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# Different standards: engineers' expectations and listener adoption of digital and FM radio broadcasting

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**Biography**
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**Abstract**
As digital radio broadcasting enters its third decade of operation, few would argue that it has met all expectations expressed at the time of its launch in the mid-1990s. Observers are now more circumspect, with views divided on the pace of transition to an all-digital future. In exploring this mismatch between expectation and actuality, this article considers the introduction of FM radio from the 1950s. It too was expected to replace its forebear (AM) but, like digital radio, its adoption by listeners was slower than anticipated. An examination of published literature, in particular engineering and technical documents, reveals a number of similarities in the development of digital radio and FM. Assumptions about listeners' needs and preferences appear to have been based on little actual audience research and, with continual reference in the literature to the supposed deficiencies of the predecessor technology, suggest an emphasis in decision making on the technical qualities of radio broadcasting over an appreciation of actual audience preferences.

**Keywords**
Digital radio
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## Article

As digital radio broadcasting enters its third decade of operation, few would argue that it has met all expectations as expressed at the time of its launch in the mid-1990s. Even allowing for the usual industry and media hyperbole, many, more measured insiders nevertheless anticipated that, by now, digital broadcasting would have all but supplanted analogue FM (and AM) radio, at least in Europe (Ala-Fossi et al., 2008). Instead, industry people and policymakers alike are now more circumspect, with views divided on the pace of transition to an all-digital radio broadcast future (Jauert et al., 2017 this issue). Reflecting on this mismatch between expectation and actuality, it is

instructive to examine the introduction of FM itself as a novel broadcast radio platform. Like digital radio broadcasting, it too was anticipated to be a replacement technology, displacing its AM forerunner with all its perceived shortcomings. Yet FM also failed to meet such expectations and was adopted by listeners far more warily than anticipated by broadcasters. While avoiding any suggestion of historical determinism, and indeed wary of offering much by way of generalised theory or explanation, this article explores the history of FM's introduction and compares it with the more recent emergence of digital broadcasting.

At a superficial level, digital radio, in its most long-lived and most widely adopted form DAB (for 'Digital Audio Broadcasting') exhibits a number of parallels with FM. Both were intended as 'replacement' technologies, displacing the existing platform rather than simply enhancing it by existing alongside (stereo broadcasting and radio data systems are examples of the latter instance). Thus, 'switchover' strategies would be needed – as have been witnessed in the recent transition to digital television – as listeners would have to acquire new receivers or face the eventual prospect of losing services altogether. Both DAB and FM were technically superior to their predecessors, offering the prospect of improved reception and sound quality along with an increase in capacity and thus new stations available to listeners. These benefits over existing systems formed the basis of promotion to listeners in order to encourage the purchase of replacement radio sets. In their respective ways, both FM and DAB were expected to become global standards for radio broadcasting in a similar way that AM was universal from broadcasting's inception. (FM, originating in the US, did indeed become an internationally adopted technique; DAB, begun as a European project, has so far not done so.)

Equally common to the cases of both DAB and FM has been the relatively slow progress in the transition: FM has still not replaced AM completely; even where public service broadcasters, such as those in Europe, have ended most of their AM transmissions in favour of FM, that change took some four decades to complete. DAB, as noted, has also been adopted both less deeply and widely than hoped: less deeply in the sense that, in countries where it has been selected by policymakers and broadcasters as a new standard, listener adoption has been lower than expected; and less widely in that far fewer countries than anticipated have actually made serious plans for the roll out of DAB (or, often, of any digital radio service at all).

So it is instructive to look beyond the superficial evidence and examine the emergence of each system in more detail. The process of developing such novel broadcast technologies begins, in many cases, with technical considerations and a quest for engineering solutions to perceived shortcomings of existing systems. For example, reception problems reported by listeners will be directed to broadcast engineers or technical staff; quests for additional capacity, whether encouraged by policymakers or existing broadcasters themselves, will require technical developments and investigation in addition to regulatory considerations. The technical press, internal broadcast engineering papers and academic engineering journals thus afford a particular insight into the inception of novel broadcasting platforms. Such literature, particularly in the early stages of developing new techniques, frequently reveals detail about the limitations of the existing system, the proposed solution offered by its replacement and thus, in this case, the assumptions about the purposes of radio and the nature and needs of listeners. Once the new platform is launched, further refinements in response to teething troubles or unanticipated problems become, again, an engineering issue and so the literature, alongside policy and regulatory considerations, reveals new aspects about the relationship between broadcasters and listeners.

