the Learning Network on Sustainability

3Ecologies

Visualizing sustainability factors and futures

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'3Ecologies' makes visible factors affecting the sustainability of consumer products. Within engineering and economics, there are a variety of models for analyzing and 'predicting' the environmental factors such as energy, emissions and waste involved during production, consumption and disposal. We develop an expanded model, which emphasizes human impact and choices as well as potential consequences and futures. Psychological, sociological and environmental factors are mapped over time – throughout the lifespan (production, purchase, use, and disposal) and the extended lifecycle(s) of products. Case studies of familiar products in everyday life are developed to demonstrate the conceptual model, and three applications are proposed to reach designers, consumers and the general public. 3Ecologies uses diagrams and narratives to visualize the history and possible futures of products, including natural disintegration, active recycling and unexpected adaptations – an alternative view upon the 'life' of things that we might ordinarily take for granted.

Rather than conceiving the sustainability of any particular thing as a static or eternal matter of fact, we consider it as a consequence of multiple factors that are constantly changing and that are open to renegotiation. Consider an ordinary bottle made of glass or plastic. Of course, we can say something about sustainability if we examine its basic material components, for instance if they are recyclable or biodegradable. Tracing back to the original source of its materials and conditions of manufacture, we can say something more about environmental factors such as the use of renewable resources, chemical additives or bi-products, energy consumption and transportation, etc. In fact, it is just such aspects that lifecycle assessment typically tries to identify and quantify in terms of standard metrics.

However, there are other critical factors involved, including those that may be difficult to isolate and measure, that vary over time, and that depend upon other actors and circumstances. As designers and as consumers, we have asked ourselves questions such as: How do the conditions in farms and factories impact the local environment, benefit those involved, or contribute to a society? At point-of-purchase, what about consumer perceptions, gendered buying habits, peer pressure or brand experience? During use, what about attachment, memory, status or trends? What about the factors impinging upon disposal, such as information and options, loss and breakage, or time and space pressures? How do we consider gifts and inheritance, donations, charity and reclamation? Might it change how we consider the sustainability of things if we know that a bottle been refilled hundreds of time, if our new fleece jacket is made of synthetic fibres from discarded plastic bottles, if the insulating and aesthetic properties of glass bottles mean that they are ideal building materials for homes and shelters in developing countries?

In the project '3Ecologies', we have been investigating how such factors affecting the sustainability of designed things might be considered and expressed. In particular, we have inquired into how the qualitative, relative and temporal aspects of these might be incorporated into how we can conceptualize and model product sustainability in design research and practice. Further, we have explored how design methods and materials might be engaged to call attention to the choices of, and consequences for, people involved in production and consumption practices.

3Ecologies develops and visualizes a conceptual model that incorporates human and non-human factors affecting the sustainability of an artefact at multiple points throughout its lifecycle(s). In this paper,

we present the conceptual model behind 3Ecologies, contextualized in relation to some other sustainability models and certain environmental and design theories. We have developed the model for our purposes as designers and researchers through an iterative sketching process on the basis of two inter-related diagrams. A design method for developing the conceptual model, diagrams and narratives have also been designed to communicate visually about sustainability to different audiences through product cases. Three applications of 3Ecologies are proposed, including an internet program, eco-labelling scheme, and museum installation. Finally, we discuss the implications of modelling sustainability in design research.

Modelling product sustainability

The production and consumption of durable and non-durable consumer goods, such as clothing, furniture, toys, appliances, cars, food and packaging, involves, for example, energy, chemicals, waste, etc. There are several existing ways to model sustainability factors. On the production side, for example, the 'triple bottom line'[0] accounts for environmental factors as part of financial metrics, and 'lifecycle assessment'[0] provides detailed information about environmental offsets and side-effects. Typically stemming from engineering, economics or environmental science, many such models either tend to take schematic forms, such as process chains, organizational maps or matrix audits, or very complex statistical graphs and quantitative mappings. Resulting abstraction and complexity can entail that their use is restricted to engineers and managers, with only limited accessibility to design, marketing and consumer interests.

Industry (and the design profession) is under increasing political directives and economic imperatives to consider environmental factors, and there is growing consumer and public demand for knowledge, choice and change. However, this is situated within a number of different understandings and approaches to sustainability. Much research is taking place within and, increasingly, across the natural and social sciences, economics, law and policy.[0] Previous techno-centric and managerialist approaches to sustainable development in countries such as Sweden are under critique for a lack of social, cultural and political reflexivity (for some discussion of this, see Bradley, 2009). A range of contemporary theories attempt to integrate perspectives from multiple disciplines in order to understand what might be termed 'ecological complexity', taking into account issues such as 'resilience' and 'panarchy' from ecology,[0] 'emergence' from biology, and 'becoming' and 'futurity' from philosophy.[0] In product development, designers are in need of conceptual models and practical methods for relating to these issues – for engaging in necessarily complex and multi-disciplinary ways to think and act.

[0] "The Triple Bottom Line (TBL) Innovation Audit Tool should assist corporations in the development of new business ideas aiming at achievement of significant triple-bottom-line improvements (social, economic and ecological improvements)" (Tukker and Tischner, 2006: 442).

[0] Examples include the SimaPro software (http://www.pre.nl) and, specific to the textile industry, the Eco-Metrics Calculator (http://www.ecotextile.com/ecometrics).

[0] An example is the setup and research program of the Stockholm Resilience Centre, a "transdisciplinary research for governance of social-ecological systems" (http://www.stockholmresilience.org).

