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ARTICLE

Music – Bodies – Machines: Fritz Kahn and Acousmatic Music

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This article provides an overview of the *Music – Bodies – Machines: Fritz Kahn and Acousmatic Music* project and accompanying suite of music – *Der Industriepalast.* The project is inspired by the work of infographics pioneer Fritz Kahn (1888-1968) who developed works such as *Der Mensch als Industriepalast.* There is a body of work examining Kahn's work (Sappol 2017; Von Debschitz 2017; Doudova 2018) that has revealed Kahn's intent of making the human anatomy accessible to the non-specialised reader through visual metaphors; unlike the descriptive anatomical illustrations of the eighteenth and nineteenth centuries, which show how the human body looks, Kahn's works visually explain how internal structures work using concepts, metaphors, and allusions.

This article explores some of the ways in which Kahn's striking visual images have inspired the composition of five novel acousmatic works of music. The article starts with a survey of existing works making use of similar, extra-musical influences to examine how extra-musical influences such as infographics and painting may influence the formal design of acousmatic music. It goes on to consider how, exactly, the infographics of Fritz Kahn have been used within the project. In some cases, this guides the choice of particular materials (such as the sound of a beating heart to represent an image of a heart monitor), but in other cases, there is influence on phrasing, placement, and even the formal design of entire pieces.

Taken as a whole, the article seeks to explore the following questions; 1) What impact does the context of a particular image have on a composers' response? 2) How do composers respond to visual stimuli in acousmatic music? What is their compositional process? 3) How do such parallels between the specific sonic and visual examples offer new interdisciplinary insight to artistic practices and research? 4) How do sound recording techniques inform acousmatic music and generate new creative processes that operate within the sphere of human-machine relations?

Keywords: Acousmatic, composition, extra-musical stimuli, infographics

Introduction

In the middle of the 20th Century, composer and researcher Pierre Schaeffer developed a new method for composing music. Rather than using a musical score, Schaeffer started composing using recorded sounds. By doing so, he discovered that through the transformation and manipulation of recorded sound, a musical form could arise of its own accord, as opposed to permanently fixing it within the confines of a musical score. Schaeffer argued that this demonstrated a profound departure from compositional methods associated mainly with instrumental music, and inspired the birth of compositional studios around the world.

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Contemporary composers of such music, which is now known by the term *acousmatic*, continue to articulate the same core method (Smalley 2010; Harrison 2013; Lewis 2015; Moore 2015). However, over the past decade, the methodology of contemporary composers has evolved. Rather than merely viewing form as something to be discovered within materials, contemporary acousmatic composers have started using extra-musical influences to determine formal ideas in advance. For example, Monty Adkin's *Five Panels* takes works of Rothko as a direct influence (2009), Amanda Stewart's *Light and Sharpness* draws formal design from Paul Klee's painting of the same name (2012), and Pete Stollery's *Of the Swan* (2014) aims to examine and explore the transformative possibilities of the text image-narrative structure of the Aberdeen Bestiary. In similar ways, works of sculpture, film, drama and poetry have all been studied in electroacoustic music, alongside many non-artistic sources, including objects, spaces, events, and historical contexts. The consequences of this transformation are profound. Although Schaeffer's approach to material remains, mainly through the use of recorded sound, it is clear that form is no longer seen as something emergent. Instead, the methods employed by contemporary practitioners are becoming increasingly reliant upon external, often extra-musical influences on their formal ideas.

This article has two central aims. Firstly, it aims to provide an overview of how contemporary acousmatic methods are changing. In particular, it will focus on how contemporary methods produce musical form, particularly in cases where extra-musical influences have been used to establish musical form. Secondly, it will provide an overview of the *Music–Bodies–Machines* project and an insight into how the infographics of Fritz Kahn have directed the composition of two of the works created so far.

Music, and the Influence of the Visual Arts

Before we can find a position for a 'new' visual music – one inspired by extra-musical influences that are not limited to the moving image – it is worth attempting to define what visual music is and to place it within a context which is juxtapositional to electroacoustic music. Several researchers have already defined visual music works. For example, Maura McDonnell (2010) identified etymological paths to describe and define visual works and practices. Andrew Hill (2013) proposed various interpretations of what he termed 'electroacoustic audio-visual music' in the context of his doctoral research on audience reception. Diego Garro (2012) notes the term *Visual Music* has a hybrid provenance as it was used in 1912 by artist and art critic Roger Fry to describe Kandinsky's abstract paintings. He further notes that the term could have been used to draw attention to a shift in focus from the figurative to the obscure. An early example of 'visual music' is seen in Kadinsky's abstract painting, *Fuga* (1914). The work possesses a temporal dimension which the spectator may travel through as they cast their eye over the shapes and colours, the connections between them, and how they contribute to the painting as a whole. This approach is particularly evident in works such as *Fuga* where the artist strives for a visual equivalent of the bright, enveloping colours produced by an orchestra. The correlation between colour and music was a concept that attracted many artists at the time. Several artists (Robert Delaunay, Sonia Delaunay, František Kupka, Fernand Léger, Francis Picabia, Jean Metzinger, and Marcel Duchamp) saw analogies between musical tones and visual hues.

Kupka's *Disks of Newton* (study for 'Fugue in Two Colours') (1912) (Figure 1) is a particularly evocative example as it encapsulates the inherent temporality of a still image, which is evident from an examination of the images visual spectromorphologies. The concentric spiralling shapes prompt a centrifugal motion, with movement linked to the colours present in each curve. Through this trajectory, it is reasonable for the viewer to comprehend *Disks of Newton* similarly to how listeners will perceive a musical gesture in a piece of acousmatic music. Given the powerful potential for abstract work to be viewed temporarily, it could also be argued that it might go even further to inspire

or direct formal ideas in acousmatic music. This influence stretches back to the Eighteenth century (Peacock, 1988) with the early manifestations of 'visual music' – with the term rooted in the visual arts.