In this study, therefore, the role of the UK's public broadcaster the BBC, and especially its Engineering department, is explored in relationship to the development of FM from the 1940s and of DAB from the 1980s. The BBC was not the first broadcaster to begin FM transmissions, of course, but

after beginning regular domestic transmissions in 1955 it very quickly rolled out FM across the country. The emergence of new broadcasters, including commercial radio, is a valuable illustration of the interplay of technical and policy considerations in radio's development. The BBC was an early participant in the development of DAB and one of the first to launch regular digital transmissions. BBC engineers were regular contributors to academic and trade journals and selections of internal BBC documents (if not entire collections) are readily available; this literature coupled with related policy documents form the basis of this research.

## FM and DAB: summary of developments

The technique of frequency modulation (FM) emerged as an alternative to amplitude modulation in the 1930s and 1940s as part of a general concern amongst broadcasters about the technical complexities invariably encountered in receiving radio broadcasts. The title of Edwin Armstrong's 1936 article in the Proceedings of the Institute of Radio Engineers specifically refers to 'reducing the disturbances' in radio transmission (Armstrong 1936). FM could achieve a better signal-to-noise ratio than AM, interference between stations on nearby frequencies was more effectively suppressed and thus sound quality for listeners could be improved, quite dramatically in some instances. For numerous and intricate reasons, Armstrong and his fellow advocates were unable to persuade broadcasters to adopt FM with any enthusiasm and, for European countries at least, the imminence and outbreak of the Second World War ensured that all efforts in radio broadcaster were directed at consolidating and securing the existing AM infrastructure given radio's likely importance during wartime. By the end of the war, the technical arguments in favour FM were not disputed and post-war allocations and reassignments of radio frequencies opened up potential for its wider adoption. In the US, where the arguments about FM had been raging longest, disagreements between broadcasters and regulators and a lack of consensus amongst technical advisers on the best frequency allocations for FM (at a time when frequencies were also being newly allocated to television broadcasting) created barriers to FM's development (see, for example, Slotten, 1996, Frost 2010). Elsewhere, such as in the UK where the BBC's broadcasting monopoly eliminated one element – commercial competition – from these debates, progress was more sedate and its trials of FM transmissions began in 1945. Reporting these experiments, H L Kirke recalled observations from an earlier visit to the US and Canada: 'There was so much disagreement in America, and in addition a certain amount of political background, that it was not possible to obtain a true picture of the value of F.M.'. Hence, trials were instead undertaken in the UK (Kirke, 1946: 8).

FM subsequently emerged as a fully developed system for radio broadcasting from the early 1950s. Services were on air in a number of countries and the UK's regular transmissions began on 2 May 1955 (Pawley, 1972: 339-40). Initial broadcasts were simulcasts of the BBC's existing stations, the Home, Light and Third programmes which already transmitted on AM. Novel, FM-only programming did not begin until the introduction of 'local' BBC stations from 1967. The introduction of 'independent' – or, in effect, commercial – radio from 1973, and the ending of the BBC monopoly on radio broadcasting, introduced yet more stations on FM but, like the BBC, these stations also simulcast on AM medium wave for most of their time. Such simulcasting was favoured by broadcasters since ownership of FM receivers remained low in the UK. This was not uncommon: FM had been around far longer in the US, for example, but had made little impact on listening figures since most popular programming was to be found on AM (Keith 2002). Only following the passage of the UK's 1990 Broadcasting Act was the BBC obliged to vacate its AM frequencies, ending simulcasting and requiring its listeners to tune exclusively to FM. By mid-2016 the FM band carried a total of 516 stations (236 commercial, 47 BBC and 233 community stations) while 95 stations transmitted on AM – 35 simulcast with FM, the remainder on AM only (Ofcom, 2016: 123).

Digital radio broadcasting emerged from a collaborative European research project, Eureka 147, which developed the specification known as DAB. DAB was approved by the ITU as a 'recommended'