[0] The cross-scale and dynamic nature of the concepts and diagrams developed in 3Ecologies, in combination with the emphasis on and acknowledgement of uncertainty, relate to notions of 'panarchy'. Lance Holling and C.S. Gunderson coined the term, drawing "upon the Greek god Pan to capture an image of unpredictable change and upon notions of hierarchies across scales to represent structures that sustain experiments, test results, and allow adaptive evolution" (2002: 5). The essence of panarchy is to rationalize the interplay between change and persistence, the predictable and unpredictable. The notion of panarchy belongs to three dimensions: *potential* (limits of change), *connectedness* (degree of internal control over variability) and *resilience* (vulnerability to change). The latter dimension addresses the accidental and random aspects (potentiality) visualized and integrated throughout our project. In this sense, 3Ecologies not only addresses scales that move from the micro to the macro traced through the human – retaining a human-centred perspective while remaining in dialogue with unpredictable elements that constitute the sources of constant transformations. For a relevant related argument, see also Ernstson, 2008.

[0] "Futurity is not amenable to exact prediction" writes Elizabeth Grosz (1999: 21). It is this approach to 'the future' that we adopt in this project, in which randomness and chance are constituent phenomena of the processes of becoming. We understand, however, that the exercise of 'prediction' might incorporate useful diagramming towards visions for an open-ended future, and a better understanding of the 'potentialities' ahead. For discussion of relevant theories see Avila, forthcoming 2012 and Mazé, 2007.

As design research, the project[0] has focused less on the application of theory to product development than on the development of design methodology and materiality as a basis for querying and engaging with theories of sustainable development and ecological complexity.[0] Recognizing multiple and potentially conflicting logics intersecting in sustainable design, we approach this as an 'essentially contestable concept' (c.f. Guy and Farmer, 2001), and theories of sustainability, as well as sustainability factors in design, as necessarily open to renegotiation. Thus, we understand the role of design research as developing a critical discourse in which alternative ways of thinking and modelling sustainability can be materialized and debated.

3Ecologies

The conceptual model behind 3Ecologies embodies and communicates a particular approach to ecological complexity, based on principles set out in Felix Guattari's book *The Three Ecologies* (2008 [1989]). We have adopted this as a conceptual framework in order to "be able to apprehend the world through the interchangeable lenses or points of view of the three ecologies" (Guattari, 2008: 28), and to challenge and extend conventional 'triple bottom line' and 'lifecycle assessment' models.

Guattari sketches an ecosophy,[0] which is composed of three ecologies (or ecological registers) – a psychological ecology, a social ecology and an environmental ecology – which are each constantly present and in relation to the other. The 'triple bottom line' also considers three factors: economic, environmental and social. In our view, placing economy as a separate category obscures the individual dimension, social construction and situated nature of economics. Economy is crucial as a standard measure of ecological conditions and of exchange within society – but is bound into particular forms of social interactions, human values and material contexts. The alternative and explicitly human-centred model that we explore, following Guattari, considers economy as an underlying principle and identifies three factors understood to be in constant relation over time. Sustainability, thus, is understood as a continual negotiation, an ongoing achievement produced by, and with consequences for, human and nonhuman actors. .

Our 3Ecologies project develops this model in conjunction with a second, lifecycle model, in which relations among three ecologies are mapped over the time and space of product lifecycle(s) (Box 1).

Box 1: The two models constituting the conceptual model developed in 3Ecologies

- Three ecologies: A conceptual model that articulates the inter-relations among three sets of factors determining the sustainability of consumer products – psychological, sociological, and environmental (see Fig. 1)
- Product lifecycle(s): Based on the cyclical model typical in 'lifecycle assessment', a model which extends beyond product lifespan (purchase, use and disposal) to consider phases and factors before, after and ongoing (see Fig. 1)

[0] 3Ecologies is a design research response to rapidly growing interest in and demand for information about the ecological costs and consequences of products – and to the gap in the set of available methods for visualizing and communicating sustainability factors and actionable choices to designers and consumers. It is an ongoing project involving a media artist, a product designer and an interaction designer, funded through a research grant, an artistic commission and doctoral studies.

[0] Here, we make a distinction between research *for* design and research *through* design, c.f. Frayling, 1993-4. This approach might also be understood as 'critical practice', c.f. Mazé and Redström, 2009.

[0] The notion of ecosophy has been criticized by Tomás Maldonado (1999: 26-31), who highlights the dangers of a science that encompasses all others. Maldonado's attack particularly addressed Arne Naess' conception of ecosophy. "Ecosophy T" (Naess 2001) is a result of the development of the so-called 'deep ecology' that has been put in contrast to the shallow ecology of environmentalists seeking "compatibilities". Maldonado considers deep ecology "fundamentalist", with a risk of embracing spirituality and emptying the operative content and credibility of other forms of environmentalism included in the shallow ecologies. Without going into the particulars of this debate, it is important to emphasize that our adaptation of Guattari's ecosophy is intended as a form of ecophilosophy (see Naess 2001: 35), in which ecophilosophy does not make a choice between fundamental value priorities, but seeks to examine and articulate a particular kind of problem. Guattari himself was aware of this risk (2008: 34), which we address in the Discussion section of this paper.