Within the early Futurist circles at the beginning of the Twentieth Century, there grew an appetite for a new musical language based on noise. This Futurist attitude contributed to the development of technology leading to the first moving images – inspired by the futurist concept of unity between different artistic media, for example, sound, images, music, and poetry.

Figure 1: František Kupka, *Disks of Newton (study for 'Fugue in Two Colours')* (1912)
Oil on canvas, 100,3 x 73,7 cm. Philadelphia Museum of Art, Philadelphia
Source: https://ccsearch.creativecommons.org/photos/f20900ea-6d10-4321-88ce- e2df5cb150f0 (licensed under CC BY-SA 2.0)

Electroacoustic Music and Extra-musical Influences

Electroacoustic music is intrinsically a hybrid genre because of the syntactical challenges posed through the pure sound spectromorphologies when they are combined with the visual arts. Acousmatic music is also inherently multi-mediatic. Few acousmatic compositions are truly mono-mediatic (Emmerson 1986). If an acousmatic composition combines abstract and mimetic materials with intelligible speech or musical phrases, both composer and listener become involved in complex relationships with the piece that can be both multi-modal and multi-mediatic. Such works demand of the listener constant shifts in decoding strategies to conceive a sensible narrative of the work. Intrinsically, sound can and does, carry an array of cognitive, cultural and artistic classifications such as the social and historical contexts that sounds are extracted from, or generated within. Sound can represent not only the current world that we live in but also entirely imaginary impressions of past or future places.

The technology that is available to electroacoustic composers means that we can not only record sound but completely immerse the listener into our sound worlds. Binaural sound, ambisonics and loudspeaker domes permit the composer to not only create intricate sound worlds but project these in such a way that they become hyper-realistic. Mobile technologies such as *Oculus* virtual reality headsets coupled with binaural sound, offer massive potential for the development of works that harness the human senses of both sight and hearing.

Survey of Works influenced by Extra-Musical Influences

Examples of works that use extra-musical influences to direct compositional elements such as form are numerous, but three examples from the acousmatic repertoire will now be discussed.

Light and Sharpness (2012)

Light and Sharpness (2012) by Amanda Stewart draws formal design from Paul Klee's painting of the same name dating from 1935 (Figure 2). To create *Light and Sharpness,* Klee analysed musical composition methods and translated them into "polyphony painting" – a style of painting in which music is represented as pictorial art (Stuart, 2012). The central concept of polyphonic paining is that both painting and music are temporal arts. Whereas music has to be played for the listener to hear it, and it takes place in time and space, starting from the first note played, or first sound heard, and ending after the composition is finished. In art, however, time is fixed on one segment and becomes a form or a line. Therefore, time in art becomes a spatial element. Stewart reversed this process and used the colours, lines and shapes of Klee's work to direct her composition. To document this compositional process, she created a video consisting of her piece, accompanied by a score showing the musical elements used at each moment of the piece[1].

Figure 2: Paul Klee, *Light and Sharpness* (1935)
Watercolour and pencil on paper on cardboard, 32 x 48 cm. Zentrum Paul Klee, Bern, Switzerland
Source: https://www.flickr.com/photos/kotomi-jewelry/27413804695 (licensed under CC BY-SA 2.0)

Of the Swan (2014)

Of the Swan (2014) (Figure 3) by Pete Stollery formed part of Aberdeen Bestiary: Sound-Image-Narrative, an artistic research project led by Pete Stollery and Suk-Jun Kim from SERG at the University of Aberdeen. The project aimed to examine and explore the transformative possibilities of the text-image-narrative structure of the Aberdeen Bestiary by situating (and re-situating) the Aberdeen Bestiary Collection in imaginative aural settings. In the project, Stollery responded to selected images from Aberdeen Bestiary, focusing, mainly, on imaginary animals depicted and described in the collection. *Of the Swan* aims to evoke "not only the animals themselves but their surroundings such as imaginary habitats and behaviours, to animate them and conjure up to the viewer-listener a probable world of the fantastic animals" (Stollery 2014).

[1] A video of Light and Sharpness (2012) by Amanda Stewart is available at: https://amandastuart.com/light-sharpness

Figure 3: *The Swan from the Aberdeen Beastiary* (c.1200)
MS 24, parchment, 30,2 x 21 cm. Aberdeen, Scotland
Source: The University of Aberdeen (reproduced with permission)

Five Panels (no.5) (2008)

Five Panels (no.5) by Monty Adkins is one of a suite of five experimental electronic works that takes the abstract expressionist paintings of Mark Rothko is its influence. Rothko's style of painting is defined as colour field painting – the term applied to the work of American painters Mark Rothko, Barnett Newman and Clyfford Still. Colour field painting differed from abstract expressionism in that emotional, mythic and religious content associated with abstract expressionism artists was omitted.

In a paper accompanying *Five Panels*, Adkins acknowledges how Rothko's *No. 5* (Figure 4) influenced every aspect of his composition. In particular, he notes the notion of immersion created by the large size of Rothko's work which has the effect of enveloping the visual senses and replicated this through immersive layers of sound presented in a multi-channel configuration. Adkins states that the idea behind *Five Panels* is to use similar sonic material and create five different, yet related 'panels of sound' through different sound processing and spatial manipulation sin each piece. Within *Five Panels (no.5)*, the varying degrees of 'saturation' of colour from Rothko's work is translated onto the timbral manipulation of sound, and colour to pitch. Adkins notes that this correlation between timbre/saturation and colour/pitch is not a purely subjective response to Rothko's work. Instead, it is a synesthetic mapping of colour to sound. *Five Panels* also uses a similar structure to those of Rothko's work where rectangular blocks of colours are transferred into sonic material possessing its timbral colour.

Figure 4: Mark Rothko, *No. 5* (1950)
Oil on canvas, 297 x 272 cm. Museum of Modern Art (MOMA), New York, USA
Source: https://www.flickr.com/photos/wallyg/2378828888/in/photostream/ (licenced under CC BY-NC-ND 2.0)

Five Panels (no. 5) contains five identifiable layers:

1. a continual, sustained guitar harmonica 'ground.'
2. processed guitar harmonics.
3. sine-based sustains.
4. individual guitar harmonics.
5. 'glitch' elements.