standard in 1994 and a small number of public service broadcasters in Europe, including the BBC, began demonstration transmissions in 1995. Intended as a replacement for FM, it offered the prospect of more stations than FM, data services alongside audio, easier tuning and better sound quality – the phrase 'CD-quality sound' was used in recognition that the compact disc was by this time widely adopted by consumers and, for most, their only direct experience of digital audio (Hoeg et al., 2001: 2-4). Although there had been interest in DAB beyond Europe, the intention that it should become a global standard did not materialise. While Canadian broadcasters and regulators readily adopted the DAB platform in 1995, it was subsequently abandoned (O'Neill, 2010). Broadcasters in the US, although expressing initial interest, adopted a quite different platform, IBOC (now known as HD radio) which was approved by the FCC in 2002 (Stavitsky and Huntsberger, 2010). Thus, Canada aside, it was within Europe that most attention was focused upon DAB, with some level of coordination being exercised by the European Broadcasting Union (EBU). The UK proved to be the country where DAB grew fastest: legislative procedures were put in place in 1996 and in 1999 commercial DAB services began alongside BBC stations. In addition to simulcasts of the existing three analogue commercial stations operating nationally, twice that number of new stations were launched. Thus DAB offered, as promised, an increase in the number of stations, including several exclusive to this new digital platform. Local digital services launched in the years following, again mostly carrying simulcasts of existing analogue stations but also, in some cases, completely new stations or, in others, stations that already broadcast on analogue in other localities. So DAB did offer novelty, new stations including, from 2002, digital-only stations from the BBC, and sales of DAB receivers continued to increase, steadily rather than swiftly. Similar patterns of steady DAB growth were experienced in a handful of other countries – Denmark, Norway and Switzerland, for example – while elsewhere, such as Finland and Sweden, DAB was abandoned altogether. Indeed, two decades after its launch, DAB-listening has still not become the dominant way of receiving radio anywhere and by the end of 2016 only one country, Norway, had planned to switch off FM transmissions of its main NRK radio stations in favour of DAB-only.

Thus, the picture is one of fragmentation: a small number of apparently determined countries where DAB is a significant presence, a larger number where it has been explicitly rejected and, perhaps the largest group of all, countries across the world where DAB is either at a preliminary trial stage or simply not on the agenda at all (see, for example, EBU, 2016). In the UK, an example of the first group, 2016 figures show that DAB's share of all radio listening is 32 percent (in contrast with 55 percent listening via analogue AM or FM) while its weekly reach is 45 percent; 56 percent of adults own a DAB receiver and 437 radio stations are broadcast on the platform, the vast majority on local services, but some 30 commercial and 11 BBC services available nationally (Rajar, 2016; Ofcom, 2016: 123).

## The development and adoption of FM and DAB: common themes

Both FM and DAB, then, share one overriding observation: both have taken longer than anticipated to become established as the norm for radio listening. There is a mismatch between broadcasters' early expectations and the subsequent responses by listeners. A comparison of the two platforms suggests a number of common themes which, while not wholly explaining this difference between expectation and outcome, do offer some insight into the assumptions made by broadcasters – and their technical developers – and the significance of the relationship between broadcasters and policymakers. For example, in the case of both FM and DAB's development, deficiencies with the existing system were identified; broadcasters were concerned about the future of radio and competition for new media; and changing audience habits (presumed or, as it turned out, unanticipated) proved significant. Such common themes are discussed here.

## Engineering-led 'solutions' to self-evident problems

As noted earlier, almost from the outset of radio broadcasting, the technical superiority of FM over AM was understood. Slotten quotes W R G Baker, the US Radio Manufacturers Association engineering department's director, speaking in 1943: he argued that FM was 'so much better technically than the present regular broadcast system that it can't fail of acceptance' (Slotten, 1996: 686). The post-war rollout of FM following favourable frequency reallocations enabled engineers to begin serious exploration of its possibilities. The benefits of FM were widely recognised by engineers: Kirke's 1946 report, already referred to, lists suppression of both interference and internal noise, increased dynamic range and inclusion of the full audio bandwidth in transmissions. The 1947 World Radio and Television Annual presented an introduction to FM to the wider public. 'More faithful reproduction of sounds' and reduced 'background noise' were the key benefits while, almost incidentally, the use of the VHF waveband would relieve the 'congestion' on the AM bands and would bring the prospect of more stations (Pedrick, 1947: 152-3).

That such improvements in sound quality would not find immediate application with listeners was understood by engineers. For example, a 1948 BBC Research Department report sought to address the improvements needed in studio and recording techniques in the quest for 'high fidelity sound reproduction'. Its author, T Somerville, noted that sound quality might not matter when the 'average receiver' was capable of only a limited audio bandwidth and medium wave AM reception. It was, however, only a matter of time before this would change. Somerville described the need for 'all-round improvement' as 'urgent', concluding, 'The need for rapid improvement cannot be over-emphasised, for new systems of transmission, such as F.M., will make only too obvious the poor quality of many of our transmissions' (Somerville, 1948: 6). This urgency, understandable from the technical perspective given that the advanced nature of FM was clearly apparent, nevertheless assumed rapid acceptance by listeners. Edward Pawley, himself a senior BBC engineer, reveals a degree of perplexity in the slow adoption of FM: 'Despite the advantages offered by the VHF/FM transmissions, the public was slow to acquire VHF receivers and the proportion of listeners able to receive the VHF/FM transmissions was still only about 30 per cent after the service had been operating for ten years.' He accepts that this may because many listeners 'were still reasonably served' by AM transmissions (Pawley, 1972: 343). A further decade later, the BBC noted, just 40 percent of receivers could receive FM (MacEwan, 1977: 38).

