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Knowing Sonic Impressionism: The Design of Theatre Sound Effects

What historical theatre practitioners knew about sound and its affective potential has not been examined in the context of a long history of creative soundmaking. As I argue here, our present-day practices in sound design do not necessarily originate with the introduction of sound recording technology in the twentieth century but can be traced back further to theatrical approaches. To deepen our understanding of sound effects practice, I draw together a variety of sources from the late nineteenth and early twentieth century and place them within the framework of Cross' *designerly ways of knowing* (2006, 29) with the aim of exploring the knowledge at the heart of practitioners' soundmaking. Historical practitioners faced the challenges of working with acoustic materials and mechanisms to design sound in much the same way as present-day sound designers; by considering the material of sound itself not just as a way to provoke recognition in the listener, but also emotion and mood. My approach evidences that theatre practitioners were concerned with aspects such as sync or spatialisation that we would usually trace back to the evolution of film soundtrack techniques and had a deep understanding of sound as effect (Brown 2020, 14).

Keywords: sound design; theatre production; performance; history of sound technology

Introduction

Sound design, the *deliberate use* of sound (Murray 2019, 11), now incorporates many knowledges across a variety of technologies and contexts. Practices include object manipulation, recording, coding, modular synthesis, controller use and processing or sequencing with hardware or software, among others. What connects these deliberate uses of sonic objects and tools is the possibility of sound not just as a functional and representational material, but a transmitter of affect and emotion. In the aesthetic work of sound design, objects and materials are potentially *ecstatic*, possessing the ability to emanate atmosphere when activated (Böhme 2018, 22). Practitioners develop an ability

to read the material world for this ecstatic potential. The labour undertaken in creative soundmaking, develops a knowing of how sound can be generated and refined for its potential effect on a listener. This knowing may incorporate aspects of embodied technique (Spatz, 2015), as the practitioner moves to activate objects and materials to create sounds. It can also be procedural or system-oriented, extending the movement of the hand into software environments through the configuration of hardware controllers for example. Throughout, the peculiarity of sonic practice remains; sound is intangible but discovered and expressed through the material world.

The evolution of sound design as an area of creative practice has often been tied to the development of recording technology and media (Kahn 1999, 10), or to the avant-garde use of sound and noise (Russolo 1913). Strategies for the creation and manipulation of sound existed long before this, however (Curtin 2014, xii), and can be traced back to an origin in theatre performance. Theatrical soundmaking before the advent of recording technology focused on the sound effect, an acoustic and mechanical object that, when operated, mimicked an everyday sound such as rain, wind, or thunder. Theatrical sound effects have been well documented as a chronology of specific methods (Collison 2008), but this approach does not give a full account of the ambition of the practice and its ensuing challenges. Sound effects have been framed as a potentially less holistic approach to sound in previous theatre scholarship (Brown 2020, 33), with understandings of soundscape or amplification only emerging in theatres with the integration of associated technologies (Roesner 2017, 66). However, as I argue here, despite the material limitations of sound effects practice, practitioners understood more about sound and its affective potential than previous considerations of individual mechanical designs might suggest. Brown has argued that human experience of sound is intimately tied to *effect*, in that we continually connect sounds heard to a broader and

potentially dramaturgical context within our everyday hearing. For Brown, sound effects are all that we hear (2020, 14). As we will explore, historical soundmaking practices in theatre were not merely designed to imitate familiar sounds but had to effect the audience to be successful. Sound was understood as effect or *impression*.

This article aims to deepen our understanding of the design approach and philosophy that created sound effects by making connections between the approaches of practitioners in various sound-focused roles across theatres and productions as the practice reaches its height between the late nineteenth and early twentieth century. Here, I survey information from historical publications and manuals, a method that has already revealed information about sound design and performance within silent cinema and theatre (Bottomore (1999) and Rost (2016)). In order to build as coherent a picture as possible of the practice beyond its individual designs for effects, I will consider available historical sources within the framework of Cross' *designerly ways of knowing* (2006, 29). This uncovers what practitioners knew about sound and its dramatic and affective potential and draws the information together in a way that consolidates the historically distributed theatrical roles, bringing them closer to our understanding of the term *designer* today. I am to highlight how creative practice in soundmaking worked to effect audiences even before audio recording or software became widespread, and to show that some of the concerns of theatre practitioners in the age of sound effects mirror those working in present-day contexts such as screen media. I hope to suggest that what it means to work with sound as a creative material might transcend the technologies we choose to work with.

A note on terminology

Examining the history of soundmaking in theatre requires us to engage with texts discussing sound and performance from an era before sound recording was ubiquitous.

The terminology used to describe sound, and sound performance, in late nineteenth and early twentieth century theatres originated long before the present-day term sound effects (or SFX) implied the use or manipulation of recorded sounds, or a collection of audio files (.wav, .mp3 etc.) ready to insert into a film or game soundtrack. Sounds were instead designed through action, mechanism and material, and the naming conventions around this practice were much more loosely defined without the process of recording to capture a sound event as a piece of fixed media. The effect is discussed in historical sources in terms of its qualities in the final production as well as its mechanical method. In his instructional manual *Equipment for Stage Production* Krows (1928, 114)[i] offers a useful definition, saying that an effect is *any impression produced upon an audience by mechanical means.* Although an effect is merely an impression, the term is regularly deployed as if referring to an object, such as *working an effect* (Green 1958, 15)[ii] for example. Freed from the process of recording, these sound effects are less tangible than our present-day understanding of recorded sound. They are born in the space between the performer, the sounding object, the audience, the dramaturgy, and the theatre space. To engage more fully with historical designers, their terminology is retained as much as possible throughout this article to allow their understandings of the design and performance of sound to be clearly heard. Inadequate terms such as apparatus, device, machine or prop will not be used to qualify the term effect to avoid overburdening the reader.