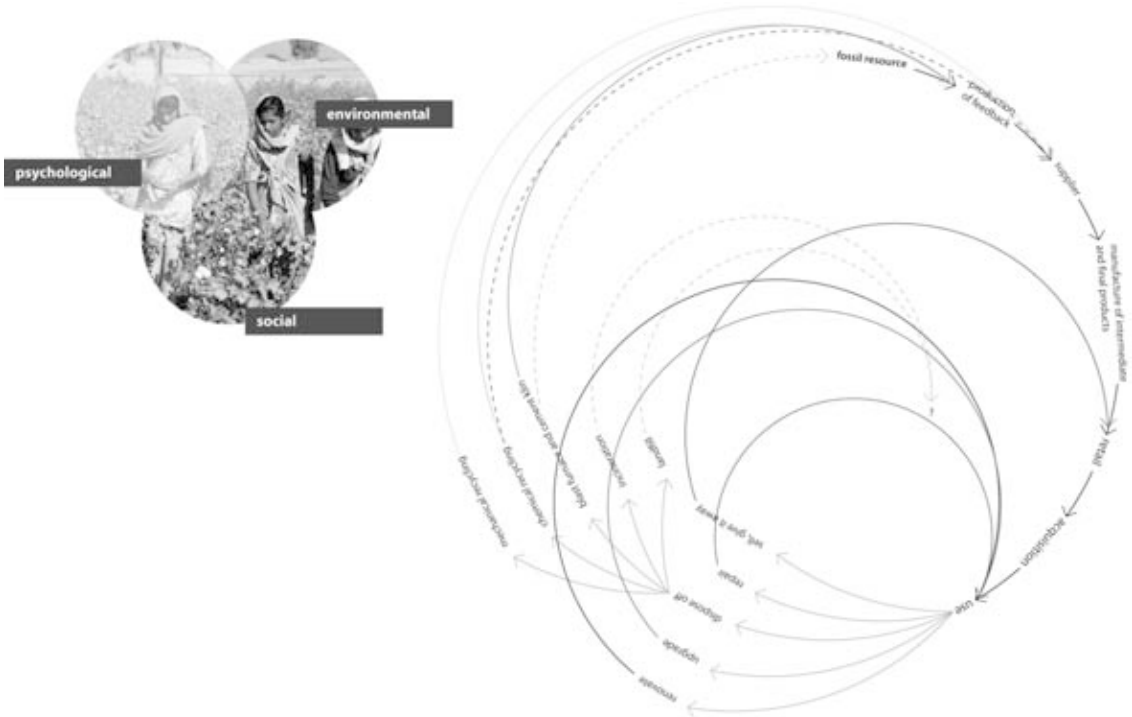

Figure 1: An example of the three ecologies diagram (left) and product lifecycle(s) diagram (right). The background image used in the diagram at the left and the lifecycle phases in the diagram at the right illustrate the product case (a cotton T-Shirt) described in this paper.

Particular concepts that have been of concern to us are discussed below, along with an account of the process and methods that we have used to elaborate these in visual (diagrammatic and narrative) forms.

Diagramming ecologies and lifecycle(s)

The project has been developed through a methodology of generating and iterating visual representations of the two models, focusing on relations among the three ecologies throughout product lifecycle(s) over time. Our initial focus was the lifecycle model, on the trajectory of a product from material sources and natural resources, through manufacture and product production, transport and distribution, wholesale and retail, acquisition and consumption, to the various options for disposal (see Fig. 1). At each phase in the lifecycle, we investigated the impact of the three ecologies, considered in relation to one another and across phases. We also identified key points where relations altered significantly and where options for human actors and social groups might be articulated (see Fig. 2). Disposal, for example, might diverge into different trajectories, depending on choices made to recycle, repair, reuse, resell, gift, etc., each with different potential impacts on the overall sustainability of a product from a vantage point in the future.

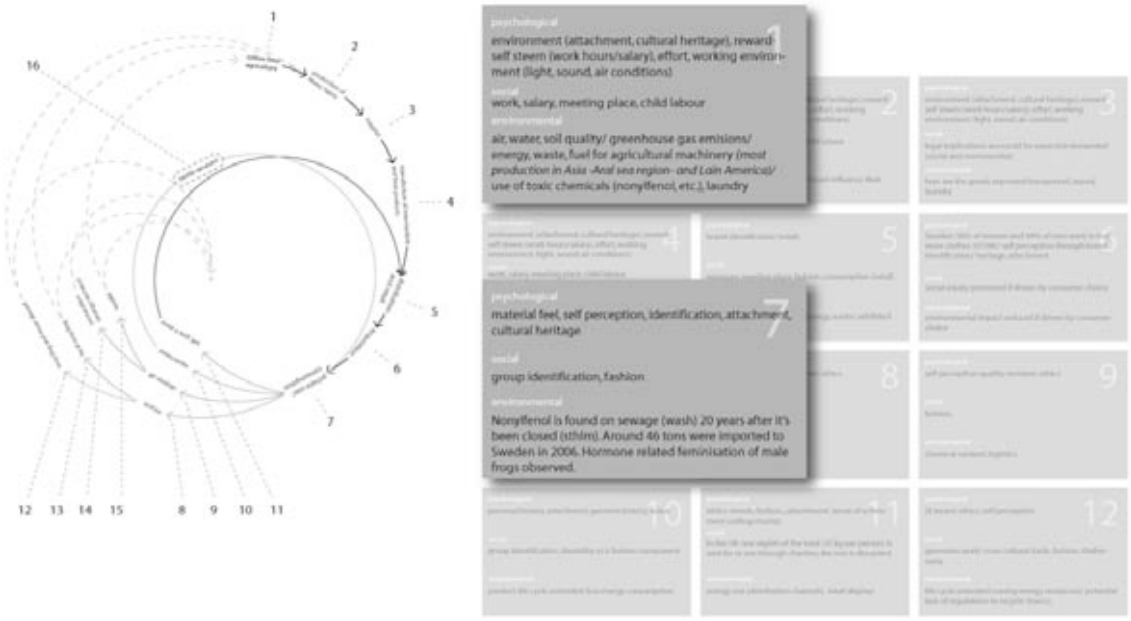

Figure 2: The lifecycle diagram divided into 16 phases or key points. Agriculture and private use are highlighted (points 1 and 7, inset detail), which illustrates how the tripartite ecological reasoning has been analyzed for each point.

Practically, this conceptual development took a diagrammatic form. By 'diagram', we refer to a set of visual techniques with a long history in architecture and design, ranging from maps and plans to experimental notations of geography, socio-cultural dynamics and scales of time-space (c.f. van Berkel and Bos, 1998; de Zegher and Wigley, 2003; Allen, 1999). In terms of our theoretical orientation, diagrams allow us to express how the uncertain aspects inherent in ecological complexity might appear, when new or unexpected factors emerge and what potentials this holds for the ongoing negotiation of sustainability.[0] For our practical purposes, diagrams also acted as a bridging device between abstract models of ecological complexity and particular, logical structures that could be scaled to instances at the human or product scale. Diagrams acted as both a concept and a method for appropriating schematic techniques from mainstream sustainability into a language and materiality of design.

