University of Northampton

UNIVERSITY OF NORTHAMPTON
UoA 32 ART AND DESIGN: HISTORY, PRACTICE AND THEORY. BODY OF WORK

Circular Taxidermia

Friedemann Schaber

CONTENTS

Figure 1. (cover)
Tensile testing of leather and collagenic fibres at ICLT

Title

Circular Taxidermia, or a new approach in the arrangement of skin τάξις (táxis, “arrangement", "order”) + δέρμα (derma, “skin”); circular = systems thinking in line with UN Sustainable Development Goals

Background and Motivation

Leather is a natural, sustainable material with unique properties when properly made and sourced. The research sets out to explore and evaluate innovative uses of leather, whilst being based in the East Midlands of England in an industrial town with a tradition in leather processing and the making of footwear, which provided a supportive environment to undertake the prototyping of artefacts that will showcase new possibilities. At the same time, the research interrogates knowledge transfer with communities of practice associated with a particular material, probing the interplay between craft traditions and innovation, and demonstrating the scope for ‘New Product Development’. Working closely aligned with a cluster, the research aims to shed light on the contribution of design and networks to give a future to the British leather industry. It does this principally by mapping the interactions of emerging design talent and established RCA alumni with Northampton shoemakers, apparel, the Leathersellers Company and Scottish tanneries producing automotive leather.

Submission Details

Researcher	Friedemann Schaber
Collaborators	Staff and facilities at The School of Design, Royal College of Art London (RCA) where part-time PhD Research was conducted and situated. Staff and facilities at the Institute for Creative Leather Technologies (ICLT) at the University of Northampton, where prototypes were made and tested. Staff and facilities at D-Lab, Kyoto Institute of Technology where material experiments were undertaken and a handbook was created; during a scholarship and fieldwork in Japan.
Title	Circular Taxidermia
Output Type	Artefact
Output Component(s)	Body of work, including artefacts, diagrams and glossaries
Dates	2012-2020
ORCID	https://orcid.org/0000-0002-9479-706X
DOI	https://doi.org/10.24339/m0ad-hv43

Aims and Objectives

The Aims and Objectives for this project by practice include future applied design capabilities for leather as a material within the circular economy, and with the upcycling and recycling potential, focusing on gaps in understanding leather and the technology of leathermaking. The application of leather and collagenic fibres in the design process were shown as artefacts as part of the practice. The research "demonstrates how tacit knowledge can be employed, observed and created in a methodical way, with new artefacts playing a role in provoking insights based on tacit understanding" (Rust 2007).

The situated learning has been captured through material experiments, photographic records and a handbook of terms and processes, which has become central to the research. The focus is about a systematic and contextual study of leather material, and its application and intersection with the automotive industry, looked at through case studies and exploration via practice. The end prototypes, ranging from chrome-based, zirconium tanned, vegetable tanned, and engineered composites material will be as an exemplar of what could be done going forward to innovate the material and to safeguard this ancient community of practice.

Submission Details

Application of leather and collagenic fibres developed in practice, that led to a curated display of artefacts as part of the practice including handbooks, models, test rigs, experiments, tableaus, swatch books, and photographic output.

Exhibition of artefacts

2018 Schaber, F. Conductive Leather. Work in Progress Show. Henry Moore Gallery. Royal College of Art. London

2019 Schaber, F. collagenic fibres. Work in Progress Show. Henry Moore Gallery. Royal College of Art. London

Talk at a symposium

2018 Schaber, F. Advanced Textiles for Health and Wellbeing Symposium. Royal College of Art. London

Leather glossary - handbook of terms and processes.

Japan Handbook

Additional Statement

The purpose of this research by practice determines how leather can be used as a sustainable material of choice for the future. Using a design-led methodology, this research develops knowledge for guidelines for sustainable practice in this traditional industry, to make leather a material of choice for sustainable future consumer experiences and manufacturing. This investigation updates and re-evaluates old practices of handling leather and presents modern practices using alternative tanning methods, digital manufacturing and upcycling leather wastes into bonded collagenic fibres which address the end-of-life directive in the automotive industry. This portfolio entails the practice of my research. Through the means of curated artefacts. handbooks and diagrams; it proposes leather as an eco-informed material choice (Ashby 2009), and it introduces new practices to the

catalogue of working with leather (Waterer 1946, Amberg 2018).

My methods address the future of leather by undertaking detailed observations of practice through fieldwork in the UK, Italy and Japan. Also, by prototyping circular practices using leather through hands-on investigation in a design laboratory and tannery environment.

My findings identified collaborative communities which were drawn out in three areas: an actor network map, a leather processing diagram with closed loops and an atlas of locations of leathermaking. I produced a framework and an accompanying glossary to inform future practice with leather, including composite fabrication and digital manufacturing. In the practice part of this research, several artefacts have been created, demonstrating a potential process for undertaking 'circular' product design. A body of findings resulting from this research were categorised and presented in guidelines aimed at supporting future practice. Physical leather samples and upcycled composite materials from leather shaving waste tested the validity of the guidelines. Here, the studies demonstrate circular systems for production and reclaiming production by-products, through experiment and prototyping. An outcome of this research highlights the relevance of leather as a material for the circular economy – this is communicated through a handbook that illustrates terms and processes, which it is hoped will inspire makers and users.

Research Context

The value of this research for design practice is in its exploration of sustainable manufacturing methods and uses of leather, exemplified by providing samples, as well as the creation of the illustrated handbook.

For the academic community, its consideration lies in developing design and reframing the position of leather and its by-products in the circular economy, which unlocks value from the reuse, repair, remanufacture, retrieval and recycling of products, components and materials.

Research Questions

How can leather be used as a sustainable material of choice for the future?

How can design thinking create an impact and make an ageing industry like leather relevant once more?

And, asking a question related to Experiential Knowledge (Nidderer 2015; Fisher 2017), how will emerging technologies affect practices (around leather products) from the designer and the user perspective? Which led me to experiment with digital techniques, composites fabrication and alternative tannages.

The research questions emerged from previous iterations: Can leathers be produced to respond to increasing or changing usage? Is there a future for leather in the circular economy? What can the leather industry do to avoid becoming just another commodity? Leather and sustainable communities – can we empower communities through ‘making’ and participating in the leather value chain? The research illustrates the need for the UK to exploit its creative capabilities – as identified by The Cox Review of Creativity in Business (2005). There is a lack of interrogation of how emerging technology affect leather practices from the designer and the user perspective.

Figure 2.
Goatskin. Deep 3D effect through calcium chloride applied in a screenprinting process

Research Methodology

The methodology employed to answer the research question of how leather can be used as a sustainable material of choice for the future. The methods will address the future of leather through 1) observations (fieldwork) in the UK, Italy and Japan. 2) Development of a circular practice of using leather through the prototyping of leather through action research situated in a design laboratory and tannery setting.

Research methods include ethnography, participant observation in a fieldwork context, prototyping and curation. Links between the textual and practical components of this research are discussed in the context of my PhD by Project that presents the research phases, including data collection and analysis methods.