Finding the best term to describe who created and operated sound effects within theatres in the late nineteenth and early twentieth century is similarly challenging. The historical research presented here evidences that sound effects were not designed by a dedicated group of sound specialists such as we would recognise in present-day theatre, film or game design. The activity of designing the sound effect was somewhat separate

from constructing it, and in turn separate from performing with it. Expertise in soundmaking is therefore diffused throughout different backstage and production roles during this era. Any member of a production - stage manager, director or patron - can be assigned credit for a particularly interesting design in historical sources. It is the prop-maker, or property master, that has been singled out by writers as the person who actually constructed sound effects (Vincent (1904, 418) and Sommerfield (1934, 77))[iii], but the director has ultimate control over the intensity and duration of the performance (Jackson & Wilson 1976, 132). Similarly, a successful performance of effects is attributed to directors and stage managers rather than to the stagehands that performed them. There is a division of labour implied in the way this historical practice is described. As I will explore, the finer details of mechanical principles and carpentry techniques, and how designs were specifically refined and made to work, have not been very well preserved. My approach here aims to reveal some of the implied expertise in carpentry and performance that is not explicitly described in historical sources. Throughout this article, two simple terms are used to distinguish between the making and performance stages of a theatre sound effect. Designer refers to all those who worked to design and construct a sound effect, and performer refers to all those who performed and directed the performance of the sound effects. To encapsulate both aspects of the practice, the term practitioner is used.

Sonic Impressionism

Brown defines theatrical sound design as a process of *constructing attitudinal dispositions of spectators towards the audible stage* (2020, 22). This was also understood during the era of acoustic and mechanical sound effects, when practitioners worked on the quality of the *impression* they were making rather than merely the timbral accuracy of their sounds (Krows 1928, 114). Although sound effects may have

imitated familiar events such as rain, wind or thunder, sound was understood as affective, producing *shivers* in the audience for example (De Nansouty 1909, 41). The craft of scenography, which established the setting and mood of a play through light, sound, costume, stage painting and construction, aimed to touch the emotions of the audience (Baugh 2005, 17). Theatre sound effects were part of the atmosphere produced for the drama, the objects and materials that produced them chosen for their ability to generate what Böhme has termed *scenic value* (2018, 125). Sound's dramatic potential relied upon the audience's ability to make the connections intended as part of the narrative, for the desired effect to be produced (Brown 2020, 14). My aim here is to explore what this practice of sonic impressionism may have looked like when realised through acoustic or mechanical processes.

Theatre has probably always incorporated the creative use of sound. Writings on the acoustics of the theatre space, with methods for sound reinforcement, date back to 1 BCE (Brown 2010, 158). The long history of soundmaking for theatrical performance is therefore far too broad in scope to examine fully here. Instead, I focus only on theatre memoirs, technical manuals, newspaper and magazine articles that detail the practice during the late nineteenth and early twentieth century in Europe and the U.S. This era arguably offers the most interesting, and immediately accessible, information on the practice that created theatre sound effects. It straddles what Curtin has termed *sonic modernity,* between 1890 and 1925 (2014, 12), and what Sterne has termed *Ensoniment,* between 1750 and 1925 (Sterne 2003, 2). During this time, sound became separated from music into its own particular area of thought and practice, resulting in an explosion of new ideas about sound, and new technology to create and reproduce it. Examining theatre sound effects practice at this time places it in context with some of those wider cultural changes in sound thought and technology as part of a broader history of sound

in creative practice. Looking at this era also allows theatre sound effects methods to be more directly connected to the soundmaking practices developed for silent cinema and magic lantern shows (Bottomore (1999), Altman (2007) and Curtin (2011)), radio (Turnbull (1951) and Mott (1990)) and early sound film (Ament 2009).

By the late nineteenth and early twentieth century, some sound effects methods were very well established, forming what Brown has called a *culturally defining repertoire* or an *acoustemology of theatre* (2010, 9).[iv] Sounds commonly used across productions were tied to specific mechanical devices. The sound of wind, for example, was provided by the wind machine, a rotated wooden cylinder and cloth. The wind machine was used across nineteenth and twentieth century productions (Keenan 2022). Examining sources for this shared repertoire of sounds allows connections to be made between the approach and philosophy of different designers and performers tackling the same design problem across productions. As specific sound effects methods are described, practitioners and reviewers also comment on their efficacy, the approach of a production, and the key to a successful effect. Commonalities emerge from these stories, giving more of a sense of what practitioners may have known about soundmaking and its affective potential. This is particularly important given the often-scant information available in individual sources. Devices for soundmaking were part of an entire group of effects that encompassed scenic, lighting, and other elements (Browne 1913)[v], and as such were often not documented in as great a level of detail as their visual counterparts unless they were unique or particularly complex (Culver 1981, 12). Within this article, more well-known and detailed sources on sound effects practice, such as Frank Napier's *Noises Off*, first published in 1936, help to substantiate information given in less well-known sources. Where biographical information is readily available for the author, this has been included for the reader. Some more recent examinations of the history of theatre sound effects have also been included here. Shirley's (1963) study of

how sound effects were used in Shakespearean plays, Culver's (1981) thesis that presents a historical timeline of theatre sound effects methods to 1927, and Collison's (2008) publications on his career as a theatre sound designer in the UK from the 1950s have all helped to uncover more sources from the late nineteenth and early twentieth century and corroborate their accounts.