It is relatively straightforward to find examples of similar optimism amongst early articles about DAB. Engineers' presentations at industry conferences, for example, anticipated DAB becoming an adopted standard across the globe by the year 2000, noting a 'high level of interest' amongst consumers in all countries, before concluding (Gleave, 1997: 242):

> Much work is still needed, but Eureka 147 digital radio has moved from the early technical development phase to a point where it can be confidently seen as the radio system for the new millennium, with an important role in the developing digital communications environment, both terrestrially and via satellite.

Likewise, writing in 1998, Tuttlebee and Hawkins wondered whether in a decade's time, plain old VHF/FM radio would be but a mere memory (1998: 276). The sense that DAB was a natural successor to analogue radio was implicit in the BBC's 1995 public announcement of the new system, albeit in a 'soft launch' given the minimal services available. Liz Forgan, BBC Radio's Managing Director, described DAB as the 'dawn of a third age of radio, the technological progression from AM …and FM, now 50 years old, into the digital multi-media [sic] world of the 21st century' (quoted in Williams, 1995: 6). While the last of these examples might be no more than what one would expect at a media launch, the engineers' accounts suggest a genuine sense that the technical breakthrough represented by DAB would be followed by an almost inevitable adoption by consumers, recalling Baker's phrase (of FM) that it 'cannot fail of acceptance'. That DAB had been expected rapidly to

become a world standard and find favour with consumers is also demonstrated, somewhat perversely, by the EBU's senior engineer Franc Kozamernik. In a generally upbeat article, he acknowledged that the roll out of DAB was 'much slower than expected' (Kozamernik, 1999: 1), a point he makes again some five years later, this time more explicitly: 'DAB rollout has been slower than most of us – the enthusiastic engineers who helped to develop and promote it – were hoping' (2004: 1).

The few examples referred to here – a necessarily selective sample unfairly singling out particular authors – suggest that, like FM, DAB's future was assured from an engineering point of view. Some of these authors included cautionary notes – Gleave for example reminding his audience that some technological successes subsequently do indeed fail in the marketplace – but the overriding sense is of a technologically proven improvement on the existing broadcasting platform which, with judicious planning and implementation, would become the next-generation radio platform.

Despite the UK initially being one of the most rapidly growing markets for DAB receivers, the engineers were not alone in overstating the pace of adoption. Broadcasters and their associated marketing organisations similarly generated forecasts that proved over-optimistic. The Digital Radio Development Bureau, the DAB promotion agency established by both BBC and UK commercial broadcasters, published forecasts in 2004 and 2007 for DAB receiver sales and household adoption; in both cases, numbers forecast for four years later turned out to be optimistic by some 50 percent or more (DRDB, 2004 and 2007). As recently as 2009 the industry, with government support, was predicting that a 'drive to digital' might result in digital radio's share of listening reaching the 50 percent threshold by 2013, triggering a process of switchover from FM to DAB (DCMS, 2009: 93).

In both cases, then, we find instances where broadcast engineers argue that, so obvious are the improvements offered by the successor technology, take up will be rapid and, yet, when this fails to materialise, an impression of some bemusement suggests itself in the engineers' writings.

## Improving radio: discourse on deficiencies

In articles introducing both FM and DAB, we find continual reference to the limitations and deficiencies of the existing platform which the new technology is destined to replace. With AM, the technical problems were straightforward and familiar to engineers and broadcasters, neither in some cases could they be ignored by listeners. Reception on AM was, and remains, poor in certain circumstances, particularly in crowded markets where spectrum is in high demand and the problem was highlighted at night, after sunset. This particular problem was a feature of AM listening from the outset and resulted from the physical fact that radio waves of certain frequency ranges are able to travel further at night when the skies are dark, by means of reflected waves bouncing around the earth off the upper atmosphere. (In the daylight, a photo-chemical reaction interferes with and absorbs these reflected waves so they cannot propagate far and cause problems.) Thus, tuning to an AM station at night, a listener has to contend with a host of potentially interfering signals from overseas which are simply not present during the daytime. FM does not suffer from this, not least because of its use of the higher VHF frequencies, which do not reflect off the atmosphere and so are confined at night as in the day.