(Fore)telling product stories

While most sustainability models tend to focus on the past life of a product, based on scientific variables that can be isolated and measured, 3Ecologies takes ongoing and future use into consideration. Indeed, the product lifecycle(s) model explicitly extends after production and well into consumption, beyond point-of-purchase within the primary market economy (an isolated moment in space and time typically the basis for statistics about 'green consumption') and into secondary- and tertiary-markets of product (mis/re)use, (up/re)cycling, etc. (c.f. Dobers and Strannegård, 2005; Margolin, 1995; Bell, 2003). Furthermore, one of the most important implications of our model is the divergence among possible options and choices located along the lifecycle trajectory (see Fig. 4).

[0] Succinctly, one could say that thinking diagrammatically implies a view that highlights the actualization of a process in connection with an environment (see DeLanda, M. "Deleuze, Diagrams and the Open-Ended Becoming of the World" in Grosz, 1999). Elizabeth Grosz argues that "Becoming is what immerses both matter and information: it is for this reason that temporal modelling, though not prediction, is as possible in social and cultural activities as in ethnology, biology, physics or genetics. This is made abundantly clear in the ways in which information, in virtual space, in computing programs of various kinds, exhibits emergent properties even though it is difficult to ascertain exactly what their mode of materiality consists in." (1999: 24). In this sense, the process of designing has in-formed our design.

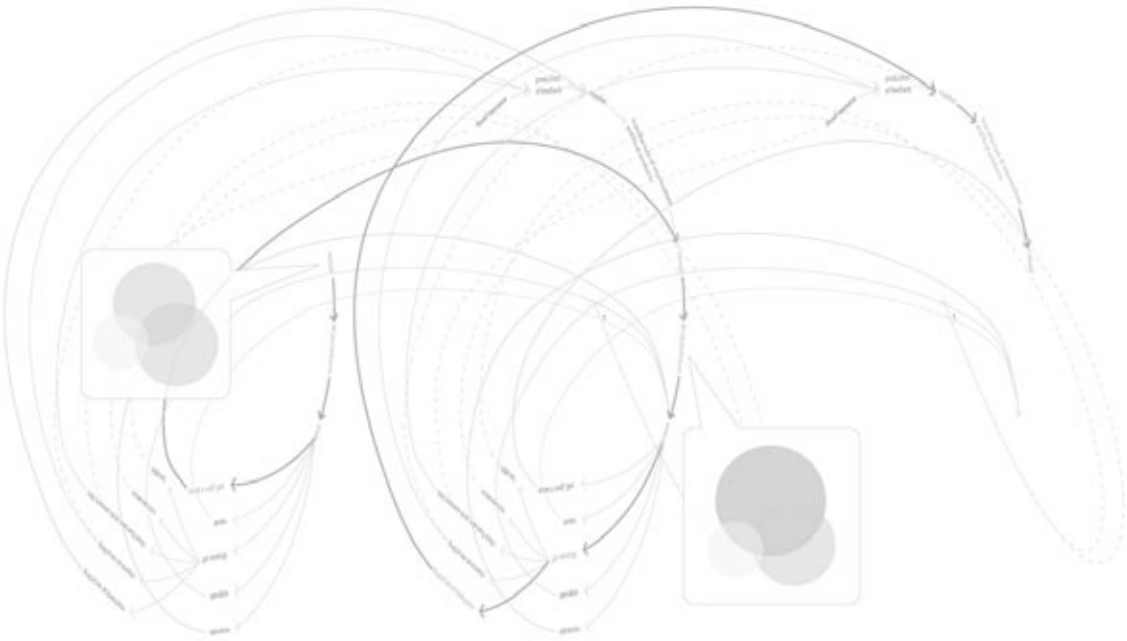

Figure 3: This diagram illustrates how we moved from a cyclical to a spiral logic, and how this can be used to trace one (of several potential) trajectory through the lifecycle(s) of a particular product, over time and across multiple spaces. The three ecologies appear as overlapping circles (inset details), which visualize the influence of each ecology relative to the others at key points in the space-time of the product lifecycle(s).

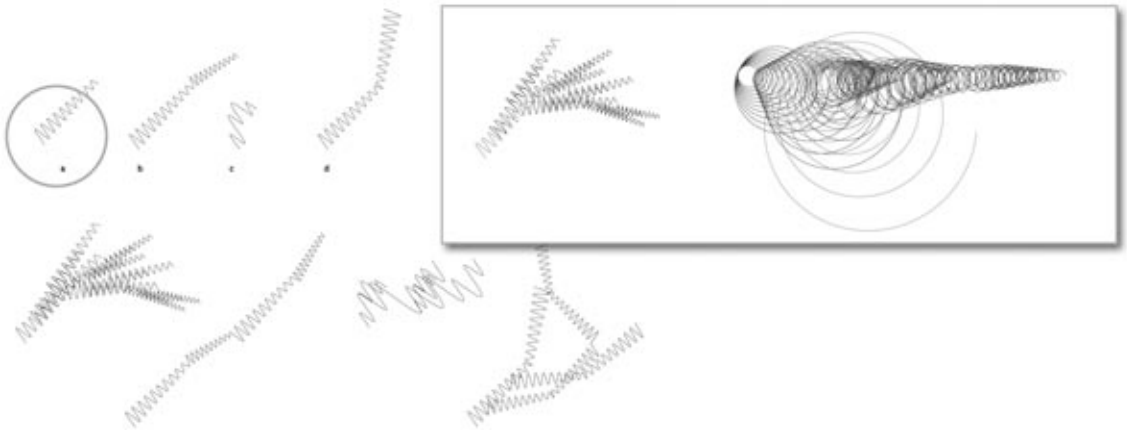

Figure 4: Sketches investigating formations that express divergence at key points of interaction among three ecologies and/or at key points along product lifecyle(s).