Theatre's acoustemology is also particularly interesting between the late nineteenth and early twentieth century. Historical sources describing theatrical production from the nineteenth century onwards focus heavily on the technical prowess and inventiveness of theatre sound effects practitioners. This was a time when theatre embraced technology and became increasingly ambitious in its attempts to deliver a sensory experience. By the early twentieth century designers with a particular interest in sound were producing publications about their own particular methods, even giving some detail on their design ethos or devising process (Rose 1928). This may have been in response to an increased demand for information on sound effects technique from practitioners in emerging areas such as silent cinema (Bottomore 2001), or perhaps to defend theatre sound effects as methods for recording and playing back sounds became more popular (Brown 2010, 24). Practitioners seem to have been very interested in theatre's historical productions and methods during this era, particularly those used for Elizabethan plays. This is evidenced in sources such as Dutton Cook's *A Book of the Play*, which discusses sixteenth-century sources of information on theatrical effects alongside more recent nineteenth century performances of sounds for Shakespearean plays (1876, 246). Napier's 1962 publication also references his own work to provide sound effects for Shakespearean plays in the 1930s. Leverton's 1936 publication presents a syllabus for teaching and staging an authentic recreation of nineteenth-century U.S. dramas and includes instructions for sound effects as he suggests they

would have been created. This awareness of historical methods is also to be found in texts where writers reference the origins of the particular sound effect that they are describing. Though not always accurate, this has proved useful in gathering the various sources together under the framework used here. Theatre's acoustemology is also expanding at this time to encompass new and more complex sounds. There is evidence of new inventions to produce the sound of machines and vehicles. There are also some detailed descriptions of how sound effects producing large thunderstorms or moving trains were devised and performed, as I will explore here. These accounts help to reveal more of the knowledge of soundmaking, and its impressionistic potential, deployed by practitioners.

Designerly Ways of Knowing

Although theatre sound effects were realised through the work of many distinct practitioners (carpenter, property master, operator, stage director), this article frames these objects and their use in performance as the result of a unified chain of *designerly ways of knowing* as defined by Cross (2006, 22-29). I extend Cross' five aspects of designerly knowing beyond their initial focus on design of objects to also encompass the design and performance of sound effects. Here, they are employed as a framework to examine various historical sources of information and connect them together, allowing the insights and solutions of multiple theatre practitioners to begin to be unified into a single design practice.

(1) *Designers tackle "ill-defined" problems:* Ill-defined or "wicked" problems are those that can only be understood through a series of attempts to solve them (Rittel & Webber 1973). Each new solution enables a further understanding of the problem. Theatre sound effects practice tackled a problem that was

particularly ill-defined in an age before sound recording became widespread; how to produce sound effects that are not just imitations of real-world sound events, but also effect the audience as intended, as part of the scenography.

(2) *Their mode of problem-solving is "solution-focused":* This kind of problem-solving works to create a timely and good enough solution rather than a perfect outcome after consideration of all possible approaches. Theatre sound effects were produced to serve a specific function within a theatre production and were made to work according to the requirements of the stage director. Those involved in their construction and performance would not have had time to explore every potential iteration of a design to find the optimal solution. Instead, they worked on good enough solutions to perform each sound effect in a way that accommodated the timeframe of pre-production, rehearsal, and performance run.

(3) *Their mode of thinking is "constructive":* Constructive thinking is based not in verbal, literary or numerical modes, but instead sketches and prototypes to develop, communicate and realise ideas. Theatre sound effects were not designed from standardised technical diagrams. There were not always tried and tested materials and actions to work with. Instead, practitioners constructively explored the sonic properties of materials and prototyped configurations of objects and mechanisms, focusing on their potential to produce atmosphere. Rather than describing the sound effect verbally or in writing, they performed it for the stage director's approval, and adjusted the object or performance to any additional requirements.

(4) *They use "codes" that translate abstract requirements into concrete objects:* Designers translate abstract requests into physical artefacts. Similarly, theatre

sound effects were created not from specific requests, such as for a machine of specific length and height. Instead, dramas called for sound as affect, such as Shakespeare's call for *a tempestuous noise of thunder and lightning heard* in Act I Scene 1 of The Tempest (Shirley 1963, 42). Practitioners had to translate instructions like this into objects and performances through a synthesis of codes; knowledge of the possible actions of an operator, the potential of mechanisms, the sonic range of materials, the acoustics of the theatre space, and the dramatic approach of the director.

(5) *They use these codes to both "read and write" in "object languages":* Designers develop a fluency in their process that enables them to extend the knowledge they have already accumulated to the creation of new designs. As the acoustemology of theatre sound effects consolidated in the late nineteenth and early twentieth century, the codes of actions, mechanisms, materials and the theatre space enabled practitioners to explore the design of specific new mechanisms or complex new sounds, such as train effects.

Using these various ways of knowing as a framework draws out common themes in the creation of late nineteenth and early twentieth century sound effects, giving a more complete picture of the thought and practical work that created them than what is implied by the often-brief descriptions in individual historical sources.

Designerly Knowledge of Soundmaking

We will now explore the designerly way in which sound effects were created using actions, mechanisms and materials through a consideration of historical sources on theatre from the late nineteenth to early twentieth century and an examination of them as designerly ways of knowing. I aim here to make connections between the approaches

of sound practitioners in various roles across theatres and productions in order to build a more complete picture of the practice.

The Problem of Sound Effects

Theatre practitioners understood that the success of a sound effect lay in its ability to create meaning for an audience. There is a sense of the fragility of that potential success in historical writings. The mechanisms and materials did not just have to produce recognisable sounds, but also successfully give the audience an *impression* (Krows 1928, 114), conveying mood and affect as part of the drama. This was a very challenging design problem to solve, as several factors could potentially impact a sound effect's ability to create meaning. Historical practitioners are not always united on what these factors are, but they do offer some general insights into what should be considered when undertaking this work. These insights have been gained through a process of trying new solutions and adjusting established ones to fit each production. As Frank Napier[vi] notes in his theatrical sound manual *Noises Off:*

> Whereas the design and execution of period costume is guided by rules, which are to be ascertained from the study of historical data, there are no rules, but only a few principles, involved in making noises off, for the problems differ with every play and every theatre. (1962, 1)

A central concern of designers and performers was that audiences understood which sounds the designers and performers intended them to hear. Theatrical manuals advise that a sound effect should be as realistic as possible (Rose 1928, 2), and also that it is instantly recognisable when heard (Napier 1962, 42). The design process involved listening to an original sound, or recalling one from memory (Rose 1928, 1), and then trying to imitate it with available materials (Napier 1962, 13).