This problem of interference was made worse by the number of stations coming on air in the post-war period. One possible solution, albeit temporary and possibly rather single minded, would be for a radio station to increase the power of its transmissions so that its listeners could find the station while it drowned out any lower power interfering stations. That, of course, exacerbated the problem in neighbouring countries. This feature of AM was commented upon by numerous engineers and broadcasters as a key argument in favour of FM. For example, BBC Director of Engineering, James Redmond, suggested in 1969 that the problem of after-dark reception was so bad that 'it seems

reasonable to regard this [AM] band as most suitable for speech and background music, relying on the vhf [FM] band for the really high-fidelity reception of programmes' (1969: 6). Carpenter's popular account of the BBC's classical music station Radio 3 and its predecessor, the Third, suggests that in these pre-FM days it was believed the station could be heard better in Switzerland than in central London (1997: 48). Pawley's account of BBC engineering argues that the development of FM was driven principally as a solution to after-dark interference, describing it as 'a means of escape from this problem' (1972: 342). Like others, he also expresses some perplexity at the slow take-up of FM receivers.

(It should be noted that the after-dark interference 'problem' was actually a source of entertainment for some listeners, admittedly a small number. These were the 'DX-ers', who took pleasure from seeking out distant stations at night, the more faraway and obscure the better.)

FM offered further benefits for listeners. Given its ability to eliminate, or at least reduce interference, it could broadcast a greater dynamic range (the range between quiet and loud sounds) and together with almost the full audio bandwidth (compared with AM's quite restricted bandwidth) could offer the prospect of high-fidelity sound. AM was simply unable to do this. The classical music broadcast on the Third, later Radio 3, would perhaps stand to benefit most. Already by 1947, Wireless World was using the term high-fidelity in its reporting from the Olympia Radio Exhibition (Wireless World, 1947). Here, commentary was less about radio, however, and more focused on audio principles and performance of equipment such as high-end tape recorders and loudspeakers. Such equipment, at this stage, was not intended for domestic markets. Nevertheless, as Somerville's report, noted above, suggests, the BBC engineers were preparing for the prospect of high quality audio delivered by FM (Somerville, 1948). The small but growing numbers of hi fi enthusiasts were a symptom, perhaps, of a new interest in audio and sound quality. While, for Wireless World, by 1961 the hi fi enthusiasts were becoming a little tedious, preoccupied with 'sound for its own sake' in a 'solitary pursuit' for perfection (Wireless World, 1961) nevertheless, some argued that tastes were changing and that, in radio, AM would no longer do. Cherry notes that 'During the 1960s, high quality home hi-fi systems came into widespread use. The portion of our population raised in that environment, sometimes called the youth market, have adopted hi-fi sound as a fact of life' (Cherry, 1980). FM radio, particularly in the car where radio was the principal or only audio source, suited this new trend in audio consumption.

DAB was also, in part, justified on the basis of listeners' preferences for high audio quality. Price, for example, suggests that 'the spread of the CD - and other consumer digital sound products – has shown up the shortcomings of the present VHF FM radio broadcast system' (1992: 131). Others conflated listener tastes with a potential threat to the existing FM system. Pommier and Ratliff, like Price, also suggested that the adoption of domestic digital audio had led to a 'wider public appreciation of high quality sound' in their introduction to an explanation of new digital audio coding techniques for radio (1988: 349). It seems clear that these propositions, like those made by others, were not based on any systematically derived evidence of consumer preference, since none was presented nor referred to, but instead were mere presumptions. While audio engineers have often conducted subjective listener tests of audio coding systems and reached conclusions on differences in perceived sound quality, evidence in either the technical or non-technical literature of audience preferences in relation to audio quality is scant, and thus offers little guide as to its relevance in listening choices or decisions on equipment purchase, for example. More recent commentary has, in fact, noted the apparent preference – for reasons necessarily other than audio quality – for MP3 audio over uncompressed CD audio (for example Rothenbuhler, 2012; Sterne, 2012) and the recent revival of the vinyl LP (Osborne, 2012; Bartmanski and Woodward, 2015).

Nevertheless, the perceived failings of the existing FM system formed the prelude to a number of articles introducing DAB and its benefits. Typical narratives include the statement that FM had 'reached the limits of technical improvement' (Müller-Römer, 1993: 1; see also O'Leary 1993: 19). Pommier and Ratliff, like others, suggest an imminent, if not actual, threat to the continued quality of FM. While noting that it had 'once delivered a sound quality in the home that was second to none', increasing demand for FM spectrum – 'congestion' of the VHF band is a recurring observation (for example Shelswell, 1995) - meant FM quality was becoming threatened. Mobile reception – that is, listening on a car radio – was also frequently noted as revealing FM's worst failings with some suggesting that FM was never intended to work while on the move (O'Leary, 1993: 20). DAB, in contrast, was specifically designed with mobile reception in mind: 'perfect mobile reception was the overall aim…even at high speeds' (Hoeg et al., 2001: 5). Drivers would be able to cross whole countries and listen to a station without having to re-tune their radios.

