

5th PLATE 2023 Conference

Espoo, Finland - 31 May - 2 June 2023

Thinking beyond circles: Developing visual research methods for circularity in design education

Laura Knight^(a), Kate Goldsworthy^(b), Sanne Visser^(c) Cathryn Anneka Hall^(d)

a) Associate Researcher, Centre for Circular Design, London, UK

b) Professor of Circular Design and Innovation, Centre for Circular Design, London, UK

c) Researcher, Centre for Circular Design, London, UK

d) Postdoctoral Researcher, Centre for Circular Design, London, UK

Keywords: Visual communication; Lifecycle visualisation; Circular economy; Design research; Design education.

Abstract: This paper presents a case study of a material-lifecycle design project developed between educators, researchers and industry. Communicating and conceptualising circularity presented an opportunity to expand the reach of the research into a curriculum intervention. The project invited graphic design students to visualise a product lifecycle for a circular textile industry client - Piñatex. This paper explores the challenges of communicating circular lifecycles to non-expert audiences. It is acknowledged that there is a need for new kinds of designers in practice-based research. Therefore, the paper presents examples of new knowledge that visual communication methods, more traditionally taught in graphic design programmes can bring to research. Drawing on practice-based iconic research methods, which in contrast to theory-driven research enabled the production of images as a means producing knowledge about visual communication. Through an after-action review, the research demonstrated three surprising approaches to communication of circular processes that typically creates diagrams with icons in a circular shape. Through working with non-experts, the research exposed the client and the research team to range of visual approaches, namely, symbolic, non-circular and quantitative visuals. The research found that visual communication methods have the potential to play a pivotal role in development of new visual languages for circularity. It concludes that visual research methods can bring different design disciplines closer and build a stronger educational base for the transition to a circular economy.

Introduction

In their report, "Beyond Net Zero: A Systemic Approach to Design" the UK Design Council emphasises the vital role that designers will play in building 'a bridge between technological research and innovation and their application to social practice (UK Design Council, 2021:6).' collaborative research, bringing together different disciplinary knowledge and methods, is increasingly understood as key to working with complexity and has been identified as 'particularly significant' for sustainability research (Peukert, 2022). Literature from the field of practice-based design research also acknowledges the need for a new type of designer; with the 'expanded capacity' to undertake and participate in research (Vaughan 2017).

In design education, this calls for innovative approaches to teaching and learning, combining traditional design skills with

sustainability literacy and contextual transdisciplinary knowledge (Peukert, 2022).

This paper presents a case study of a material-lifecycle design project developed between educators, researchers, and industry. The project was situated as part of ongoing research activity (IUK, Grant 78073, 2021) between University of the Arts London and material technology company Ananas Anam. A key challenge highlighted during the research was that of communicating circular product life cycles to non-expert audiences. The researchers wanted to explore the role

of teaching and learning in addressing this challenge and developed a curriculum-based project with graphic design students. The students - as non-experts in material design and circularity - were asked to develop visual alternatives to an Ananas Anam product life cycle.

Visualising circularity

The main aim of design for circularity is to create closed loop systems, by extending the life of materials, products, and services in use, or retain their value through cascading, where materials or products become feedstock for another use (Ellen MacArthur Foundation, 2015). Circularity has been conceptualised and communicated in multiple ways, both within academia and industry, often through the visualisation of closed circles and interconnected flows of materials and production processes. Significant to one of the first circularity models is the distinction between biological and technical cycles, where one should not enter the other. This 'cradle-to-cradle' model was first highlighted by McDonough and Braungart (2002) and later incorporated into the Ellen MacArthur Foundation (2013) 'butterfly diagram'.

Subsequent visualisation models focus on material sourcing, production, use and end-of-life phases. Others highlight multidisciplinary stakeholders within each stage of the lifecycle like the Great Recovery project (RSA, 2016), potential business models within a circular economy (Accenture, 2014), or highlight the value retention options each flow offers (Reike, Vermeulen and Witjes, 2018). This last example, a type of combined cascading and supply chain mapping, shows the complexity of material and product lifecycles. A very different visualisation model is the 'Moonfish' circularity model developed by participants from the TU Delft (2014). This horizontal, figure-of-eight shape is focused on matching the value of the user with the value of the manufacturer.