Adkins states that it is not just the recognition of these sonic layers that is important, but the relationship that exists between them. He points out that except for the paintings produced for the Rothko Chapel, Rothko did not use tape to delineate one block of material from another. It is often this lack of delineation, alongside saturation of colour that lends itself to the organic, intangible quality that exists in his work. This quality is reflected within *Five Panels (no.5)* through "instances in which the atemporal 'ground' (layer one) shows through in *Five Panels (no.5)* occur at 0'45, 4'10 and 6'15 where harmonic changes, glissandi, or slow melodic figures permeate the foreground layers (Adkins 2008, 3). In terms of structure, Adkins notes that sections drift into one another and that there is only one occasion where the material is juxtaposed, and when this occurs, it does so only in one layer.

The second characteristic of Rothko's work which is mapped onto Adkins work is the size. Rothko painted large pictures to immerse his audience. Adkins replicates this through immersion in the sonic space. Adkins states that this is "not only achieved through the use of surround sound but also be removing all visual cues by playing the work in as near darkness of possible" (Adkins 2008, 4). The sound world is deliberately restrained, and as such, the spatialisation is subtle. Adkins states that the work is not intended to proceed "on its own journey as an autonomous work". Instead, the listener is required to "create their own journey through their own engagement with the work" (Adkins 2008, 6). This sentiment is similar to Rothko's own attitudes towards the role of the viewer where he believed that artworks were not to be thought of like objects, but rather, as ongoing processes of communication, in which participation of the spectator was vital. Adkins does not want the audience to listen to his work; instead, he wants them to have an experience. What this experience is, depends very much on the listener's view of the world, and perception of the sounds used.

The Music – Bodies – Machines Project

The Music – Bodies – Machines project aims to explore the compositional process in acousmatic music when responding to extra-musical stimuli. The project attempts to document both the compositional process of the composer and update the *Traité des objets musicaux* to incorporate the effect of these extra-musical influences. The output of the project includes a suite of acousmatic pieces based upon the work of infographics pioneer, Dr Fritz Kahn. This project uses infographics as extra-musical influences. These are images which combine images with text or data, and diagrams, to describe the scientific or technical workings of the material world. For the most part, infographics do not aim to show how things look, but rather, reveal how they work. Infographics model, celebrate, or narrate processes; they can dramatize data and statistics, natural cycles, and events; or, they allude to, or evoke the operations of living things, chemical reactions, and technical devices. Implementing these visual sources as an extra-musical source thus offers the composer a deep level of complexity as the images themselves carry meaning which will drive both the composer's process as well as the listening experience of the audience member.

Dr Fritz Kahn (1888 - 1968)

The images used as extra-musical stimuli within this project are infographics produced by Pioneer Dr Fritz Kahn. Kahn was born in Halle an der Salle, Germany, in 1888. In 1907, he began his studies in medicine at the University

of Berlin, specialising in microbiology. He eventually specialised in gynaecology and writing articles for the *Kosmos*[2] magazine.

What makes Khan's graphics so remarkable are their ability to tap directly into our imaginations to convey complex scientific concepts and anatomical processes such as digestion and neuron transmission. During his most influential period, Kahn was steeped in the discourse of medical and scientific self-making and improvement, which was known in the Nineteenth Century English-speaking countries as 'popular anatomy'. However, by the 1920s this mystique had worn away, and anatomy was no longer attractive as it had been devalued by too much sensationalism and was no longer regarded as cutting-edge science. The general view of anatomy had degraded to such a point that it was increasingly linked to disreputable popular museums, fairground exhibitions, and schoolbooks. Kahn took full advantage of this discontent by inventing a new way of presenting the human anatomy to the lay reader. He did not limit himself to pictures of cadavers, specimens and models, but rather, presented bodies comprised of physics and chemistry, machine engines and electricity, cities and factories, automobiles and telephones.

Kahn presented the human body as a complex machine containing the cutting-edge technology of the day. Reinterpreting the body in this way permitted Kahn's readership to visualise themselves within the context depicted in his images. By doing this, Kahn demanded that his readers which fantasies a technical revolution and modernisation of the human anatomy – imagining their minds and bodies not merely as muscles, bones and blood vessels, but rather, as sites of production and manufacturing processing. This branded Kahn as both as a modern and as a useful intermediary between medical experts and the lay public. Influenced by advertisements, mass-market newspapers and magazines, Kahn bombarded his readership with pictures that evoked modernity. He portrayed images that allowed readers to see themselves in the images – in their city, homes, workplace and cars – and then compared these with internal body functions.

Kahn embodied the notion of the modern. He sought to make a name for himself as a moderniser of the image practices of medical and scientific publications. His work comprised of profusely and imaginatively illustrated texts, and pictures that referred to the industrial revolution that accompanied the rise of the Weimar Republic. It is this industrial revolution that provided Kahn with much of the material for his work, and the modernist approach that has inspired several films, comics and artworks.

Der Mensch Als Industriepalast Suite

Kahn's most recognisable work *Der Mensch als Industriepalast* (1927) (Figure 5) showcased his innovative and creative approach to conveying processes within the human body. This work – a life-sized colour poster which accompanied the publications *Das Leben des Menschen* – had the purpose of visually presenting industrial processes within the human body – forces "which have an invisible character" and cannot be "directly observed" in real life or through anatomical illustrations (Kahn 1923). Essentially, Kahn created a collection of images which showcased the industrial technologies that were vitally important to Kahn and his immersion into the modern world. In *Der Mensch als Industriepalast,* readers are represented by proxy – by the body's army of miniaturised humans – each of whom is responsible for carrying out a particular function in the body. This enables the reader to visualise themselves as being represented by a whole army of generic 'Mensch-kin' proxies, or homunculi, each involved in a specific job in a particular part of the body. In Kahn's image, there are homunculi tending machinery,

[2] Kosmos (now Franckh-Kosmos Verlags-GmbH & Co.) is based in Stuttgart, Germany and was founded in 1822 by Johann Friedrich Franckh. It established the 'Friends of Nature Club' in 1903 in response to the increasing public interest in science and technology. It reached a peak subscriber base of 100,00 members to its monthly magazine *Kosmos* in 1912.

stocking shelves, operating controls and instruments, cleaning the factory floor, assembling components, stoking fires, and directing and overseeing the production lines.