That DAB offered a solution to all these deficiencies in FM was under no doubt. The interference from other stations would be eliminated by the DAB system and multipath reception, which causes fading in car-based listening was explicitly addressed by DAB (for example see Bell and Stott, 1990). Not surprisingly, perhaps, the perceived problems of FM listed in the introduction to these articles serve as simple preludes to explaining precisely these novel attributes of DAB. They remain, then, 'problems' for engineers rather than listeners. In fact, significant progress in analogue FM radio design, particularly in car radios, had already gone some way to removing interference and fading, such as the use of digital tuning circuitry. The development of the Radio Data System also incorporated an 'alternative frequency' feature, which automatically re-tunes a radio on the move. Similarly, the impending deterioration in FM quality by the pressure from new stations seems somewhat overstated: FM services continue to exist some two decades later, indeed FM remains the majority listening platform, without evidence of diminished reception quality; further expansion in station numbers has taken place, for example the development of community radio in the UK with more than 200 FM stations coming on air since 2003 (Ofcom, 2016: 123).

## The existential threat to radio: new media

The final theme discussed here, but related to the previous one, is a more general understanding amongst broadcasters, voiced equally it seems by engineers and their non-engineering radio colleagues, of radio's threatened existence. The predicted death of radio on the emergence of television in the 1950s and 1960s, instead followed by radio's survival through changes in both production and consumption, is well understood. Nevertheless, other perceived threats resulted in frequent calls for radio to adapt to survive. Some have been noted above: the habituation of audiences through their use of consumer digital audio in recorded form made the introduction of digital audio in radio broadcasting essential. For example, Thomas described DAB as 'badly needed' in the era of the Digital Compact Cassette and MiniDisc (1993: 1), technologies which, Müller-Römer argues 'presented broadcasters with a serious basic problem' (1993: 1). More explicitly, Ratliff suggests DAB would eliminate the 'danger of [radio] being eclipsed by modern high-quality digital recorded media' (1993: 1).

This concern that radio would be 'left behind' in the new digital age proved a continuing refrain from broadcasters. In opening remarks at a gathering of the industry at a European Commission conference, the Director General of DG X, Audio Visual Policy, stated that 'It is obvious that the future is digital. The future for broadcasting, for audio broadcasting, for audio-visual broadcasting, is digital' (Pappas, 1998). Addressing the annual NAB conference in 2003, the BBC's Director of Radio stated that 'radio must go digital if it is not to go into long term decline' (Abramsky, 2003). In 2009 the then President of World DAB (then 'World DMB') perhaps unsurprisingly, made the same point: 'that radio must go digital is beyond doubt' if it is to compete effectively with new consumer technologies, basing the claim this time not on sound quality but on the competition's 'richer

content offerings' (Howard, 2009: 2). Two years later, the EBU repeated simply that 'radio must not remain the only analogue medium in a digital world' (2011: 1). These examples, spanning more than a decade, echo the earlier assumptions of engineers that radio's existence was under considerable threat, principally because of the superiority of new digital media, whether in terms of sound quality, digital content or, in some instances, an unexplained logic that 'analogue' did not fit in a 'digital world'.

In the case of the introduction of FM in the 1950s and 1960s, doubts about the future of radio were perhaps more credible. Broadcasters' attention – and expenditure – had turned to television, as had that of audiences. Briggs notes that audiences for key radio programmes, both news and entertainment, plummeted. News on the Home Service, for example, listened to by 14 percent of adults in 1955, reached only 5.1 percent in 1960, while the audience for Friday Night is Music Night fell by a similar amount (Briggs, 1995: 222). Crisell suggests that, with radio audiences falling and the BBC committing more to television programming at radio's expense, 'television was radio's greatest enemy, and 1964 perhaps marked the nadir of BBC sound broadcasting' (2002: 137). So, audiences were turning to television, while the audio enthusiasts, who might spurn television, now had more affordable hi fi goods available. The Economist's report of the 1958 London Radio Show – or, 'the so called radio exhibition' – reported that stereo record players and tape recorders attracted much more interest than radio (Economist, 1958: 694). Meanwhile the problem of medium wave analogue radio reception continued to get worse. In the face of these trends, introducing FM addressed at least two concerns: offering good sound quality (including the prospect of stereo) which was also largely free of interference.