As designing for circularity becomes more complex, visualisations have evolved into multifaceted and dynamic maps that go beyond material flows and include stakeholders, ecological values and the wider societal impacts. These visualisations combine icons and symbols with diagrams and labels in increasingly complex and interrelated ways. In the next section we will discuss how these visualisations of the circular economy are constructed with specific reference to three types of visual; diagrams, icons and symbols.

Dissecting circular visualisations

Diagrams form the basis of most circular visualisations. They are particularly suited to this task as their primary function is to communicate interrelations (Stjernfelt, 2007). Walter R. Stahel's diagram from 1976 illustrated the life cycle of an industrial product within a circular economy. As shown by Fig. 1 is a classic example of a diagram; using only simple lines and labels to communicate its content.

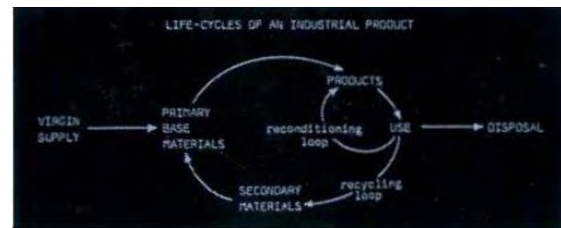


Fig.1 Diagram of closed-loop industry – Walter R. Stahel 1976

Subsequent visualisations of the circular economy incorporate layers of icons, symbols, colours and text over the top of a diagrammatic base; transforming the overall visualisation into something more broadly described as *infographic*.

Icons are consistently used in infographics. Historically, the term icon describes graphics that are literal visual descriptions of the objects they represent. However, they are increasingly used to represent more abstract or nuanced concepts. An example can be found at the centre of the EMF Butterfly diagram with two icons representing a 'consumer' and a 'user'. In absence of a visual idea that could communicate these ideas directly, two visual ideas are combined. The consumer icon combines a person with a barcode (Fig.2), the user combines a person with a digital interface (Fig.3).



Fig.2 Icon for consumer. Fig.3 Icon for user.
© Ellen MacArthur Foundation (2013)

Circular visualisations also incorporate symbols, often alongside icons. The visual relationship between a symbol and its object is less direct. Symbols are used when no concrete object exists. We can see this Fig. 4 in the biological cycle of William McDonough and Michael Braungarts Cradle to Cradle visualisation. The visual representing 'plants' is iconic –literally a plant. However, the visual representation of 'biological nutrients' is encoded in a symbol. Here the relationship between the visual and the concept must be recognised to be understood.

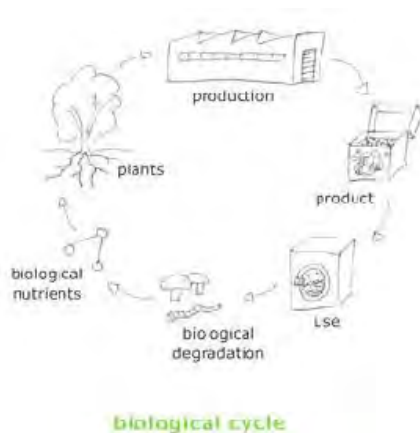


Fig. 4 Cradle to Cradle Diagram.
© William McDonough and Michael Braungart

Increasing complexity

Circular visualisations often need to combine concrete and abstract ideas and visualise them in both sequence and interrelation. In many circular visualisations, symbols and icons are combined with text-based labels to support the communication. This layering of diagrams, icons and symbols with labels makes the task for the non-expert viewer quite complex. As designing for circularity becomes more complex, designers will need to respond with an increasing level of visual innovation. Johana Drucker suggests that this will require a break with the 'literalism' of current representational strategies, exploring alternative visual languages that connect non-experts with the content in new ways. (Drucker, 2014)

The Piñatex Case study

This paper describes research conducted to explore this idea of visual innovation. Developed in collaboration with Ananas Annam focussing on the lifecycle of their product Piñatex. This product is made of fibre from the

leaves of the pineapple plant. After pineapple harvests, the long fibres of the leaves are extracted, purified and undergo several processes to create the non-woven mesh that forms the basis of Piñatex products. The focus of the project was to use the existing forms of icons, symbols and diagrams to generate alternative versions of the Piñatex product lifecycle.