In the research, I devised projects to find solutions to systemic environmental challenges, as outlined in the UN's Sustainable Development Goals. Other projects around defined applications such as 'cutting out waste' led to the experimental use of digital fabrication, laser engraving and cutting, digital nesting and tessellating, embossing and debossing with rapid prototyped dyes and pattern stamps, screen printing circuity onto substrate and a wide range of artefacts.

Participant-observation provides 'Ethnography', that describes the findings from several field work undertaken in locations both in the U.K. and in Japan amongst leather manufacturers, in some cases by interacting with practitioners. In Japan I undertook observations in districts where tanneries cluster and two locations relating to manufacturing, design and retail. Following Bound (1999), I undertook photographic recording and some observations of practitioners. Furthermore, field work was undertaken in locations of leather manufacture and interacting with practitioners, so to shed light on the contribution of design and networks in the transformation of the shoe and leather industry.

Developing circular practices of using leather through prototyping, my early investigation led to the creation of artefacts from leather off-cuts and waste, using techniques of nesting and tessellation. Considerations were taken of scars and defects of the animal skin and processes to conceal or to enhance these characteristics with techniques such as pull-up effect and distressing. There was a focus on user perception of a sustainable material that mellows and ages gracefully.

Observation of the practice of designers from the Royal College of Art led to the subsequent exploration of smart material properties through the introduction of sensory and conductive capabilities into leather. This was initiated by participating in the 'Bare Conductive' workshop (Johnson 2013). Through practice-led research, exemplary prototypes were presented using recently developed technologies such as rapid prototyping and artefacts, that when use and tested, reveal new ideas and research opportunities. I developed through practice a knowledge base for leather and requirements for potential applications and explained this through diagrams. These are included in a glossary / handbook where research and practice converge. The illustrated handbook codifies my tacit practice.

Research Outcomes

1. Processes
Gaining subject knowledge (leather craft, processing, collagenic materials chemistry) through 'leather appreciation' courses at ICLT in 2012 and 2017. Undertake material testing and scanning electron microscopy of collagenic fibres

2. The field study
Qualitative survey of leather industry and supply chain, initially Northampton and Walsall based leather goods manufacture, then global tanners, manufacturers and educational research institutes, as follows:

UK: Northamptonshire archives and companies 2011-2020
Investigation based in the East Midlands of England in an industrial district with a tradition in leather processing and the making of footwear, which provided a supportive environment to undertake the prototyping of artefacts. Museum of Leathercraft, Northampton Shoe Museum, ICLT, and Shoe manufacturers Churchs, John Lobb, Doc Martens, Crockett-Jones, Trickers. Findings resulted in book chapter for Springer 2019

UK: London based designers and makers, Leathersellers Hall St Helens, City of London
2009-2018 Recorded in conferences and exhibitions section, some of which precede Ph D studies. Photo record

UK: West Country leather manufacturers
August 2016 – fieldwork; site visit to Pittards Tannery in Yeovil and Baker Tannery in Colyton.

January 2018 – fieldwork; site visit to Thomas Ware tannery in Bristol.

India: Chennai
In February 2012, attending the Intl. Leather Fair in Chennai, India and building links with Indian and Italian manufacturers, designers and education institutes; followed by visit to footwear manufacturers with discussion on new product lines, diabetic podiatry and socially responsible design. Workshop and UG assignment on Breadline shoes, presented at conference. Recipient of Chancellors Fellowship and Santander Universities grant to conduct field work in India.

Brazil: Sao Paulo and Novo Hamburgo, Rio Grande do Sul
August - 8 September 2012 - Visit to the Brazilian footwear cluster in Rio Grande do Sul, National Footwear Museum, Courovisao leather trade fair, sustainability forum and various universities in Novo Hamburgo, Sao Paulo and Porto Alegre.

3-6 September 2013 - I C D H S, 8th Conference of the International Committee for Design History and Design Studies DESIGN | FRONTIERS in Sao Paulo with paper presentation titled: History, Design and Technology in the Leather Trade - Case Studies from India and Britain. Published in the conference proceedings. Photo record

Italy: Arzignano, Torino
Fieldwork to Europe's foremost leather district, including several factory visits and a leather finishing training course in Arzignano, a tannery cluster in Veneto Province, Italy (13-18 May 2012) Visit to the National Automotive Museum in Turin and a manufacturer of vegetable tannin agents in Piedmont. Photo record

Netherlands: Waalwijk and Dongen
June 2017 visit to leather conference (Freiberger Ledertage) and Dutch cluster of leather and chemicals companies. ECCO, Stahl, and leather education Boxtel and SLEM Waalwijk. Photo record

Japan 1: Tokyo, Himeji, Kyoto
September 2013 – Fieldwork in Japan with visit to leather cluster and Hyogo Prefectural Museum; visited tanners in Himeji including Mr. Kashiwa and the tanneries of Jun Kawaguchi, Sayonan Co and the Kyoshin Co. Excursion facilitated by Photographer Prof Katsushi Hasegawa and Prof Yuko Nishimura. Kyoto Museum of Traditional Crafts "FUREAIKAN", meeting place of industry, culture, people and traditional techniques

Japan 2 Kyoto, Tatsuno, Nara, Nagoya, Gifu
31 January - 31 March 2018 - Scholarship at Kyoto Institute of Technology. At the materials science department I undertook composites fabrication with shavings from leather production waste, appropriating the Washi Japanese paper making process and recorded initial results and adhesion achieved. Optimised fibre composition and fibre size in collaboration with materials scientists and technicians.

Summary:

* Gained knowledge of research methodologies, current and future trends in product, automotive and interior design, fashion and accessories, by attending relevant trade fairs and conferences.
* Investigated the conceptual ideas necessary for prototypes.

3. Objects
4. Diagrams
5. Handbook

Processes

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Figure 3.
Coating and stabilising of sample
from leather waste fibres

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Figure 4.
Processing and application of foil to
sample from leather waste fibres

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Figure 5.
Leather finishing processes. Rawhide in a toggle frame. Cover image for Handbook of Processes and Practices.

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Figure 6.
Plant Matter (Waste) as Tannins. Tanning experiments at ICLT on the reuse of plant waste - Alternative tannages from plant matter, farm and forestry waste that contain phenolic tannins.

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Figure 7.
Experimental tanning of rawhide with apple pulp, alder tree and foliage, chestnut and cherry tree shavings and bark, hop plant waste and mulberry.

