is present as well in the radical media archaeology of Wolfgang Ernst, as he posits that “radio of the twentieth century was an ongoing massage”, as in the more orthodox broadcasting history of Paddy Scannell, who suggests that “[t]hus, the momentum of broadcasting has always been towards a continuous, uninterrupted flow of program output” (Ernst, 2012: 162; Scannell, 1986: 21). These are ontological statements of the same degree as what I am proposing; the only difference is that empirical evidence now points in a slightly different direction. Unlike the ongoing message of the 20th century, radio is gradually unfolding outside of continuous flow, and into a merely implicitly temporal domain.

As I’ve argued in these articles, adopting a signal-focused perspective fundamentally challenges several of the epistemological assumptions underpinning contemporary media and communication studies methodologies. I hope to have presented the importance of adding the

¹² See for example: Drew, Rob. (2016): 165-183.

signal content to previous histories of media, thereby granting a richer understanding of sonic aesthetics, verbal communication and the very sound of the medium. This integration is particularly crucial as media studies and digital humanities continue to converge; a process accelerated by our increasing engagement with archived broadcasting material. Beyond these considerations, however, I want to emphasize that this approach also calls for new methodological thinking – a recalibration of how we interpret and analyze media artifacts. This body of work, therefore, serves as a call for the signal archaeology of the future.

As I have suggested in other works beyond this dissertation, the importance of approaching archives with sensitivity to signaletic elements extends well beyond radio (Malmstedt 2023a; Malmstedt 2023b). This perspective is crucial for understanding the entire media landscape. For instance, I have argued that political audio archives benefit from an approach that recognizes the latent sonic qualities inherent in these recordings. Looking forward, I aim to broaden this scope to encompass the audiovisual dimensions of television data, illustrating how such content is composed of multimodal signals that convey far more than just narrative elements. This approach reveals layers of informational complexity embedded within the audiovisual fabric, offering a richer understanding of media artifacts across different platforms and time periods.

Sound Out of Time

Finally, as each article aims to demonstrate, the archive presents an epistemological challenge because the signals are only temporal upon my activation, putting the author in charge of deciding the temporal form and state in which they appear. This multidimensional approach to analysis necessitates a gradual unfolding of perspectives, in turn requiring both patience and experience. Acoustic measures need to be transformed and compared in multiple ways to begin grasping the complexity of sonic aesthetics in a manner that oscillates across the time and frequency spectrum. The issue of scalability and perspective is not new to cultural studies, nor to digital humanities. It might even be applicable to all matters that oscillate between quantitative and qualitative inquiries. The difficulty does not arise from any inherent qualities of sound itself but, as I suggest, more from the processes of storage and processing. This is partly why I emphasize the sense in which these documents exist outside of time in an epistemologically significant way. Or, as Ernst puts it, “with the digitalization of time-based signals, time itself implodes into operative mathematics” (Ernst, 2017: 44).

It is an old phenomenological trope that the acoustic experience is the most inherently temporally bound of perceptions. The philosopher P.F. Strawson even famously went so far as to assert that sound is exclusively time-existent (Locke, 1961). Perhaps the quintessential example is found in Husserl's favorite illustration of time-consciousness. Husserl explicates this through the experience of listening to a melody: "das Phänomen der Tondauer, das selbst ein zeitliches ist, seine jeweilige Jetztphase hat und seine Gewesenheitsphasen" (Husserl, 1973: 68). It is as if listening to a melody almost perfectly aligns with the very flow of time. This point has been echoed more recently by philosopher Michel Chion in his work *Sound: An acoulogical treatise*, where he concludes that "[e]very passing sound is marked with hallucination because it leaves no traces" (Chion, 2015: 30). Although there have been recurring refutations of sound's prioritized phenomenological relationship to time, the idea seems to persist (Cohen, 2010).

But what happens to this intuitive relationship when it is confronted with evidence from recording technology? For Chion, this issue is resolved by the fact that "if sound becomes repeatable with the help of a medium, it continues to require time to lay itself forth once again, and we are never sure to have heard it properly" (Chion, 2015: 32). However, if we trust media scholar Wolfgang Ernst, the issue is slightly more complicated. The "shock" generated by the collapsing of sonic temporality into archives still inhibits us from clearly theorizing sound recordings, tempting us to hallucinate life in the mute archive. Ernst even goes so far as to say that 'audio' is a false term. Yet, we cannot escape from the fact that audio data relates to the representation of a certain modality. We can, as we have seen in the examples in the article, use visual means to represent acoustic data, but this will not allow us to experience the acoustic perception.