Working with Graphic Design students, the project's aim was to explore what new design knowledge, visual communication methods could bring to the challenge of conceptualising and communicating circularity. This live brief asked the students to explore alternative visualisations of the Piñatex lifecycle with specific focus on nine key stages in the process; harvesting, extraction, purification, meshing, coating, finishing, degrading, shredding and recycling.

Methods

This research was conducted in two parts. Firstly, a live brief was designed and delivered by the Course Leader (Author 1) in collaboration with researchers at the Centre for Circular Design (Authors 2 and 3).

Secondly, the Course Leader and researchers (including Author4) conducted an after-action review (Morrison and Meliza, 1999) to reflect on the process and the insights generated through the process. Analysis focused on what was specific or unique about the ways that participants had approached the problem as non-experts. The outcomes produced by the students are used in the paper to expand on the insights generated.

The project methodology used *'the systematic creation of visual variations'* (Renner, 2017:5) as a means of producing knowledge about visual communication, exploring how *'the practical knowledge of visual communication contributes to the understanding of how images generate meaning'* (Schubach, 2017:14).

The methods used by the students included:

- mark-making
- visual description (icons)
- visual abstraction (symbols)
- visual arrangement (diagramming)

Project activities took place online over the course of one week. An initial briefing from the researchers (Author 2) was followed by three online studios. Students applied different visual research methods over the course of the week to produce a visualisation of the Piñatex lifecycle. Generative processes and visual prototypes were collated on a collaborative Miro workboard. All participants were given the choice of whether to participate in the research and written consent was sought for their work to be shared beyond the project.

Findings

The participants were asked to produce visual representations based on a written description; therefore, their visualisations were based on their own (non-expert) interpretations of the content. This resulted in some new and surprising visual approaches to diagrammatic, iconic and symbolic forms that exposed the client and the research team to a range of visual approaches. Three key themes were identified in the after-action review and the insights that they generated are discussed below with reference to specific visual examples.

Theme 1: Symbolic vs iconic

The icon and symbols, created by the students, visualising the nine key words in the lifecycle (harvesting, extraction, purification, meshing, coating, finishing, degrading, shredding and recycling) were surprising in their range. It was specifically noted that very few participants adopted more literal icon-based visual approach of existing circular visualisations. Rather, a symbolic approach was used.

Fig.5 is an example that used symbols rather than icons, where the final visualisation combines a set of simple symbols with labels over a simplified diagrammatic base. The insight for client and researchers here was that despite being simplified and symbolic, this visual language was still 'readable' – both as a circular process and in terms of its individual stages. As circular visualisations usually combine both icons and symbols within diagrams in increasingly complex and interrelated ways, a simplified symbolic form (as demonstrated Fig.5) could be further explored with specific audiences.