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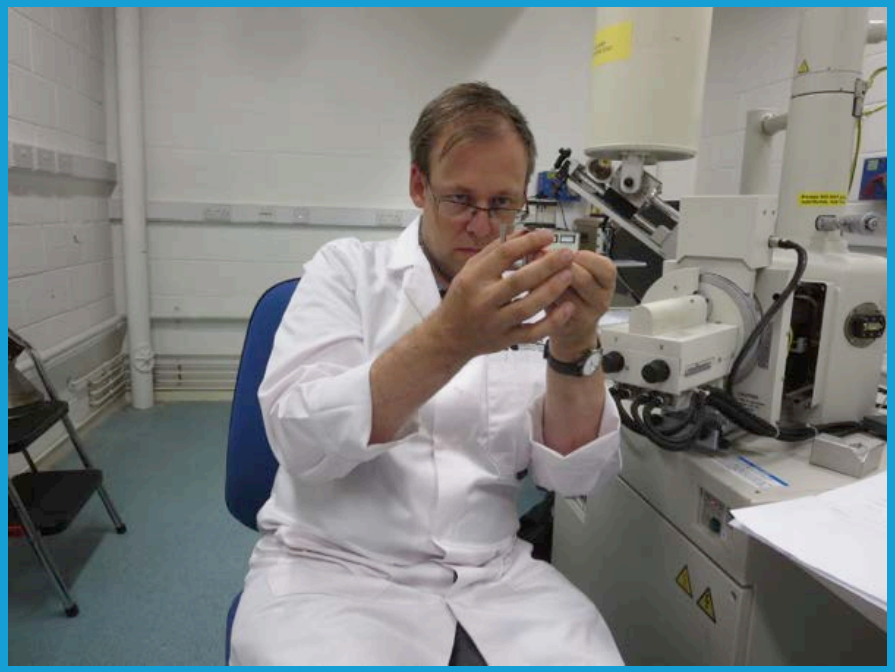

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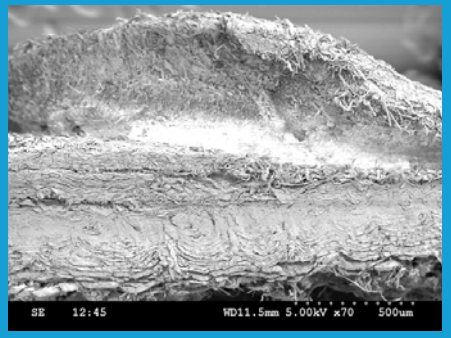

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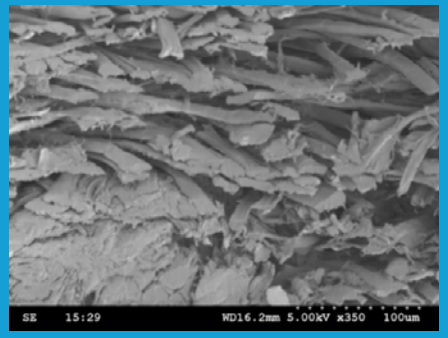

Figure 8. Scanning Electron Microscopy at ICLT.
Figure 9. Fish skin sample
Figure 10. Sample made from leather shaving waste fibres

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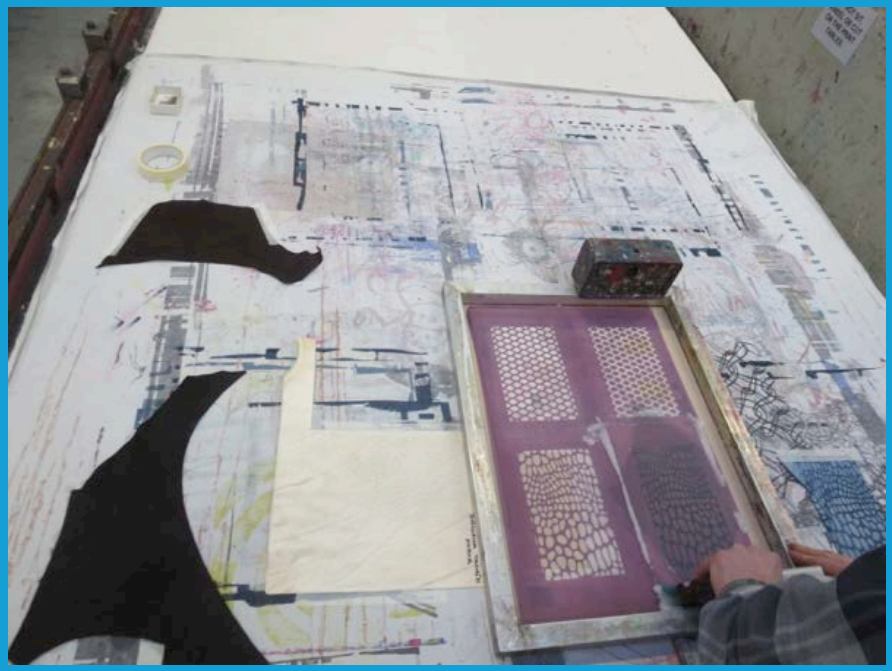

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Figure 11.
Experimental application of calcium chloride through screenprinting process

Figure 12.
Goatskin. Deep 3D effect through calcium chloride applied in a screenprinting process

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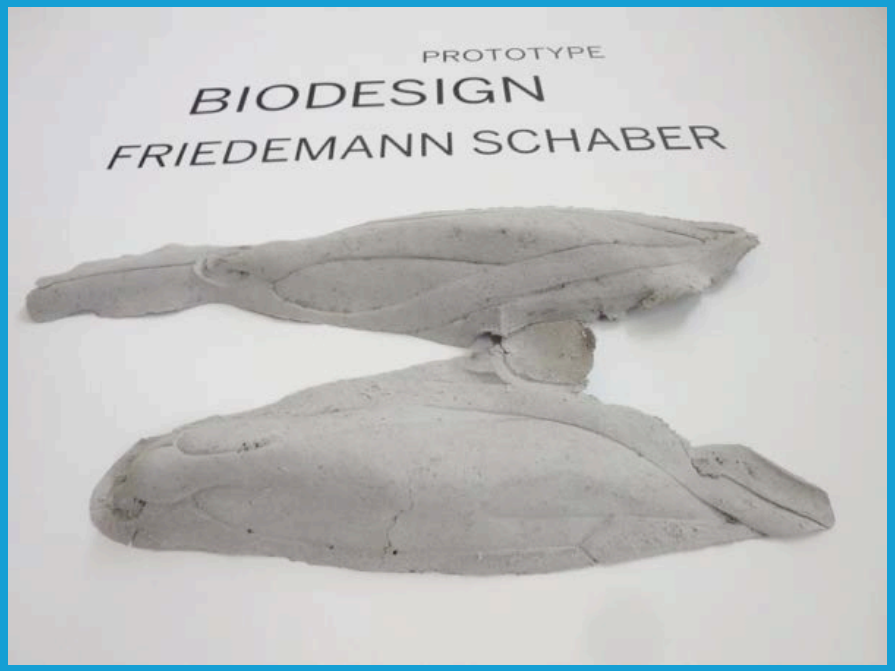

Figure 13.
Fabrication from leather fibres. Mouldmaking and spray coating application of collagenous fibres with and without resins, binders and foils for upscaling of production, on display at RCA WIP 2019.