3Ecologies investigates and integrates the impact of such potentialities. Thus, at each key point along product lifecycle(s), the three registers (sociological, psychological and environmental) function in relation, or tension, to one another, reflecting an uncertainty, or opening onto multiple possible futures. These are projected, or forecast, and it has been important for us to articulate and elaborate the moment of divergence as a potential for making alternative choices or imagining unconventional possibilities beside mainstream production and consumption. Unlike traditional models, however, the qualitative and projective aspects of 3Ecologies means that we cannot rely on direct data and scientific metrics to the same extent – indeed, there are many questions about validity, probability and generalizability when it comes to including sociological and psychological factors typically excluded from other sustainability models.

Tactics that we have developed in response include narrative methods.[0] Indeed, methods for storytelling involving visual, verbal and textual elements have proved to be a powerful persuasive and pedagogical technique in the popular discourse around sustainable development.[0] However, there is often limited access to the data or instances behind arguments, and linear forms of presentation can entail difficulties in registering multiple and future effects of choices, which have been of particular interest for us. Narrative, for our purposes, is deployed as a means of evading (for technical as well as ideological purposes) the construction of a complete and comprehensive picture of the entirety of variables and possibilities. In 3Ecologies, investigation of narrative techniques has unfolded as a series of graphical and interactive sketches elaborating key points along lifecycle(s) over time, instances where 'hard' and 'soft' variables are made more explicit through projective, rather than predictive or quantitative, means.

Sketching methods for different kinds of narratives layered into our spatial-temporal diagrams, we also began to dig into the metrics behind the two models, and to develop how these would relate over time. Diagramming and storytelling evolved through sketches using the open-source visual programming language Processing,[0] which is built by and for artists and designers (examples include Fig. 8 and 9, which also show different points in our design development). At a certain point in our development process, we shifted focus from the use of the program for sketching to its ability to calculate and animate relations between the visual forms over time. This evolved as a shift from thinking not only in terms of information or data visualization, but to parametric and generative systems that might eventually be integrated. Our process progressed from developing the aesthetics of the system to the logics and structures behind, complemented by a new series of spatial-temporal diagrams (for example, figures 3, 5 and 8).

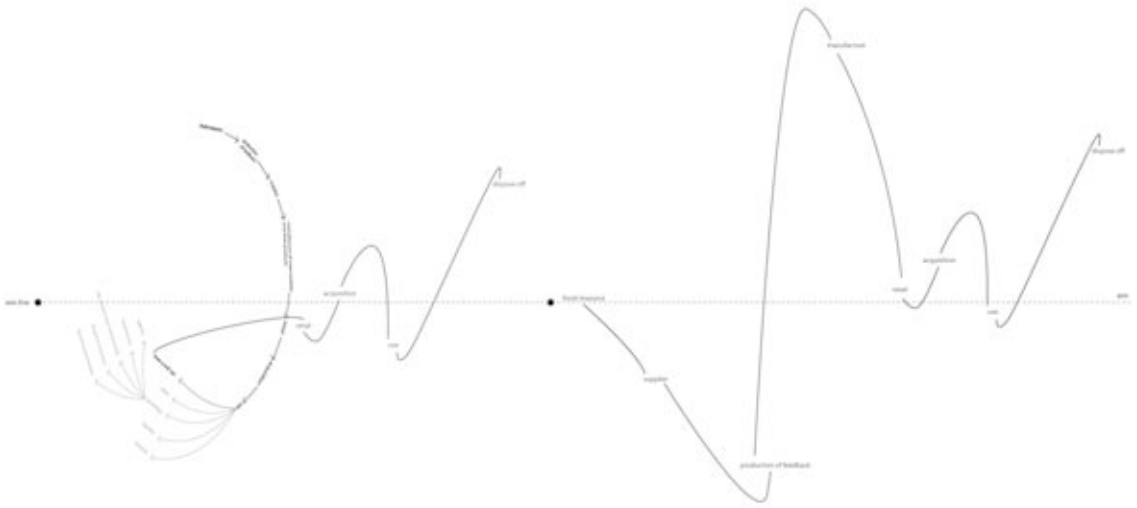

Figure 5: Depiction of spatial-temporal coordinates. The lifecycle(s) diagram is mapped not only as a progression through time, but a trajectory through multiple spaces through which a product travels for various durations over time. The incorporation of spatial-temporal metrics allows the diagram to be used for comparison among multiple alternative trajectories of the same product or of multiple different products.

[0] Guattari writes, "we can do no better than cite Walter Benjamin, condemning the reductionism that accompanies the primacy of information: 'When information supplants the old form, storytelling, and when it itself gives way to sensation, this double process reflects an imaginary degradation of experience. Each of these forms is in its own way an offshoot of storytelling. Storytelling… does not aim to convey the pure essence of a thing, like information or a report. It sinks the thing into the life of the storyteller, in order to bring it out of him again. Thus traces of the storyteller cling to the story the way the handprints of the potter cling to the clay vessel.' To bring into being other worlds beyond those of purely abstract information, to engender Universes of reference and existential Territories… these are the tangled paths of the tri-ecological vision" (2008: 44).

[0] For example, see "The Story of Stuff" (http://www.storyofstuff.com) and Al Gore's film "An Inconvenient Truth".

[0] See (http://www.processing.org) and Reas, C.E.B., and Fry, B., 2007. Potential relations can also be found in the literature around 'parametric design' and 'agent-based modelling'.

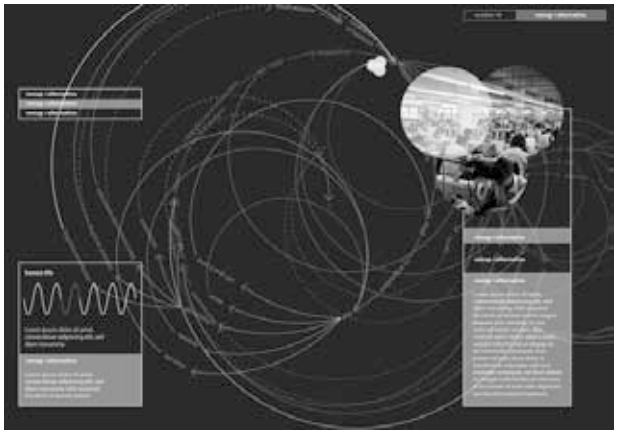

Figure 6: An early sketch of a narrative layered on top of the diagram. This illustrates ways in which the three ecologies can become animated and interactive through the presentation of different texts and images, located along the temporal and spatial coordinates of the lifecycle(s).

