# Introduction

Traditional textile patterns are primarily developed from visual stimuli. In the Scottish context, these traditional patterns like tartans and tweed not only maintain a foothold in the imagination of contemporary society, they perpetuate particular imagery and established cultural norms of the region, thereby stifling design innovation. This paper proposes an alternative to existing visually based pattern creation of traditional Scottish textiles using a co-creation and data-driven approach to its development.

Co-creation is typically considered a process of bringing customer and creator together to produce items of mutual value, allowing the design aspect of production to sit between customer and creator (Prahalad and Ramaswamy 2004). One aspect of supporting such a process includes fashioning tractable methods to collect and manipulate “design inspiration” that a customer can input into and that are amenable to the application of computer-based production. Using sound recordings and their respective audio visualisation of spectrograms, the sounds of landscape become the source pattern for the development of knitted and woven textile patterns. The overall aim of our work is to challenge the visual bias in designing and disseminating contemporary Scottish textile patterns, while simultaneously developing a pathway towards customer-involved design using self-recorded sounds.

This case study covers the evolving project begun as an experiment in landscape sound recording. First, the paper discusses the visual bias of the way humans ‘see’ the world. This is followed with the way that pattern making is created, particularly shifting towards the use of audio sources and the spectrogram. This is explored through the visualisation and application towards experimental textile design. It then moves towards the case study and co-design relationship between weaver and researcher interested in the themes of audio data-driven pattern making to promote an open source and distributed nature of textile creation. The ongoing working relationship between researcher and maker represents a variety of methods and approaches to co-creation and co-design and individual working. The aim of the paper is to promote alternatives to existing visually based pattern creation inspired by the more than visual inputs from the landscape, and consider how these might be amenable to collaborative customer-creator textile production.

# Visual Patterns

Human beings are excellent pattern finders and makers (Kurzweil 2013), encountering patterns in what they see, hear and feel. Vision plays a dominant role in how these patterns come about, yielding nine tenths of the knowledge of the external world (Pocock 1981). As such, pattern creation is developed primarily by that which is seen, and is one of the fundamentals of common design practice in most design disciplines. Specific to textiles, the final design also requires consideration of haptic qualities appropriate to the final function of the textile, such as the feel against skin or movement of the fabric. Textile patterns have been a part of society across multiple cultures from the time of early fabric production. Historically, patterns would be developed through mnemonic practices, since the requirements of weaving or knot-making devices limited the way that certain patterns could be created (hence the simple written sequences or easily remembered movements). In Scotland traditionally considered textile patterns range from the Highland tartan, Celtic knot work, and Fair Isle knitting patterns that provided village identities, towards the industrial developments of paisley from the bupa plant (Stillie 1970). In most of these cases, a visual dominance or bias is maintained where patterns that are seen are emulated and reproduced (though simplified) into geometric shapes in which to develop the pattern.

## Ocularcentricism and non-visual textile inspiration

This type of visual bias is known as ocularcentricism, or a focus on the visual senses within the research and design domain (Sui 2000). This visual focus, though useful, limits our understanding of the other senses. In other words, contemporary society’s vision bias impoverishes embodied experiences. Pow (2000) asserts that not only do non-visual senses become peripheral, but it also reduces the experiences of the non-sighted when the dominance of sight is maintained. Holistically, it is problematic to carry on maintaining an ocularcentric approach to pattern creation. It perpetuates established practises, as is the case where regional Victorian tartan patterns maintain a foothold in the Scottish landscape (Stillie 1970). These ‘historic Scottish Highland’ patterns are propagated and appropriated for global consumption (Figure 1), reinforcing a Romantic imagery of the Scottish landscape that opposes regional development where the patterns do not represent the contemporary Scottish experience (Pittock 2010). Therefore, new approaches are needed to challenge the dominant visual process.

(INSERT FIGURE 1 HERE)

Many textile patterns can originate from multi-sensory approaches of sound, touch and even digital data that offer the opportunity to maintain the link with the specific environment of the site of origin while bypassing the cultural politics and historical norms embedded within “traditional” patterns. Haptic qualities, in particular, play major roles in the development of new textile patterns either through three-dimensional form wear (Gloy et al. 2015), smart textiles (Leutheuser 2015), or even biomimicry (Ellison 2013). Furthermore, contemporary developments show attempts at data-driven textiles through the use of census deprivation data (Booker 2014) or an individual’s DNA sequence variation (Tucker 2015). Therefore, these multi-sensory pattern creations represent a new way of design developed through non-visual approaches and can be a useful alternative in developing new patterns. We would like to explore the aural sensory path in the next section.