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Figure 14.
Material experiments in Japan
a) A prototype of composite material from collagenic fibres and mulberry (kozo) fibres. The processes including the blending of leather fibres from production waste with a plant fibre Japanese kozo, optimising fibre composition towards a bio-composite,
b) A prototype of composite material from collagenic fibres with palm oil fibres, from another waste stream, investigating the creative and commercial potential of blended natural fibres.
c) A prototype of collagenic fibres laminated with biodegradable polylactide, experiment to strengthen the fibres, towards new systems that I have devised to use leather waste and offcuts.
d) A prototype of collagenic composite materials using plant-based starches experiment to use biodegradable binders.

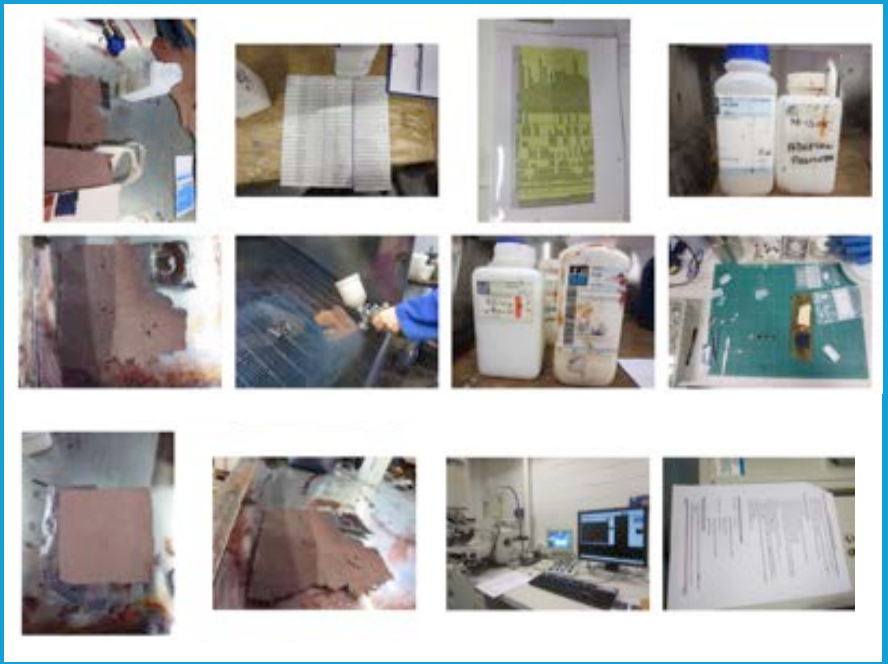

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Figure 15.
Material experiments in Northampton Creation and coating of composite material from collagenic fibres including the blending of leather fibres from production waste. Application of films, foils and biodegradable resins to strengthen the fibres, towards new systems that I have devised to use leather waste and offcuts

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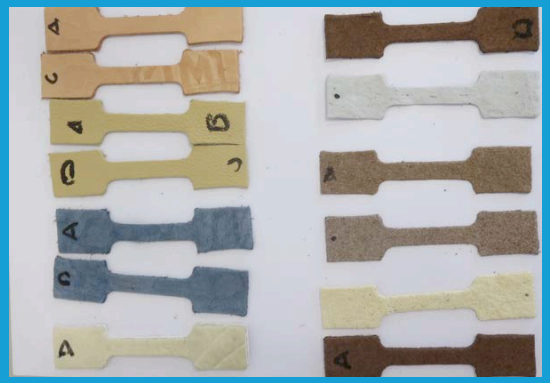

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Figure 16 & 17.
Tensile testing of leather and collagenic fibres at ICLT

The field study

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Figure 18.
Off-cuts from Walsall saddleries. Designing waste out. The practice is reframing the position of leather and its by-products in the circular economy, which unlocks value from the reuse, repair, remanufacture, retrieval and recycling of products, components and materials.

Figure 19.
Artefact. Laminated off-cuts from Walsall saddleries.

Figure 20.
Fieldwork in Japan. Urushi manufacture in Kyoto. A natural resin traditionally used for the coating of leathergoods

Objects

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Figure 21.
Prototype of a Despatch Box (300x240x120) featuring a distressed finish, scars and surface defects; demonstrating leather material that ages gracefully. RCA Design Biennale Exhibition 2013

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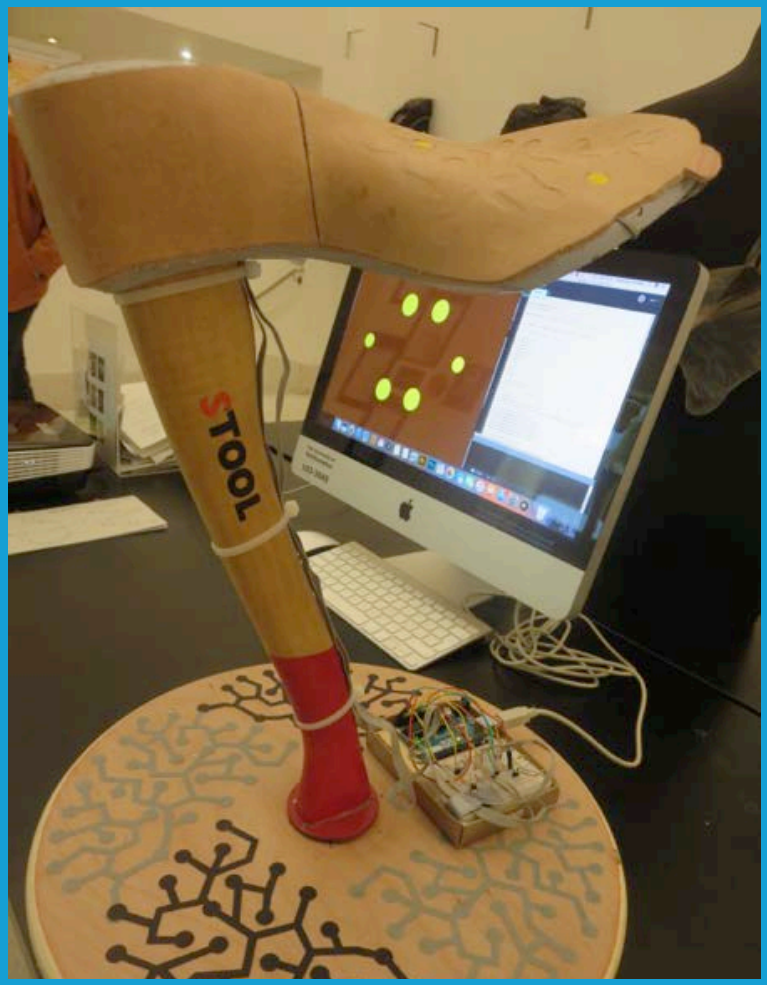

Figure 22.
Saddle covered in alternative tanned leather from plant matter. Physical leather samples and upcycled composite materials from leather shaving waste tested the validity of guidelines of how leather can be used as a material of choice. Here, the final projects demonstrate circular systems for production and reclaiming production by-products, through experiment and prototyping.

Figure 23.
Saddle/Seat with force sensors embedded in vegetable tanned embossed cowhide and wired to Arduino Micro Controller, displaying pressure distribution, with potential benefits for posture and health. RCA WIP Show.