Product case: a cotton T-shirt

To develop and exemplify the conceptual model, we have been developing case studies of common consumer products, building on research conducted by various organizations in Sweden and elsewhere. Our first case is a cotton T-Shirt – traced through its lifecycle(s) over 12 years in China, the US and Africa. This product is of particular relevance given contemporary trends toward 'fast fashion', in which retailers rotate stock quickly, and fashion companies produce every more variety of increasingly disposable items. Exemplifying a few of the many choices that Swedish consumers had in 2008, a reported 56% of women and 44% of men want to buy more clothes than they did in 2007, and the major clothing product categories, both by value and mass, are trousers, pullovers and T-Shirts (Prevodnik, 2008). A T-Shirt, however, implies not only consideration of cotton quality, retail price and design brand – the aspects that producers mostly inform consumers about – but a range of other factors and actions, such as the choice (or not) to buy, and how to launder, care and dispose of clothes. Through the case of an ordinary cotton T-Shirt, 3Ecologies demonstrates another view upon ecological complexity, including an in-depth and long-term view upon choice and consequences.

Source: Prevodnik, 2008

> "Purchasing a 250g cotton T-shirt implies purchasing 1,700g of fossil fuel, depositing 450g of waste to landfill and emitting 4kg of CO2 into the atmosphere." .– quoted in the 3Ecologies narrative

Building on extensive research underway in this area globally and at Naturskyddsföreningen,[0] the product story diagrammed within 3Ecologies has been created consulting multiple sources. Newspaper articles and academic research from different parts of the world were collected to gather stories, views and conflicting situations in social and economic contexts. In developing a visual and written narrative around key points in the lifecycle(s) of T-Shirts, we have experimented with use- and product-centric methods for storytelling. For example, we developed scenarios based on the human actors, stories told from the product(s) point-of-view, and journalistic accounts combining these. The current narrative was created by combining real-life characters from journalistic sources, actual and fictional settings and situations, and scientific data about environmental factors of T-Shirts.

[0] Naturskyddsföreningen is the Swedish Association for the Conservation of Nature, see Prevodnik, A., 2008. Also Alwood, J. et al., 2006; Rivoli, 2005.

Figure 7: An example of a trajectory, from pre- to post-consumption stages, of a T-Shirt that 'travels' across China, the USA and Africa over a 12-year period. This illustration includes source materials compiled into the text and flow of our narrative. The overlapping circle diagram represents the relative impact of each of the three ecologies at each stage along the lifecycle(s) trajectory.

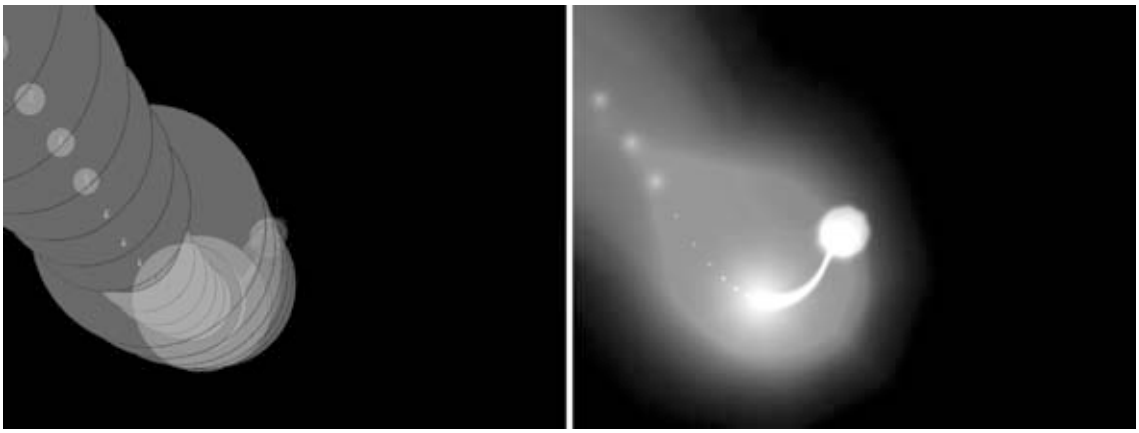

Figure 8: In the image (left), each circle represents one of the three ecologies (psychological, social or environmental). Each is assigned a diameter, based on values predefined within the narrative (Fig. 7). In this image, the overlapping circles are layered sequentially and projected through time-space. Rather than drawn as a line, this trajectory thus becomes a volume that varies in proportion based on the three ecologies values. The image (right) interprets the ecologies in terms of three colours of volumetric model. This creates a visual effect of the ecologies as 'incorporeal', made up of 'intensities' (defined by the diameters of the original circles), that, thus, affects the colours of the others and creates a visual effect of 'fuzziness' or 'diffuseness' which, we believe, relates to the nature of ecological complexity. The combination of the three colours (RGB) creates white, thus highlighting the idea of intensity and mutual influence.