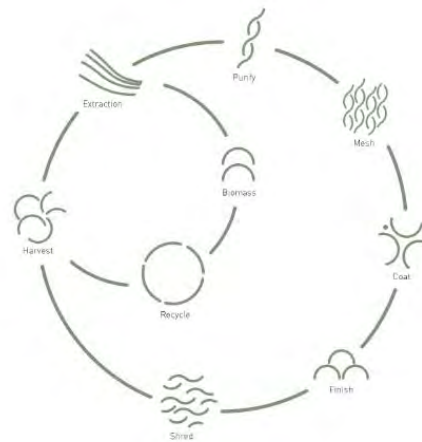


Fig 5. Final Piñatex diagram - Jie Li

Two further examples broke entirely with the literalism of existing approaches to circular visuals. In Fig.6 the imagery is abstract and yet iconic - constructed from marks made through direct experimentation with pineapple fibres. In Fig.7 the imagery is digital but visually suggestive of textile fibres. Graphically, both examples (Fig. 6 and Fig. 7) could be described as 'symbolic of the processes' in that they are abstract rather than literal visual representations of each lifecycle stage. However, both examples (Fig. 6 and Fig. 7) also succeed in being visually *iconic* of the subject matter. The form of these visuals are suggestive of the subject being discussed, in this case textiles made from pineapple leaf fibre.

The insight for the researchers was that infographic approaches, while effective at delivering information, can be visually homogenising, often failing to visually place the circular design process in a specific context. As circular design is increasingly applied within different industries and fields, further research could explore how the visual approaches might better communicate the connection between application and context.

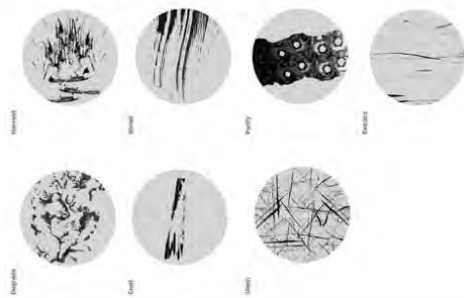


Fig 6. Visual language - Siriwan Champorn

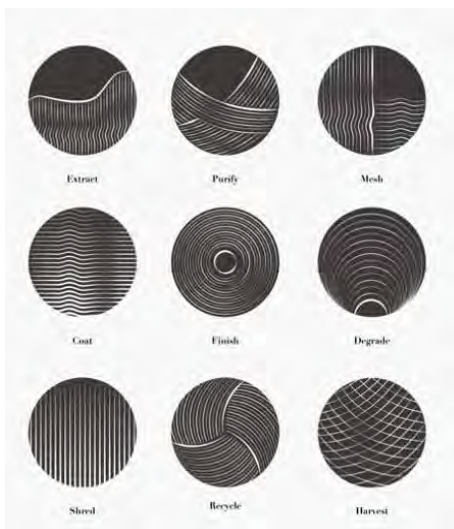


Fig 7. Visual language - Ji Zhou

Theme 2: Circular vs. linear

Just over half of the visualisations generated in the project uses a circular diagrammatic base. For example, Fig. 8 shows a participant's re-visualisation of the client's existing lifecycle. It uses the typical approach of using a circular shaped diagrammatic base with iconic imagery for each lifecycle stage.

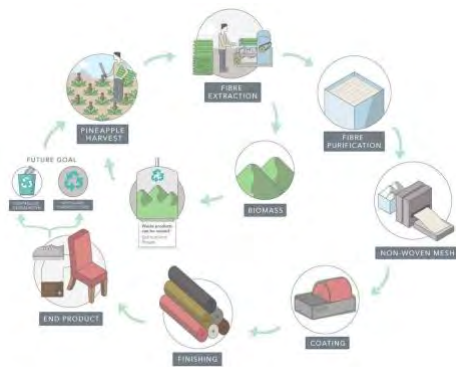


Fig.8 Pinatex lifecycle visualization
© Ananas Annam

However, the remaining visualisations broke with the visual 'circular bias' of the field. An example that used a non-circular base was Fig 9. Consisting of straight lines, it flows downwards to a rectangular recycling loop that feeds back up again.