Figure 24. (next page)
RCA WIP Show.

Diagrams

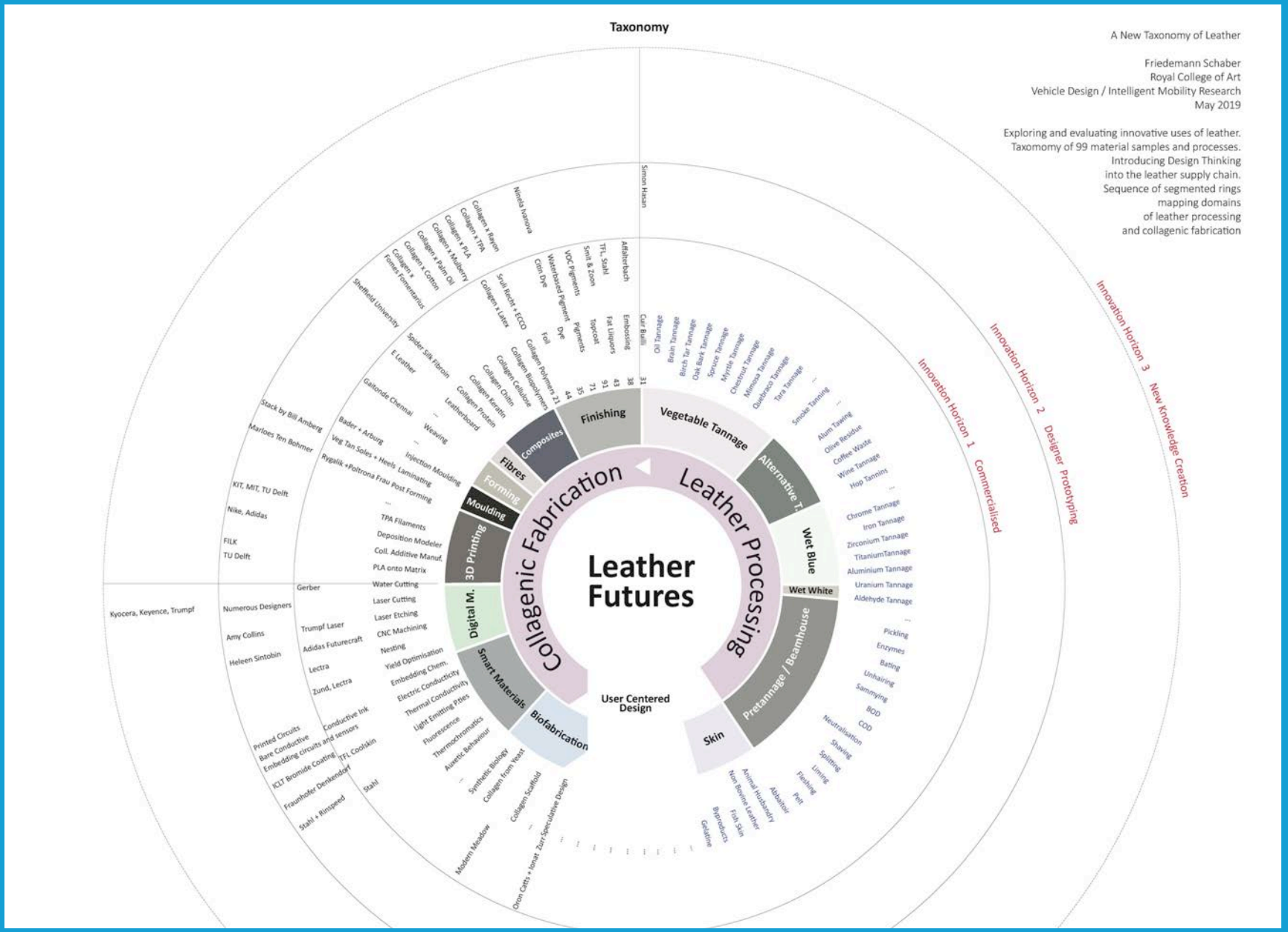

Figure 25.
Taxonomy of Leather Processing and Collagenic Fabrication

Circular arrangement of leather processes and introduction of terms to the finishing stages and beyond. The diagram introduces new practices to the catalogue of working with leather and explores the production of knowledge in a particular industry, through visual means. Material samples including composites extend eco-informed material choices.

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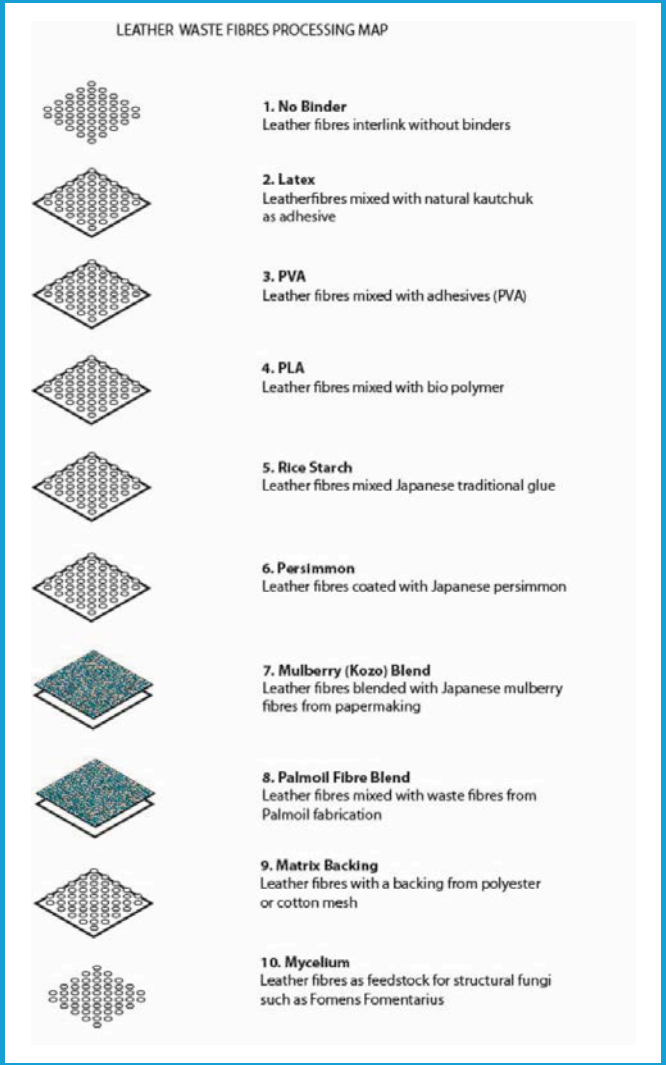

Figure 26.
Creation of Bonded Fibres from Leather Waste

There are considerable environmental benefits by using leather, by-products and waste efficiently, with material samples created at the Fibro Science Lab at Kyoto Institute of Technology,