# Aural Landscapes

The sound landscape is a key component of embedded multi-sensory research. Environmental sound has been explored from an early era of sound recording, where in the mid-twentieth century, John Cage and Graeme Miller experimented with their music in creating more than just melodies, but entire sound spaces (Paquette & McCartney 2012). Transcending the realm of music, Schafer (1994) introduced the concept of the soundscape in the late 1970s. He sought to make people more aware of the nuanced sounds around us, of listening attentively to the landscape. He suggests that much of the aural landscape is not perceived, yet each of us make sound, and nothing is ever silent. For example, human voices have internal overtones but our brains and senses tend to cancel out these sounds. In this sense, Schafer tried to engage us with a sonorous world that exists—only if we just pay attention.

Today, sound research covers ideas of audio manipulation (Gallagher 2014) and sound art (DeSilvey 2010) to the soundwalk of the Thames River (Butler 2006) and of the body enacted (Anderson 2004). These projects explore the nuanced aural aspects of the landscape. Similarly, we consider that the soundscape embodies the central focus of the enacted landscape and argue for a level of attunement that relates to a different sense of the landscape—a presence of things unseen. It is within the sounds, the noise, the whir of the tractor, the dawn chorus, or the “silence” of the moorland that the unforgotten landscape is evoked. This soundscape can challenge the visual bias of existing patterns, contributing to the sensory ethnography (Nakamura 2013) of the contemporary landscape.

## Visualising Sound

Visualising sounds has existed since the first notation of music was developed in ancient societies (West 1994). In western societies, early Medieval monastic societies developed musical notation with the rise of polyphony, which necessitated a way of allowing many people to understand and follow a series of sounds. These musical patterns allowed many people to read and sing the same notes, as well as, record the patterns of sound for future people to sing. The development of mechanical music boxes brought about ways that sounds could be recorded and played back, with the eighteenth and nineteenth centuries bringing about a true transformation in the way that sound could be visualised. Using cogs and other pegged and punched opening technologies, the sound could be replayed. There are well-described parallels here with the historical method of punch cards used to operate Jacquard weaving looms, often considered to be the predecessor to early computers (Fernaeus 2012). By the nineteenth century, these early visualisation and recordings included Scott de Martinville’s *phonautograph* and Edison’s phonograph. These systems allowed soundwaves to be visualised on a type of paper or physically carved into grooves and able to be reproduced. As sound waves increased and decreased air pressure, mechanical measuring devices would record those changes through impressions over a rotating drum. These audio wave impressions would be the predecessors to today’s digital visualisations, including oscillograms, wave displays, and spectrograms.

Spectrograms are a type of audio visualisation where rather than the pitch and amplitude of sound source is displayed (as is normally portrayed through wave modulation) the intensity and multiple frequencies are displayed across time. It is a useful tool in understanding phonetic speech (Kingsbury et al. 1998), in bioacoustics applications (De Oliveira et al. 2015), and even the vibrations of the earth in seismology (Gupta & Patton 2008). The field of bioacoustics is especially useful in spectrogram use as different animals that normally cannot be tagged like large underwater mammals or migrating birds can be tracked by their specific call (like an audio voiceprint).

In terms of sound, fabrics tend to be considered largely in terms of sound-absorbing qualities, rather than as an alternative way to experience sound through touch and sight. Where there are explorations of sound, these are typically single artist explorations; for example, transforming sheet music into woven textiles (Apprill 2015), recorded sounds into woven textiles and vice versa (Mooney 2011, Ricketts 2017), birdsong into knitted textiles (Cantwell & Weir 2011) or folk embroidery into music (Sziarmay 2014). These aural input creations showcase not only how sounds are a useful and inspirational form of textile creation but also how these can be an alternative in developing new patterns. Only recently are artists starting to consider how these might be marketed to a consumer audience interested in personalised artefacts (Ricketts 2017), with new opportunities to explore. It is within this realm of aural interpretation and use that we explore this sonic alternative.