It is likely that regular theatregoers would also have become familiar with certain kinds of complex sound effects, such as thunderstorms, which were often a part of productions (Scientific American (1913, 378) and Leverton (1936, 50))[vii]. Weather sounds such as thunder and rain also had a particularly dramatic and symbolic meaning for audiences, foreshadowing conflict or cosmic imbalance (Brown 2010, 36). This would have made certain sound effects more immediately meaningful. The real-world experience of sound that audiences brought to performances was also recognised as having the potential to reduce the efficacy of certain sound effects. In a chapter entitled "The Problem of Sound Effects", Philip Barber highlights the difficulty in recreating the sound of a bomber flying overhead after U.S. audiences' recent experience of hearing wartime air traffic[viii] - the previous illusion, a loudspeaker playing a phonograph recording (presumably from a height), no longer works as it once did. He links this kind of phenomenon to a growing reluctance among practitioners to include any sound effects in productions (Gassner & Barber 1953, 744).[ix]

It does seem that practitioners were very cautious and would rather exclude a sound effect altogether rather than use one they thought was imperfect (Napier (1962, 3) and Peterson (1934, 245)). Besides a consideration of whether the audience would recognise, understand and not be overly critical of a sound, it was also crucial to ensure that each effect fitted with the other sonic elements of the play. A breaking glass could not be louder than a thunderstorm, and that thunderstorm could not be loud enough to mask ongoing dialogue, for example (Peterson 1934, 133). The size of the theatre space was a significant influence on the intelligibility and loudness of sounds (Napier 1962, 5). To disperse sound effects to the full audience, devices were placed on each side of the stage (Scientific American 1913, 378), under the stage (Collison 2008, 44) and in the ceiling of the theatre (Southern 1944). Timing was also crucial as to how smoothly

sound effects fitted with the performance, particularly if they were to cue a part of the drama. Green (1958, 13) gives the examples of a ringing phone or explosion which, if delayed, will leave the actors waiting and potentially cause the atmosphere of the play to break down, drawing unintended laughter from the audience. In his introduction to A. E. Peterson's "Stage Effects and Noises Off", Arnold Ridley[x] goes further, saying that synchronisation is key to the success of a sound effect, and that at the time of his writing this is a more pressing concern than for previous generations of theatre practitioners (Peterson 1934, 30).

However, creating a realistic, familiar and accurately timed sound was no guarantee of success. Barber links the ability of a sound effect to stir the imagination directly to the qualities of the play's text, set, lighting and actors' performances (Gassner & Barber 1953, 744). Ridley similarly suggests that audiences' recognition of a sound is contingent upon the onstage action. He gives the example of a scene being introduced with the sound of rain. If a character appears onstage dripping wet, the audience immediately understand that they are hearing rain. If the same character enters the scene with no such visual clue, the audience might be confused by the same sound (Peterson 1934, 29). This appreciation of the role of context in making a sound effect meaningful suggests that practitioners understood how the visual and auditory weld together to create meaning in our perception, what we now understand as *syncresis* in the context of film soundtrack (Chion 2009, 492). It is clear that theatre practitioners considered carefully how the previous sonic experiences of their audience, as well as the technical prowess they themselves could bring to their practice, would impact the ability of their sound effects to convey meaning. As Ridley explains:

> An audience must be with the off-stage effect. They must never be allowed to say: "I wonder what that is supposed to be?" They must know what it is supposed to be

> in advance. Then it is they themselves who provide the effect and not the workers behind the scenes. (Peterson 1934, 30)

We have so far explored the particularly wicked problems that practitioners were faced with in the design and performance of theatre sound effects. Next, the approach practitioners took to solving these problems will be outlined.

Solutions for Stage Directions

It is clear from historical sources that sound effects in the late nineteenth and early twentieth century were recast for each theatre building or performance run. This led to several distinct designs being produced to perform different qualities of the same popular sound. It seems that practitioners were caught in a constant design cycle of iteration and reconfiguration, and there was little agreement on specifically which devices should be used for particular effects (Krows 1928, 114). This constant search for design solutions must have caused frustration:

> There has been little improvement in them in the last 50 years, and it really seems as though there is a field for some inventor to get up a universal sound machine the component parts of which could be operated from one central point. (Hopkins 1920, 80)[xi]

How particular sound effect designs were first arrived at is not well documented, leading to inaccurate claims of inventiveness or confusion around the origin of particular methods (Culver 1981, 228). There is certainly an air of mystery, invention and individual skill around accounts of stage effects, particularly in the nineteenth century. The story of composer Giacomo Meyerbeer's thunder effect is a good example of this. In 1859, his opera *Le pardon de Plöermel* (later known as *Dinorah*) was due to

be performed in Paris, but Meyerbeer was apparently holding up the whole production because of his dissatisfaction with the imperfect thunder effect he was being offered by the stage carpenter (Logan 1874, 637):[xii]

> Passing under the scaffolding outside the Louvre, which at that time was being restored, he noticed the builders discharging plaster rubble from upstairs windows by letting it slide down a wooden chute. The dull rumbling produced by the fall of plaster rubble consisting of irregular shapes and weights gave him an idea, which he carried out on the stage of the Opera-Comique. A huge chimney or hopper was built out of thick pine planks running from the grid to the stage. Angled cross-pieces were fitted inside and a trap-door closed in the upper end of this huge pipe. When the thunder effect was called for, a load of quarry rubble - pebbles and foundry clinker - was placed upon the trap-door which was swung open on cue. Everything fell into the chimney, bouncing against the obstacles, hitting the sides and falling with a deafening noise upon the floor. (Moynet (1874), translated by Baugh & Wilmore (2015, 165-166))[xiii]