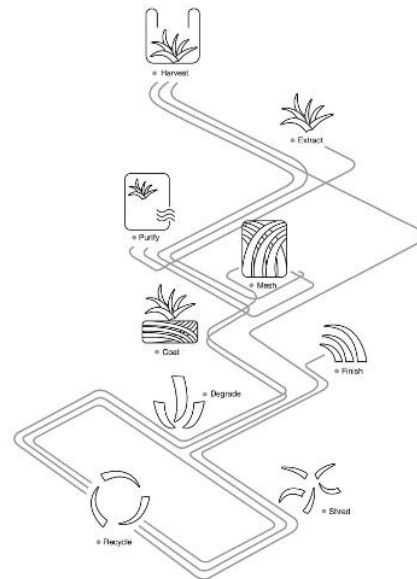


Fig 9. Piñatex diagram - Jiayi Liu

While not a technically perfect representation, the insight here was that a circular form is not necessarily the only way to communicate the circularity of a process and could be a useful approach to visualise processes that are not entirely circular or that have multiple complex interrelations. This demonstrates that practice-based iconic research, such as this, is a method to explore 'how the practical knowledge of visual communication contributes to the understanding of how images generate meaning' (Schubach, 2017:14). Further research might generate knowledge on how to balance the complexity of a circular process with the complexity of the visual for specific audiences.

Theme 3: quantification

The final theme that presented itself was the incorporation of quantitative data in the visualisations. As discussed in the introduction, Bianchini et al. (2019) have highlighted that many circularity visualisations do not embed a 'quantification' as part of their communication. Fig.10 and Fig. 11 addressed this in different

ways. In Fig.10 this was achieved illustratively using accessible visual comparisons e.g. transporting leaves = 104 elephants.



Fig 10. Piñatex visual language - Jiaoyang Zhang

In Fig.11 the approach was both more experimental and yet more classically quantitative. Echoing the visual form of a bar graph, it represented the CO2 emissions of the different stages of the lifecycle. The height of each bar represented the duration of the process, and the width represented a banded weight of CO2 emissions (Fig.11).



Fig 11. Piñatex diagram - Siriwan Champorn

The insight highlighted in the review stage was that approaches to quantification are an important area of innovation in circular lifecycle visualisation. Bianchini et al (2019), highlight existing visualisation types that could offer input here. However, further research might consider where new visualisation approaches are needed to meet the requirements of different contexts.

Findings and Next Steps

The review of the participants work highlighted the value of the non-expert perspective for the client and created a discussion about the potential value that design practice, that uses

visual methods, could have when implemented by expert practitioners.

Working with communication designers, the research demonstrated that their methods could play a central role in the development of new visual languages for circularity with a particular emphasis on their communicative potential for specific audience. This points the need for further research into how the teaching of visual research methods in design education can support designers across disciplines in connecting research and innovation to social practice.

Overall, this project highlighted the broader utility of visual research methods in bringing design disciplines (such as, material design and graphic communication design, as in this research) closer. It concludes that this can build a stronger educational base for the transition to a circular economy.

Conclusion

Through a designed teaching and learning intervention, this project explored the new design knowledge that visual communication methods might bring to the challenges of communicating a circular lifecycle.

Graphic design students applied a sequence of visual research methods to interpret a circular lifecycle. Analysis of the visuals was conducted through an after-action review (Morrison and Meliza, 1999). While many of the resulting visualisations were less-than-perfect technical representations; the project resulted in three surprising approaches to communication, namely symbolic, non-linear and quantitative. This exposed the client and the research team to a range of visual approaches produced by non-experts.

The research found that visual communication methods have the potential to play a pivotal role in development of new visual languages for circularity. It concludes that visual research methods can bring different design disciplines closer and build a stronger educational base for the transition to a circular economy.

Acknowledgments

This research is part of an Innovate UK research project (IUK, Grant 78073, 2021) between University of the Arts London and a

material technology company called Ananas Annam.

