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Rhythms of Silence: Digital audio analysis of Swedish Radio Broadcasting, 1980-1989

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ABSTRACT

How can silence be studied, and what can we learn from it? This article explores the so-called 'modernization' of Swedish Public Service radio by pertaining to pauses, halts and the absence of content. By applying computational analysis to the broadcasting archive, radio can be explored on a larger scale than previously affordable. The article argues that it is possible to understand the rhythm between more and less dense content by studying the distribution of silence in time. The analysis focuses on how varying degrees of silence are distributed throughout the day in broadcasting by the Public Service Program 1 (P1). Sweden was one of the last western, democratic countries to undergo broadcasting de-monopolization. However, in order to stimulate a modernization process, competition was introduced within the state monopoly before the proper commercialization of radio in 1993. Though the actual effect of this process remains disputed, the last decade of the Swedish radio monopoly is considered a significant media historical period of transition. Whilst the organizational structure endured, public discourse witnessed a clash between new and old ideas concerning the very essence of radio. The period thus enables the study of radio in transition.

To grasp the potential effects of these debates and organizational changes on the very content of radio, this study takes its cue from the overlooked but essential matter of silence in the radio medium. Tracing the changes and trends in a set of sample weeks from 1980 to 1989, the results indicate both how the amount of silence diminished and its rhythm became more uniform. Whilst providing insights into the style of Swedish public service radio, the work is also intended to inspire new, creative ways of researching sound media.

Rhythms of silence

Thirteen days of radio silence. During two weeks in spring 1980, the Swedish airwaves were empty. At least according to the archive at the National Library of Sweden, which already at the time kept complete recordings of the daily

broadcasting. Omissions of this kind were rare, and as it turns out, this literal archival silence is no result of documentation error. These dates coincide with the largest strike in Swedish history. 'The Great Conflict', as it has come to be remembered, was the escalation of growing unrest over the cause of several wage cuts throughout the 1970s.[1] Come spring 1980, the union had managed to engage over 700 000 workers from across the labor force, resulting in a strike that effectively put the entire country to a halt. In prior historical research, the actual strike is conceived to have lasted between the 2nd and 11th of May, yet the void in the radio archive starts already on the 29th of April.[2] This suggests that Swedish radio, in effect, might have predated the official strike action, calling for a revised role of media in the history of 'The Great Conflict'. We can arrive at this conclusion by paying attention to the very absence of content. In the sound archive, silence is information.

This article maps and analyzes silence in the history of Swedish public broadcasting. The proposition is simple: silence constitutes an important, yet historically contingent feature of the radio medium which allows for qualitative research. Throughout the 20th century, radio silence has been understood as vital for communication, beneficial for the audience as well as a serious danger to the very medium itself. Broadcasting is today often regulated by silence detectors warning against any undesirable pauses. According to Andrew Crisell's 1986 milestone in radio semiotics, the medium can in fact be condensed to just two parameters: "noise and silence".[3] Despite this, the history of radio silences has remained largely in the unexplored periphery of media studies.

But how can silence be explored, and what can we learn from it? This article proposes a method for computational analysis of silence in sound media. By mapping how silence occurs throughout the broadcasting day, my research

contributes to the understanding of the aesthetics of public service radio. For this purpose, the Swedish case offers a unique opportunity. Prior historical research has linked a more hostile stance towards radio silence to commercial radio production and the economic dependency on the listener numbers.[4] In contrast, Sweden can be considered the staple example of public service media, where production was to a large extent state-financed. In the early postwar era, Sweden had one of the most vacant broadcasting schedules in all Europe.[5] Not only was the program schedule itself spacious, pauses and halts are supposed to have occurred with high frequency.[6] There are even occasions were Swedish critics praised the pauses between speech, granting the listener time to contemplate the messages.[7]

Swedish radio history is distinctive in two interesting ways. First off, Sweden sustained a radio monopoly all through the 1980s, at a time when European broadcasting policy was characterized by increasingly liberalist measures. As a result, Sweden witnessed a delayed and debated reception of the Anglo-American commercial style of radio. Secondly, Sweden was one of the first countries in the world to legislate a rule of legal deposit for complete broadcasting. Total archiving was unheard of in most places at the time, and radio is said to have been the most scarcely archived mass medium throughout the second half of the 20th century.[8] Swedish history sets itself apart from this tendency through the 1979 legal deposit act, which is registered as the first in the world to include radio and television.[9] This early and extensive collection of broadcasting data, combined with late de-monopolization, provides an illustrative opportunity to study the history of public service broadcasting. The analysis focuses specifically on broadcasting by the Swedish radio monopoly flagship P1 – or Program 1, the so-called "spoken channel" – from 1980 to 1989. Established in 1925, it was the first radio channel in the country and it remains the flagship of Swedish public service broadcasting. The content is

considered to be oriented towards information and news and is to a large extent composed by speech.

This analysis extracts data on the distribution and rhythm of silence throughout the broadcasting day. By computational means, the rhythmic variations in density of silence within this material can be coded and analyzed on a larger scale than possible with human listening. The aim of this article is to map these rhythms and subsequently examine how the results can be connected to previous media historical research. The term 'rhythm' is here referring to the fluctuations between varying densities of silence throughout the day. As the analysis demonstrates, by studying these fluctuations it is possible to explore aspects of what Raymond Williams called the "flow" of media.[10] William observed how television and radio came to offer their own characteristic media experience by replacing the discrete pages of the book with an uninterrupted flow. He particularly points out how it is the careful management, and minimization, of "intervals", which is constitutive for the experience of broadcasting as a never-seizing stream of content, fused together through sound. The quantitative study of silence, or "intervals" can thus grant insight into how radio has changed over time.[11] This was also the proposition put forward by one of the key figures in the emergence of sound studies, Murray Schafer. In his reflections on "rhythms" in his book *The Soundscape* from 1977, he proposed that "broadcasting is always changing and these changes can thus be studied, exactly as a critic or historian studies the styles and tendencies of contrasting schools of literature or music".[12] He proceeds by stating that these changes can be considered in "how broadcasting was at first occasional, separated by extensive periods of silence or low-keyed activity".[13] Influenced by this careful attention to the historical style of broadcasting, it is today possible to explore the very signal itself. The method of digital signal processing allows for a study of radio history, not only through textual

remains but by means of preserved signal values. This connotes what Wolfgang Ernst has dubbed "radical media archeology", in the sense that it "stays close to the signal", and "concentrates on the non-discursive elements in dealing with the past".[14] The results presented in my article confirm the prospect of such an approach. By paying close attention to the signal, it is possible to provide an elementary overview of the rhythm of the entire broadcasting day, which in turn grants new insights into the stylistic development of radio. As the distribution of silence is compared throughout the decade, on a scale unaffordable for human listening, results indicate that P1 was developing in the direction of a more effective broadcasting style. Silence does not only gradually decrease; it also settles into a more uniform rhythm. Furthermore, the results can be constructively put in dialogue with previous media historical scholarship, both in order to confirm the plausibility of the results, and contribute new knowledge to the debated history of the decentralization of Swedish radio.