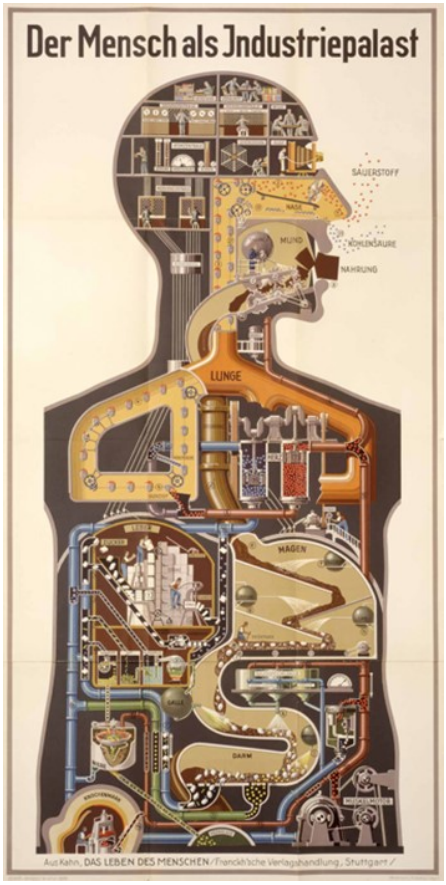

Figure 5: Fritz Kahn, Der Mensch als Industriepalast (1927)
Chromolithograph. National Library of Medicine, Stuttgart
Source: Fritz Kahn: Infographics Pioneer. Köln: Taschen (reproduced with permission)

The term homunculus (Latin for 'Little Man') can be traced back to Sixteenth Century alchemy. The homunculus is a tiny preformed human that inhabits or constitutes the sperm or egg. Upon insemination, it grows to become a fully formed human. Unlike the alchemical homunculus, Kahn's homunculi stay small and do not develop any further. Instead, Kahn's homunculi in *Der Mensch als Industriepalast* are playfully distinct social types representing stability rather than uncertainty through transformability. They are not ghosts in a machine, and they do not haunt anything. They go nicely about their business, undertaking the many tasks involved in the operation of the body. Kahn's homunculi do, however, have a secondary function outside the frame of the illustration: to persuade the reader to scientific authority gently and to identify with the figure of the machine.

In order to demonstrate how extra-musical influences have informed compositional processes, two acousmatic pieces *Homo Machina* and *Neuronen* will be discussed. These works have been chosen as they mark significant departures in the authors' compositional process.

Presentation of Compositions

The nature of Kahn's infographics has posed questions relating to the presentations of the extra-musical materials which accompany the works in a concert situation: for example, programme notes which can provide extra-musical

information which influences a listener perception of the piece. As a result, experimentation has taken place throughout the project so far, in order to ascertain the optimum presentation conditions of Kahn's imagery. From this experiment, it would appear that a short oral (or written) introduction to provide context for the works and the projection of the images for the duration of the piece produces the best experience for the listener. This is because of an appreciation of seeing the extra-musical source, but also because quite often, the projected image can strengthen the narrative of the piece. Indeed, the general response to only providing a textual programme note was a wish to have had the choice to view the image throughout the piece. It is unclear at the moment exactly why there is this preference. However, it would suggest that the listener experience is enhanced when an extra-musical influence is allowed to be viewed in the context of the performance.

***Homo Machina* (2018)**

Homo Machina was the first work completed in the *Der Industriepalast* suite and is intended for stereo diffusion. This piece was designed to be a one-off, but as the piece was written, further immersion in Kahn's work resulted in the decision to write a series of pieces, and for *Homo Machina* to function as the introductory work. The image that influenced the piece – *Der Mensch als Industriepalast* – is entirely appropriate in fulfilling this role, partly because of its depiction of the human body, but also because of how structured and compartmentalised it is. It could be argued that this lends itself nicely to acousmatic music, given the vivid nature of the images and how these can be represented either literally, or through more abstract sound.

The image itself shows the interior of the working body. The head and the trunk of the figure are exposed to lay bare the organs and their operations. Instead of bones, nerves, or blood vessels, the image consists of an intricate arrangement of machine parts. The heart is represented by large pistons which pump blue and red particles into a ramified tubing system. An extensive ventilation system represents the lungs. The digestive tract is represented by a series of blades and grinders representing the teeth. These lend to blenders, mashers and rollers which separate incoming food into its basic constituent units which are then fed to a chemical plant to undergo synthesis for energy (Borck 2007).

The nervous system of the body is represented by information systems which link all of the bodies compartments with central offices for calculation, communication, and control at the top of the image where the brain is located. The depicted figure is unambiguously demarcated as human by its silhouette and, in particular, its profile of a human face looking to the right. However, the installations in the body's interior appear to be as convoluted as an industrial complex that has to accommodate ever-expanding production lines in its limited quarters.

Upon closer inspection, it becomes clear how the illustration assembles specific machinery to represent a particular organ and its function within its natural place. The image obeys the details of human anatomy to a surprising degree. Following this strategy, the ventilation system, for example, stands in for the lungs and the mechanical break-up of substances along the chain of conveyer belts represents the digestive tract. At the same time, the chemical plant is an analogue of the liver. The motor has two pistons as the heart chambers and is located to the body's left, while the ventilation apparatus is bifurcated as the two parts of the lung. A spherical tank in proximity to the chemical factory collects special fermenting fluids. It releases them into the digestive tract slightly underneath the stomach's exit, where the bile enters from the gallbladder into the jejunum.