FM thus did make sense as a response to a decline in radio listening. Stereo followed soon after, with regular transmissions from 1966. This development followed somewhat naturally from the introduction of the stereo LP in the 1950s. BBC radio producer Douglas Cleverdon wrote that 'the rapid commercial development of stereo LPs inevitably forced the BBC into stereo broadcasting of classical music on Third Programme [sic] and pop music on the Light' but stereo, he noted, also offered new creative possibilities in the features and drama departments (1973: 496). Part of radio's survival strategy depended on differentiating it from television, which by now had become the main focus of broadcast entertainment in most households. In 1970, the BBC's Managing Director of Radio suggested that stereo would play a role in this: 'In some ways, stereo is as momentous a development to radio as colour is to television' (Trethowan, 1970: 4). By now, television was indeed in colour, but its sound in mono, and for 'serious' viewing of, for example, classical music concerts like the Proms, television viewers were advised through the Radio Times magazine to turn the sound down on their sets and listen to simulcasts on radio while watching the screen. But if colour brought a new naturalism to television, stereo could do something similar for radio and, as Cleverdon noted, stereo radio went far beyond the mere playing of stereo records and helped stimulate a revival of enthusiasm for radio amongst writers and producers (Hendy, 2007: 197-200).

## Technical solutions and non-existent problems?

Radio did not go into terminal decline in the 1960s. Indeed, by the end of that decade any decline in audiences had begun to reverse, radio sales were increasing and so was daytime listening (Hendy, 2007: 56). This turnaround, however, had little to do with FM. As seen earlier, by the middle of that decade fewer than one third of UK homes had an FM receiver. In fact, the early configuration of FM had led to reception problems of its own. In the 1950s, it had been assumed that receivers would, by and large, be like those that had been in use thereto, that is a fixed receiver in many cases using an external roof mounted aerial. Engineers planning FM had calculated necessary field strengths at a height of 10m above the ground, typical for an external aerial. Tuning new FM receivers could prove difficult and the use of a portable receiver – increasingly popular with the miniaturisation of electronics – coupled with a telescopic aerial compounded the problems. Briggs reports the BBC

receiving complaints (1995: 840) while the BBC's Director General later conceded that there had indeed been problems (Curran, 1972: 7):

> Thus we ought to have seen that automatic frequency control should be a standard provision of any VHF receiver. It eliminates many of the arguments that VHF is difficult to tune or difficult to keep in tune, which proved such a handicap in the initial campaign to sell VHF receiver.

So FM made little initial impact on listening figures, nor, for that matter, on sales of radio sets. Instead it was the coming of, first, miniature valves but soon after, the transistor, that permitted radio manufacturers to begin production of small, highly portable radios which could run for considerable time on small batteries. New manufacturers sprang up, particularly in rapidly industrialising countries such as Japan and Hong Kong and prices fell. UK sales of transistor-based radios increased by a factor of 20 in the three years from 1960 (Geddes, 1991: 350). These receivers were AM-only, and typically carried their aerials inside their casing rather than extending telescopically which, paradoxically, caused reception after dark to be even worse than that which had stimulated FM's development. But these radios were, by and large, not being used in the evenings when their owners were, in common with more and more of the population, likely to be settled in front of the television. Listening was taking place more during the daytime, and more often as an individual in private space. Pirate radio stations launched around the world, reflecting the emergence of this new audience: younger, interested in pop music and wanting to take their radio with them on the move (see for example Briggs, 1995: 507; Crisell, 2002: 138-44).

This revival of radio resulted in the launch of the BBC's own pop music station, Radio 1, together with a reconfiguration of programming. By the 1970s, BBC radio considered itself to be addressing two distinct kinds of listener: the 'casual' listener who listens 'mainly during the day', carries the radio around, and for whom the radio is background listening; and the 'serious' listener, smaller in number, but equally important, who would avail themselves of quality equipment and would 'relish the quality of the sound' (Trethowan, 1970: 5 and 1975: 8). These two strands of listeners could only be served, therefore, by the BBC continuing to simulcast its network stations on both AM and FM, a situation that prevailed until 1978, when frequency changes that followed reassignments at the 1975 Geneva Radio Conference raised once more the issue of low ownership of FM receivers. BBC Radio 4 was to move off medium wave to long wave (alongside VHF/FM simulcasts of course), prompting many to fear they would lose access to the station altogether (many cheap portables lacked long wave as well as VHF). Early newspaper reports suggested the numbers who might need to acquire new sets could number in the millions, but in fact the number who would lose favourite stations completely was more likely to be far fewer (Anon, 1978; Ward, 1978).