Analyzing radio silence

To quote Swedish Radio Scholar Carin Åberg: "Radio Analysis? Sure! But How?"[15] When Åberg posed this quite legitimate methodological question back in 2001, she was echoing simultaneous research interests in German radio studies. This emerging approach to radio analysis aimed to move beyond content and "look more deeply into the structure of the programmes".[16] Together with authors like Detlef Schröter, she pioneered the practical application of the theories of Raymond William to radio material.[17] With the ambition to study "radio as sound in time", she ventured into the quantitative analysis of the aesthetics and form of radio.[18] Nevertheless, this method quickly ran into a significant obstacle. To manually code entire days of radio content is slow and tedious work. Every minute of material demanded real-time analysis by the researcher. Today, such problems can be bypassed by tapping into

the affordance of digital audio signal processing. By feeding these tasks to the machine, it becomes possible to consider "the structure of the programmes" on an unexplored scale.

Two principal criteria need to be set in order to study radio silence as quantifiable data; amplitude and duration. This analysis employs a negative definition of silence, as anything that isn't sound. Therefore, these two criteria will determine the status of sound, and silence will be calculated as any sequence not qualifying as sound. Since there is no absolute silence on the radio, a threshold is needed to determine the amplitude of silence. The somewhat puzzling question of how silent silence is, can today productively be translated into a matter of the loudness of the background noise. In the age of modern signal processing, this pursuit is best understood in terms of the signal-to-noise ratio. This technique, which Friedrich Kittler once proposed to be the successor to poetry and hermeneutics, is the mathematical estimation of what matters, and what doesn't, in regards to the transmission of a message.[19] From this perspective, silence is demarcated by the static background noise indicating the temporary absence of radio content. The specific level of this static can be determined through spectral analysis – that is, the analysis of a spectrum of frequencies – by which it is possible to single out the frequency of the background noise and measure its amplitude separately. Figure 1 demonstrates a sample from the audio, where a low-frequency buzz is detectable. As the level of the background noise may vary due to the shifting quality of pre-recorded material, a sample every twenty minutes has been used to determine the appropriate threshold.

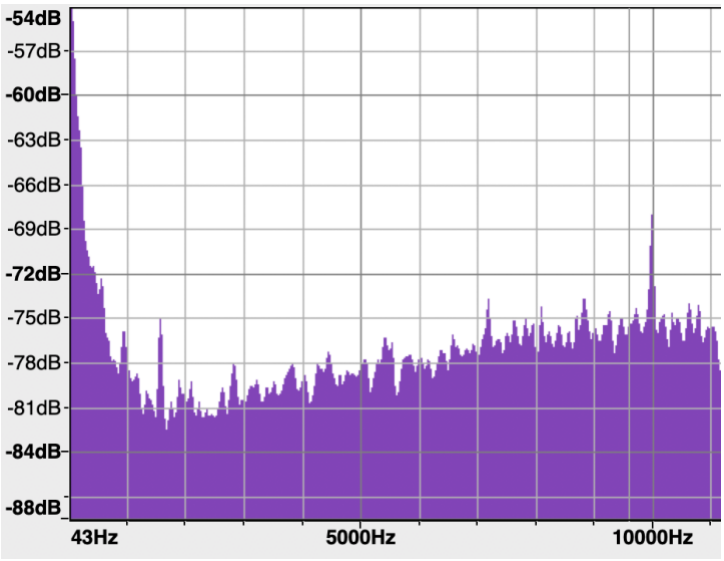

Figure 1: Spectral image of background noise measured by its negative decibel value. The amplitude is centered around the low end of the frequency spectrum, indicating a low buzz. By measuring the negative decibel of this background noise, it is possible to set a variable threshold for when actual auditory activity appears.

The second criterion concerns the aspect of duration. As with amplitude, the employed definition is defined negatively, and thus, what must be defined is the threshold length of a sound. Depending on the frequency of the sound, the upper limit of what the human ear possibly can perceive is very short. A very high-pitched sound can potentially be audible even at a duration up to a couple of milliseconds. However, in the case of this archived material, the broadcasting was originally recorded on tape. Due to the quality of the cassette decks that were used, many recordings suffer from pre-and post-echo. This phenomenon, which can be caused both by magnetization and compression of a recording, produces an effect where every click, or infinitesimally short sound, is spread out and extended by thousands of milliseconds. In order to avoid as much as possible of these disturbances, the threshold for what is counted as sound is set to any duration longer than 500 milliseconds. Reversely, based on the prior research in the field of conversation analysis and linguistics, the duration of a silent part must be longer than 300 milliseconds to count.[20] This method, therefore, assumes a definition of silence

which is defined negatively as any moment of broadcasting where a signal does not remain above the background noise threshold for more than half a second. In this sense, the method is mimicking the praxis of 'silence detection', already employed within broadcasting.

The data that is utilized in my research is composed of digitized recordings of live broadcasting. The original recordings, made on tape, were documented by the Swedish radio. Back in 1966, a new law rendered Swedish broadcasting accountable to conserve all broadcasted material for 6 months. The initiative was financed by the Swedish state and was intended to provide juridical evidence for issues related to broadcasting.[21] This process had demonstrated how total radio recording was possible, yet the purpose at the time was not historical, and therefore no archival measures were undertaken. This would all change when the law of legal deposit for audiovisual media was reformed in 1979. According to the legal deposit register at the International Association of Sound and Audiovisual Archive, Sweden was the first country to attempt a complete archiving of public service broadcasting.[22] With financial backing from the state, the Swedish National Archive of Recorded Sound and Moving Images was inaugurated. This new archival institution was equipped with storage capacity suited for far more extensive documentation.[23] The new scope of the archive meant no extensive changes to the technical infrastructure. It was the economic aspect which was more daunting. What was needed was more tape, and a lot of it. In contrast to the juridical material, which could be rerecorded twice every year, this new documentation required a constant expenditure. Therefore, the juridical material could be stored on high quality tape, whilst the archive recordings were object to economic restraints. The result is that sections of the documented material suffer from an apparent tape noise.

Digitization, later conducted by the National Library of Sweden, transferred the material from tape to Waveform Audio File Format. The digitized documents correspond to the manner in which the material was originally recorded. The daily broadcasting is composed of three separate files, each containing six hours of content, ranging from 06:00 in the morning, until 24:00, midnight. My research attends only to the week days, excluding weekends. In an early state of research, it was clear that the weekends, in their concisely different structure, provided variations in the statistics which would have required a separate analysis. The data is thus composed of the collected week days from the same one sample week every, week nine of the year. The results are controlled against another sample week, composed from randomized weekdays from every year. Altogether, the data set is composed of 1800 hours of broadcasting, over 100 days. To randomly sample complete broadcasting days in this manner is only possible due to the unique affordances of the Swedish media archive. [24] The rigorous collection grants access to plenty of new ways to study broadcasting during the welfare state epoch, far from exhausted by this article.

The audio files have also required considerable data cleaning. I have mainly employed two computational tools for preparing and studying the data. For the purpose of simple labeling and time stamping, aubio has been employed. Aubio is an audio labeling tool kit developed in the programming language of C.[25] It is written in order to run directly in Python, and provides a simple and effective audio processing tool. For the purpose of the aforementioned cleaning, more advanced software was necessary. The process, which mostly consisted in the removal of irrelevant rewind noises remaining from the original tape recording, was carried out in Audacity.[26] This free software is recognized and an established tool in audio

analysis. By virtue of being open-source, the simple, yet hands-on controls are under constant improvement, and therefore appropriate for data cleaning.