This image acted as an extra-musical stimulus because of the literal analogies of machines for human organs. Conventionally, one may speak of the image explaining a particular body function or the operations of an organ employing a machine analogue. However, here, the images show the human body to be made up of these machines. If this were a standard anatomical chart, the printed labels would be redundant. Here, however, the printed names denote each industrial compartment as a particular organ; they fuse the biological with the technological object. It

is precisely the fusion of the human body with a machine ensemble that turns this mode of visualisation into such a significant visual object. As such, the structure of *Homo Machina* represents some of the main 'compartments' conveyed in Kahn's image.

The vivid and detailed nature of the image permitted the creation of an imaginary sound world while tracing the processes through the different compartments of the image. The sound world created imitates both the body compartments themselves, but also one that represents what the homunculi in Kahn's imaginary world may have heard in their work environment. One of the central aims of the suite is to convey this unique sound world to the listener in all of the *Der Industriepalast* suite pieces. The compartmentalisation of the image led to *Homo Machina* being structured into small sections which each focus on a particular part of the anatomy; in this case, the lungs, the heart, the brain, and the digestion system. In terms of the ordering of the sections, this was realised musically. There was no preference with which system took priority. What was important, was that each section used enough recognisable sound, for the systems of the body to be precise and evident to the listener. As such, unlike the pieces that have followed that have focused on an individual anatomical system or structure, each section uses unmistakable real-world sound. The lungs are represented by steam and air-like sounds which like human breathing, occur regularly. While an industrial sound world is built up to signify what the workers may hear around these main gestures, these 'human' sounds are always at the fore. The heart was somewhat simpler to represent. A heart monitor representing a constant heartbeat was created using sine tones, and a bass drum was used to generate the *dum-duuum* of a heartbeat. The brain, depicted by a series of offices and cables was the most complicated section to compose. To do so, an imaginary sound world was created which represented the working environment in the body through the eyes of the homunculi and researched the technology of the day – namely typewriters and Morse code – which along with electricity, represented the brain as the centre of the body, and the area which commands all others.

Compositional Process of *Homo Machina*

In order to discuss the compositional process fully, each section of *Homo Machina* will be discussed with references to specific compositional techniques implemented, and source sounds used[3].

Introduction (00:00 – 00:21)

The introductory section[4] of Homo Machina provides the listener with a brief synopsis or overview of the sounds explored throughout the piece. The sounds heard between 00:00 and 00:21 are abstract and unrecognisable to build tension and anticipation for the listener throughout the piece. My focus on surrealism and enigmatic sounds created throughout the work require the listener to use their imagination to form a plausible virtual 'scene' which might then determine the way expectations of future events develop.

The sounds in this introductory section are composed of granulated water recordings and drones created from materials deployed throughout the piece and manipulated with GRM Tools and SoundToys Crystallizer and Echoboy to create granular material that envelops the listener. The sense of envelopment, which initiates interplays between noisy and pitched sonorities to create a surreal sound world.

Lungs (00:22 – 02:03)

Like the introductory section of *Homo Machina*, the section depicting the lungs[5] implement a contrast between recognisable and abstract sounds to create a plausible sonic 'industrial lung'. In *Der Mensch als Industriepalast*, the lungs are represented by a series of conveyor belts carrying red (carbon dioxide) and blue (oxygen) molecules to

[3] A recording of *Homo Machina* is available at the following web address: http://louiserossiter.com/homo-machina/
[4] Sound Example 1: http://louiserossiter.com/AIREA/Example 1.wav
[5] Sound Example 2: http://louiserossiter.com/AIREA/Example 2.wav

and from the nose, before being processed by the lungs and sent to the heart for dissemination around the body. The breath-like sounds are created from bowing metal plates and treating these with extended (and somewhat un-natural) reverb. This processing creates a sense of envelopment within an ample space which can be further extended through sound diffusion in a performance situation. These breath-like sounds are also individually shaped through manipulation of both volume and panning to give the 'machine' a human presence.

The presence of granular sounds is designed to represent the flow of blood and air through the body and becomes more prominent at the foreground of the sonic canvas as the piece develops.

A 'ping-like' gesture marks the start of the section at 00:22 alongside the introduction of a high pitched, slow descending drone which begins to take on an 'air-like' appearance the first breath gestures appearance at 00:53. From this point, there is an agglomeration of granular material, subtly developed with delays before the granular content is slowly developed with a liquid quality accompanied by panning tremolo material and a metallic based drone which descends in pitch, suggesting movement through the respiratory tract to the lungs.

Brain (02:04 – 04:01)

The section of *Homo Machina* depicting the brain[6] through sound was, by far, the most complicated to conceive owing to the known complexity of the organ. External factors that collectively influence what the composer and listener know about the brain and its function and the role the brain has in controlling all of the other systems in the human body influenced the sounds chosen and the manipulation of these sounds.

Kahn's depiction of the brain as a hierarchy of offices for a) communication and, b) machinery to send messages and instructions to other parts of the body presented the opportunity to reimagine the brain as the 'hub' of the industrial body Kahn had created.

The sound sources in the brain section are mostly literal, real-world and recognisable sounds which were chosen after research into Kahn's imaginary industrial palace and the function of the homunculus in his conception. With this knowledge, the sound-world was composed from the perspective of a homunculus working within the human body. Thus, sounds included in the piece are very literal and make use of sound sources that would have been present at the time the image was created (c.1927). Thus, communication is represented by the sounds of keys being pressed on an antique typewriter, Morse code generated from processed sine tone, as well as references being made to other sections of the piece, such as the heart and lungs to maintain coherency and narrative throughout the work. The recording of a 'click' gesture to represent the eyes is a more literal interpretation of the image but also serves a functional purpose as a source of momentum to drive the section forward.

Electricity sounds (created from a processed recording of violin) are prominent throughout this section and represent something present in many of Kahn's images, as a fundamental output of the brain, and as a source of transmission for information and messaging throughout the body. The decision to include electrical sounds as material at this point in the work was necessary, as *Homo Machina* is intended as the first work of the *Der Industriepalast* suite, and therefore also references sounds that will be heard in other works. For example, electrical sounds are prominent in *Neuronen* as this work examines a particular function of the human body.