This is an elegant solution that models the process Meyerbeer witnessed in the street but offers the potential for further control over the thunder sound through adjusting the quality of the materials emptied into the chimney. The story is interesting in that Meyerbeer is both the sound effect designer and the composer with the authority to decide on the resulting sound. It was more usual that theatre sound practitioners did not set their own design briefs. The requests for sounds came from the play's text, or from the director and stage manager, and had to be responded to with timely solutions. Historical sources emphasise the difficulty and specificity of the challenges put to theatre sound effects practitioners. This description of a request for a more dramatic gale is typical:

> The gale I want, he says, must have teeth, or how is the hero to be rescued in them? I want roaring and pelting and smashing and clashing. None of your land zephyrs for me. I must hear the dolphin howl and the shark shriek! (Vincent 1904, 418)

Barber outlines a methodical approach to soundmaking that could give us a solution for even this exaggerated request, which is summarised here:

> Listen to the actual sound you seek to imitate if you can, and analyse it.
> Select the conventional sound machines you need or devise new ones.
> Imitate the sound as closely as possible.
> When satisfied, rehearse the sound for the director.
> Adjust according to the director's changes.
> Note down exactly how the sound effect was produced so that it is ready for dress rehearsal. (1953, 745-746)

This suggests that although the conventional machines of theatre's acoustemology are available for use, they may still need to be improved upon or adjusted somehow to accommodate a very specific request for sound. Theatrical manuals confirm this theory, as they tend to present several methods of making a sound to their readers, advising that they test and choose according to the needs of their own production (Napier 1962, 62). Methods are described as ranging from very simple, but sufficient, to more complicated but better-sounding (Leverton 1936, 55). Manuals offer instructions for larger objects to facilitate louder sounds (Rose 1928, 14), and scale down these larger designs usually installed within theatres to make use of more readily available and less expensive materials (Peterson 1934, 134). This suggests that the practice was solution-focused. Any of the factors previously outlined that might impact a sound effect's ability to create meaning for an audience could be heightened in the circumstances of a particular production (for example, a change of theatre building or a

request for a particularly complicated or abstract effect). This would necessitate some adjustment and development on previously satisfactory methods.

Performance was also a crucial part of how sound effects were developed and improved upon. Cue systems were installed within the theatre to ensure that sound effects were accurately timed and added to the drama of the play rather than causing disruption. These were originally achieved by tying string to the performers who were out of the line of sight, and tugging on it to activate their performance (Napier 1962, 23). A coding system of coloured electric lights was later implemented (Green 1958, 16). Not all solutions offered by theatre sound effects designers were successful, however. Nineteenth century theatre writers in particular take delight in reporting the mishaps that occurred in theatrical performances. These stories give a sense of how practitioners developed their embodied knowledge of soundmaking as they improved on previous failures.

Edward Dutton Cook reports an attempt to replicate an Elizabethan method for making thunder in an Edinburgh theatre, which was achieved by pushing a wheelbarrow full of cannonballs over an uneven surface behind the stage. This works well until the operator trips up, turning over the wheelbarrow and sending cannonballs rolling all over the stage, into the orchestra pit and even towards the audience (1876, 246-247). Similarly, Percy Fitzgerald recounts a last-minute attempt by an effects operator to produce the sound of a rain shower in a country theatre production in the absence of proper equipment. Someone is sent to buy a large sheet of brown paper, and the operator grabs it in both hands, desperately rubbing it against a wall behind the stage. Fitzgerald reports that this sounded much more like hissing air rather than rain, however (1881, 62-63).[xiv] Perhaps this effect was improved upon for the next performance.

Having established some of the solutions theatre sound effects practitioners developed in response to requests for particular sounds, we will move on to consider some examples of the constructive thinking that practitioners used in their work.

Soundmaking Thinking

Despite Barber's advice to take written notes on exactly how a sound effect was produced (Gassner & Barber 1953, 746), there is little evidence of a culture of archiving specific mechanical diagrams or of notating performances as part of theatre sound practice in the late nineteenth and early twentieth century in the sources accessed for this research. Some practitioners are also very clear that this was not part of their work. For example, Napier advises his readers that unmusical sound cannot be drawn or notated in any way (1962, 1). There is evidence that this practice was centred on constructive thinking however, as listening, configuring and performing led the design process and communicated ideas to others.

In his manual *Noises Off,* Frank Napier advises his readers to train the auditory observation, and analyse the components of a sound. He gives the example of a door slam effect, which is usually achieved by dropping one wooden board against another one laid flat on the floor. He complains that this only replicates one part of the sound, which should also include the rattle of a letter box or the squeak of a hinge (1962, 13-15). This is a simple example. An everyday sound, a wooden door with a letterbox being slammed, is replicated with a similar action and configuration of materials - wooden boards, and a metal rattle, being slammed to the floor. Further evidence of the deconstruction of a real-world sound, and its reconstruction as an action and sounding object can be found in designs that specifically played with resonance, when mechanisms were enclosed within wooden boxes (Napier 1962, 34), objects swirled on

the surface of drums (Collison 2008, 44), or sheets of metal struck to give echoes to a gunfire effect (Napier 1962, 76).

The translation of a stage direction or sound heard into action, mechanism and material could be much more complex, however. In the foreword to *Noises Off,* director Tyrone Guthrie quips that Napier could easily sound the direction *the nightbirds exult in the tree-tops* armed with only an empty matchbox and three bent pins (1962, v). At first glance this seems overly complimentary, but within his own text Napier does discuss in detail his prototyping of the sound of a steam-ship engine with his fists, a signet ring, a writing desk, a typewriter on a rubber sheet, and some rattling desk drawers:

> By pounding alternately with my closed fists I find that I get a surprisingly good representation, for the table booms, the drawers make one rattle, the typewriter another, and the ring striking through the rubber sheet gives exactly the right knocking sound. I doubt whether one could keep this up for any great length of time, however, but the work of each hand could be given to a separate person, thereby halving the labour. (1962, 45).