Audacity has also been used for control listening. After marking up the silence in the data, the subsequent timestamps have been reapplied to the audio file. The resulting edit contains only the total silence of the recording, contracted together. This technique has been used in order to determine the accuracy of the method, granting insight into what the program renders as silence. The applied method has the limitation of consequently rendering every signal below the level of the background noise as silence. For the question at hand, this is deemed as an affordable loss, as most of these sounds would be too quiet to be audible. Yet, there are exceptions, where distinguished sounds remain buried under the surface noise level. Such occasions are part of signal processing theory, and commonly referred to as "artefacts". Figure 2 displays how elusive these phenomena appear, yet by amplifying the audio signal, it is sometimes possible to identify an auditory event.

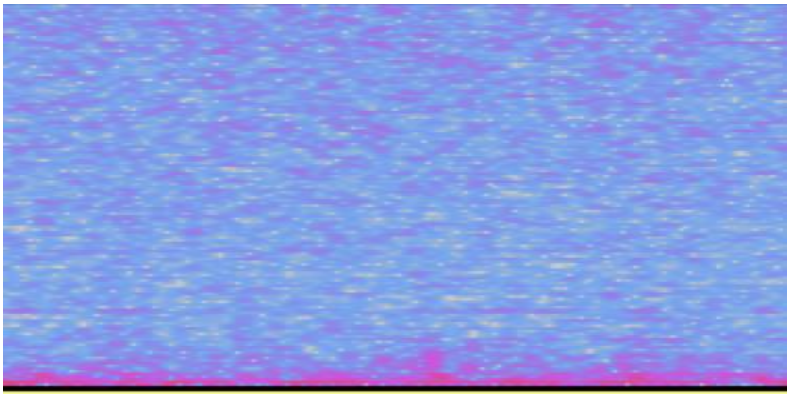

Figure 2: Image of an artefact. The slight increase in the lower frequencies in the middle of the image indicates an auditory event. At this level, it remains quiet and covered in noise, imperceptible by the human ear, yet with enough amplification, it might be possible to identify the sound.

To investigate the sort of sounds which lay sunken beneath the threshold of silence, sample excavation has been conducted on every file. The results, however curious,

seem not to interfere with the validity of the method. The detected artefacts consist most commonly of external respiration; breathing and sighs. On rare occasions, mumbled voices have also been detected. These appear not to be part of the intentional broadcast, as the speech is imperceptible, and appear to take place behind a wall. Finally, some artefacts are the last moments of music being faded out. My discoveries are similar to the ones detected by Matt Rogalsky in his artist work with silences in broadcasting at the BBC: "I immediately discovered that the 'silences' were interesting; they weren't silent at all. They were full of tiny sounds which mainly went unnoticed in the flow of a broadcast, and also included a strong human presence mostly in the form of breath".[27] These are interesting discoveries in their own right, but they are neither the subject for this study, neither do they, as Rogalsky proposes, pose any greater effect on the experience of the broadcasting.

Silence in the history of radio

Radio was an integral part of the sonic transformation of the 20th century, attracting attention from a range of cultural critics. The swiss philosopher Max Picard, for example, linked the development of radio to an overall loss of silence. In his book, *Die Welt des Schweigens* from 1948 – translated as *The World of Silence* – he proclaimed radio to be the final nail in the coffin for silence. "Man is no longer aware of the radio-noise all around him. He does not hear the constant hum of the radio: it has become a kind of noisy silence of which he hardly takes any notice at all, however loud it may be all around him".[28] If, to Picard, radio was auxiliary to the disappearance of contemplative quietness, the medium simultaneously seemed to establish its own form of silence.

Researcher like John Mowitt and Kate Lacey have demonstrated how radio producers in America developed a sophisticated usage of absences in broadcasting

content.[29] An illustrative example can be found in the final lines of the script for the renowned radio rendition of Welles' "War of The Worlds" – which called for 'dead silence'. In order to leave a final haunting impression on the audience, producers first considered the sound of an alien laser beam. Instead, however, they went with the far more subtle effect of a staged broadcast interruption. One had to be familiar with the haunting effects of this crackling absence of content in order to realize that it would prove far more unsettling than any loud weapon sound. Yet, radio silence wasn't only discovered as a narrative device. In the 1930s, pauses came to be a valued feature in broadcasting. The BBC could insert a 15 minutes break between programs to let the audience "contemplate what they just heard".[30] There are indications that a similar positive attitude towards silence informed the dawn of Swedish radio production. In 1925, an early on-site segment from the Gothenburg harbor received praise for the reporter's bold use of silence. The supposedly five minutes long pause provided the listeners with suggestive environmental sounds and allowed time for contemplation.[31] The idea that pauses in broadcasting could be used to provide the listener time to reflect recalls the musings of the proclaimed "first media man" and radio programmer Filson Young. To Young, silence was "a definitive opportunity to sit without the distraction of voice and sound, and think the thoughts that are within oneself".[32] Nevertheless, prior research has demonstrated how such positive conceptions of silence were restricted to public service broadcasting.[33] In early British commercial radio, silence was instead perceived as a threat. Absence of content was considered to increase the risk of losing the listener. In order to keep the audience transfixed, commercial radio had to supply an unwavering flow of content. The distribution of silence on radio can thus be understood in analogy to Raymond William's writings on the flow of television. Silences between discrete sequences of content disrupt "the process of relative unification, into a flow of otherwise diverse or at best loosely related items".[34]

Williams propose his concept of media flow in order to get at the glue of television, but as researcher like Mimi White has argued, it is equally appliable on radio.[35] The manner in which contentless gaps are left in the ether is part and parcel of the historical development of any sonic broadcasting media.

Prior research has connected the venture to minimize silence, to the development of commercial radio during the interwar period in America. Within this context, a hostile view towards extended absences of content was cultivated. Aptly put, "[t]he absence of predetermined sound ('dead air') is anathema, and every second of precious ad airtime is carefully scheduled".[36] By the late 1960s, it was possible to declare that radio silence itself might be "dead".[37] Paddy Scannell regards this as an almost natural tendency in the radio medium as such:

> "But radio has no sense of occasion, of a time and place set apart from ordinary life and affairs. On the contrary, its distinctive features are the reverse of occasionality. Because it appears as a domestic utility always on tap like water, gas or electricity it must always have an available content. Thus, the momentum of broadcasting has always been towards a continuous, uninterrupted flow of program output."[38]

In prior research on radio silence in the British context, the reduction of silence is often directly linked to the concept of commercialization. In the early days of British and American commercial radio, the tempo and content of programming were both suited to an ideal audience. Subsequently, this change in commercial broadcasting style has been proven to also influence public service content. In 1969, the BBC concluded that the challenges posed by commercial radio and television meant that public service broadcasting needed to adapt to a "changing world to meet changing

tastes and needs".[39] Old time radio programming, with its breaks, sudden changes, and pleasant surprises was "inherently unfit" to provide its services to the new audience. What was required was a "more uniform and predictable kind of content, an uninterrupted supply of music, perhaps, or of information".[40]

The BBC was not alone in facing these troubles. Stirrings in the structure and role of radio have been observed in many liberal democratic countries in the early second half of the 20th century.[41] In this context, silence is suggested to decline as a consequence of adjusting radio to the modern listener. This was a listener who was perceived to reach for the transmission knob without hesitation, at the slightest pause between content. In prior media historical research, commercial radio is usually proposed to be the culprit in this development. "Commercial radio avoids all moments of silence with a three-second cut-off point. This prevents the space of anticipation to extend into doubt about the heard. The sounds of commercial radio build a formidable wall, solid and permanent".[42]