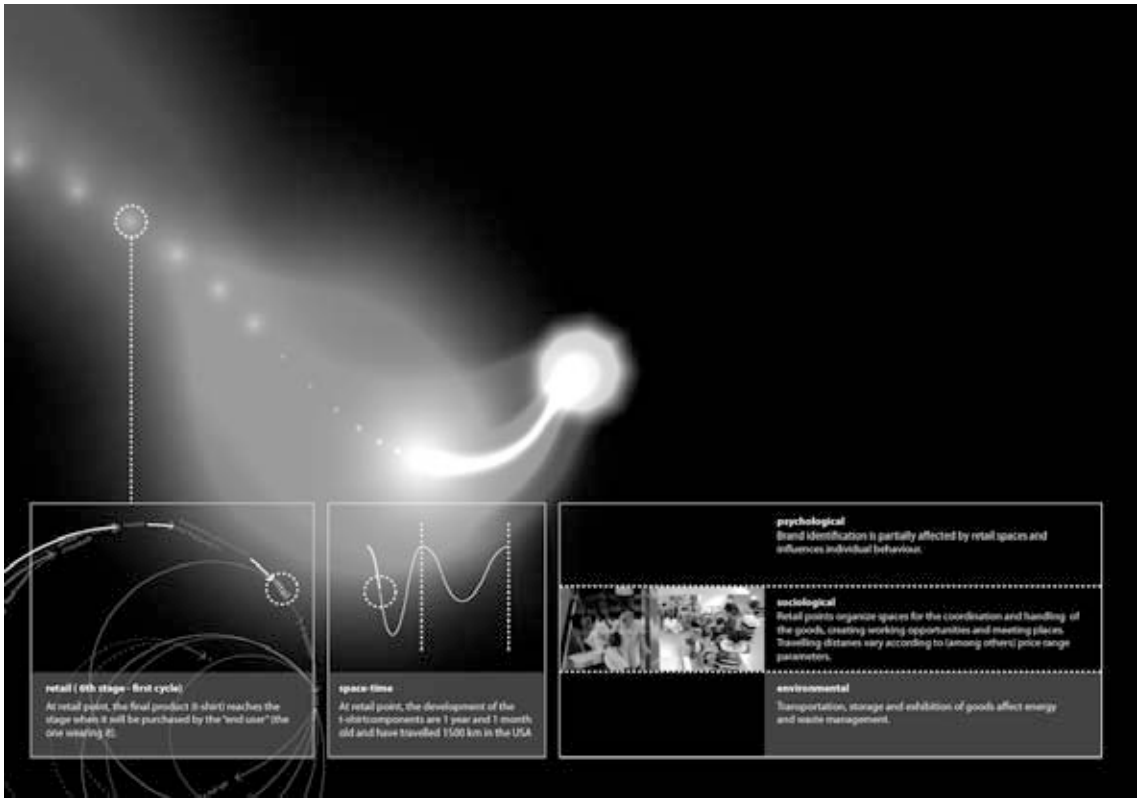

Figure 9: A recent visualization of the combined three ecologies and lifecycle(s) diagram for a cotton T-Shirt. The background image is generated and animated through Processing. Text and images provide a narrative and data at key points. An explanation of the tripartite ecological reasoning is attached onto each space-time position in the diagram.

Through this process of conceptual development and design-based inquiry, as applied to particular product cases, we have refined how we think about and express the models (Box 1, Fig. 1):

> • Three ecologies: Our focus is on the inter-relations between the ecologies, considering the conditions or circumstances of a product at specific moments of and over time.

We have not treated the ecologies as mutually-exclusive or self-contained categories, to which any absolute value might be assigned. This allows us to explore the ecological complexity and relativity of costs and benefits at stake – in the case of the T-Shirt, for example, of introducing genetic modification to Indian cotton and the effects on the well-being and practices of a traditional farmer, local ecosystem and other organisms, village life and national competitiveness, etc. In the visualization, we have expressed this in various ways. For example, the metrics behind the proportions of the circles have been treated as relative values, and the aesthetics of diffusion and intensity emphasize change in relation and over time. Through such means, attention is drawn to instances of interaction between the ecologies and events that cause the relations to be renegotiated.

> • Product lifecycle(s): We consider the extended lifecycle of products, including possibilities for more than one lifecyle and future.

While certain aspects of lifecyle diagrams can be generalized, our investigation of multiple options and divergent trajectories implies disparate, and perhaps unexpected, futures. This allows us to present sustainability at a human scale but also across multiple contexts and over long temporal scales – in the case of the T-Shirt, for example, includes the experience at point-of-purchase, the differences in consumer values, the choices involved in maintaining and disposing of the shirt, and the trans-local systems for distributing, renewing and valuing second-hand items. In the visualization, this is expressed through the pace and appearance of the model, as it is generated considering multiple variables in time-space, and punctuation with rich materials from real-world situations that bring the data to life in diverse places and times. Through the visual (and potentially interactive) aesthetics of the model, generated and narrated over time, product sustainability is expressed as an active and ongoing production within everyday life.

Possible applications

As we have continued to develop 3Ecologies, certain versions of the visual representations have been taken further. Visualization of the product case and three possible applications have been further developed to communicate with different audiences – communication of the general conceptual model to environmental agencies and the general public, for example, and of specific examples to demonstrate relevance for target industries, domain experts and designers. Three possible applications – which could also be seen as proposals for future work – are suggested below.

Open-source internet application

3Ecologies could be developed as a knowledge platform for and by the design community. Users could upload data about multiple products or product categories to a website (Fig 10), thereby generating visual models that could be compared, annotated and commented. Mechanisms for zooming, highlighting and editing could support navigation at multiple scales and viewing products through alternative lenses.

Figure 10: A visualization of the 3Ecologies model would be generated case-by-case by information about the events, occurrences and accidents in the life of a particular product. Examples of how this might appear include: (at left) visual comparisons of the same product produced and consumed differently, and; (at right) embedded details and data. .

Product labelling system

3Ecologies could take the form of a graphic system for (future) eco-labelling retail products. Options for consumers after point-of-purchase are presented via an attached tag (Fig. 11), through simple ‘what if’ scenarios and graphics, based on the colour-coding and visual proportions of the three ecologies.