References

- Accenture (2014) Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth. Available at: https://www.accenture.com/t20150523T053139__w_/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Strategy_6/Accenture-Circular-Advantage-Innovative-Business-Models-Technologies-Value-Growth.pdf (Accessed: 13 March 2023).
- Bianchini, A., Rossi, J. and Pellegrini, M. (2019) 'Overcoming the Main Barriers of Circular Economy Implementation through a New Visualization Tool for Circular Business Models', *Sustainability*, 11(23), p. 6614. Available at: <https://doi.org/10.3390/su11236614>.
- Drucker, J. (2014) *Graphesis: Visual Forms of Knowledge Production*. Harvard University Press
- Ellen MacArthur Foundation (2013) *Towards the circular economy Vol. 2: opportunities for the consumer goods sector*. Available at: <https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-2-opportunities-for-the-consumer-goods> (Accessed: 3 March 2023).
- Ellen MacArthur Foundation (2015) *Towards a Circular Economy. Business rationale for an accelerated transition*
- Institute of Positive Fashion (2022) *The Circular Fashion Ecosystem*. Available at: <https://www.3keel.com/accelerating-the-transition-to-circular-fashion/> (Accessed: 13 March 2023).
- IUK, Grant 78073 (2021) Sustainable alternatives for COVID-19 PPE: biodegradable wipes and reusable masks made of pineapple leaf fibre, Innovate UK, Sustainable Innovation Fund, with Ananas Anam and UAL. Available at: <https://qtr.ukri.org/projects?ref=78073>.
- McDonough, W. and Braungart, M. (2002) *Cradle to cradle: remaking the way we make things*. 1st ed. New York: North Point Press.
- Meadows, D.H. (2008) *Thinking in Systems: A Primer*. London, United Kingdom: Chelsea Green Publishing.
- Morrison, J.E. and Meliza, L.L. (1999) *Foundations of the After Action Review Process*. IDA/HQ-D2332. INSTITUTE FOR DEFENSE ANALYSES ALEXANDRIA VA. Available at: <https://apps.dtic.mil/docs/citations/ADA368651> (Accessed: 14 June 2021)
- Peukert, D. (2022) Material metaphors: An approach to collaborative knowledge production in transdisciplinary sustainability research, in Lockton, D., Lenzi, S., Hekkert, P., Oak, A., Sádaba, J., Lloyd, P.(eds.), *DRS2022: Bilbao*, 25 June – 3 July, Bilbao, Spain. <https://doi.org/10.21606/drs.2022.775>
- Reike, D., Vermeulen, W.J.V. and Witjes, S. (2018) 'The circular economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options', *Resources, Conservation and Recycling*, 135, pp. 246–264. Available at: <https://doi.org/10.1016/j.resconrec.2017.08.027>.
- Renner, M, 'Practice-led Iconic Research: Towards a Research Methodology for Visual Communication', *Visible Language*, Vol. 51, No. 3-1 (2017): pp8-33
- RSA (2016) *Designing for a circular economy - lessons from The Great Recovery 2012-2016*. Available at: <https://www.thersa.org/reports/designing-for-a-circular-economy-lessons-from-the-great-recovery-2012-2016> (Accessed: 28 October 2022).
- TU Delft (2014) *Moonfish: Creating Sustainable value for the Future*. Available at: <https://strategicvalueofdesign.org/2014/06/17/creating-sustainable-value-for-the-future/>.
- Tubito, C. et al. (2019) *Applied DDMI: A White Paper on how Design-Driven Material Innovation Methodology was applied in the Trash-2-Cash Project*.
- Vaughan, L. (2017). *Introducing Practice-Based Design Research*. In L. Vaughan (Ed.). *Practice-based Design Research*, London: Bloomsbury Academic. Pp.1-6
- Schubbach, A, ' The Practice of Practice-led Iconic Research', *Visible Language*, Vol. 51, No. 3-1 (2017): pp34-55
- The Product-Life Institute. (2013). *Cradle to Cradle* [Online]. Available: <http://www.product-life.org/en/cradle-to-cradle>. [Accessed: 20 March 2023]
- UK Design Council. (2021). *Beyond Net Zero; A Systemic Design Approach*: <https://www.designcouncil.org.uk/fileadmin/upload/s/dc/Documents/Beyond%2520Net%2520Zero%2520-%2520A%2520Systemic%2520Design%2520Approach.pdf>
- World Economic Forum (no date) *Strategic Intelligence*, Stategic Intelligence. Available at: <https://intelligence.weforum.org> (Accessed: 13 March 2023).