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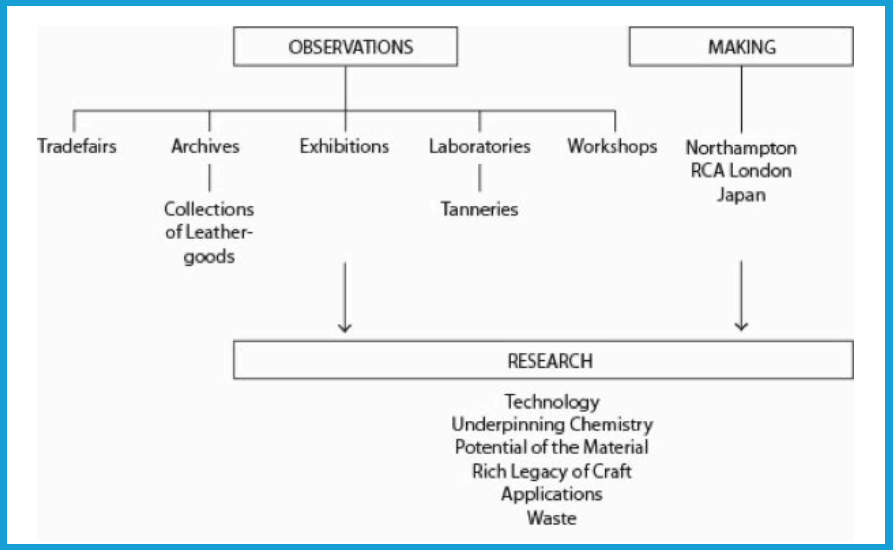

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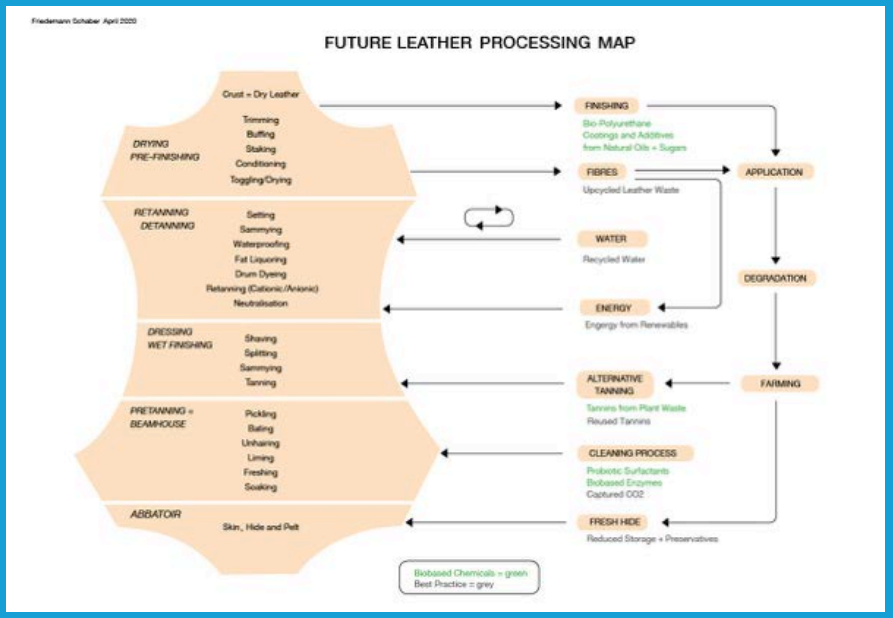

Figure 27.
Design research methods employed in the study

Figure 28.
Leather processing map towards closed loops and the circular economy

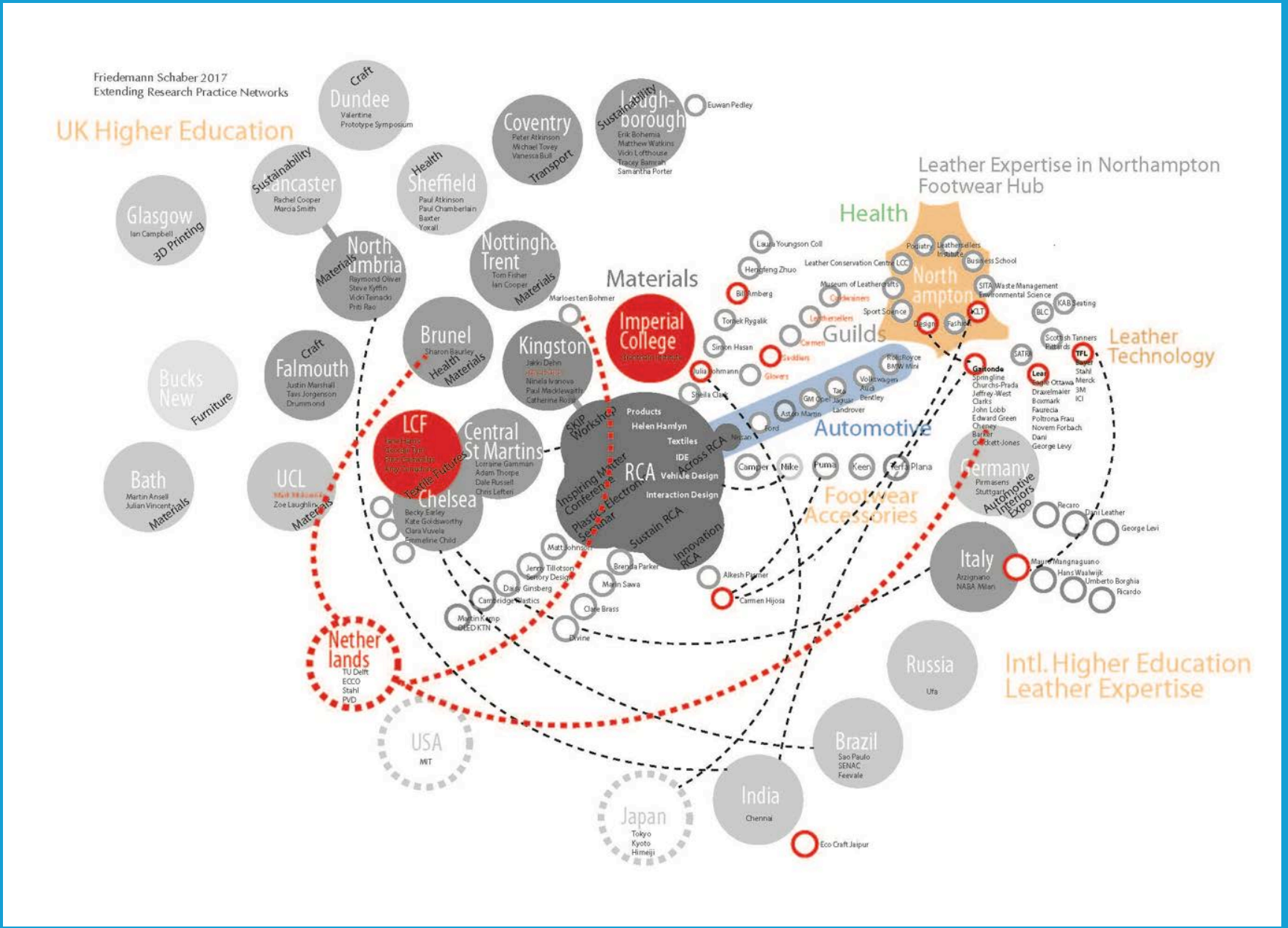

Figure 29.
Network Map

Determines actors, leather clusters, educational and research links, based on insights from observations, literature and conference attendance. Displaying multiple relationships of the leather industry with designers, design education and research. For design research, it highlights the role of designers who connect and innovate. Longitudinal approach shows movement of actors within the network.