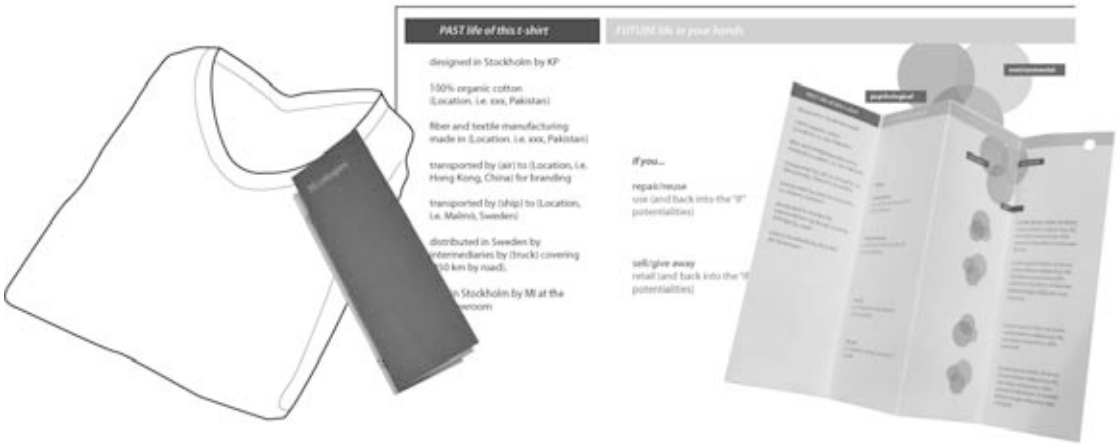

Figure 11: Supplementing existing eco-labelling schemes, this would focus on the future life of a product. Summarizing the past life of a product (text in black), the “FUTURE LIFE in your hands” (text in purple and green) communicates the consequences “If you...” throw away, recycle, give away, etc., the product in the future.

Interactive museum installation

3Ecologies could become a tool for the general public to ‘try on’ the consequences of their choices. An audio-visual animation (Fig. 12), populated with rich stories from documentary sources, is the context for a visitor to experience the history of a familiar product and to make decisions that enact possible futures. Decisions are made tangible through hands-on or full-body interaction techniques.

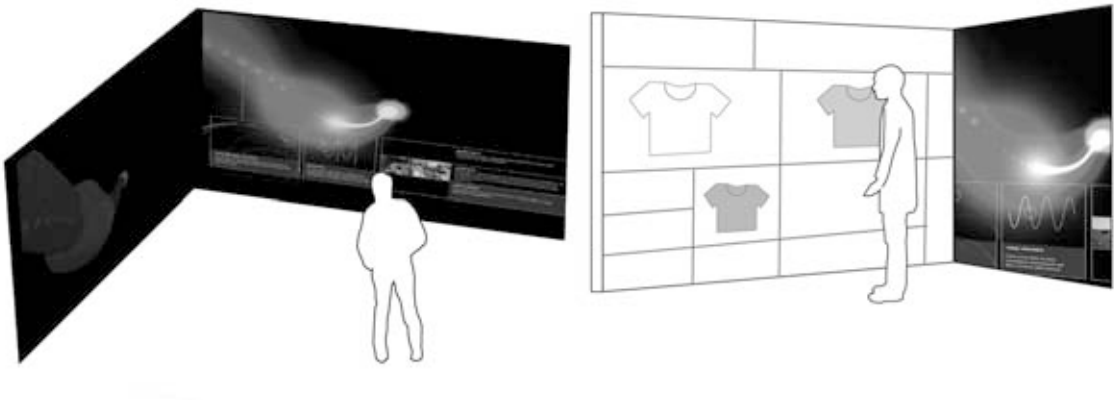

Figure 12: As a stand-alone installation or as a supplement to products already featured in a design/architectural exhibition, this would be an immersive experience for hands-on engagement with ecological thinking in action. It could also be an arena for developing low-energy display technologies and mechanisms for visitor interaction with digital materials.

Discussion

In relation to current models, 3Ecologies challenges the reduction of sustainability to statistical data that is often solely based on environmental aspects of material origins and offsets. Instead, qualitative aspects are visualized and potential futures are forecast. Following Guattari’s conception, and in contrast to other existing models, this is a human-centred model that explicitly emphasizes the individual dimension, social construction and situated nature of ecological costs and benefits. This allows us to consider additional and other factors than those typically in focus, such as the social conditions and contingencies of product use, gender, culture and class dimensions of environmentalism, ethical and equity issues in globalized production and consumption.

The diagrammatic and narrative versions of the conceptual models open for ways of communicating, learning and debating sustainability that are often left out of scientific and economic discourses. By accounting for the influence of multiple factors, including those at an individual human and societal level, our aim is to open up for discussing the values, interests, conditions and circumstances involved in sus-

tainability. Indeed, we have explicitly explored accidental futures and unexpected (mis/re-)uses of products, which reflect the potentials of personal agency, (sub)cultural interpretations and localized appropriations. Rather than 'prediction', this can be seen as a sort of projective activity that helps us to better understand, imagine and anticipate possible future effects of the things that we design. By highlighting key decision and action points – and developing ways to communicate these – our ambition is to foster increased self-reflexivity and empowered choices among designers and consumers.

Holistic in its conception, 3Ecologies does not claim that such modelling, regardless of how it might grow in complexity and interrelations, could or should account for 'a whole', much less 'the whole'. This reflects our theoretical orientation, as articulated by Guattari:

> One might object that large-scale struggles are not necessarily in sync with ecological praxis and the micropolitics of desire, but that's the point: it is important not to homogenize various levels of practice or to make connections between them under some transcendental supervision, but instead to engage them in the processes of heterogenesis (2008: 34).

As described above, this is an aim in the project – to engage people in exploring the models, in the form of visual diagrams and accessible narratives, product cases and data behind. By materializing the multiplicity of impacts produced by people's everyday and ongoing actions, our intention is to stimulate reflection on and change in how people might think and act. As designers and researchers, we are striving to produce conceptual models that can be understood as "tools for transversality",[0] to create conditions for ecologized thinking in all its fluidity and complexity.

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[0] For an explanation of Guattari's notion of transversality, see Genosko, G., "The life and work of Félix Guattari: From transversality to ecosophy," in Guattari, 2008: 46.

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