Full migration of BBC services to FM-only transmission followed the passage of the 1990 Broadcasting Act, which was driven by a policy objective of expanding commercial radio broadcasting. Numbers of commercial stations increased dramatically and FM became the preferred listening platform. It remains so today, in the UK certainly and also in just about everywhere else. DAB, then, rather like FM three decades or so earlier, did not become the salvation of a radio broadcast platform in jeopardy. Radio, it appears, can survive as an analogue medium in a digital world. Congestion of the FM band has not rendered radio unlistenable, and radio's reach remains undiminished in many countries (Ofcom, 2015: 197). The improved sound quality offered by DAB was also not a decisive factor for listeners and the phrase 'CD-quality sound' was dropped by broadcasters early on (Lax, 2003). Instead, sound quality has been lowered in favour of allowing space for more stations. As Quentin Howard argues, 'Only a very small percentage of radio listeners demand or appreciate audio fidelity and near-CD quality. This is not surprising given that most radio listening takes place in sub-optimal conditions' (2009: 3). The long term future of FM appears assured and new technical developments in digital radio, such as Radio DNS supporting hybrid and visual radio, have been developed to work with both DAB and FM. Indeed, some of the novel, digital

media that were identified as competition for radio, such as Digital Compact Cassette and MiniDisc (and to some extent the Compact Disc) have themselves disappeared from the audio landscape, outlived by analogue FM.

## Conclusions

The preceding observations suggest a number of similarities between the emergence of FM and DAB. The intention has been to examine the technical origins of each and explore the reasoning behind the development and its anticipated outcomes. Based, necessarily, on a selective sample of evidence (not least, because of the variability in availability of source material) some tentative conclusions may be drawn.

Firstly, and most obviously, there is a difference between how engineers and technical staff understand radio and how listeners use and value it. In each case, engineering commentary identified deficiencies with the existing platform and thus, self-evidently, noted the scope for improvement. To some extent, this became self-reinforcing: as research progressed in the new platform and more articles were published, the lists of faults with the old were repeated. Rarely, however, was there a direct reference to listeners' perspectives. 'Interference' after dark, for example, was clearly a technical issue with little indication of there being a general tendency amongst listeners to switch off or to complain to broadcasters about such interference. Similarly, there is little evidence in either case that most listeners were concerned about audio quality and thus would eagerly embrace the higher fidelity of FM or, in its turn, DAB. For listeners, presumably, the content of the radio stations was most important and there was no need, necessarily, for radio to 'compete' with tape recording, hi fi or, later, digital recording media in this respect. Howard acknowledges the difference between engineers' expectations and the listeners': 'Many engineers feel uncomfortable with this issue but the economic success of a platform designed for mass consumption is far more important than satisfying a small minority of audiophiles…Content remains the primary consideration for a successful new platform' (2009: 3).

Indeed, the apparent perplexity at the slow adoption of the novel platforms omits consideration of audience habits and preferences. The new mobility and 'relegation' of radio to background listening as FM emerged was a trait noted only in hindsight by broadcasters and their engineers while, in the case of DAB, it was perhaps the stability of audience habits that thwarted its rapid adoption. The anticipated elevation of the 'radio' receiver to a digital multimedia platform (see, for example, Kozamernik, 2009) was eclipsed by cellular phone and data networks; the assumed growing importance of high speed, in-car listening has also not been borne out at a time when, in some countries at least, car driving is either levelling off or in decline (DfT, 2016; Tuttle, 2015).

Instead, perhaps the more significant factor shaping the adoption of these new platforms has been the more pragmatic policy developments. In the case of FM radio, policy which, in effect, initially required FM and AM simulcasting meant that for listeners there was little incentive to substitute existing receivers which worked as well as they had always done; the end of simulcasting came with the political desire to expand commercial radio (and international frequency agreements obliging some migration) and so only then were listeners becoming obliged to acquire FM receivers. Of course, by this time, many had already done so; price differences between FM and AM-only receivers had diminished and the adoption of FM equipment was more a process of accretion by default rather than a positive selection in favour of the new platform. Similarly, in the case of DAB, most listening is to stations which remain simulcast on FM, with DAB-only stations in most cases attracting quite small audiences. A policy of offering licencing incentives to commercial broadcasters to support DAB, intended to kick-start the migration of commercial radio to DAB, remains in place some years after it might have been expected to have had the desired effect. Again, the willingness

to broadcast on DAB may be seen less as a station demonstrating support for the DAB platform itself than a simple commercial decision to retain its FM licence (Lax, 2014: 106).

Of course, technical developments (and the engineers behind them), broadcasters and policy developments are not separate. Broadcasters seek to influence policy while policymakers regulate on the basis of political leaning and technical advice. Policy can hinder or promote particular technological developments. Engineers, too, do not work and develop new ideas in isolation from a social, economic and political reality. Nevertheless, at the very least, the evidence offered here perhaps suggests that a limited appreciation of the 'bigger picture', the needs of audiences and listeners' habits, might explain why these broadcast engineers' expectations about the role of their new broadcast platforms turn out to be unfulfilled.

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