# Aural data-driven design

Our work began as part of an earlier project of looking at Hebridean landscapes. Initial sound recordings were taken to better understand the relationship between what is seen and what is heard within the rural landscape. Out on the North Uist Royal Society for the Protection of Birds (RSPB) machair site, a few days were spent recording the soundscape of the site, including: lapwing and other bird calls, waves, the wind and manmade sounds such as machinery and airplanes overhead, in an attempt to better understand the region beyond that which was seen. Upon inspection of the spectrograms, the unique call of the lapwing with its trills, and undulating sounds became the inspiration for a new type of pattern creation and initial exploration of the concept of data-driven design (Figure 2). The image was digitally manipulated to reduce background noise and simplify the bioacoustics pattern, transforming into a pattern that could be ‘read’ by knitters and weavers (Figure 3). Initially, the pattern was directly knitted as seen, representing the birdsong faithfully in textile form (Figure 4). From here, segments were abstracted and interaction with a designer led to alternative patterns. At the same time, the simplified birdsong pattern was used as a starting point for woven textile design, exploring a variety of threading patterns, weave structures, colours and textures (Figure 5). From the single spectrogram, a variety of initial knitted and woven samples were produced, and the options for generating many more were identified.

(INSERT FIGURES 2, 3, 4 & 5)

The development of these sounds into textiles has undergone a series of transcriptions as part of the co-design process between the authors. The source data from the audio file and digital image manipulation is one aspect of the textile produced; but the finished piece was also dependent upon the interaction between data and designer-maker, and between weaver and researcher. This, in turn, was dependent upon the creative process and experience of the designer-maker, and (though not yet formally tested) we expect that different designer-makers would create completely different textiles from the same spectrogram. The initial idea of taking the audio file and having it digitally transposed into simple knitting or weaving patterns can be developed in the future, bypassing the requirement for involvement of a designer-maker and transferring the design role to a customer, allowing generative weaving to be created from algorithmic processes (Koutsomichalis and Psarra 2015). However, more complex textile structures and patterns will still require the input of an expert practitioner, providing opportunities for collaboration between customer and practitioner.

# Reflections

Our initial exploration has demonstrated the opportunities for aural, data-driven design. Beyond the initial exploration of experimenting with the way we create textile designs and its input from source data, the bigger picture is that through extra-visual stimuli – not necessarily limited to acoustics, but more generally to anything that can be transformed into data – a pattern can be created that is just as viable as one inspired from the visual landscape. This pattern though is not bound by its traditional lineage of tartans or tweed but given the freedom to forge new types of narratives, ones that can promote a contemporary vision for Scotland and the highlands, and that can be applied more widely. Existing projects from data driven weaving of generative textiles showcases how textiles can be created from digital input (Tucker 2015; Ricketts 2017). In our example, the input is one of auditory forms transposed into directions for the creator to produce the textile.

## Next Steps

The non-visual design development work here is described with reference to the Scottish context, but the concepts are equally applicable across other cultures and geographies. In the future, we anticipate a scenario where a “customer” records sounds of interest from their local soundscape, and uploads this to an interface where they can see and manipulate this into a pattern for simple algorithmic textile production, including selection of colour palette. While these designs would be based on sound, the resultant textile would still require to be visually pleasing to the consumer, and input from an experienced textile designer would be necessary during the algorithm development stage to ensure this. Beyond this straightforward textile co-creation process, there is opportunity for further human interaction between the customer-designer and designer-creator for more complex knitted, woven, printed or embroidered textiles.

Inherent throughout is the concept of single run, production on-demand, with associated knock-on effects for conscious consumption and waste reduction. Similarly, there are opportunities within this for distributed production in a model akin to that used for production of Harris Tweed, providing micro/nano scale manufacturing work for skilled designer-makers in varied and remote geographies via collaborative/collective production networks. This fits with a longer term aim to promote distributed manufacturing processes, and would benefit from more open-source developments in the manufacturing of textiles whereby new pattern creation methods integrate with digital technologies allowing for bespoke, create-on-demand textiles.

Personalisation of products is an expanding consumer market, as evidenced by the rise of online marketplaces for handmade items, such as Etsy. Indeed, a report on the European apparel market (CBI 2017) highlighted the trend for a shift towards highly personalised shopping experiences, with younger consumers favouring direct-to-consumer purchasing and suppliers shifting towards becoming “partners” with their customers. This is currently seen in the way that DNA (Tucker 2015) or existing digital beats (Ricketts 2017) use customer data to create their bespoke patterns. Therefore, customer created aural inputs including one’s voice, family members, or favourite song could also have potential for development and consumer demand.

As well as bespoke co-creation, this model allows for knowledge generation through creation of an open-access repository of sounds that can be accessed by other customers/makers within the collective, expanding the design possibilities and raising questions around data federation for algorithmic textile creation. Clearly, considerable work would be required to achieve this, not least the formalisation of collaborative networks, raising awareness of data-driven design processes, and development of flexible digital interfaces between customers and creators. In the end, this project showcases not only the potential of textile co-design and co-creation to challenge traditional pattern creation but also contributes to discourse about how we design and manufacture textiles in the twenty-first century.

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