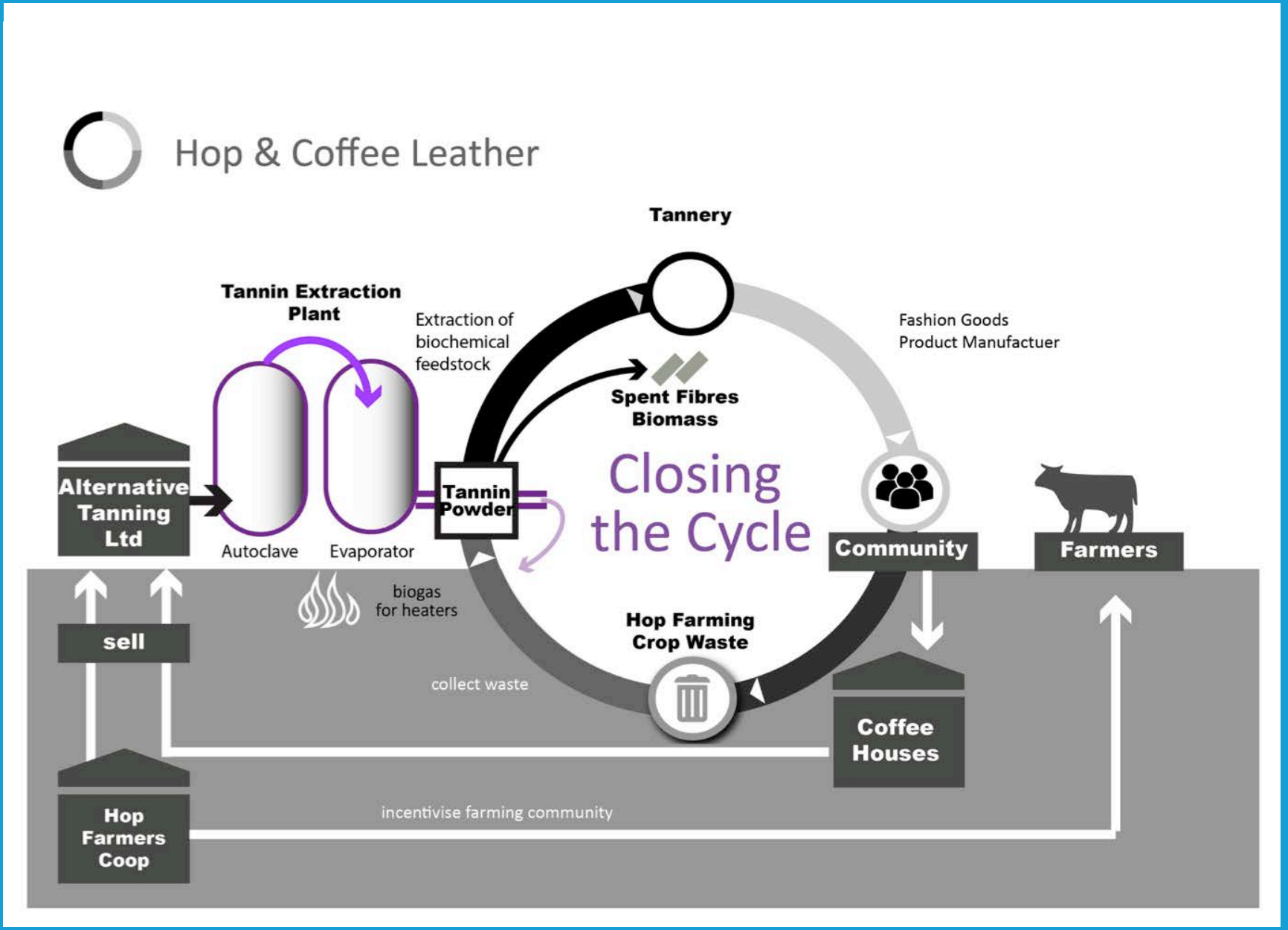

Figure 30.

Valorisation of waste from beverage industries (coffee ground and hop for brewing) as vegetable tanning agent

Handbook

Contents

Figure 31.
Handbook of Processes and Practices.

Glossary list of contents. 99 terms and processes from Accessories to Zirconium

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Figure 32–25.
Handbook of Processes and Practices.

An illustrated glossary that sets out to define relevant terms and processes. It adds new practices and clarifies responsible usage of leather for the benefit of designers and users.

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Insights

Revisiting the research question of *How can leather be used as a sustainable material of choice for the future?* Though my research, I found traditional practices of making and working with leather, and applied eco strategies of durability, reparability and longevity. Through prototyping I explored and tested modern practices of processing and handling leather.

Through observation, I found that designer's network with leathermakers and leather education and through a collaborative process innovate by way of experimental making and prototyping. Leather chemists devise and follow scientific methods, the technologists apply these. Innovation happened in multiple ways, not only within leather making but through brands that develop a vertical supply chain and integrate leather factories. Through observer participation, it became evident to notice that:

1. The leather industry is affected by developments and movements in the global supply chain, including automotive and luxury goods / apparel.
2. Skills gap; whilst there are country-specific education routes such as work based learning, apprenticeship models are scarce, with few institutions offering access courses, top-up or degrees. It was noted that tannery staff are trained and upskilled by chemical suppliers.
3. The emergence of design 'hothouses and 'appreciation' courses for creatives and opinion makers provided by leather consortia, chemical companies and brands.
4. And leather makers are under an ongoing challenge to respond to environmental pressures and regulations in many locations, with certification processes and consortia to change perceptions of the trade and product, exemplified by Tuscany Vegetable Tanners in Italy, Leather Naturally in the UK, and Hyogo Leather and Tatsuno Leather Corporation in Japan.

Collaborative practice has been demonstrated by me with leather technologists, fibro science and papermaking; it demonstrates the role of leather knowhow. Through the making of prototypes, I have accessed tacit knowledge and I have come to an understanding of how that knowledge has been accessed by material research and creatives.

The prototypes created by me, ranging from chrome-based, zirconium tanned, vegetable tanned and engineered composites material, will be exemplars of what could be done going forward with the research outcomes:

* Development of a Handbook/Glossary
* New material and sustainable design solutions of leather and its by-products
* Extending an understanding of leather in the circular economy

To summarise, I investigated the conceptual ideas necessary for prototypes, questioned social and cultural histories of the material, and perceptions of existing alternatives. I mapped processes of leather making, the usage and outlet, and asked: can new leathers be produced to respond to increasing or changing usage?