There is a blend of abstract and real-world sounds included throughout the section to set and maintain narrative. Given that the image used as a stimulus is (in most cases) visible throughout a performance, reference to objects in that image was necessary to form tangible links for the listener. However, the sound world remains enigmatic through the presentation of sounds in different contexts by implying the co-existence of what would be ordinarily

[6] Sound Example 3: http://louiserossiter.com/AIREA/Example 3.wav

incompatible objects. The juxtaposition of naturally occurring, recognisable sounds with unrecognisable ones in this manner, can create a new context of unpredictability with the potential for surprise within a work (Rossiter, 2017).

Heart (04:02 – 06:05)

The heart[7] is represented using instantly recognisable sounds – for example, sine tones processed as heart monitors and, a bass drum to represent the *dum-dum* of a heartbeat. In contrast to the previous section which relied on an imaginary sound-world constructed from numerous recognisable objects, this section is very upfront about what it is intended to represent and aims to gain the listeners' attention from the outset. The beginning of the section is marked by a sudden attack, giving way to the steady sound of a heart monitor. Accompanying this sound is a steady pulse, representing the continual movement of the human-machine. Squeaking machinery intended to represent pistons and the chambers of the heart are introduced and become more prominent through a gradual increase in dynamic level until a climax is reached at 04:37 and the recognisable sounds give way to a more gritty, abstract, industrial sound world which eventually gives way to the next section at 06:06.

Digestion (06:06 – 07:59)

The digestion system is represented sonically in *Homo Machina* as a giant processing plant[8]. Perhaps the most prominent and dramatic sound in the section is a warning horn recorded during the demolition of Leicester Council headquarters in February 2015. Within the section, this horn marks the beginning of a dangerous process and segments different processes within the digestion system.

In this part of *Der Mensch als Industriepalast,* Kahn represents the mouth and teeth as grinding tools, knives and industrial rollers and this is reflected sonically through recordings of grinders, circular saws and brewery equipment.

At 06:36, Further iteration of the warning signal is heard, which leads to gestures with a prominent attack that are both unrecognisable but also spaced unevenly to create a source of unease and tension for the listener. At 07:10, there is disintegration from attacks to much more granular textures that represent food being broken down into its constituent parts and sent for processing around the body.

Homo Machina (08:00 – 10:07)

The final section of the work, *Homo Machina*[9] acts as a recapitulation of material heard throughout the work and, in particular, develops sounds from the 'Brain' section – for example, the sonar ping and Morse code. At this point in the piece, the focus was on drawing to a close the numerous sonic ideas present in the composition while permitting surreal juxtapositions to remain.

Summary

The vignette form deployed within *Homo Machina* was intended to allow for the creation of surprise. Each movement contains twists and turns, which never permits the material to develop fully before the next section begins. It may depend significantly on a listener's capacity to draw on familiar sounds or to form imagery from vicariously understood sounds, or even reference to *Der Mensch als Industriepalast*.

Neuronen (2019)

Neuronen is the fourth work completed as part of the *Der Industriepalast* suite and is based on Kahn's infographic that does not bear a formal title, but compares the nervous system of the human body to the mechanisms of a doorbell – in particular, the comparison between impulse and reflex responses (Figure 6). This piece attempts to

[7] Sound Example 4: http://louiserossiter.com/AIREA/Example 4.wav
[8] Sound Example 5: http://louiserossiter.com/AIREA/Example 5.wav
[9] Sound Example 6: http://louiserossiter.com/AIREA/Example 6.wav

describe aurally, over 9:33, events which occur in a split second and are repeated millions of times a day in the human body. It strives to achieve through sound, what Fritz Kahn's infographics do visually – that is, the understanding, or at least, some comprehension of an extremely complicated process.

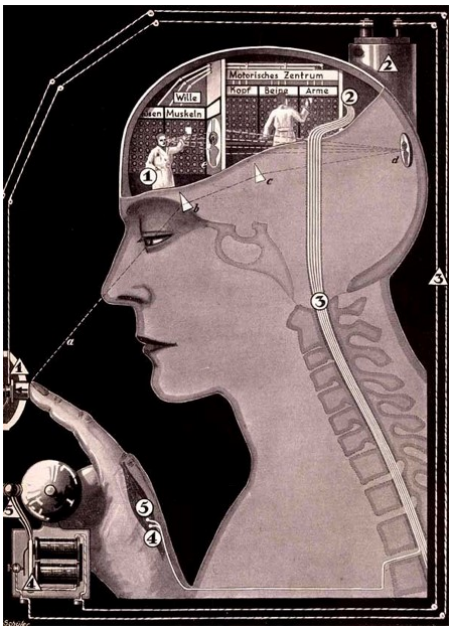

Figure 6: Stimulus for Neuronen
Source: Fritz Kahn: Infographics Pioneer. Köln: Taschen (reproduced with permission)

In a concert situation, this image will be presented to the audience in place of a formal, written programme note. Notes such as these may be provided as supplementary material – dependent on where and what kind of situation the piece is being performed. The piece is intended to be humorous and light-hearted while exploring an area rarely encountered in electroacoustic music.

Compositional Process – The Visualisation of sound

The compositional process of this piece is central to its understanding and meaning and represented a significant departure for the author. An important outcome of *Neuronen* was the identification of the need to document aural responses to extra-musical stimuli visually by the composer. As part of the compositional process for *Neuronen,* the authors' auditory response to the chosen image was recorded through a visual illustration (Figure 7). This image provided an unexpected influence on both the structure and sound shapes within the work. The drafting of the score was useful, in that potential sounds could be drawn as sound shapes.

Representing sounds in this way is not new. An essential aspect of acousmatic composition is its potency to conjure up powerful imagery, shapes, trajectories, spaces and places, which we as listeners describe verbally through spectromorphological terms (Smalley 1986, 1997). Manuella Blackburn (2011) took this a step further to produce a series of visual sound shapes that can aid composers in describing the sonic processes in their works.