These conclusions are however not directly translatable to the case of Swedish broadcasting. The exceptionally late de-monopolization of radio in Sweden delayed any real commercial concurrence until 1993. Therefore, the effective decline of silence over the decade cannot be regarded as the result of any direct commercial influence. Nevertheless, the 1980s is far from a static decade in the history of Swedish broadcasting. The legislative permission for commercial radio in 1993 can rather be understood as just one step in the instigation of competition within the medium. The market-liberal ideas prevalent in Europe throughout the second half of the 20th century also caught attention within Swedish broadcasting. The company behind the broadcasting monopoly, Sveriges Radio, faced accusations of hampering the natural development of the medium.[43] The plea for competition was further

motivated by the struggle for Radio to maintain footing in the intermedial struggle against television. Thus, the idea of competition as a beneficial, and sometimes necessary component in culture was not foreign to the Swedish discourse.[44]

Media Scholar Michael Forsman has proposed that the process can be understood as two succedent stages, with each solution corresponding to the political leadership in Sweden at the time. The proper commercialization of radio in the 90s constitutes from this perspective the later step in the development, determined by the more distinctly liberal government at the time.[45] However, the social democratic party had already provided their response to the matter, 15 years earlier. Instead of introducing the commercial forces, this approach decentralized broadcasting by installing competition within the sphere of the public service monopoly. Alternative channels were established alongside the flagship P1. The second channel, P2, was instigated back in 1955, and functioned principally as a source for classical music, together with educational segments. A decade later, Sveriges Radio introduced a third alternative, P3, which at the time was conceived as yet another complementary channel, focusing largely on popular music.[46] Whilst P2 remained a marginal option for the radio audience, P3 grew rapidly in popularity, and by the 1980s it was cause for loud concerns at the Swedish Radio. Towards the mid-1980s, P3 had an estimated audience of 67 percent of the population, against a waning 13 percent sported by P1.[47] P3 was not in a strict sense a commercial competitor, however, these concerns mirrored many of the tropes from British radio history. The growing imbalance in listeners between the flagship P1, and the popular entertainment alternative, was conceived as a threat to culture.[48] The critique against P3 actualized the pejorative features of tap listening. It was seen as antithetical to cultural education, instead of providing the youth with a fast-paced, undemanding stream of popular music.

Keeping with the spirit of decentralization, the Swedish government ruled in favor of local radio production in 1978. The consequence was, not just a third, or fourth alternative, but an upsurge of regional alternatives. By 1984, more than 20 local channels were transmitting parallelly, and beyond that, hundreds of communal radio stations ha had popped up across Sweden.[49] Research into Swedish media history has located this to be the defining onset of the disintegration of the radio monopoly.[50] Local radio came to influence the ether. Yet, as Birgitta Höijer has pointed out in her research on radio history, the local was at the same time the global.[51] Looking to the British radio for inspiration, these new broadcasting initiatives immediately assumed a more international style of broadcasting. This entailed the introduction of production tools like stopwatches and commercial jingles, rendering a type of broadcasting that less and less resembled the classic public service radio. In order to win back the audience, the flagship had to adapt. Forsman has shown how this pressure brought about heated debates within the profession, which in turn can be tied directly to the matter of silence. P1 needed to be "modernized".[52] The debate revolved around the issue of the programming structure. The older producer-controlled approach was challenged by the effective block system. Radio needed to become "more uniform and predictable". Yet, we ought to yield careful attention when we consider the cause for this development. As been argued by scholars like Jane Feuer, media studies ought not to conflate the historical factors behind commercial broadcasting with media history in general.[53]

The "modernization" debate, which ran throughout the second half of the 1980s have been granted varying significance in earlier historical scholarship. In Lennart Weibull's work on the grand history of Swedish broadcasting, the actual change is conceived to be limited to the role of music on channel 1.[54] In contrast, Forsman's account considers the effects on a more structural level, proposing general increase

in uniformity.[55] The following analysis provides granular examination of the signal value of the actual broadcasting, in order the return to these questions by studying the radio data, instead of textual accounts.