Napier goes on to discuss how this prototyped sound effect could be then made loud enough for a theatre setting through the use of different objects. This kind of embodied skill and constructive thinking for soundmaking must have been at the heart of other practitioners' approaches. There are clues to this in the texts that single out particular practitioners for their ability to imitate any possible sound (Vincent 1904, 418), and in some of the legends told about their skill:

> There has been current in the theatre for years the story of a veteran property-man who saw Niagara Falls for the first time. When asked what he thought of that grand sight he replied contemptuously that he could make a much better effect with a

> wheel-barrow and a piece of tin. The amazing part of the story is that he probably could as far as the theatre is concerned. (Krows 1928, 115)

As well as having enough implicit knowledge to be able to reach for and configure just the right materials to make a specific sound, practitioners also developed embodied technique in the performance of sound effects. A good example of this is the wind machine, which Napier (1962, 50) highlights as particularly performable. Rehearsal was considered crucial to the success of a sound effect, particularly if it required a complex performance (Bax 1936, 56).[xv] Napier suggests that this soundmaking skill can be developed within the body through a process of repetition of movement and an assessment of the resulting sonic feedback:

> The feel of it, transmitted to our brains through the sense of touch seated in the joints, muscles and skin. This feel is retained by what I have called the tactile memory. Let the man rehearse his gunfire [sic], therefore, often enough to impress the correct feel on his tactile memory. (1962, 6)

It is evident that listening, configuring materials and rehearsing performances were all a crucial part of the constructive thinking designers used to develop sound effects. We will now consider some of the codes of this practice as implied by the available historical sources.

The Codes of Soundmaking

Theatre sound practitioners used codes to translate the stage director's requirements into appropriate sound effects. As I have previously explored here, descriptions of sounds could be highly complex and abstract. These had to be realised through the application of an embodied knowledge of sound, the sonic possibilities of materials, an

understanding of mechanism, and a familiarity with theatre performance practices. One of the codes of theatrical soundmaking that is explored in more detail as part of this research relates to the craft of carpentry for machine design. Backstage in the late nineteenth and early twentieth century theatre was a truly mechanical space, with *innumerable drums and windlasses* (Logan 1874, 629) used to move scenery, curtains and visual illusions. These mechanisms were hand-operated. The skill of the *carpenter-machinists* (Jackson & Wilson 1976, 109) who made them was highly specialised:

> Stage carpentry is a separate branch of the craft, and most first-class stage carpenters have served their time with one of the scenic contractors. In this way the stage carpenter learns all sorts of tricks of the trade that an ordinary man [sic] never thinks about. (Bax 1936, 53)

It is suggested here that these carpenters learned their trade through apprenticeship. There is little detail on the specific mechanics of particular sound effects designs, or the carpentry techniques used to realise them, in the available historical sources that discuss theatre sound. As mechanical diagrams had long been part of engineering by the late nineteenth century (Lefèvre 2004), their absence in theatrical sound manuals does suggest that stage carpentry was an embodied technique that was not documented in written or diagrammatic form. In his exploration of the craft of mediaeval carpentry, Ingold offers some insights that can be usefully extended to the ill-documented practice of stage carpentry for theatre sound effects. He suggests that buildings were constructed in the Middle Ages through a *tactile and practical geometry* (2013, 51). Carpenters would have used their own bodies and perspectives to calculate distances and angles to determine, for example, the eventual height of a tower. Mediaeval buildings were therefore constructed through an iterative process of solving

design problems as they arose, rather than sketching and planning the final structure in advance (2013, 53). The lack of mechanical diagrams in historical sources on theatre sound effects practice suggests that a similar approach was taken to their design and construction. The lack of explicit reference to the acoustics of specific sound effects designs in historical sources, despite advances in acoustical science in the nineteenth century (Beyer & Raichel 1999), also lends weight to this.

Within the late nineteenth and early twentieth century theatre, practitioners understood the relationship between the performance space and the potential loudness, duration and position of a sound. This is evidenced by the design of what I term *primed sound effects*. These effects are prepared in advance, and merely activated by a performer rather than continuously interacted with. We have already examined one of these, Meyerbeer's trémie design, where masonry and other materials were emptied down a specially designed chute. This design was used in several theatres (Vincent (1904, 421) and Napier (1962, 55)). Another design, known as a rabbit hutch, consisted of stacked cannonballs inside a wooden cupboard with sloping shelves (Rose 1928, 7) built high up into the theatre above the stage. To perform the effect, the doors of the cupboard were simply opened, sending the cannonballs rolling down from the shelves and through some wooden chutes designed to let them roll down the back wall behind the stage (Peterson 1934, 133), or perhaps across the flies above the stage. Theatres also had channels called thunder runs built into their ceilings (Southern 1944). Performers rolled individual cannonballs through these chutes to give the effect of thunder rumbling above the audience (Southern 1952, 101). The venetian blind design to produce a thunderclap consisted of large planks of wood strung up like a blind and hung high up backstage. To perform the effect, the rope was pulled and released to send the planks crashing down to the floor (Logan (1874, 637) and Rose (1928, 17)).

These four methods the trémie, rabbit hutch, thunder run, and venetian blind all share a common approach, in that they do not require a continuous interaction to produce the thunder sound. Instead, in each case the performer primes an apparatus and releases something to trigger the sound. The importance of the theatre space is evident in these four designs and must have been a critical part of how thunder was made loud enough and of long enough duration for performances. These devices too must have been the result of an embodied practice of tactile geometry, as designs were adjusted to produce just the right quality of sound. This embodied technique of stage carpentry must have realised sounding objects in theatres that allowed a sound to be performed, but also allowed that sound to be varied by the performer.