The research question posed earlier, entitled as *How will emerging leather materials affect practices (around products) from the designer and the user perspective?* has been explored, and it lead to a novel utilisation of waste fibres and leather by-products.

The research aligns with, and critically evaluates an increasing interest in creating, tinkering and designing with new materials (Karana et al. 2015; Rognoli et al. 2015). Of note here is the growing of materials from living organisms (Collett 2017; Myers 2012) and creating active composites by embedding electronics into materials (Vallgårda et al. 2016). My contribution to the practices of design is to contribute to a positive social environmental and to economic and political change (Drazin and Küchler 2015).

Overall, the scope of my research is “Leather Futures”, and I have extended the practice of leather processing into “Collagenic Fabrication”. My model includes the terms 3D printing, composites, digital manufacture, smart materials and bio fabrication. In my research, the model has been described through a diagram.

Leather making is a traditional industry and has its own jargon (Covington 2009). Some of the terms are set out in glossaries and more can be found in the British Standards Glossary of Leather Terms. Through review, I have identified a knowledge gap. A contribution to knowledge is the handbook, which is presented as illustrated glossary of terms of leather processing, trade locations and practitioners. The handbook adds glossary terms and updates expressions and practices of leather making. This handbook is a useful resource to a diverse group of stakeholders who are engaged in creating, fabricating, trading and consuming the material.

An output is the creation of a design tool. The handbook, accompanied by physical leather samples, will be a guide for users, designers and manufacturers engaging with the material.

A contribution of this research for design practice is the exploration of sustainable manufacturing methods of leather, exemplified by providing samples. For the academic community, its value lies in developing design considerations and reframing the position of leather and its by-products in the circular economy.

My research offers prototype creation. I investigated several processes including chrome tanned, and vegetable tanned bovine fibres from production waste, optimising fibre composition in collaboration with the materials scientist at Kyoto Institute of Technology and technologists at Northampton. This resulted in:

New materials:

* A prototype of composite materials from collagenic fibres and mulberry fibres
* A prototype of composite material from collagenic fibres with fibres from another waste stream, palm oil, investigating the creative and commercial potential of blended natural fibres.

The research investigated transferrable fabrication processes:

* A prototype of collagenic fibres laminated with biodegradable polylactide
* A prototype of collagenic composite materials using plant-based starches
* Mouldmaking and spray coating application of collagenous fibres with and without resins, binders and foils for upscaling of production

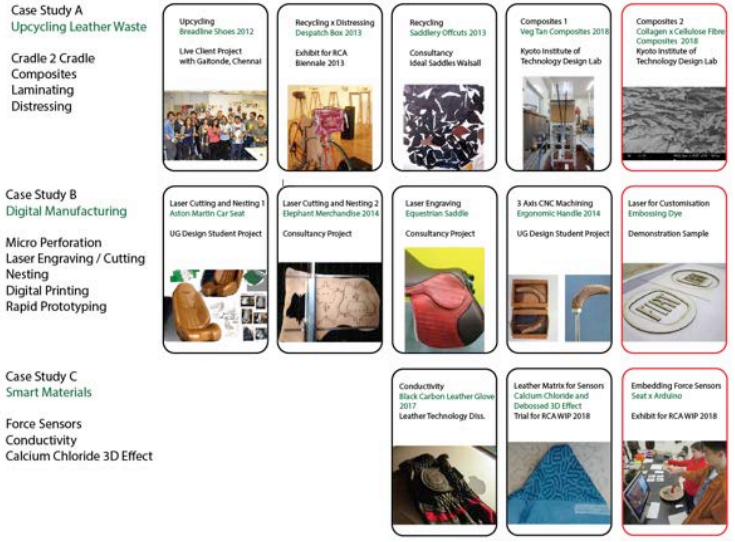

Figure 36.
Structure of Practice.
Upcycling Leather Waste.
Digital Manufacture
and Smart Materials
Investigation.

Dissemination

1. Leather: Practice and Innovation in Japan. Fieldwork report, guide, manual. Kyoto Institute of Technology [KYOTO Design Lab] JASSO Visiting Scholar from 31 January - 31 March 2018. Creative material investigation and innovative applications of leather within craft, product and automotive design practice. PDF 74 pages.
2. Smart leather - Perceived Quality and User Acceptance of sensors and structural biomaterials. RCA Work in Progress Show. Henry Moore Gallery 24/01/18 – 27/01/18 London, United Kingdom. Smart material exploration and embedding of force pressure sensors in vegetable tanned saddle hide. Research output: Non-Textual Output › Design
3. Collagenic Fabrication: Darwin Entrance Gallery, Royal College of Art, Work-in-Progress Show Schaber, F., 24 Jan 2019 Research output: Non-Textual Output › Design
4. RCA Research Biennale
5. Super-i-fabrics, 8 April 2016- Horizon20:20 bid submission (unsuccessful) Led by Iannis Ioannides, UoL, Will Wise and T. Covington UoN 14 strong Consortium. multi-partner project, H2020-ICT-2016-2017. Proposal acronym: SUPERiFABRICS aimed at ...enabling design-driven disruptive market-creating solutions for reliable, safe and secure, direct active monitoring smart capabilities development in cross cut Weartech, wellbeing, comfort, safety and security, as well as Health applications. The 3-year research programme will lead to the de novo 3D- architecture modeling and co-design of universal intelligent generic collagenic biomaterials/ composites, building blocks enabling mass customization, 3D-fusion, biosynthetic and additive manufacturing of smart heterogenous fabrics and systems. Turnkey enabling technologies for the lab scale prototyping of conducting, thermo-regulating, energy harvesting and functionalized smart materials comprise in: surface micro/nano-treatments, 3D-chemical modification with deep eutectic solvents, as well as 3D–fusion with polymers, nano-fibers and –composites.

Objects

* Thesis excerpt: 4.3. sustainable Future leather Use 4.3.1. curated Artefacts on Display (the diagrams, the handbook)
* Scholarship and fieldwork with a JASSO grant to Kyoto Institute of Technology, examining creative usage of leather and related hybrid materials in broader cultural contexts such as Japanese white leather, fish skin, lamination and parchment manufacture. Some of these processes have been preserved in Himeji, Japan.
* Academic paper at the 8th Conference of the International Committee for Design History and Design Studies from 3 – 6 September 2012 in São Paulo – Brazil.

Bibliography

Key Topics are eco-informed material choice and material experience. I have engaged with the theory of the Circular Economy and innovation for sustainable development. The process of Design Thinking and some of its concepts such as collaboration, visualisation and an emphasis on creative research tools used during the creative exploration of 'leather futures' together with literature on new materials in design (Stattmann 2000), (Howes and Laughlin 2012), eco informed material choices (Ashby 2009), materials experience (Pedgley 2010), (Parisi and Rognoli 2017) and fundamentals of materials and design, (Covington 2009; Heidemann 1993). It was found that leather is a complex material with issues, but also with unique aesthetics and performance properties that – when responsibly processed – will positively address changing user demand the growing concern for leather's sustainability credentials (Redwood, 2017).

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