Analysis

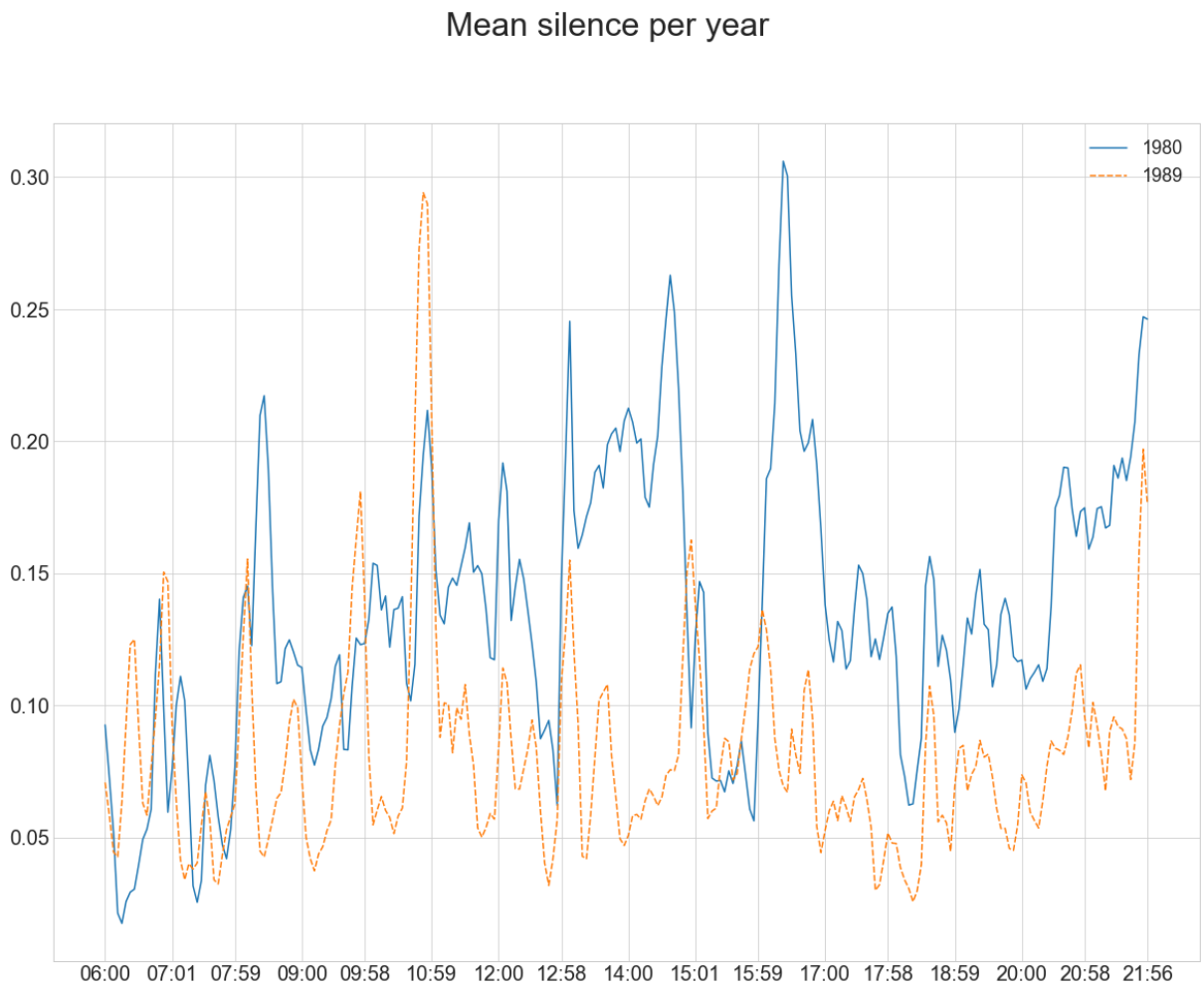

Figure 4: The rhythm of average relative silence during broadcasting hours 06:00 until 22:00 for 1980 and 1989. Each data point corresponds to a 10-minute window for which the relative amount of silence is presented. Despite the overall lower frequency of the orange curve, corresponding to 1989, the graph displays intriguing similarities in rhythm. The timestamps for decrease and increase in the distribution of silence appear to correspond. This correspondence will be further perused in the following graphs.

This graph is a representation of the silence rhythm of the entire broadcasting day, displayed as percentage of silence within 10 minutes segments. The yearly average

in the sample data from 1980 and 1989 are plotted parallelly by visual tools provided in python, with added packages. The visualization allows for several noteworthy interpretations. First of all, Max Picard might perhaps have been too hasty when he diagnosed the extinction of silence already in 1948. There are measurable amounts of silence in broadcasting still occurring towards the end of the 1980s – at least in Sweden. Yet, it is a clear discrepancy between the start and the end of the decade. The orange curve, corresponding to data from 1989, remains below the value from the 1980, drawn in blue, with only a few exceptions. Regarded from the perspective of international radio history, the results seem to confirm an established tendency. The reduction of silence demonstrated by the results can thus be understood as part of a larger development towards the minimization of silence, and seem to align with what prior research has hypothesized in regards to the Anglo-American context.

There is however another interesting aspect to the graph. Due to the general difference in frequency, the two curves rarely overlap, yet the graph seems to indicate correspondence on a structural level. It is possible to identify several cooccurrences in fluctuation, especially throughout the second half of the day. These signs seem to point towards a shared configuration of silences throughout the day. Despite the diminishing amount of silence, the graph still displays clear moments of alignment. This begs the question of the general level of similarity within the data set.

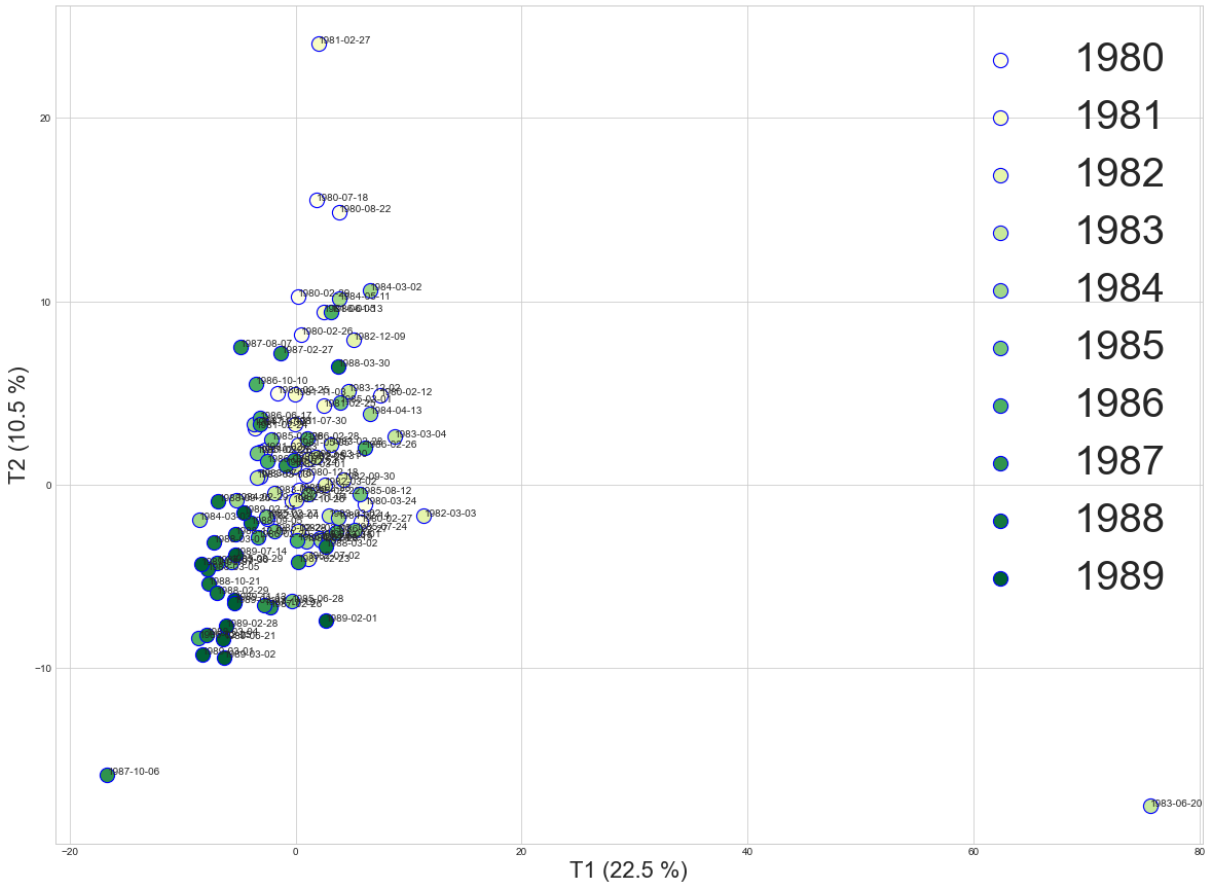

Figure 5: Principal components analysis (PCA) of the rhythm of silence. Each data point corresponds to a sampled day, the principal components have been computed from the proportion of silence during each 10-minute window as variables, as demonstrated in the prior graph. X and y-axes are two variant approximations of the trends in the total data. Components clustering closer to each other are more similar and those that cluster closer to the origin have less deviation from the overall mean.

Figure 5 displays the statistical correspondence in the data according to principal component analysis. The computation confirms a high level of similarity between the data points. The only noteworthy exception within the data is "1983-06-20" to the far right, which breaks with overall tendency, indicating significantly higher values of silence. The explanation for this is a scheduled broadcasting pause appearing this day, resulting in a longer silent pause before noon.[56] Altogether, the graphs demonstrate a significant and intriguing similarity in rhythm. The following part of the analysis investigates the plausibility and causality of these reoccurring

rhythms of silence, through the overall uniformity in programming structure, the specific similarity in broadcasting content, and finally, the validity of the data.