As recorded sound began to be used in theatres, practitioners struggled with a new way of working that did not conform to the old codes around sound creation with actions, mechanisms and materials. This can be glimpsed in some sources. For example, Napier (1962, 50)) outlines his prejudices against a gramophone recording of wind, explaining that its limited duration and inability to respond to events onstage results in obvious repetition, and ultimately an alienating experience for the audience when compared with a performed mechanical wind machine. The recorded sound has violated previous codes around the way a wind sound was made performable, creating a new set of design problems to solve. Part of the success of a performance involved what Napier calls *stage sense* (1962, 9), or an understanding of the importance of dramatic timing. We have already explored how practitioners stressed the importance of timing to the success of an effect, and how cue systems were used to help time sound effects performance. Dramatic timing, and knowledge of what is required of the play in production, is another design code implied in historical sources.

Here, we have considered some of the codes of theatrical soundmaking practice that are implied in historical sources from the late nineteenth and early twentieth century. Finally, we move to explore how the object language of soundmaking with actions, mechanisms and materials was used to read and write in a designerly way, through an examination of some more inventive sound effects designs and complex performances.

The Object Language of Sound Effects

Theatre's sound design problems and solutions, the constructive way in which practitioners devised their sound effects, and the codes that designers might have made use of in their practice have already been considered. Further evidence of theatre sound effects practitioners' ability to read and write in their designerly language of action, mechanism and material for sound creation can be found in examples of particularly inventive designs or ambitious performance methods. Stage directions for sound became much more specific towards the end of the nineteenth century (Culver 1981, 121), and therefore more demanding of the skills of designers and performers. With an acoustemology of theatre sound already established, practitioners worked to create new sounds that were not already a regular part of performances. There is evidence of some unique sounding objects in historical sources. For example, in his manual *Stage Effects: How to Make and Work Them*, Rose presents his readers with a design to imitate the sounds of an aeroplane with a rotating toothed wheel and crank handle:

> Now if a banjo or guitar string is made loose or tightened up by turning the peg to which the string is attached, a moaning and variation of sound will be the result, as given by the propeller of an aeroplane; but when a number of strings are worked in unison, the volume of sound is greater, and may be so manipulated as to give a very good imitation of an aeroplane speeding through the clouds (1928, 24)

Without a textual description like this of a particularly unique design, it can be unclear as to what the original purpose of a sound effect was. Collison describes a machine preserved from the Theatre Royal in Drury Lane, London, that makes a very unique sound when rotated, which at first seems to mimic a carriage wheel. Without any written record, it is difficult to establish the specific effect that it has been created to produce:

> This machine has a revolving wheel made of iron with a heavy metal weight resting on it. The scraping sound could resemble the mechanics of carriage wheels or, perhaps, some kind of lathe - were it not for the piece of wood fixed to the rim of the wheel. This lifts the weight on each rotation, briefly interrupting the scraping noise, then lets it fall with a metallic clank. Could it be for a ship's engine or a factory machine or a comic car? (2008, 61)

Unique examples like this give weight to the myths about the skills of particular practitioners. It is clear that some designers and performers were able to develop a sophisticated practice that could accommodate requests for very specific sound effects. As well as inventing new devices, practitioners also devised elaborate performances of evolving sound effects for larger set pieces, particularly thunderstorms or trains. This description of a thunder effect used in Century Theatre in New York 1913 evidences a configuration of different objects and carefully timed performances:

> Thunder is produced in two parts of the stage. The crash takes place in one part of the fly galleries, while the reverberation or roll is produced on the thunder drum, which is beaten by a hand near the backdrop. Then the fly man releases a bolt, which allows a pivoted box to dump about eight hundred pounds of stones and assorted junk down a chute, striking a large iron place at the bottom. This is immediately followed by three hundred pounds of chain, which is also released and

> allowed to fall on an iron plate. Then the roll is begun by dropping five or six cannon balls down an incline or chute, which is technically called a "rabbit hutch." The finale of the effect is produced by deforming a large sheet of iron, which is twisted. This is used in connection with the thunder drum. (Scientific American, 1913, 874)

Train sounds were also produced through a combination of objects, such as wire brushes, drums and metal tubing (Krows 1916, 228), and were considered particularly complex and important effects to create. In his interview with the New York Times, Lincoln J. Carter claims that he first devised his visual and sound effects for his 1889 play *The Fast Mail,* and then wrote his script around them, for example (1913, SM12). One particularly famous train effect from *The Ghost Train,* a play by Arnold Ridley which first ran in London in 1925, is cited by several sources as an impressive example of the potential of sound effects (Sommerfield (1934, 79) and Napier (1962, 39)). Ridley gives his own brief overview of the effect:

> The effect itself was perfectly simple, being merely a judicious mixture of thunder sheets, compressed air, a garden roller, and pieces of sandpaper and wire brushes combined with a kettle-drum. (Peterson 1934, 29)

In fact, the play included three distinct train effects, and gave audiences the sensation of a train moving through the theatre. A complete breakdown of each train sound, along with detailed stage directions, can be found in Collison's *Stage Sound* (1976). Each train was produced through a combination of a thunder sheet, various whistles, a garden roller, an iron tank, wire brushes and some electrical motors. The stage directions cue each specific element very carefully in order to create three distinct train effects (1976, 89-90).

As theatre sound effects practice developed in the late nineteenth and early twentieth century, practitioners played with their established acoustemology to encompass new requests for sounds and produce performances to rival those of other popular entertainments. This required them to develop a fluency in the object language of theatre sound effects.