While diffusion scores are commonly created after the completion of a piece of acousmatic music, compositional practice demands individual tools and strategies, and sometimes a customised vocabulary to suit the style or circumstance of the piece being composed. As the *Music – Bodies – Machines* project developed, there was a

demand to document the compositional process to begin to understand the process of using extra-musical stimuli to create works of acousmatic music, and the effects of using such stimuli on the composer and the listener.

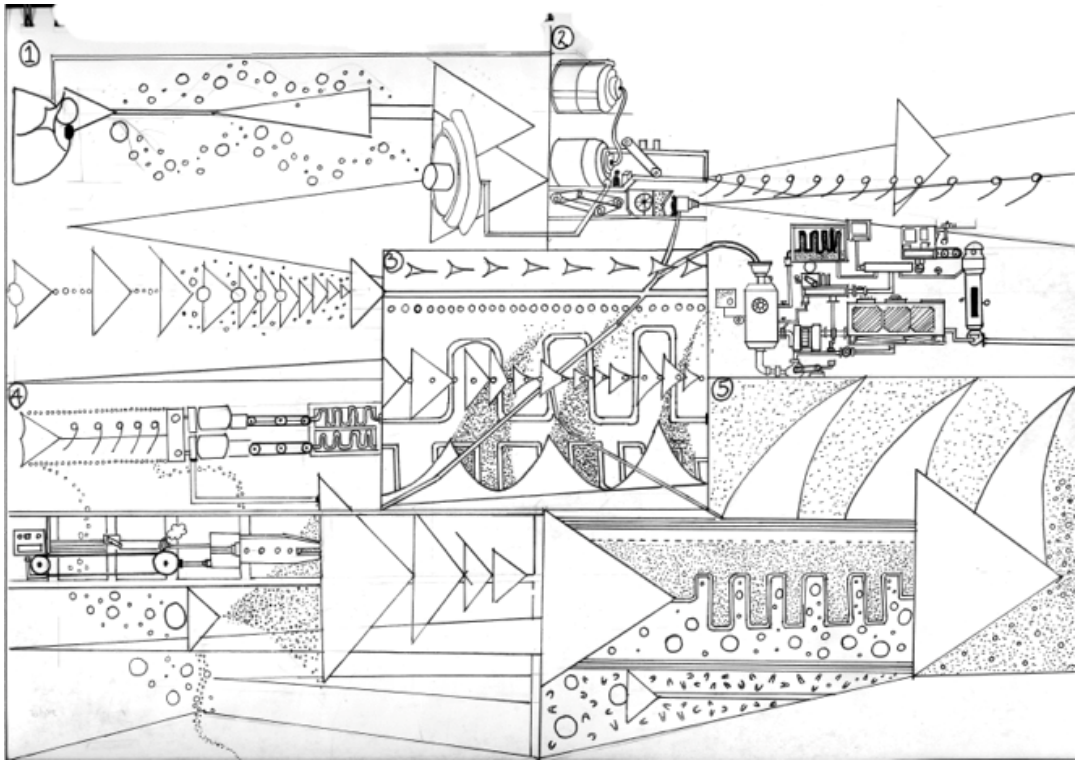

Figure 7: 'Pre-composition' score for *Neuronen*
Source: generated by the author

While most of the sound shapes used in the project follow those commonly found in Smalley's spectromorphology, there are some instances where the sonorous object that creates the required sound is drawn, as opposed to a spectromorphological shape which shows transformation over time. These drawn objects may be real or imaginary, but regardless, will be detailed enough to build a highly intricate sound world based upon it.

Timescales and phrasing are also affected by this composition method. For example, drawings of a plane with a downward trajectory with a tightly grouped agglomeration of textural material (Figure 8) will likely be drawn out over a shorter timescale than a single sound which builds in volume with gradual onsets and developments of additional gestures (Figure 9). Images themselves can also provide a stimulus for sound shapes through consideration of the potential for movement, behaviour, interaction and occupancy of space.

Figure 8: Gesture with a downward trajectory
Source: generated by the author

Figure 9: Slowly developing sound with additional gestures added over a longer timescale
Source: generated by the author

Sound Sources in *Neuronen*

One of the main difficulties experienced in composing *Neuronen* was addressing a process that is highly complicated visually but also has no known sound attributed to it. Perhaps the most distinct sound to represent the brains messaging system is electricity. However, electricity does not carry information, so what does? What would the bodies communication sound like? How would it communicate with other parts of the body? Therefore, while the piece itself is mainly comprised of highly processed and abstract sound worlds, a decision was made to record and include the sounds of unprocessed doorbells to represent the outcome of a process. Processes have outcomes and the signal moving from the control centre (brain) to the finger and instructing it to press the doorbell has to have an outcome. Secondly, this real-world sound acts as an essential structural feature, stating that the final section of the work has been reached.

Compositional Process of *Neuronen*

In order to discuss the compositional process thoroughly, each section of *Neuronen* will be considered with references to specific compositional techniques implemented, and source sounds used[10].

Section 1: 00:00 – 01:04

The introductory section of *Neuronen*[11] opens with a sudden gesture created from heavily processed balloons, which is followed rapidly by a moment of silence, the development of the opening gesture and a sudden climatic attack which resolves into granular debris. From the outset, this establishes the processes of gestural interaction and the formation of cohesive textural constructs apparent throughout the piece. The silences in the very opening of the work are intended to frame the gestural forms by allowing silence to punctuate the dominant sounds. The function of silence in this manner fulfils an important role in *Neuronen* by articulating musical structures and serving both a structural and dramatic purpose. They also have a bearing on the spatial, and structural trajectories of the work and permit complicated diffusion in performance. The granular debris that emerges at 00:03 builds in intensity and fills the entire spectral space until being interrupted by machine-like sounds at 00:11.