As discussed in the prior section, discursive records from the mid 1980s contain evidence of controversy in regards to the question of broadcasting standards. The sample data in this study indicate that the advocates of a more modern radio had an impact on the actual content of radio at the time. The program schedule accompanying the radio recordings document the gradual reorganization of content. Toward the latter half of the decade, there is evidence supporting the shift to block structure programming proposed by Forsman. Content came to be thematically arranged over larger sections of time. However, within these block sections, the sheer number of separate segments tends to increase. Between 1980 and 1989, there was an increase from an average of 2,5 to 3,7 programs per hour. The transformation to block structure thus resulted in more separate shows, despite a decrease in silence. This indicates that the number of separate shows does not, with necessity, determine the amount of silence. If the substantial quantity of silence was depending on the pauses between segments, an increase in the number of shows would likely have produced the same effect on silence. Furthermore, considering these extensive changes in schedule structure, programming alone does not provide a satisfactory explanation for the similarity in the rhythm of silence.

Figure 6: Rhythm of silence, aligned with content of broadcasting on singular days. The graphs display data from Monday and Tuesday from 1980 and 1989 respectively. Purple nodes correspond to content with explicit news orientation. Orange nodes correspond to music content. Green nodes make up the remaining mixture of programs.

The second variable of interest is the content of the broadcast. If the shows were to remain similar, only with slightly shifted time slots, this would provide an explanation for the similarity in the frequency of silence. Figure 6 aligns the program structure with the data from the Monday and Tuesday from the first and last sample week in the data set. These graphs provide insight into the greater variation of silence throughout the first half of the day. As indicated by the orange markers, morning radio in 1980 contained significantly more musical content, which in turn seems to heavily influence the frequency of silence. As displayed in the two upper graphs in figure 6, the low frequency of silence in the first hours of the day corresponds to specific musical segments. As has been argued by prior research, one of the early effects of the emergence of local radio was a migration of music content from P1, to the other channels.[57] The effects of the migration of music can clearly be identified in the frequency of silence. Orange markers tend to be followed by a steep decrease in silence, which seems intuitive considering the different functions of silence within music. Thus, the reorganization of musical content throughout the first part of the

day can account partially for the variation in rhythm between 1980 and 1989. Besides this tendency, however, there are no clear trends between the specific content and the frequency of silence. Explicitly news-oriented segments exhibit no more a clear tendency than the thematically diverse elements merged under the "Misc"-tag. Both tags are followed by drastic increases and decreases in silence interchangeably. The 08:00 o'clock news, which on Monday causes a reduction of silence, has the opposite effect the next day.

A number of shows do remain in the same time slot throughout the decade. A longer news segment appears at the same time, 12:30, in almost all broadcasting data. There are also three shorter news segments, each between two and five minutes in length, occurring at 08:00, at 15:00, and at 21:00. Similarly, a five minutes long weather report reoccurs three times every day, at 06:00, at 13:00, and 18:00. These unvarying elements do affect the rhythm of silence. Yet, the total amount of time, in particular throughout the second part of the day, only constitutes a subsidiary factor amongst the many hours of data. Taking the above-mentioned unpredictability of the effect into consideration, the consistency in content proves unsatisfying as an explanation for the similarity in the rhythm of silence. Thus, beyond the clear effect of music, the content of the program appears an equally insufficient variable for explaining the overlap in pattern throughout the second half of the day.

Figure 7: Deviation from average in proportion of silence. The average rhythm of silence is plotted in dark blue and the shaded region corresponds to the minimum and maximum proportion of silence. The graphs display data from every third year throughout the decade, from top to bottom: 1980, 1983, 1986, and 1989.

The rhythm of silence thus seems to display a certain degree of autonomy in regards to the radio content and programming. This calls for a closer investigation of the data itself. Figure 7 displays the rhythm of silence for each separate year, plotted against the deviation from average. From a methodological perspective, this visualization draws attention to the limitations of the generalizing method applied in the analysis. The considerable variation displayed between 09:00 and 13:00 in the first graph demonstrates the degree to which the method generalizes occasionally highly heterogeneous data. However, these graphs also display occasions of noteworthy similarity in the data. The almost exact overlap in both of the upper graphs occurring prior 13:00 and 17:00 are examples of strong correspondence, redeeming the accuracy of the method. It is possible to conclude that, despite being reductive in character, the analysis still provides insight into the high congruence within the data.

Studying the deviation from average, however, also provides significant indications

in regards to the historical development. By comparing the variance in data throughout the decade, it is possible to elucidate a difference in uniformity within the rhythm of silence. In figure 7, the minor deviation from average in sample week 1989 poses a strong contrast to the large shaded regions in the data from 1980. The two sample weeks between, 1983 and 1986, seem to indicate a gradual development towards a higher degree of homogeneity. This tendency is also confirmed by the PCA analysis in Figure 8, where the later sample weeks cluster closer to the middle of the graph.

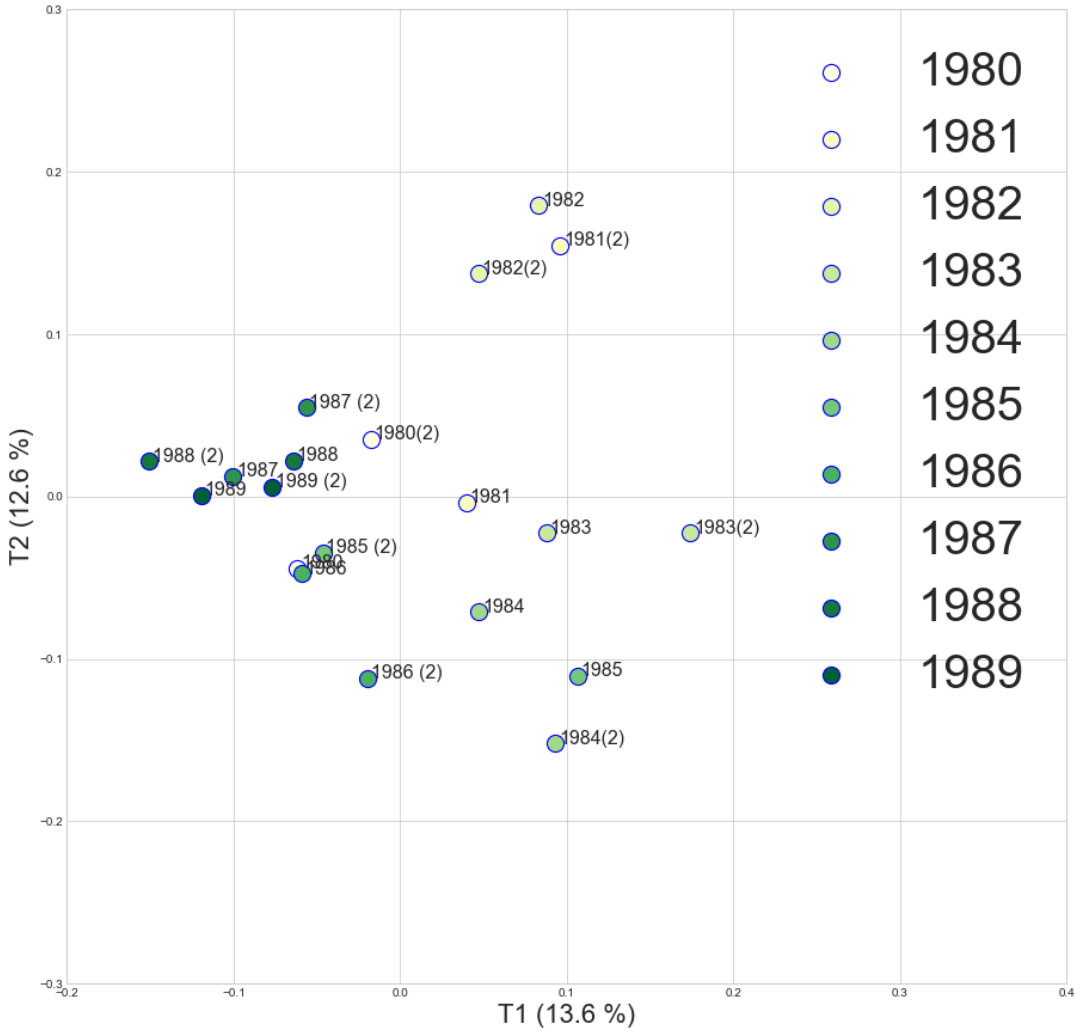

Figure 8: Principal components of proportion of silence averaged over days in each sampled week. The opaque data points, corresponding to later years, cluster towards the zero point of the graph, indicating less diversion from average.