Conclusion

Creative soundmaking, and the deliberate use of sound, has a long history. Despite the apparent simplicity of theatrical mechanisms before the age of sound recording, practitioners worked with sound as an aesthetic and affective material, conscious of the sonic experiences of their audiences. This article has explored historical sources on theatre sound effects from the late nineteenth and early twentieth century using the framework of Cross' five aspects of *designerly ways of knowing* (2006, 29) to uncover more about the practice that created them. By focusing on the accounts of the practice itself rather than its mechanical designs, we have been able to examine more fully what practitioners may have known about sound and its scenic value, and how they worked to achieve the desired impression in their audiences. Although sound effects practice did attempt to mimic real-world sounds and provoke recognition in audiences, the focus was always on effect rather than accurate imitation. For theatre practitioners, sound was indeed effect (Brown 2020, 14). The impact of the sound, its emotional and affective weight, was the measure by which an effect was designed, directed, and ultimately incorporated into the drama – or not. Much of the effective potential of sound was developed through embodied technique (Spatz 2015), with bodily action a critical component of how most sounds were activated and modulated as part of the performance. The focus on rehearsal and the development of listening skills as part of the design process adds a further dimension to chronologies of

specific sound effects methods. Based on my findings here, I would argue that the embodied technique of the performer was as important to the success of an effect as its mechanical design.

Examining theatre sound effects practice as it transitions from the late nineteenth to the twentieth century, places it in context with some of the wider cultural changes occurring in sound thought and technology in a time of *sonic modernity* (Curtin 2014, 12) and *Ensoniment* (Sterne 2003, 2). Theatre practitioners do seem to have been influenced by cultural shifts in soundmaking practices, particularly with the emergence of sound recording technology. Practitioners compare their established methods of soundmaking to the emerging use of sound recordings in theatre, sometimes unfavourably. Sound effects practitioners may have been at odds with the use of recorded sound, or indeed the coming of film, but what we see evidenced here in stage sound approaches are the seeds of present-day film soundtrack technique. Concerns about timing and sync, syncresis between sonic and visual elements, loudness and even spatialisation in the theatre are all critical to sound effects methods. Although there is increasing inventiveness and complexity in sound effects by the twentieth century, there is an acknowledgement that the sonic experiences of audiences are impacting their efficacy. Beyond the coming of sound recording technology, the increasing presence of motorised vehicles or the sounds of wartime technologies have made their own impression upon theatre's public. As a solution-focused design practice, sound effects had to adapt to a changing sonic culture. As the everyday acoustemology of theatre audiences changed, so did their appreciation of the soundworld of the theatre. Sounds previously central to theatre's acoustemology lost their intended effect, requiring different solutions. Our present-day methods for the deliberate use of sound may also undergo similar shifts. Examining creative soundmaking for its design strategies rather

than the specific technologies it uses may help to uncover how, beyond theatre practice, we develop a knowing of sound as effect.

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[i] Arthur Edwin Krows (1892 – 1958) was a U.S. writer and director who published on technical theatre, playwriting, and 'the talkies' (early sound film). He also wrote and directed films in the early 1920s.

[ii] Michael Green (1927 – 2018) was a British journalist and humourist author, who also published a technical theatre handbook in 1958.

[iii] John Sommerfield (1908 – 1991) was a British writer who worked as a stage hand, publishing *Behind the Scenes* in 1934.

[iv] Acoustemology, or acoustic knowing (Feld 2015) is culturally situated. Techniques to create performable weather, battle and animal sounds within European and U.S. theatres during this era may not have been shared by other parts of the world, and so there may be new methods to discover. Further research may be able to explore other geographical contexts and cultures to expand on the specific acoustemology of late nineteenth and early twentieth century theatre explored in this article.

[v] There is little biographical information to be found on Browne, who may have been a theatre practitioner in London in the late nineteenth century. The fifth edition of his theatrical manual Secrets of Scene Painting and Stage Effects was published in 1913. Vandyke brown is also a term used for a particular shade of black-brown paint as early as the sixteenth century (Eastaugh et al. 2008, 388), which suggests that this name may have been a pseudonym for a scene painter.

[vi] Frank Napier was an actor and stage director, notably at the Old Vic Theatre in London from 1931-1934 He published Noises Off, a manual of sound effects practice, in 1936, and another book about the visual side of theatre, Curtains for Stage Settings, in 1937.

[vii] Garrett Leverton (1896 – 1949) was a theatre producer, scholar and educator in the U.S. in the first half of the twentieth century, publishing The Production of Later Nineteenth Century Drama: A Basis for Teaching in 1936.

[viii] Barber refers to "events of the last few years" (1953, p.744), which suggests he is alluding to WWII.

[ix] John Gassner (1903 – 1967) was a U.S. theatre historian and professor of drama, while Philip Barber (1903 – 1981) was a dramatist who taught playwriting at Yale University.

[x] William Arnold Ridley (1896 – 1984) was also an actor and playwright, and later starred as Private Godfrey in the BBC television sitcom Dad's Army (1968 - 1977).

[xi] Albert A. Hopkins (1869 – 1939) was a U.S. author, publishing on stage illusions, as well as an editor of *Scientific American* in the early 1900s.

[xii] Olive Logan (1839 – 1909) was a U.S. actress and author, who published a theatre memoir *Before the Footlights and Behind the Scenes* in 1870, as well as several theatre-focused articles for periodicals.

[xiii] Jean-Pierre Moynet (1819 – 1876) was a trained architect, scene painter and stage designer in nineteenth century Paris. His 1874 publication on theatre production is entitled *L'Envers du Théatre* (Baugh & Wilmore 2015).

[xiv] Percy H. Fitzgerald (1830 – 1925) was an Anglo-Irish author and drama critic who published extensively on theatre history.

[xv] Peter Bax (1895 - 1953) was a British stage manager and stage designer who worked at the Theatre Royal Drury Lane before he was recruited to the BBC in the 1930s.