We can thus adopt the phrase "implicitly sonic" (Ernst, 2017: 76). The challenge lies in determining to what extent a phenomenon, so highly dependent on the unfolding of a time axis, can be meaningfully treated within the vector metrics of computer space. My suggested method of signal archaeology takes the implications of this seriously. The sounds stored out of time are not unrelated to what might have once been phenomenologically experienced, but this relationship is highly ambiguous. Thus, I argue that we ought to remain epistemologically close to the signals. Once we release our grip primarily on rendering valuable results about how radio or other historical sources sounded, we can engage in new forms of knowledge, oriented around the structure of signals. Contrary to what much contemporary phenomenological research might argue, this is not unimportant. Surely, the subjective experience of

radio is of great interest in understanding media history, but the structures of the actual content are equally valuable and might, as Sybille Krämer has argued, provide insights into the latent character of culture (Krämer, 2023). Arguing alongside Matthew Kirschenbaum, Armen Nassehi, and others, she has proposed that “data-driven processes can bring to light and disclose the culturally unconscious embodied in symbolic forms and practices” (Krämer, 2023: 9). Ambitious as it may sound, this approach is deeply rooted within the humanities and media studies. It suggests that by carefully employing the cultural technique of flattening, it is possible to reveal inaccessible parts of culture.

Much remains to be said about the extent to which vector space captures something essential about the acoustic experience or not. However, this does not mean it is irrelevant for understanding the medium of radio. On the contrary, it is precisely because it offers another way to contemplate the medium that it enables a comparative, richer understanding of radio. As demonstrated in the articles, there is often a noticeable divergence between both the audience’s experience and the producers’ ambitions in relation to the actual signal. This is part of the reason why I try to emphasize the pseudo-autonomous status of this signal material. My ambition is not to solidify an age-old trope of producer, content, and receiver. Certainly, there are multiple producers and receivers involved in the act of signal archaeology as well. As Ernst argues, digital audio only comes into sonic existence through technopoesis – not only of the machine but also of the coder and whoever presses the buttons.

Nevertheless, I hope to have begun demonstrating the value of considering audio signal content as a supplementary approach to the medium, rather than as a corrective. I would not argue that audio signals should override the discursive remains of the producers. Surely, there were processes making broadcasting content more diverse and entropic during the 1990s. There were also listeners who found radio increasingly boring and predictable. These historical facts do not exclude each other. Instead, I propose this as another form of knowledge about the history of sound media, which supplements other insights.

When the radio critic at a Swedish newspaper consumed the content, it was in his or her own phenomenological time. And when the product development group met to discuss the acoustic branding of SR, it was yet in another temporal conjuncture. However, when we speak of the broadcast material as such, this implies another, nonspecific temporality of content – a sonic experience that can be manifested in several

individuals' temporal experiences, whether during the first broadcast, the rerun, or 50 years later in the archive

This, then, is what I hope to offer the reader of this dissertation, that by grasping the signaleptic domain of sound media, it is possible to study communication through new perspectives (Malmstedt, 2022a). The strange object displaced on the cover of this book are precisely this. At first, estranged and unintuitive, but gradually offering structural intuition of the large temporal flows. In a certain way, time is viewed as space, as sound outside time. I am not the first to draw on the potential of this quality of sonicity. In his philosophical musings from 1970, Iannis Xenakis would praise the possibility to “distinguish [...] sound organisms from their temporal manifestations” (Xenakis, 1970: 12). He suggested that music “outside-time” had been present at least since the Hellenic times, but in recent time overshadowed by our obsessive insistence on the temporality of the heard experience (Xenakis, 1970: 5). However, as signal archeologists, we can fairly state today that there is no good reason to obsess anymore about this essential temporality of sound. Rather, sounds exist in parallel temporalities, replayed radio segments from the past, or forever frozen in data strings.

If, instead of refusing the non-temporal aspects of time, we allow ourselves the curiosity to explore, Xenakis suggests that this might open up to new types of knowledge. Today it is “therefore necessary to take ‘snapshots’, to make a series of veritable tomographies over time, to compare them and bring to light their relations and architectures [...] in order to understand the universal past and present” (Xenakis, 1970: 12). I would propose that it is an interest of media and communication studies, too, to understand the past and present. The images on the cover of this book, as well as the frozen structural diagrams in the articles, are my interpretation of what such a snapshot of radio history can entail. This is, then, the provocation for future scholarship that seeks to take the sonicity of media and communication seriously, the imperative of the future signal archeologists: to begin exploring sound out of time.

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