These results are a compelling indication that the deviation decreases over the decade, in a manner that brings to mind Crisell's observation that radio had to become more "uniform" and "predictable".[58] This is also similar to what Schafer proposed concerning North American commercial radio, already back in 1977. In his prediction, each station would keep on forming increasingly "tight little loops throughout the day".[59] Radio time needed to be managed with precision and silence needed to exist under controllable circumstances. If a producer were to impulsively leave room for another seven seconds of mediational silence, as encouraged by Filson Young in the 1930s, the decision would have direct consequence in the packed tabloid schedule. The consequence is that the very programming and formatting of the medium influenced both the amount and the regularity of silence. The results presented in my study does not only appear to confirm these hypothesizes, but they also demonstrate how this style of broadcasting had influence beyond the realm of American commercial broadcasting. Prior research on the history of Swedish radio has located similar tendencies in the new local radio channels which appeared on the air throughout the 1980s. These small-scale radio stations adopted strategies from commercial broadcasting, like the use of regular jingles and clocks.[60] However, due to their size, their influence on the flagship P1 has not been accentuated. Nevertheless, the increasingly more similar rhythm of silence throughout the P1 broadcasting day provides evidence that the new style was spreading throughout the public service monopoly, quicker than previously documented.

Exploring the frequency of silence has thus rendered insights into the development of P1 broadcasting. Yet, in regards to the general similarities exhibited in the data, neither programming structure, nor the content of broadcasting provide an exhaustive explanation. Instead, these silence rhythms seem to display a certain

autonomy in their consistency. Such autonomy is good reason to further consider the function of silence as a crucial element in composing the form of radio.

Conclusion

> "Historians will always insist that there is no unmediated access to the past. But as the negative sound of the archive, silence is the truest articulation of times past."[61]

As Wolfgang Ernst argues in his latest book, *Sonic Time Machines*, the historian needs to become attentive to the significance of 'negative sound'. In order to provide a scientific and methodological response to such a demand, this article has evoked the informational value of silence. By exploring both changes and similarities in the frequency of silence in P1 broadcasting, two distinct contributions to the understanding of media history can be made. Not only do the results confirm a clear and gradual decrease in silence, but the data also indicates a tendency towards a more homogenous rhythm of silence, suggesting more rigidly formalized content. Read against the backdrop of prior radio historical research, these results provide further knowledge on the question concerning the style of public service broadcasting towards the end of state monopoly. Whether the modernization of radio necessitated a more uniform program structure is a debated matter. My research provides new insights into how increased competition and ideas of modernization came to influence the very content of radio. The gradual increase in structural similarity does not only confirm Crisell's and Murray's suggestions that radio becomes more predictable, but it also demonstrates that this development took place beyond the realm of commercial radio. The extent to which my results align with prior historical estimations is also interesting from a methodological perspective.

Whilst this lessens the novelty of the results, it simultaneously grants credibility to the method. Today, the ever-increasing amount of audio data at the disposal for media and cultural studies calls for new approaches to the study of sound. By turning the attention to the audio signal and the rhythmic redistribution of silence within the several hours of data at the time, it was possible to both discover new results, as well as anchor the conclusions in prior research. In doing so, my research affirms the media archeological interest in the signal, suggested by Ernst, and points forward to the potential of digital signal processing as a method within the humanities. By studying the very signal from a structural perspective, new answers are provided to old questions.

By putting the question to silence itself, this study has managed to validate a correspondence between a homogenization of rhythm and the decentralization of radio, as it took place in Sweden. The results both support the effectivization thesis and offer new perspectives on the role of silence on radio. Nevertheless, many of the conclusions would do well to be tested on different, and larger data sets. This highlights the prospect of future comparative research. It would be highly interesting to contrast the changes and factors between broadcasting in the different countries. The study also constitutes a reminder that sound data remains both an obstacle and a resource. The very materiality of the documents has posed concrete limitations to the scope of this research. The data has furthermore required quite considerable manual cleaning and has been juridically difficult to access. These matters retain the prospects of media studies, yet, it is also a reminder that all archival documents have their own history and politics. The archive is and has always been an economic structure. The state and accessibility of the remnants of the past are subject to matters of prioritization.

These are interesting times for any media scholar sensitive to sound. The significance and potential of the accumulation of sound media, both in classical archives and in digital infrastructures, has only been scratched on its resonant surface. The possibility of large-scale signal processing enables new ways to understand the deep structure of sound media. No longer is it necessary to manually code every single minute of radio in order to study its form. Instead, as I have tried to demonstrate, audio data can be explored by simple computational methods. The means to extract information from the vast residue of the sonic past potentially changes the conditions for historical knowledge. This is a valuable insight both within and outside media studies. In this regard, the article offers only a small addition. Yet, the ambition is to make a contribution which extends beyond the specific historical topic, inspiring future excursions into the unexplored realm of digital audio. Today, there are no clear boundaries or rules for the study of sound within humanities. Rather, it is up to attuned researchers to develop the proper techniques and discover the possibilities of audio data.

Notes

[1] Kjellberg, Anders, "The Great Conflict of 1980 and other major labour conflicts in Sweden". ("Arbetarhistoria: meddelande från arbetarrörelsens arkiv och bibliotek", Vol. 35, No. 138-139, 2011), pp. 33-40.

[2] Ibid.

[3] Crisell, Andrew, *Understanding Radio*, (Routledge, 1986): 3.

[4] See: Lacey, Kate, *Listening Publics* (Polity press, 2013) and Voegelin, Salome, *Listening to Noise and Silence* (Bloomsbury, New York, 2010).

[5] Elgemyr, Göran, *Radion i strama tyglar*, (Etermedierna Sverige, 1996), p. 225.

[6] Hadenius, Stig, Weibull, Lennart, och Wadbring, Ingela, *Massmedier: press, radio och tv i den digitala tidsåldern*, (Ekerlider: Stockholm, 2008): 96.

[7] Djerf-Pierre, Monika, Weibul Lennart, *Spegla, granska, tolka: Aktualistetsjournalistik i svensk radio och TV under 1900-talet*, (Prisma förlag, 2001): 38.

[8] Brylawski, Samuel, "Preservation of Digitally Recorded Sound", in *Building a National Strategy for Digital Preservation: Issues in Digital Media Archiving*, (CLIR and Library of Congress, 2002).