The second phrase of the work begins at 00:12. It contrasts steady machine-like clunking in the lower spectral frequencies, with intricate counterpoint created from recordings of a wind-up alarm clock which occupies the upper frequencies of the spectral space. The counterpoint is interrupted at 00:27 by a sudden attack, which brings more industrial sounds back to the forefront of the sonic canvas as the intricate clicking sounds are swept away as a granular tail. This section of the work is rich in spatialisation as, along with the abstract sound world, it is intended to grab the audience's attention and leave them hanging in anticipation as to where and what will be heard next. Between 00:27 and 01:09, the machine-like clunking develops into a far more industrial sound-world occasionally

[10] A recording of *Neuronen* is available at the following address: http://louiserossiter.com/neuronen/
[11] Sound Example 7: http://louiserossiter.com/AIREA/Example 7.wav

punctuated by metallic gestures which drive the piece forward. The first section of the work is concluded at 01:04 with a disintegration of the sound-world to leave only a bass drum-like sound followed by silence.

Section 2: 01:10 – 03:02

Musically, the opening gesture of the second section[12] of *Neuronen* is similar in sound quality to that which opened the work. However, rather than being punctuated almost immediately by silence, a powerful, complex sound-world is created by the gesture leading to processed sounds of printers. The movement of the pitch from high to low of the opening gesture of this section adds powerful momentum to the composition. The printer sounds are developed through processing with overdrive and distortion effects. They are paired with rich textural material to suggest a complexity of the process it is intended to represent.

From 01:30, the printer sounds become more blurred as abstract sound worlds are developed to create a surreal and unrecognisable sound world. By 02:00, the granular, indistinct sounds have been processed to such an extent that they have an electrical quality to them – they are never static and gives a vibrant, dance-like quality to the sounds.

The ticking of a clock is then heard, accompanied by an eerie drone at 02:26, and is intended to act as a direct development to the ticking sounds heard initially in the composition, and to call the listeners attention back to the original sounds of the work. As the ticking continues, sweeping granular sounds are introduced and are intended to immerse the audience during the performance. The sound world becomes more abstract as the drone begins to morph and fill the spectral space. The section ends at 03:02 with a robust and metallic attack, calling the listeners attention with a recognisable sound.

Section 3: 03:03 – 05:10

This section[13] of the work is intended primarily, as a period of stasis and is completely abstract. The sonic quality of the opening of this section is far less dense and consists of a shimmering drone composed from heavily processed violin, punctuated by metallic gestures. In the first half of the section, there are 'scatterings' of granular materials, and electrical material heard in the previous sections, but these are merely intended as 'sonic memories'.

However, the mood of the section quickly changes at 03:36 when distorted electrical sounds begin to dominate the sonic canvas. By 04:03, a hollow, dissonant tone has filled the spectral space, its fluctuating pitch portraying uncertainty and instability emphasised by suffocating granular material which is punctured by bright metallic shards which resolve the tension by 04:34. 'String-like' attacks, contrasted with fine wind-like, granular material gradually build in dynamic before reaching a climax at 04:59 which results in repetitive deep, metallic, reverberant gestures which slowly fade into the distance. While the listener might expect these gestures to fade to silence, they are interrupted at 05:10 by a further gesture of the same sonic quality. On this occasion, it is accompanied by a descending metallic gesture which is quickly replaced by the delicate ticking sound heard in the initial section of the piece and marks the start of Section 4**.**

Section 4: 05:11 – 07:27

In light of not knowing what a neuron sounds like in the human body, the fourth section[14] of *Neuronen* aims to amalgamate many of the sounds already heard in the composition. While the end of the section reaches some stability through recognisable ticking sounds and the metallic industrial sounds, there is not much coherence or development in the sounds. While the placement of sounds appears random, the intention is for an order to be

[12] Sound Example 8: http://louiserossiter.com/AIREA/Example 8.wav
[13] Sound Example 9: http://louiserossiter.com/AIREA/Example 9.wav
[14] Sound Example 10: http://louiserossiter.com/AIREA/Example 10.wav

found as the section moves forward, while maintaining a sense of anticipation for the listener. The climax of the section occurs at 05:44 when tension is built through the recording of a high-speed drill and dissonant, brass-like drone. What follows after this point, is a gradual disintegration of the sound-world into its original constituent parts – namely, the intricate ticking sounds heard in the first section of the work.

Section 5: 07:28 – 09:35

The final section[15] of *Neuronen* is intended as a recapitulation and coda to the composition. The opening to the section is formed from the gesture initially heard at the start of the work, accompanied by granular material and clusters of electrical sound. The listener is signalled that the climax of the work has been reached at 07:45 when unprocessed recordings of doorbells are heard. With reference to Kahn's image, this represents the final stage where the finger has received the messages from the brain, and has executed the command and pressed the button. It also represents the moment that the listener is forced to a more realistic sound-world in contrast to the highly abstract one presented throughout the piece thus far. What follows after 07:45, is a gradual disintegration into a period of stasis. While there are moments of tension and release, these are largely intricate, contrasting the industrial attacks with intricate clock sounds.

Conclusions

While the *Music – Bodies – Machines* project is still at an early stage, it has begun to shed light on how composers respond to different visual stimuli. As the research project continues to develop, it is becoming apparent that the theories first proposed in the visual arts concerning structure, spatial representation, perception of time and the fusion of the corporeal and ethereal can offer some excellent insights into how we compose and receive acousmatic music. While the creative outputs of the project thus far have been promising, they have raised further questions as to how works responding to visual stimuli should be presented. Further experimentation with the presentation of programme notes and images in upcoming concerts of the works discussed is taking place to gain a greater understanding of the relationship between visual stimuli for both composer and listener. As such, the works will be presented with either formal written programme notes, or with a short programme note and the relevant image projected on a screen in the concert hall.

A pilot project is currently underway with another electroacoustic composer attempting to respond to, and document the process of responding to another of Fritz Kahn's images. On this occasion, a choice of ten images authored by Fritz Kahn where provided, with one being chosen to provide a focus for the work. It is hoped that this will lead to a significant project involving several more composers with extensive written and creative output.

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[15] Sound Example 11: http://louiserossiter.com/AIREA/Example 11.wav

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