[9] According to the legal deposit register at the International Association of Sound and Audiovisual Archives, IASA, ”Audiovisual Legal Deposit register”, June 21, 2021, https://www.iasa-web.org/legal-deposit/register.

[10] See Williams, Raymond, *Television: Technology and Cultural Form*, (Routledge, 2003/1974). The link between silences and flow in communicative content has more recently been pointed out by Shammur Absar Chowdhury et. al, see; Chowdhury, Shammur Absar, Stepanov, Evgeny, Danieli, Morena, Riccardi, Giuseppe, "Functions of Silences towards Information Flow in Spoken Conversation" in *Proceedings of the Workshop on Speech-Centric Natural Language Processing* (Association for Computational Linguistics, Copenhagen, 2017”).

[11] Ibid

[12] Schafer, R. Murray, *The Tuning of the World*, (New York: Knopf, 1977): 93.

[13] Ibid

[14] Ernst, Wolfgang, “Radical Media Archaeology (its Epistemology, Aesthetics and Case Studies)” (Artnodes, Num. 21, July 2018):3, and Ernst, Wolfgang, *Digital Memory and the Archive*, (Minneapolis: University of Minnesota Press, 2012):45.

[15] Åberg, Carin, “Radio analysis? Sure! But how?”, (*Radio-Kultur und Hör-Kunst:Zwischen Avantgarde und Poplarkultur 1923-2000*, Königsh./Neum., Würzb, 2001).

[16] Ibid.

[17] Poulsen, Ib, “Carin Åberg: The sounds of Radio. On radio as an auditive means of communication” (*MedieKultur: Journal of Media and Communication Research*, *17*(33), 2001).

[18] Åberg, Carin, *The Sound of Radio*, (Stockholm University Press, 1999).

[19] Kittler, Freidrich, *The Truth of the Technological World* (Stanford University Press, 2014): 178.

[20] In conversation analysis, it is common to use 500 milliseconds as a threshold for silence, but following the work of Lynch et. al on the lengths of silences within speech, my intention has been to captured the some of the more significant silence within dialogue as well. Further reading: Lynch JF, Josenhans LJ, Crochiere RE, ”Speech/Silence Segmentation for Real-Time Coding via Rule Based Adaptive Endpoint Detection*”, IEEE International Conference Acoustics, Speech, and Signal Processing* (ICASSP-87, Dallas 1987), pp. 1348 -1351.

[21] https://lagen.nu/1966:756

[22] IASA, ”Audiovisual Legal Deposit register”, June 21, 2021, https://www.iasa-web.org/legal-deposit/register.

[23] Snickars, Pelle, ”Mediestudiets infrastruktur: Om etableringen av Arkivet för ljud och bild” (*Massmedieproblem: Mediestudiets formering*, ed. Mats Hyvönen, Pelle Snickars, Per Vesterlund, Lunds universitet: 2015).

[24] The results would nonetheless have benefited from exhaustive data, but due to complex legal status of radio recordings, this was not possible. The method proposed in this article is time effective when applied to digital documents. However, due to the current implementation of the General Data Protection Regulation, access has been compromised, which in turned has necessitated live analyses

[25] https://aubio.org/

[26] “Audacity Team (2021). Audacity(R): Free Audio Editor and Recorder [Computer application]. Version 3.0.0 retrieved March 17th 2021 from https://audacityteam.org/ [1].”

[27] Rogalsky, Matt "Maintain radio silence: listening to the gaps between the words 2000–2003", (*Digital Creativity*, 14:2, 2003), pp. 115-118: 116.

[28] Picard, Max, *Die Welt des Schweigens*, (Piper Verlag, 1991/1948): 207.

[29] Mowitt, John, "Radio Silence; or, ON the Fritz" (Cultural Critique, vol. 91:150, 2015): 159, and Lacey, 2013.

[30] Lacey, 2013: 89.

[31] Djerf-Pierre, Monika, Weibull Lennart, *Spegla, granska, tolka: Aktualistetsjournalistik i svensk radio och TV under 1900-talet* (Prisma förlag, 2001): 38.

[32] For the moniker "first media man", see: Mazzarella, Sylvester, *Filson Young: The First Media Man (1876 – 1938), 2017.*

[33] Lacey, Kate, *Listening Publics*, (Polity Press, 2013).

[34] Williams, Raymond, *Television: Technology and Cultural Form*, (Routledge, 2003/1974): 90.

[35] White, Mimi, "Flows and Other Close Encounters with Television," in *Planet TV.A Global Television Reader*, ed. Lisa Parks and Shanti Kumar (New York: New York Press, 2003).

[36] Eastman, Susan T, Ferguson, Douglas A, Klein, Robert, *Media Promotion & Marketing for Broadcasting, Cable & the Internet* (Routledge, 2006): 128.

[37] Robert Paul Dye, "The death of silence" (*Journal of Broadcasting*, 12:3, 2009/1968), pp. 225-228: 225.

[38] Scannell, Paddy, "Radio Times: The Temporal Arrangements of Broadcasting in the Modern World", (1986): 21.

[39] British Broadcasting Corporation, "Broadcasting in the Seventies: the B.B.C.'s plan for network radio and non-metropolitan broadcasting", (B.B.C., 1969): 1.

[40] Crisell, 1986: 32.

[41] Ruohomaa, Erja. "Radio as a (Domestic) Medium Towards New Concepts of the Radio Medium" (*Nordicom*, 1997), pp. 151 - 160.

[42] Voegelin, 2010: 114.

[43] Forsman, Michael, "Radio för framtiden eller bildning i förfall? Debatterna kring moderniseringen av tablåer och tilltal i Riksradions P1 1966-1986" (*Presshistorisk Årsbok*, 2014), pp, 71-84: 119.

[44] Forsman, Michael, *Lokal radio i konkurrens 1975 – 2010*, (Ekerlids, 2010): 13.

[45] Forsman, 2010: 46.

[46] Hadenius, Stig, Weibull, Lennart, och Wadbring, Ingela, *Massmedier: press, radio och tv i den digitala tidsåldern*, (Ekerlider: Stockholm, 2008): 100 – 102.

[47] Höijer, Birgitta, *Det hörde vi allihop!: etermedierna och publiken under 1900-talet* (Prisma: Stockholm, 1998): 244.

[48] Forsman, 2014: 86.

[49] Höijer, 1998: 238.

[50] Engblom, Lars-Åke, *Radio- och TV-folket: Rekryteringen av programmedarbetare till radion och televisionen i Sverige, 1925-1995*, (*Stiftelsen Etermedierna Sverige,* 1998): 178, and Höijer, 1998: 238.

[51] Höijer, 1998: 240.

[52] Forsman, 2014: 75.

[53] Feuer, Jane, "The Concept of Live Television: Ontology as Ideology," in E. Ann Kaplan, ed. Regarding Television (Los Angeles: American Film Institute, 1983): 12-22.

[54] Hadenius, Weibull, Wadbring, 2008: 101.

[55] Forsman, 2014: 74.

[56] Scheduled broadcasting pauses are a rare phenomenon. Throughout the decade, there are 103 noted occurrences, with the majority taking place in the first half of the decade.

[57] Hadenius, Weibull, Wadbring, 2008: 101.

[58] Crisell, 1986: 32.

[59] Schafer, 1977: 235.

[60] Forsman, 2010: 117.

[61] Ernst, Wolfgang, Sonic Time Machines (Amsterdam University Press, 2016): 119.